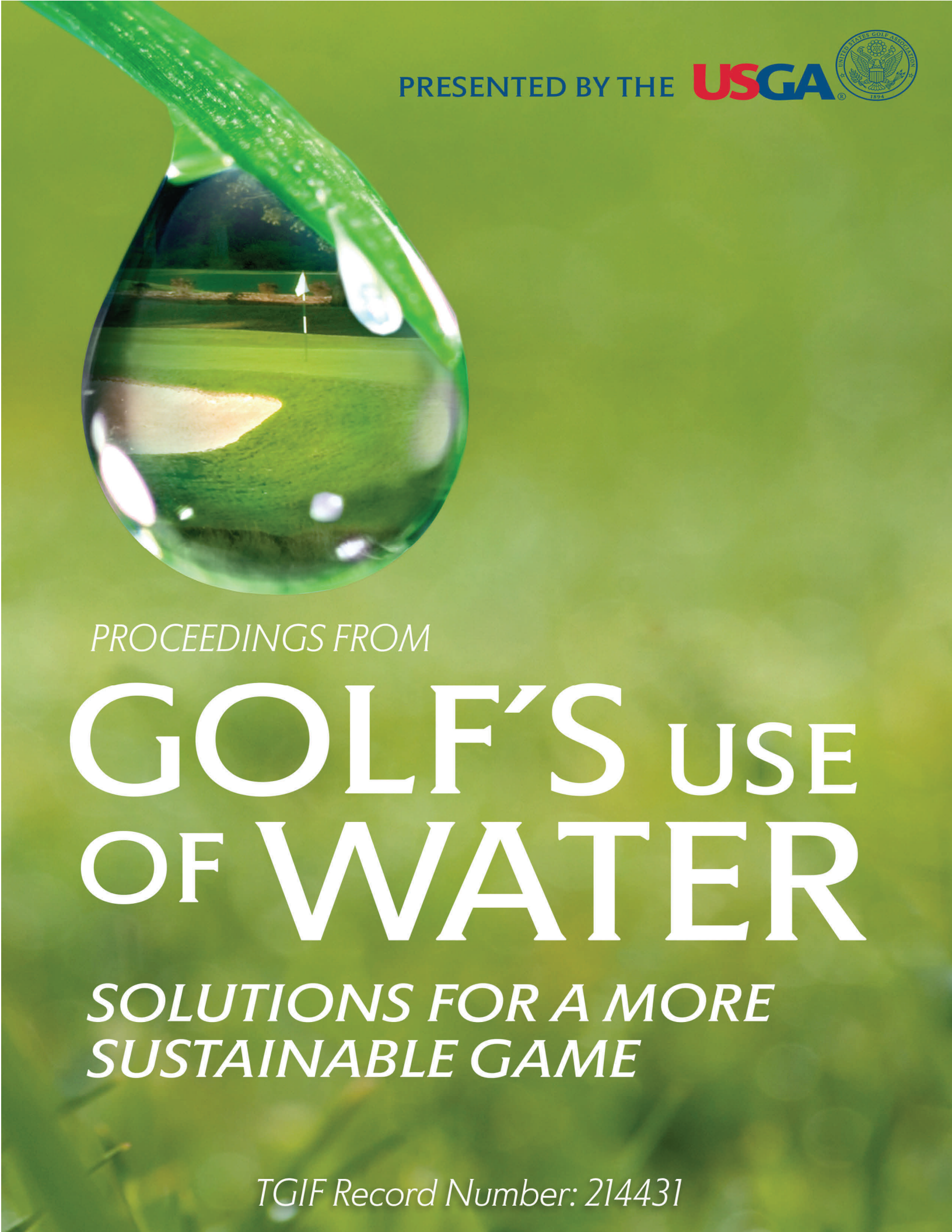

PRESENTED BY THE USGA

PROCEEDINGS FROM

GOLF'S USE OF WATER

SOLUTIONS FOR A MORE SUSTAINABLE GAME

TGIF Record Number: 214431

USGA Turfgrass and Environmental Research Online
Volume 11, Number 12. December 2012

Proceedings From

Golf's Use of Water: Solutions for a More Sustainable Game

PRESENTED BY THE USGA

Hilton DFW Lakes Executive Conference Center
Dallas, Texas
November 6 and 7, 2012

Golf's Use of Water: Solutions for a More Sustainable Game brought together experts from government, business, academia and golf to identify and discuss the most challenging issues regarding golf's use of water. With communities continually working to provide sufficient quantities of safe drinking water, it is understandable that water use for recreational purposes is heavily scrutinized. While golf courses contribute to communities by provide green space, positive economic impact and recreation for those who play the game, it also is true that golf course irrigation is a necessary component of their management. It is the responsibility of golf's leadership to ensure that our most valuable natural resource is used in the most forward –thinking, responsible manner.

Meeting Organized by
Jim Moore
Kimberly Erusha
Kay Moore

Proceedings Edited by
Ali Harivandi
Paul Brown
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Contents

ABOUT THE USGA

The USGA conducts the U.S. Open, U.S. Women´s Open and U.S. Senior Open, as well as 10 national amateur championships, two state team championships and international matches. Together with The R&A, the USGA governs the game worldwide, jointly administering the Rules of Golf, Rules of Amateur Status, equipment standards, and World Amateur Golf Rankings. The USGA's working jurisdiction comprises the United States, its territories, and Mexico.

The USGA is a global leader in the development and support of sustainable golf course management practices. It serves as a primary steward for the game´s history, and funds an ongoing "For the Good of the Game" grants program. Additionally, the USGA´s Course Rating and Handicap systems are used on six continents in more than 50 countries.

Our Mission

Who We Are

Golf´s governing body that is passionate about, dedicated to and expert in the game of golf.

Who We Serve

Everyone who loves and respects the game of golf.

Our promise based on a shared love and respect for golf, we preserve its past, foster its future and champion its best interests for everyone who enjoys the game.

USGA's Environmental Commitment

The USGA will work to make the game more sustainable through research, education, and a commitment to protecting the environment.

Golf, perhaps more than any other sport, is dependent upon a healthy environment. As the national governing body for golf in the United States, the USGA recognizes the importance of taking proactive steps to minimize our environmental footprint and integrate environmental considerations into all aspects of our activities.

To further our priority as a responsible citizen, the USGA will continue a rigorous evaluation of our consumption of natural resources and energy use, the integration of new technologies, and changes in behavior. Decisions concerning environmentally-responsible practices must be economically sound and maintain a healthy balance between established management systems and environmental sustainability. race environmentally responsible technology that it is fiscally sound.

To realize our commitment to the environment, the USGA will:

- Develop a comprehensive environmental management plan for the Association that proactively promotes awareness and protection of the environment.
- Train and educate staff to consider and incorporate environmentally-sound principles and practices into daily business decisions and operations.
- Embrace environmentally responsible technology that it is fiscally sound.
- Conduct championships in an environmentally-responsible manner given the distinct and local challenges of each event.
- Measure environmental responsibility with the goal of continuous improvement.
- Continue to support turfgrass and environmental research and focus research efforts on pesticide and nutrient fate, protection of water quality, and water conservation.
- Promote and encourage environmental responsibility among golfers, Member Clubs, allied associations, and vendors through education and support.

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WELCOME

Welcome to "Golf's Use of Water: Solutions for a More Sustainable Game." On behalf of the United States Golf Association, I would like to thank you for your participation in this summit dealing with one of the most important issues facing the game.

Water is an extraordinarily valuable resource, and the pressures on water supplies are increasing in many areas. The drought conditions experienced by much of the country over the past few years have further heightened the visibility of these conditions.

At the same time, golf course irrigation is a necessity, which means golf courses must use water in the most responsible manner possible. When done so, the game contributes not only to the enjoyment and well-being of participants, but also to the economic and environmental health of local communities.

In addition to helping courses adjust to their area's specific environmental conditions and challenges through the Turf Advisory Service, the USGA has invested in scientific research to develop grasses that require less water. Moving forward, we are committed to continuing to help courses efficiently utilize every drop of water that is available for irrigation.

Part of that mission is this summit, which has convened experts in water resource management, golf course management and scientific research. Working together, we can identify innovative solutions to preserve the game's sustainability.

While this summit hopefully will yield significant results, it is just a starting point. We hope that the cooperative spirit of this meeting will guide the industry to meet the challenges facing the game.

Thank you for participating in this effort, as well as for your support of the USGA as we work toward making the game of golf more sustainable for all.

Sincerely,

Mike Davis

For the good of the game®

Welcoming Remarks

Glen D. Nager, USGA President
Hilton DFW Lakes Executive Conference Center
Dallas, Texas
November 6, 2012

On behalf of the USGA, it is a pleasure to welcome you to this summit on the use and management of water in golf. We have gathered experts from various industries to present their thoughts about water, a subject that will gain in importance and urgency around the world in the years to come, not just for golf but for all of humanity.

The management of water already has come under intense scrutiny, when wide swaths of the country experienced severe drought conditions the past two years. For the golf industry, these crises have offered an opportunity to examine the role of water in the care and maintenance of golf courses.

As the governing body for golf in the United States, the USGA has been the leader in developing and promoting sustainable, environmentally friendly practices for golf courses. This mission dates back to 1920, when we created the Green Section. Over the years, we have fostered responsible turfgrass–maintenance practices and have consulted with thousands of courses to implement these techniques.

In addition to extensive education efforts, we have provided more than $40 million in research grants since 1983, which has resulted in the development of dozens of turfgrass varieties that contribute to golf´s sustainability because they are more resistant to heat, require less water or need fewer inputs.

Moving forward, the USGA will continue to support research, education and awareness at increased levels of funding. Our role in leading the industry toward increased sustainability is of paramount importance, and our commitment to achieving this goal is absolute.

We realize that the stakes are higher than ever, as golf faces increasingly complex and broad challenges: environmental and climate pressures, tough economic conditions, the time commitment required to play the game, the perception that golf is intimidating and unwelcoming.

We are taking action on all these fronts, and all have an impact on water use. It is impossible to maintain a golf course without water, and the industry increasingly is realizing that this invaluable resource needs to be managed responsibly, efficiently and sustainably.

Golf courses – whether public or private – are no longer just green spaces that provide recreation and refuge, operating more or less within its borders. Increasingly, the impact of golf courses on the surrounding areas is widening. Golf courses, especially in the consumption and management of water, must fit within the community´s ecosystem.

Over the next day and a half, we will hear from many speakers about how golf and the finite supply of water can co–exist in this shifting paradigm. In addition to hearing about the overall state of the supply of water – both in this country and around the world – as well as golf's place in this landscape, I am eager to learn about the creative ways the industry is handling the challenges.

As we move forward – both over the next two days and over the next few decades – I also want to remind everyone of the ultimate goal of our sustainability efforts. We are working together to make the game better for people like me.

I am not a scientist. I am not a legislator or regulator. I am neither a developer nor course owner. I am not an architect. I am not a superintendent. I am a golfer. There are millions of us around the world who enjoy the game because it provides enjoyment, exercise, competition and camaraderie. And we have a powerful voice when it comes to sustainability because we have a choice about where to play.

For too long, we have chosen courses that are longer, take up more space and are characterized by lush conditioning – courses that require plenty of resources, including water. These courses are less fun, take longer and cost more to play. This is a model that simply cannot continue to exist.

At the same time as we change the model for golf courses, we also must reset of ex–pectations of recreational golfers so they embrace these courses, which are shorter, more efficiently maintained, more affordable – and ultimately more fun.

Through an ongoing initiative called TEE IT FORWARD, we have demonstrated that playing from a shorter set of tees results in a more enjoyable, faster, more rewarding golf experience. We are embarking on a distance study that seeks to quantify how ad–ditional yardage and increased acreage add to a course's construction and mainte–nance costs.

By far, the USGA's biggest and most influential activity is the U.S. Open. And at our national championship over the next few years, we are excited to prove that increased distance, a larger footprint and immaculate conditioning are not requirements for first–class golf.

Next year, we will return to historic Merion Golf Club outside Philadelphia. Merion is squeezed onto just 120 acres and is the course that the U.S. Open supposedly outgrew. It gives us the opportunity to demonstrate that if the U.S. Open can thrive on a signifi–

cantly smaller footprint, so can the majority of golf courses in the United States. At Merion, we are prepared to make certain adjustments such as selling fewer tickets. Similarly, we should encourage golfers to adjust their expectations and embrace layouts and conditions that are playable, challenging, fun – and more sustainable.

The following year, we are very excited to show the world the new Pinehurst No. 2 in North Carolina when it hosts the back-to-back U.S. Open and U.S. Women's Open. Tomorrow, Bob Farren will talk in depth about how the restoration by Bill Coore and Ben Crenshaw significantly reduced irrigation. And in June 2014, golfers everywhere will be surprised when they see that a championship course doesn't need to be wall-to-wall green.

In 2015, we are taking the U.S. Open to the Pacific Northwest for the first time. Washington's Chambers Bay is a 100-percent fine-fescue layout that uses much less water and fertilizer than most courses, while promoting the firm, fast turf that we believe makes for great playing conditions. In addition, Chambers Bay's visuals – the various shades of green and brown – will show that the focus should be on how a golf course plays, not how it looks.

With events like the U.S. Open and this summit, the USGA is taking substantive steps to move the golf industry toward a healthier, sustainable future. We understand that water management and sustainability are long-term issues, and the path forward won't be easy.

But with the help of the speakers and the people in this room, we can formulate a road map that will guide us through the challenges facing the game – today and tomorrow. I hope that years from now, we can look back at this gathering as a significant milestone on the path toward sustainability.

I have nothing but the utmost respect for all your work, and I applaud your achievements and expertise in your respective fields. I hope you find the next two days to be immensely rewarding, and I would like to recognize the efforts of Dr. Kimberly Erusha, the managing director of the USGA Green Section, and Jim Moore, the Green Section's director of education, in putting this summit together.

As president of the USGA, I am proud to have dedicated men and women like Kimberly, Jim and our agronomists and experts – some of whom will be speaking here – on our staff, working toward fulfilling our core mission of sustaining the game for all.

Thank you for attending, and thank you for all your substantive contributions to the game of golf and the USGA.

For the good of the game®

Federal Perspectives on Water Use and Golf

Veronica Blette, WaterSense Program
US Environmental Protection Agency

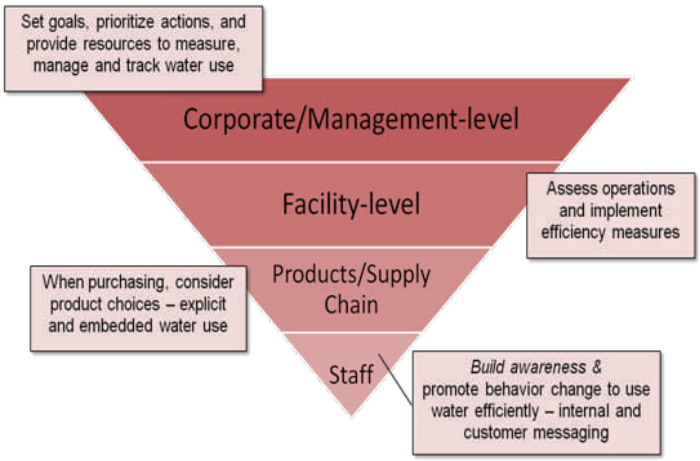
This article summarizes how the EPA, other federal agencies and businesses are looking at potential risks associated with water shortages and lack of access to clean and safe supplies of water. The WaterSense program will be described, as well as, the efforts to promote more efficient use of water and how the golf industry might address this challenge above and beyond its current efforts.

Water sustains life. It also sustains our economy and our well–being. How is this relevant to the golf industry? Course vegetation dies without access to water. Golf is an economic driver in many communities and the associated industry employs thousands throughout its supply chain. And although no golfer wants to get a bogey, playing golf contributes to the well–being of players around the country.

But our ability to have a safe and reliable supply of water – where we need it, when we need it – is at risk. While our water quality has improved since the Clean Water Act was passed 40 years ago, significant challenges remain in improving and ensuring water quality. Our drinking water and wastewater infrastructure is aging and needs billions in funding to rehabilitate and replace. Water supplies are challenged by competition for the resources required to meet the needs of a growing and shifting population. Layered on these are the challenges posed by climate change. This will lead to too much water in some regions which will only exacerbate stormwater management problems and flooding. In other regions, the problem will be not enough water, as we´ve experienced through the drought that affected much of the country during the last two years. Because water is a cross–cutting issue, water shortages can impact multiple sectors and thus we can expect competition for water between municipalities, agriculture, and energy to be significant in some areas.

Over the past several years, business has directed more attention to sustainability, with a strong focus on energy efficiency. Businesses are now recognizing the value of water and are focusing on identifying and addressing water–related risks that could affect their direct business operations and supply chains. The

Figure 1. Using water more efficiently requires action in every part of an organization.



World Business Council for Sustainable Development recently released version 3 of *Water for Business* (1), a guide that provides useful information on many tools and initiatives that can guide business water management activities. The document highlights the importance of having an adaptive management plan which includes assessing the local situation, accounting for water use, identifying risks and opportunities, monitoring and communicating performance, and regularly revisiting and reassessing progress to allow for improvement.

Golf as a business must likewise focus on how it could be affected by access to reliable supplies of water. Course managers should assess their vulnerability to water resource scarcity and undertake measures to minimize their risk, whether it be related to water quantity, quality, or reputation. These measures

can help enhance the resiliency of the business to water shortages caused by drought or other interruptions in service.

In 2011, the Council of Environmental Quality released a National Action Plan which described priority response actions for freshwater management in a changing climate. One of the recommendations was to expand water use efficiency by, for example, identifying and sharing best practices. The federal government has a number of activities underway that are aimed at improving water use efficiency. While not explicitly focused on the golf industry, many of the activities will support water efficiency in the sector. The U.S. Department of Agriculture has a variety of efforts from supporting agricultural irrigation improvements to research to identifying turfgrass that requires less water. The Department of Energy is looking at research to reduce the water use associated with different energy sources and on regional planning frameworks to help assess future siting of power generation in light of potential climate change impacts on water resources and competing demands for water.

The Army has a number of initiatives that are working to reduce water use and minimize their water "bootprint", including an initiative focused on promoting net zero energy/waste/water at a number of installations. In carrying out water balances on installations, they are finding that golf course irrigation with potable water can be significant and are thus looking to reduce water use through efficient irrigation and appropriate use of alternative supplies such as reclaimed water.

Through the Department of Interior's WaterSmart program (www.usbr.gov/watersmart), the Bureau of Reclamation is providing grants for water efficiency projects and municipal reuse and reclamation projects, some of which may support irrigation with reclaimed water. The U.S. Geological Survey is carrying out a Water Census to assess water use and availability. As part of that effort they are supporting work to evaluate use of remote sensing to assess evapotranspiration from landscapes.

Finally, the U.S. Environmental Protection Agency's WaterSense program develops specifications for water–efficient products and provides guidance and information to promote more efficient use of water. In 2011, WaterSense released a specification to label weather–based irrigation controllers which can be used for golf course applications. The program also recently released a set of best management practices to help the commercial and institutional sector improve their water efficiency.

There is no question that water is necessary to maintain the field of play on golf courses. And many golf course superintendents are already focused on measuring and reducing their water use by improving the efficiency of water application through technology, using more water–efficient plantings, and changing maintenance practices. Their strong efforts can and should be promoted throughout the industry. But there are many other uses of water at golf facilities where managers can and should work to maximize efficiency – from the bathrooms in the clubhouse, to the kitchen equipment in food service areas, to pool maintenance for country clubs, to the landscaping that is adjacent to the course or in related housing developments. By demonstrating and communicating efficient water practices in all other parts of the facility, management can show that it acknowledges concerns about water and is working to be as efficient as possible while also providing services to customers.

Figure 2. Hand–watering a putting green on a golf course to apply water only where it is needed.

Golf courses can be beautiful, provide habitat for wildlife and enjoyment for citizens. But one challenge is that when golfers go home, they want their own yards to approximate what they left on the course – which is not very sustainable in many parts of the country from a quantity or quality perspective. In the early 1900's, a USGA summit highlighted demonstration turf gardens which admittedly were focused on helping managers identify the cultivars and maintenance practices that would work best in their location. It strikes me that courses, public and private, can show leadership today by providing demonstration gardens that show guests and community members how they can design and maintain landscapes that use native vegetation and less water, pesticides and fertilizers. Golf industry professionals have the knowledge and skills to work with their local water utilities and gardening groups to promote more sustainable landscapes and, in doing so, would demonstrate their commitment to the health, economy and well–being of their local community.

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Disclaimer

The views expressed in this paper are those of the individual author and do not necessarily reflect the views and policies of the U.S. Environmental Protection Agency.

A National Perspective on Water Issues

Mary Ann Dickinson, President and CEO
Alliance for Water Efficiency

Water has emerged as a topic of constant discussion, but what is actually happening with water? Are we really in a water crisis? What are the issues facing local communities and by extension, golf course managers? This article will explore a few myths about water and make recommendations for positive action in the future.

In the midst of a looming water crisis, it is amazing the consumer perceptions that still persist. First, many consumers continue to believe that we have plenty of water (after all, isn´t that what the water utility always says? That they provide reliable service?). Second, many consumers mistakenly believe that tap water does not meet safe drinking water standards, and as a result bottled water sales have skyrocketed over the last decade. (The reverse is actually true – tap water meets more safe drinking water standards than bottled water does.) Third, consumers often complain about their water rates increasing, because they have little understanding of the true costs of providing them reliable water and sewer service. Finally, consumers do not want to be asked to conserve when they believe the golf course down the street is using so much water. These same consumers have no idea how much water they are actually applying on their own landscapes, and instead look at the golf course as the culprit. This is the political reality that water utilities – and golf course managers – have to deal with in the United States. Here are these water myths in more detail.

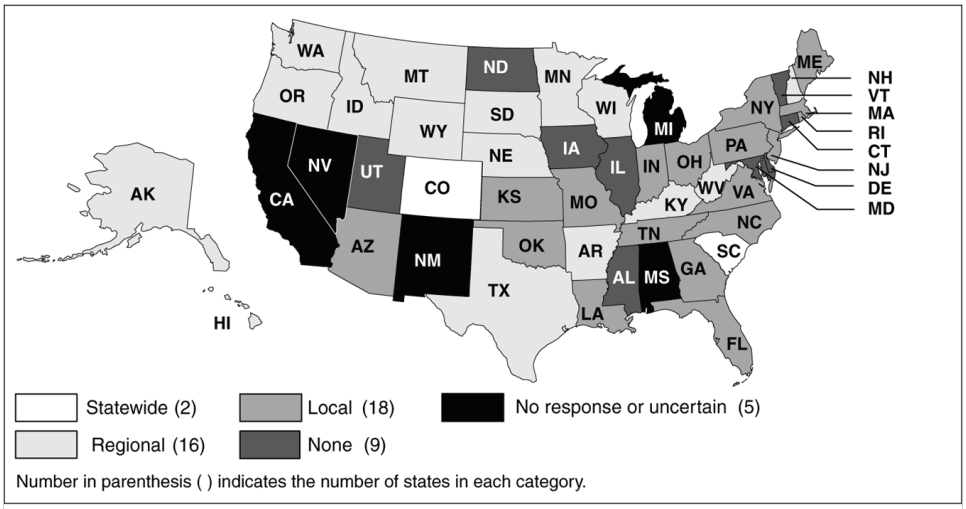
Myth #1: What water shortage?

At least 40 out of 50 states will have water shortages in the coming years. Most consumers do not perceive that this is the case, and every time it rains they relax about conserving water and become complacent. When not in a drought, water utilities across the country complain about not selling enough water as their sales revenue decreases. Conversely, consumers expect the water bill to go down – not up – when supplies are available, largely because consumers do not perceive water delivery as a service. From the utility perspective, conservation programs often get cut if there isn´t a drought crisis. The costs avoided by the utility because of conservation get for–gotten in the drive to sell excess capacity.

Myth #2: Government will fund our water infrastructure!

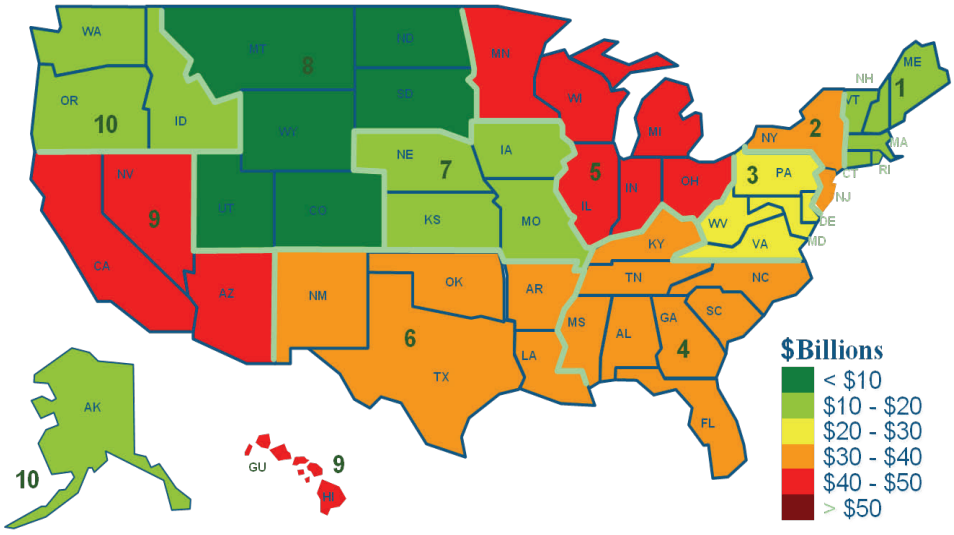
In past decades, communities always received federal and state funding to develop water facilities. The

Figure 1. At least 40 out of 50 States will have water shortages in the coming years.



Source: GAO analysis of state water managers' responses to GAO survey.

Figure 2. Twenty year drinking water and clean water infrastructure needs by EPA region.



U.S. EPA estimates that funding for drinking water and clean water infrastructure will have a $533 billion shortfall by 2020. The $787 billion stimulus bill (the American Resource and Recovery Act of 2009) only provided $6 billion for drinking water infrastructure, and there is very little other federal or state funding left for projects. Water rate–payers will have to pay for upgrading old infrastructure and increasing system capacity to provide safe drinking water. Private water companies have always dealt with having to pay for infrastructure improvements and maintenance; however, public water suppliers are now facing this true cost of doing business without subsidy, some for the first time.

Myth #3: New growth is all efficient – isn't it?

Half of the homes that will exist in 2030 have not yet been built, and the bad news is that we are not necessarily building efficiently. Studies have shown that new homes built from 1994 through 2004 used 12% to 60 % MORE water than their pre–existing counterparts. The primary reason for this, even in "wet" states, was the increase in unmanaged landscape irrigation systems installed at the new home sites. Even worse, most of the population growth has been in arid states, thus providing more pressure on limited water supplies. The good news is that there is an opportunity to build homes and businesses that use water more efficiently indoors and outdoors. Progress is being made through voluntary specifications like U.S. EPA WaterSense New Homes and LEED programs. Voluntary green codes (IAPMO and ICC) have been adopted in some areas of the U.S., while some local green codes have been implemented in New York, San Francisco, Los Angeles and Chicago. Recent studies on new homes indicate improved water efficiency, and new residential end use studies are being conducted to document if outdoor landscape irrigation is growing. Unlike the golf course industry, residential and business owners do not adequately understand how much water they are using on their own landscapes.

Figure 3. Population growth often occurs in states with scarce water resources.

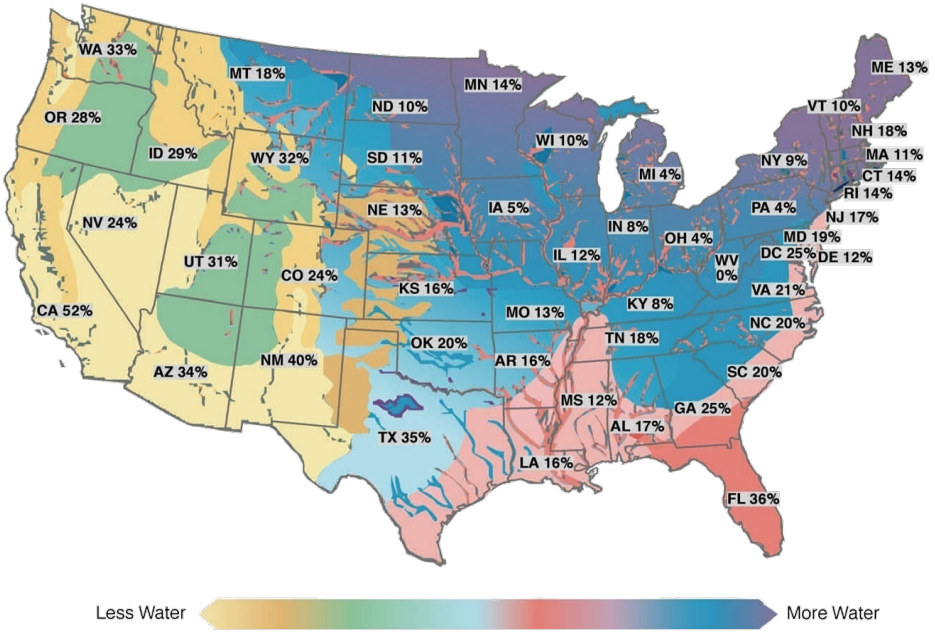
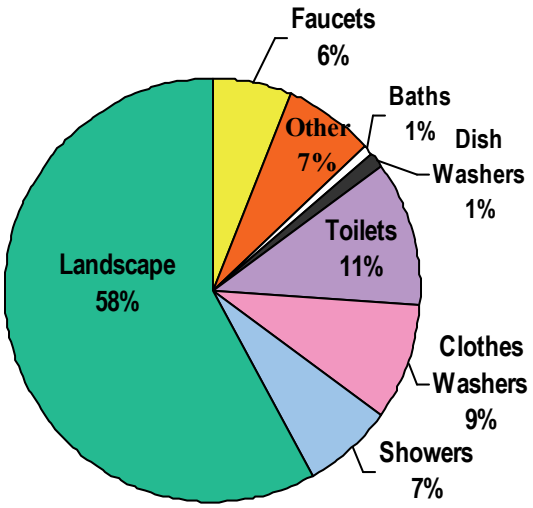


Figure 4. Urban water use in the United States. Source: AWWRF Residential End Uses of Water, 1999.



own landscapes is significant and thus contributing to local water shortages. This also is true to some degree for commercial properties that typically do not manage their outdoor irrigation. And that is the bad news here. Automatic irrigation does not mean automatic efficiency. Most automatic irrigation systems are programmed poorly, are zoned poorly, have more run times and longer run times than needed, and therefore waste a lot of water. Smart irrigation and other new technology options are becoming available to resident and commercial consumers to help make outdoor irrigation more efficient. Golf courses are the exception, where water is often managed properly for financial reasons or recycled water is applied. However, there is always room for improvement for anyone using an automatic irrigation system on their landscape.

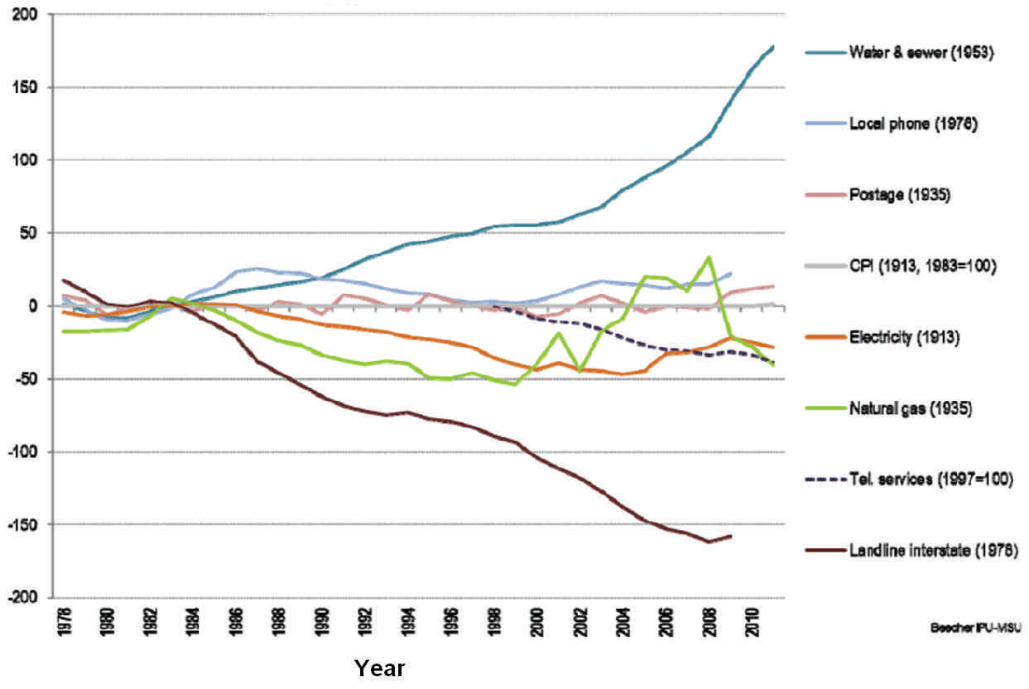
Myth #5: Water and energy are separate problems.

Of the 410 billion gallons of daily water withdrawals in the U.S., the U.S. Geological Survey estimated in 2005 that 49% of the water was withdrawn for power plant cooling. Although this water is not entirely consumed since much of cooling water is returned to rivers or lakes, this large quantity of water has to be available to begin with for withdrawal purposes. It is also returned back to the environment altered and with thermal impacts. Furthermore, electricity is needed to pump, treat, move, and heat water used by consumers. In California, a range of 2,000 to 20,000 kilowatt hours per million gallons of water has been estimated; the wide range depends on pumping and treatment methods. In fact, 19% of the electric energy load in California is for the pumping, treatment, and heating of water. A total of 32% of the natural gas energy load is related to the heating of water by natural gas. National studies indicate about 13% of the total electric energy in the U.S. is related to water and wastewater services. Thus, saving water helps to save energy, and to reduce greenhouse gas emissions. Water and energy are definitely connected.

Myth #6: Water conservation: it doesn't work and it costs too much.

It is remarkable that the average water utility manager continues to have this perception. For the last 30 years, there has been a steady reduction in annual water consumption per capita in many parts of the U.S., due to many water conservation initiatives. In Seattle, both passive and active conservation methods helped consumers reduce water use 1% per year – every year –

Figure 5. The trends in the difference between the overall CPI and the CPI for utilities (1978–2011). (Source: Jan Beecher, CPU, Michigan State University)



from 1980 through 2010. Passive measures include passing laws that reduce consumption at no cost to the water supplier, while active measures include funded programs to help educate consumers and pay rebates to retrofit their homes. Federal standards to develop efficient vs. inefficient homes have alone saved 23 gallons per day in the average residential home. New products in tandem with stricter state legislation, regulations, and ordinances will continue to reduce per capita water use. By conserving and reducing demand, water utilities can extend the life of their existing capacity by ten years or more, and avoid needing to build expensive new reservoirs, wells, and treatment plants.

Myth #7: I can't conserve because my water bill will go up!

Yes, conservation can reduce water sales, and therefore conservation can influence the need for water rate increases. However, there are several other factors affecting the amount of water sold and the level of costs to provide water service. The economic recession has resulted in industrial layoffs and home foreclosures, thus reducing water sales. Aging infrastructure has to be repaired and replaced, thus increasing water costs. Costs to provide regular service are also increasing simply through inflation alone. Additional capacity to serve new customers may have to be built, and new supplies may have to be found. All of these issues determine the level of water charges to the consumer, and these charges are rising faster than in the electric and natural gas industries because so much of the water system maintenance and repair has been deferred for so long. Yet while efficient water fixtures and conservation programs also reduce water sales, this reduction is beneficial to the growing system as it helps offset the need for new supply and treatment facilities. Lastly, we need to remember that water is still a bargain in the U.S. A 30% rise in rates often is no more than a $5 per month increase in the average consumer water bill. Many water rates remain very low at 1/10 cent per gallon, while customers buy a 16 ounce bottle of water for $1.25 – which is equivalent to $10 per gallon.

What about the future?

There are several fronts on which the Alliance for Water Use Efficiency, or AWE, continues to focus. Efficiency in codes and standards will continue to drive new product installation. When cost effective, water utilities need to fund conservation programs to incentivize consumer behavior and change. For example, when water utilities provide access to recycled water, many golf courses have willingly converted to this alternative source of water. Efficiency and conservation always should be the first option to consider in the "loading order" of water supply planning. Demand is lowering all across the U.S. on a per capita basis, but overall demand will increase as population continues to grow. As population grows and changes in climate occur, stable water supply and rates will provide economic benefits to communities. Last, and most important, consumers need to be educated.

Founded in 2007, AWE is the national voice for water efficiency in the U.S. and Canada. There is a wealth of information on the AWE website, which receives extraordinary use with more than eight million hits, 606,000 visitors, and more than 500,000 documents downloaded. AWE provides a comprehensive watch on federal policy bills proposed in the House and Senate. There also is a consumer website called "Home Water Works" that has a water calculator to help people estimate their water use. AWE provides information on water pricing and water efficiency jobs. A Blueprint for Action on water and energy provides 50 recommendations focused on state and national policies and programs. In another AWE project, states have been rated and given letter grade ranking with regard to the level of their water conservation requirements.

AWE has developed a water conservation tracking tool that provides a method for water suppliers to analyze the economic benefits from various conservation programs. There are graphs and charts that depict customer classes across the years, how service area and demands can be lowered, as well as cost benefit analyses with projected return on investment. Most importantly it helps water suppliers analyze how their revenue requirement changes with conservation programs. There is also an energy component that estimates the reduction from conservation in the amount of electricity used and greenhouse gas emissions. Lastly, in March 2013 the AWE will launch the "Never Waste" campaign print ads, billboards, bill inserts. A 20 oz. water bottle will also provide several "Never Waste" messages. For example, one ad shows that the water a running toilet wastes can fill 800 of these bottles in one day. Another ad shows that a broken sprinkler head can waste 384 of these bottles in ten minutes. Hopefully, with this kind of messaging, the consumer will realize how much water is being wasted and that they have a long term stake in water conservation for their community.

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AWE website (http://www.allianceforwaterefficiency.org)

Starting with an Open Hand:
Working with Regulators and Legislators

Mark Esoda CGCS
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When dealing with regulators, most industries tend to do the minimum to meet compliance issues and then attempt to stay under the radar. To handle legislative issues the public tends to protest or "Occupy Downtown." Regulators want help doing their jobs. In Georgia, the golf industry asked the hard question: "What can we do to help conserve water that proves we are good managers/stewards of the resource?" Change is difficult but the golf industry stepped up to prove the world wrong using a self–policing BMP program, stepping up to work with agencies on various committees and introducing educational pieces.

In Georgia a sequence of events and perceptions of the Golf Industry led to regulations that sought to restrict Golf's use of water. Furthermore during times of extreme limited resource golf courses were restricted to greens only watering. To protect the business and environment of golf, the industry took action to increase understanding changing the perceptions and hopefully reduce the restrictions that threatened the businesses.

Droughts in the late 80's kick started the regulatory process for water management in Georgia. Golf Courses began permitting water use and in some cases reporting. The late 90's brought more drought and more problems. Downstream states (Alabama and Florida) sued Georgia to ensure the water released from Lake Lanier in north Georgia made it downstream and was not used by citizens in Atlanta. Facing the loss of water use in several water basins the State of Georgia began working to produce strict drought rules. The rules went to public comment with golf restricted even during non–drought times and Public water providers holding the largest burden of water conservation. Both industries came out opposed to the regulations. Golf had the hardest time working with the regulators as the "Green Industry" had negotiated the rule content as spokesman for the golf industry as we had chosen to work with them on advocacy. Of course Golf could no longer permit someone else to negotiate in its behalf. After some negotiating by representatives from the Georgia Golf Course Superintendents Association, the rules were softened a little with promises on both sides to work together in the future.

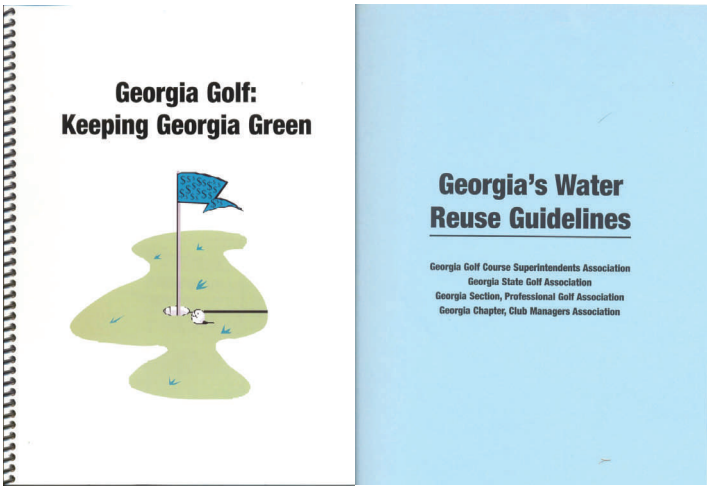
Perceptions of golf simply made it hard to start work–ing from a level playing field. For example, the Agriculture community felt that golf used too much water and therefore Agriculture would not support the industry. Golf and Agriculture had worked together in the past on regulatory issues such as posting of pesticide applications. In a Department of Natural Resources Board meeting Senator John Bulloch, Chair of the Senate Agriculture Committee, questioned "Do you want water for food or for fun?" This was a direct refer–ence to golf's efforts to retain its water use and to distance Agriculture from golf. At first regulators in the

Figure 1. The Georgia Golf Course Superintendents Asso–ciation received an accommodation from the governor for their efforts to reduce water use in Georgia.

state thought that golf used only potable water and or raw water supplied by a water provider. This was an inaccurate perception because only 1% of golf was utilizing potable water and most using surface impoundment or underground sources. Finally, legislators felt golf was a hot topic that was better left below the radar. Education was the answer.

Actions started with all industry partners assembling to form the Allied Golf Council. This group included the Club Managers, PGA professionals, the State Golf Association and the Superintendents. It was agreed that water was essential for the industry and a task force formulated. The task force produced educational pieces to be distributed to regulators and legislators. The environmental benefits of golf and the economic impact of golf were included in the documents. Golf in Georgia has a three billion dollar impact on the state's economy while using only 0.5 percent of the state's total water resource. A lobby firm was engaged by the task force to help engage legislators as this was not a strength of the volunteers. Subject matter experts – golf course superintendents – were inserted into various regulatory committees such as Water Conservation and Water Reuse. These superintendents dispelled myths about golf course water use. The final effort to help educate and change perceptions was the Memorandum of Agreement between the Georgia Environmental Protection Division of the Department of Natural Resources and the Georgia Golf Course Superintendents Association.

Figure 2. A "Water Task Force" was formed that included golf course owners, managers, professionals and superintendents. Several positive publications dealing with golf and water issues were pro-



The Memorandum of Agreement between the Georgia EPD and the GGCSA stated that 75% of the Georgia Golf Course Superintendents Association member courses in Georgia would be on Best Management Practices for Water Conservation by May of 2007. Although the agreement allowed 3 years to attain the goal, extreme effort was utilized to make sure the goal was reached. The Georgia Golf Course Superintendents Association held classes, sent forms with self-addressed stamped envelopes and even sent teams of experts to help courses complete their Best Management Practices documents. In May of 2007 the GGCSA had 93% of the courses on the program and currently exceed that number. This program was an open hand self-policing effort to help educate the State that golf courses use water efficiently.

The Best Management Practices for Water Conservation for golf in Georgia was done without any guarantee of a return for easing of restrictions or recognition from legislators. However, starting the program with an open hand and knowing that we were helping the community the BMP program should help in any future efforts to negotiate water rules. In 2007 drought restrictions hit level 4 which restricted golf to "Greens Only." Because of the effort to educate, work with and not against authorities golf was granted an Executive Order from Dr. Carol Couch the EPD Director during the drought of 2007 easing restrictions on golf thereby saving the industry. The Executive Order reduced the almost total water ban to a 35% reduction. Also, then Governor Sonny Perdue gave the golf industry a commendation for water conservation. Golf was the only industry to receive the recognition. When water conservation legislation was passed in 2010 under Governor Sonny Perdue golf was exempt from restrictions. Currently the Environmental Protection Division of the Department of Natural Resources is writing new drought rules working with the golf industry to use science based calculations to reduce water use utilizing 30 year averages from water stations around the state and crop coefficients. The State is using the BMP program as a template for other industries.

Starting with an open hand and trying to work with regulators and legislators was not the normal way to do business in Georgia. Most industries fight change. Changing for the golf industry was hard business as well. There was a lot of heavy lifting by volunteers and the cost of the program reached tens of thousands of dollars. Even though there was no guarantee of success, the results were fantastic and solid relationships were built. .

How Much Water Does Golf Use and Where Does It Come From?

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Golf Course Superintendent Association of America

The Golf Course Environmental Profile conducted by the GCSAA is a project dedicated to collecting data from the United States on the property features, management practices and inputs associated with golf courses. This article features information on irrigation water use patterns, water sources, costs, conservation practices and irrigation system infrastructure. Future water use trends and recommendations also are discussed. This project was funded through support from the Environmental Institute for Golf.

The information presented for the USGA Water Summit is provided through GCSAA's Golf Course Environmental Profile, a series of surveys to collect data on golf courses throughout the United States. The Profile reports provide insight and perspective into the property features, management practices and inputs associated with U.S. golf courses.

Water Use and Conservation Practices on U.S. Golf Courses is the second report produced from the project. It provides an accurate portrayal of water use, costs, sources and conservation practices on golf courses in the United States. It also establishes a baseline that will be compared to data from future surveys to identify change over time. All reports from the project are available at www.gcsaa.org.

The objectives of the water use and conservation survey were to measure:

- Number of irrigated turfgrass acres for the U.S. and in agronomic regions
- Total water use in the U.S. and in agronomic regions
- Water cost averages for the U.S. and in agronomic regions
- Water sources used for irrigation
- Recycled water use in the U.S. and in agronomic regions
- Water quality
- Irrigation system characteristics
- Water management and conservation practices.

Superintendents at all golf facilities in the U.S. (16,797) were invited to participate in the survey. A total of 2,548 golf facilities participated in the survey, accounting for 15 percent of the nation's facilities.

Report Highlights:

There are an estimated 1,504,210 acres of maintained turfgrass (greens, tees, fairways, rough) on golf facilities in the U.S. An estimated 1,198,381 acres or 80 percent of maintained turfgrass are irrigated. Approximately 80 acres of an average 18-hole golf course's 100 acres of maintained turfgrass are irrigated. From 2001-2005, an estimated total of 31,877 acres of irrigated turfgrass were added to existing golf facilities in the U.S. The greatest net gain in irrigated acreage occurred in the North Central and Northeast regions, where 13,513 and 8,442 new acres were irrigated, respectively. The Southwest region had an estimated net decrease of 12 acres.

Table 1. Number of irrigated acres and percentage of total irrigated acres by golf cours component for an average 18-hold golf facility in the USA.

Component	Irrigated acres	% total irrigated acres
Greens	3.7	4.6
Tees	3.4	4.2
Fairways	30.7	38.0
Rough	33.8	41.9
Practice area	5.6	6.9
Clubhouse grounds	3.5	4.3
Total	80.7	99.9

From 2003–2005, the average water use for golf course irrigation in the U.S. was estimated to be 2,312,701 acrefeet per year. That equates to approximately 2.08 billion gallons of water per day for golf course irrigation in the U.S. According to the U.S. Geological Survey's "Estimated Use of Water in the United States in 2000" report, approximately 408 billion gallons of water per day are withdrawn in the U.S. Golf course irrigation accounts for 0.5 percent of this total.

Table 2. Irrigated turfgrass acres, water use, and water use per irrigated turfgrass acre on an average 18–hole golf facility by agronomic region.

	Agronomic region[x]						
	NE	NC	Trans	SE	SW	UW/Mtn	Pac
Irrigated turfgrass (acres)[y]	54f	66e	74d	100b	115a	103b	84c
Water use (acre-feet)[y]	42.4f	76.7e	78.9e	241.8c	459.0a	300.4b	158.0d
Water use (acre-feet) / **irrigated turfgrass acre**	0.8	1.2	1.1	2.4	4.0	2.9	1.9
Water use (inches) / **irrigated turfgrass acre**	9.4	13.9	12.8	29.0	47.9	35.0	22.6

[x] Agronomic regions: NE = Northeast; NC = North Central; Trans = Transition; SE = Southeast; SW = Southwest; UW/Mtn = Upper West/Mountain; Pac = Pacific.

[y] Within a row, values followed by the same letter are not significantly different from one another. Letters denote significance at the 90% confidence level.

Water use varies significantly by agronomic region. An average 18–hole golf facility in the Southwest region uses an average of 4 acre–feet of water per irrigated acre per year. An average 18–hole golf facility in the Northeast region uses an average of 0.8 acre–feet of water per irrigated acre per year.

Annual irrigation water cost also varies significantly by agronomic region. Golf course facilities in the Southwest region had the highest water costs – approximately $107,800 per year for an average 18–hole golf course. Golf facilities in the North Central, Northeast and Transition regions had the lowest water costs, paying $4,700, $6,300 and $6,900 per year, respectively.

Multiple sources are utilized for irrigation water and many golf facilities have more than one source available for irrigation. Most 18–hole golf facilities utilize surface waters (ponds, lakes) or on–site irrigation wells. Approximately 14 percent of golf facilities use water from a public municipal source and approximately 12 percent use recycled water as a source for irrigation. Specific water sources for 18–hole courses as indicated by participants are noted below:

- 52 percent use water from ponds or lakes.
- 46 percent use water from on–site wells.
- 17 percent use water from rivers, streams and creeks.
- 14 percent use water from municipal water systems.
- 12 percent use recycled water for irrigation.

As previously noted, 12 percent of 18–hole courses use recycled water for irrigation. The most common reason cited for not using it was a lack of an available source for recycled water as indicated by 53 percent of respondents.

In general, irrigation water quality is acceptable or better in all agronomic regions, although there are golf facilities in all agronomic regions that face significant agronomic challenges due to the quality of their irrigation water.

Approximately 46 percent of 18–hole golf facilities treat their irrigation water or distribute products via the irrigation system. The most common products distributed through the irrigation system are wetting agents and fertilizers.

Nearly all 18–hole golf facilities use multiple irrigation scheduling techniques to aid in making water application decisions. Most facilities utilize direct observations of turfgrass and soil conditions to aid in irrigation scheduling decisions. Approximately 35 percent routinely utilize evapotranspiration data and approximately 3 percent use soil moisture sensors to aid in irrigation scheduling.

Superintendents at 18–hole golf facilities utilize numerous methods to conserve water. The top three conservation methods and the percent of golf facilities utilizing that method are: wetting agents (92%); hand watering (78%); and keeping turfgrass drier (69%).

An estimated 25 percent of18–hole golf facilities are subjected to recurring annual water allocations. Facilities in the Southwest (40%), Upper West/Mountain (39%) and Southeast (36%) are most likely to be subjected to a recurring annual irrigation water allocation. From 2001 to 2005, 16 percent of 18–hole golf facilities in the U.S. were subjected to mandatory irrigation water restrictions more stringent than the normal recurring annual irrigation water allocation for at least one year. Facilities in the Northeast and Upper West/ Mountain agronomic regions were more likely to experience more stringent restrictions. Approximately 28 percent of 18–hole golf facilities in the Northeast agronomic region have written drought management plans, more than any other agronomic region.

Lean and Green: Water Efficiency in the Las Vegas Golf Industry

Doug Bennett, Conservation Manager
Southern Nevada Water Authority

Las Vegas is home to some of the finest desert golf courses in the nation. A crippling 12–year drought on the Colorado River has challenged water supplies for this fast–growing city, requiring officials to make dramatic changes to water use policy. Since 2003, area golf courses have operated under a water budgeting policy that assures greater efficiency, while sustaining a high quality golf experience. Since the inception of drought, 30 golf courses have converted more than 40 million square feet (918 acres) of non–essential turfgrass to water–efficient landscape designs. Collectively, these conversions are saving more than 2.2 billion gallons of water annually.

The green industry is a critical stakeholder and should be viewed as an ally for water conservation rather than an adversary. Water purveyors and the green industry must work together to find the common ground toward a goal that conserves water and provides a vibrant green industry. The Southern Nevada Water Authority (SNWA), working with local golf courses, successfully achieved this goal for the Las Vegas, Nevada region.

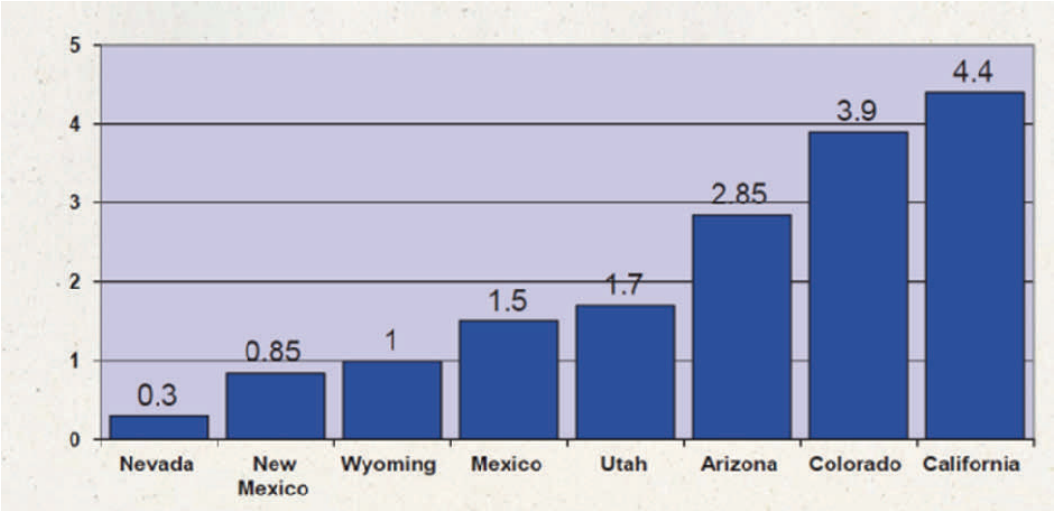
Although Nevada uses less than two percent of the water appropriated on the Colorado River, it relies on the river for 90 percent of its water supply. The Colorado River is the single most critical river system in the Western United States, serving more than 30 million people in seven states and Mexico (See Figure 1).

In addition to meeting the water needs of western cities, more than three million acres of farmland are irrigated with Colorado River water and agriculture comprises more than 70% of the total use. Unfortunately, appropriations of water for each of the seven states and the nation of Mexico, agreed to nearly a century ago, overestimated the reliable flow of the river by about 15 percent. Furthermore, a twelve–year drought on the system has diminished both flows and storage, and a warmer climate is expected to further diminish precipitation in the river basin in the future.

The Colorado River: Imperiled?

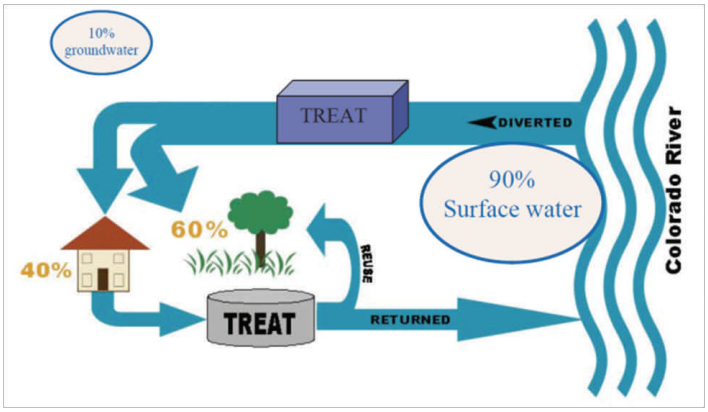
With the Colorado River accounting for 90% of Southern Nevada's water, it is critically important to find ways to conserve water. Lake Mead, located near Las Vegas, is a 256 square mile reservoir from which Las Vegas draws its water. The lake is currently 120 feet below the water level in the year 2000. This drop in the lake level translates to about 4.5 trillion fewer gallons than the lake stored one decade prior. As the drought manifested itself, so too, did aggressive population growth in the Las Vegas region. In the mid–2000's, as many as 30,000 homes were being built annually and 80,000 to 100,000 new residents were streaming in

Figure 1. The Colorado River is shared by seven states and Mexico. Southern Nevada is allocated 1.8% of the water or 0.3 million acre feet annually.



every year.

Figure 2. All water used indoors is already recovered for direct or indirect reuse. Landscape irrigation, or consumptive water use, is the amount that is lost to evaporation and the environment.



In Southern Nevada, the greatest opportunity for conservation was to find ways to reduce consumptive, or one–time, uses of water. In other words, consumptive water use is water delivered from any source that cannot be reclaimed because it is lost to evaporation and the environment. Examples of consumptive use include landscape irrigation and evaporation from water surfaces and industrial cooling towers.

Currently, about 60% of Southern Nevada´s water use is consumptive, with the vast majority of consumptive use attributable to landscape irrigation (See Figure 2). The 40% of water use that is used inside of buildings is considered non–consumptive, because it can be recovered from the sanitary sewer system, treated and directly or indirectly reused. Currently, southern Nevada reuses 100% of its wastewater, either by directly providing recycled water to parks, golf courses and industrial users, or by returning treated and polished water to Lake Mead for storage and reuse. This "reservoir storage and recovery technique" means indoor use has almost no diminishing effect on upon Southern Nevada´s water resources.

With landscape irrigation as the dominant consumptive use of water, improving water use efficiency for outdoor landscapes is the most effective means of reducing demand and extending the water supply.

It is important to reiterate that Las Vegas already directly or indirectly reuses all of the water taken from the Colorado River System. Too often, recycled water is undervalued, even though the infrastructure and energy required to reuse water is sometimes more costly than potable water. As such, municipalities in Southern Nevada are committed to reuse on a municipal scale, rather than through disaggregated, private systems. It´s also important to note that irrigating with recycled water can actually increase consumptive demand, because more water is required to leach salts through the root zone.

Outdoor Water Use

Public education efforts concerning water use were needed to address misperceptions about how water was used in the community. Surveys showed that people in Las Vegas commonly believed the majority of the community´s water was used by resorts and golf courses, primarily due to the high visibility of these sectors. In reality, just 15% of the water in Las Vegas is used by resorts (7.2%) and golf courses (6.8%) combined. Residential water comprises more than 60% of the water used in Las Vegas.

To develop effective water efficiency and drought policy, finger–pointing needed to stop –– every sector not only needed to be to be part of the solution, but they needed to know that the solutions were equitable among different classes of users. With this in mind, the SNWA worked with stakeholders to develop water demand management tools that fell into four categories: Education, Water Pricing, Regulation, and Incentives. Among the most effective measures was the implementation of Landscape Development Codes for new construction which were implemented in 2003:

- Lawns are prohibited in new residential front yards and limited to 50% of the landscape area in new backyards.
- Lawn is prohibited in new non–residential developments.
- A maximum of 50 acres of turf are allowed on a new golf course.
- Day–of–week and time–of–day watering restrictions which varied during the winter, spring/fall, and summer.

Figure 3. The Southern Nevada Water Authority and its member agencies utilize a variety of tools to pro–

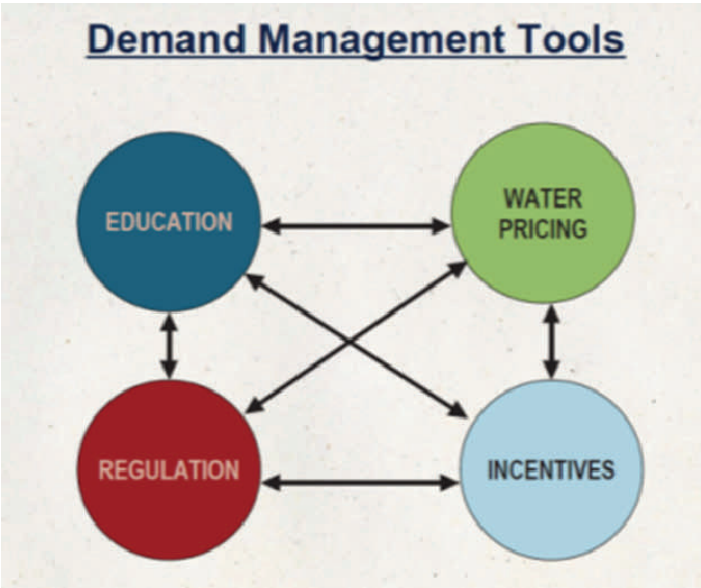
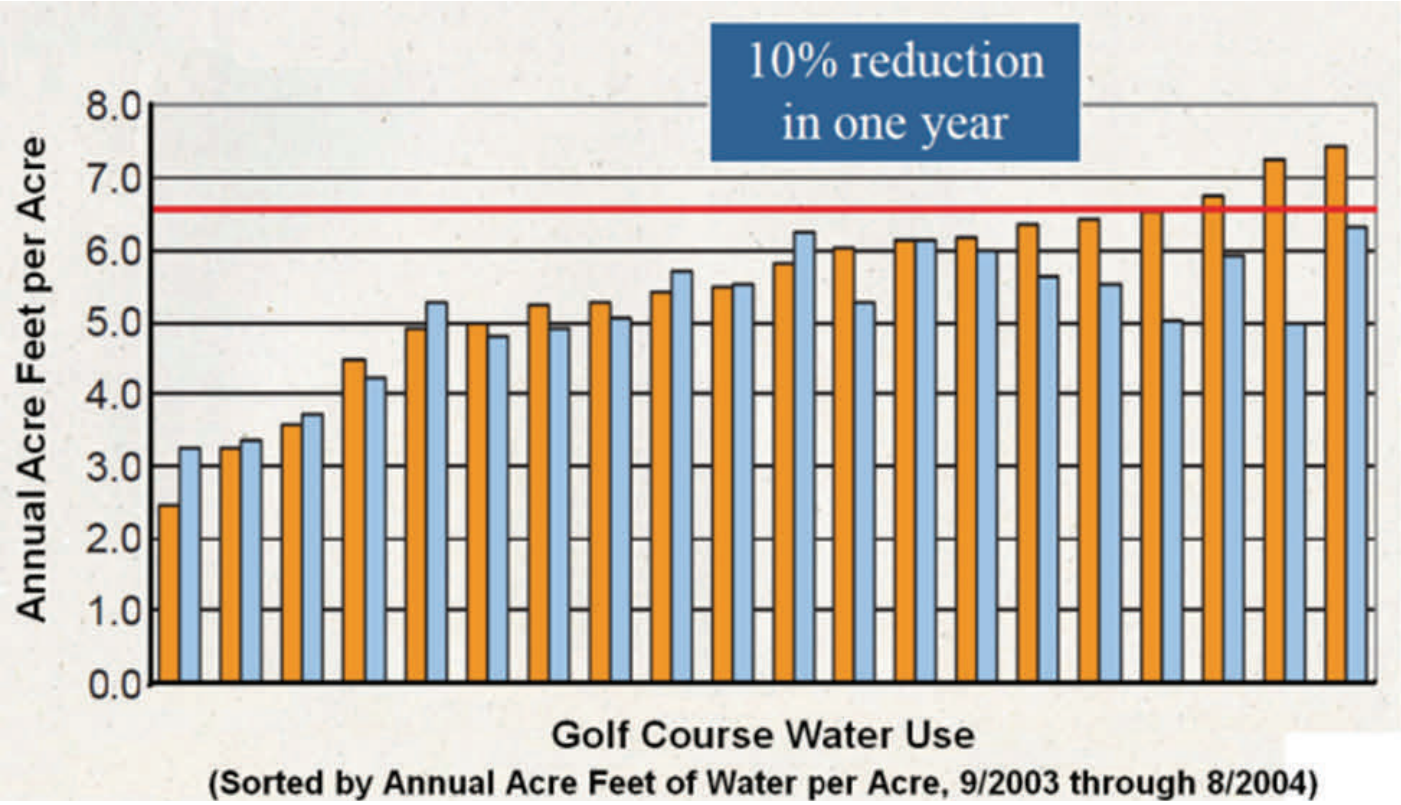


Figure 4. Yellow bars indicate each golf course´s per acre water use prior to implementation of water budgets. Blue bars show water use the following year. The agreed upon budget was initially set at 6.5 acre feet per irrigated acre (red line), and subsequently reduced to 6.3 acre feet.



- Golf course water budgets and pricing penalties in lieu of prescribed watering schedules.

Water Budget for Golf

Golf courses in the region were asked to choose whether they preferred to abide by community watering schedules, or if they would prefer being assigned a water budget based upon irrigated acreage. Overwhelmingly, the industry chose water budgets.

The SNWA presented a graph of the amount of acre feet of water per irrigated acre already being used each year by golf courses in the region to illustrate the existing differences in consumption. (Figure 3). After input from the industry, 6.5 acre feet was determined to be an acceptable amount of water for each irrigated acre of golf course turf and also predicted to produce similar savings as the mandatory watering schedule assigned to other customer classes.

The budget was predicted to affect about 30% of courses, but only those with high water use. While there was objection from some of the affected courses, the vast majority of the sector already operated within the budget and supported the policy. Water budgeting is certainly a more equitable approach than requiring all courses to effect mandatory percentage reductions, without regard to their current water use.

Water agencies provided both incentives and penalties to support the water budget strategy. Punitive pricing applied to water use in excess of the water budget. If a golf course exceeded the water budget by 1 to 20%, the course would have to pay two times the top tier water rate (currently $4.88 per 1,000 gallons). Golf courses using more than 21 to 40% of the water budget would pay five times the top tier rate, and courses exceeding the water budget by 40% or more would pay nine times the top tier rate. This punitive pricing applied whether the golf course was using potable or recycled water for irrigation.

In just one year, a 10% reduction in golf course consumptive water use was achieved by establishing an agreed upon water budget. Not surprisingly, most of the reduction was attributable to courses with the highest water use.

A major strategy used by golf courses for coping with water budgets was to remove turf from out-of-play areas, perimeter areas near homes, and driving ranges. A water savings of 34 gallons per square foot was realized for areas converted from turfgrass to desert landscape. A total of 30 golf courses conducted 324 projects which

Figure 5. Examples of golf courses removing turf from out–of–play areas, perimeter areas near homes, and driving ranges. A water savings of 34 gallons per square foot was realized for areas converted from turfgrass to desert landscape.

converted more than 836 acres of out of play turfgrass to water efficient landscape. These conversions were incentivized by SNWA with rebates of up to $1.00 per square foot of conversion. In total, golf courses received $37.7 million for conversions completed since 2004.

Conclusions

In 1990, Las Vegas´ per capita water use was nearly 350 gallons per day. Moderate conservation efforts through the 1990´s reduced per capita demand to approximately 324 gallons by 2003. Since implementation of aggressive outdoor water use regulations and programs, per capita water use has dropped to 221 gallons per capita per day (GPCD). The SNWA has an established goal to achieve 199 GPCD by the year 2035. An average reduction of 14.4 % in water use has been realized for golf courses following water budget guidelines. Overall, total golf water demand in Las Vegas has declined by 2.7 billion gallons (21%). While much of the

reduction is due to improved water efficiency, a portion of the reduction has been due to the loss of a handful of courses that could not remain economically viable.

Water budgeting is considered an equitable and effective water conservation mechanism that allows the golf course to manage water the way they want rather than be given specific days and times when irrigation can occur. Generally, through the combined education efforts of the SNWA and the golf industry, the community is aware that golf courses have responded positively and effectively to the call for greater water efficiency.

Maintenance Up the Middle:
Great Golf and Water Conservation are Not Mutually Exclusive

Chris Hartwiger, Senior Agronomist
USGA Green Section

Great golf and water conservation are not mutually exclusive. The enjoyment of golf is shared by many and can last a lifetime. As social, environmental and economic realities shift, the way golf courses are maintained will advance. The changes in the perception and the use of water re–sources on golf courses can serve as a catalyst to promote maintenance up the middle which, in turn, will lead to a more enjoyable and affordable game.

"Maintenance Up the Middle" is not a complicated golf course management concept. Focus on the playing areas in the middle of the course: tees, fairways, and putting greens. Shift the focus away from the rough. Golfers do this when they play golf. Those involved in golf course management would be well served to do the same when caring for the course.

This article will define and promote the concept of "Maintenance Up the Middle," in order to positively influence current economic realities at golf courses, serve as mechanism to reduce inputs including water, and benefit those who play the game.

Current Issues in Golf: Why Changes are Needed

The economics in golf have been bleak over the last six years. The number of golfers peaked in 2005 at 30 million and declined to 26.1 million by the end of 2010. In fact, there were more golfers (27.4 million) in 1990 than there were in 2010. All this has occurred while the number of golf courses increased by 30% since 1991 (Yasuda, 2012). As a result, most golf courses have seen flat or declining revenue over the past few years with little ability to raise prices.

On the maintenance side, energy intensive inputs such as fertilizer, fuel, electricity, pipe, and equipment have all increased in price significantly over the last 20 years. Labor costs are up as well. Regional droughts and water use regulations have added complex challenges.

The ramifications of declining revenue and increasing costs are sobering. In 2011, 157 golf courses closed (Golf Course Industry, 2012). Looking forward, either golf courses will close until supply meets demand or they must find ways to increase participation and/or decrease costs. "Maintenance Up the Middle" is positioned to address the latter.

Figure 1. Golfers focus on the middle when they play golf. Golf Course turfgrass managers would be well served to do the same when caring for the course.

Not all the news is bad, however. Golf is still enjoyed by millions of people every year. The quality of turfgrass on golf courses is at an all time high and the challenge of trying to hit a golf ball from the tee into the hole in as few strokes as possible remains as compelling as ever. Numerous national golf organizations are working together on initiatives such as Play Golf America, Tee It Forward, and others to grow participation in the game. When these initiatives are coupled with "Maintenance Up the Middle" to reduce costs and inputs that make the game more economically viable and conserve resources, everyone from golfers to golf course operators will benefit.

Defining "Maintenance Up the Middle"

In light of the statistics above, the need for a different strategy in golf course maintenance is apparent. "Maintenance Up the Middle" can reduce costs and inputs without changing the enjoyment and traditions of the game. Resource conservation including water is a byproduct of the strategy, but the overall goal remains providing a golf experience that is as good a value, if not better.

The reader should be familiar with a couple of terms. "Maintenance" refers to the way in which the golf course is cared for. It includes all inputs such as water, labor, fertilizer, pesticides, equipment, and fuel. The "Middle" refers to the areas of the golf course where the players want to be, specifically the tees, fairways, and putting greens. Management of the rough, which lies outside the "Middle," is an integral part of the strategy because of its vast size and large use of resources. Rough management will be emphasized further in the sections below.

The power of the strategy can be seen when one considers the distribution of playing areas on a golf course. A survey conducted by The Environmental Institute for Golf and published in a document called "Golf Course Environmental Profile" reported that an average 18–hole golf course has approximately 100 acres of maintained turfgrass. 36% of these maintained turf areas were found on tees, fairways, and putting greens. 58% of the maintained turfgrass was located in the rough and driving range (GCSAA, 2007).

These statistics provide massive implications. In many cases, the rough, or 58% of entire golf course receives substantial inputs in the way of water, fertilizer, herbicides, mowing, etc. If so, there is ample opportunity to reduce the intensity of maintenance without impacting the parts of the golf course where golfers want to be. When viewed through a "Maintenance Up the Middle" lens, the portion of the golf course that will be maintained to a high level just became much smaller. Further, the overall turf quality of the "Middle" is very good on most golf courses and should not require substantial additional resources. Simply reducing inputs in the outer areas will, by comparison, make the middle stand out and shine even more.

There are six questions or hurdles that "Maintenance Up the Middle" must overcome if it is to become effective.

Can it address water use?
Will it address current economic issues?
Does it make golf more enjoyable?
Will decision–makers adopt the concept?
How can be implemented?

Figure 2. "Maintenance Up the Middle" addresses economic issues by reducing inputs on golf course rough.

Question 1: Can it address water use?

Yes. 58% of the golf course is rough and the rough is an area where golfers do not want to be. Instead, they prefer to be on the more groomed and friendly areas such as the fairways and putting greens. If the expectation for turf quality in the rough is lower, inputs such as water can be reduced.

Question 2: Will it address current economic issues?

Yes. Inputs such as water, fertilizer, herbicides, and labor will be intentionally reduced under a "Maintenance up the Middle" strategy. In other words, 58% of the golf course can receive far fewer inputs. Imagine a scenario where the rough is only mowed six times per year and never watered or fertilized. Far fetched? Maybe, but there is every reason for plant breeders supported by industry to continue working to provide needed solutions.

Question 3: Does it make golf more enjoyable?

Another way to ask the question is, "Will golfers accept a lower quality and less visually appealing rough that requires fewer inputs? This is a big question and the success of "Maintenance Up the Middle" hinges substantially on the answer. As an observer of the game for many years, my inclination is that golfers will accept a lower input rough assuming that it does not play more difficult and does not slow down pace of play. Accompanied by excellent turf on tees, fairways, and putting greens, this strategy may become a popular trend and could become the new status quo. With that said, there are certain to be some comments from

golfers that do not like any change for any reason. This must be dealt with through an ongoing communication program.

Question 4: Will decision–makers adopt the concept?

Maybe, but there will be some requirements. First, decision–makers at the golf course must develop a mechanism to effectively communicate the change in strategy at their facility and why it is better for their customers in both the short and long–term. Second, they must be able to handle a few complaints and not assume a vocal few represent the majority of their customers. Also, it is likely that the most effective "Maintenance Up the Middle" program will involve an incremental approach in which golfers see small–scale changes and the staff is able to learn what works well and what doesn't. Finally, economic results must be measurable. It should be noted that one of the huge benefits of "Maintenance up the Middle" is not only an initial savings, but a savings that can be recouped every year.

Question 5: How can "Maintenance up the Middle" be implemented?

Effective implementation of "Maintenance Up the Middle" will require action at both the local level and the national level. The sections offer suggested steps that can be taken at both these levels. They are not all inclusive, but are included to encourage the advancement of this concept.

Implementing "Maintenance Up the Middle" at the Local Level

Initial Steps. The first step is for an individual golf course to determine what they are spending on each portion of the golf course. Generally, this information is not readily available because most golf course maintenance budgets are based on a line item format that groups expenses into different categories such as labor, fertilizer, pesticides, fuel, etc. Because of the desire to quantify input use and economic savings, it is a good idea to begin tracking both inputs and expenses according to the part of the course where they are allocated. Ask your local Green Section agronomist to conduct a review of your property and offer suggestions for starting. Communicate in advance what is going to occur on the golf course so that there are no surprises.

Minimal Approach. There are several steps almost any golf course can implement without too much difficulty. Reduce water and fertility by a predetermined percentage in the rough. The best approach is to increase the interval between irrigation events. Not only will this naturally reduce the number irrigation events, it increases the chance for a rainfall event to occur and further stretch the interval. Remember, it is likely that water cannot be applied only to the rough due to irrigation system design and any reduction could affect both fairways and tees.

Moderate Approach. Although there are extensive acres of rough on the golf course, not all the rough is the same from a golf perspective. For example, the rough around tee complexes is nonessential rough because golfers infrequently hit their golf balls into this area. One idea may be the use of plant growth regulators to reduce mowing frequency from once per week to monthly. Another idea is to install low growing and low/no input utility turfgrass around a tee complex. A good example of this type of turfgrass in the Southeast could be a bahiagrass and carpetgrass blend. Will this look different? Yes. Will it play differently? Not substantially. Both staff and golfers should observe the performance of these areas over time and expand as necessary.

Bold Approach. A bold approach would involve removing irrigation from the rough and expanding the installation of low or no input turfgrass or groundcover around tee complexes as described above. These areas can be evaluated and if successful, installed in the primary rough on the golf course. If these areas are expanded into the primary rough, significant modification of the irrigation system will be required.

Implementing "Maintenance Up the Middle" at the Local Level

National Initiatives. There are a number of national initiatives that will be extremely helpful in implementing "Maintenance Up the Middle". Promote the results of plant breeders who have worked to develop lower input grasses. Continue to financially support turfgrass breeders in discovering, developing, and testing turfgrasses or groundcover that persist under traffic with no irrigation and little or no fertility. Obviously, these needs and possibilities will vary greatly by region. Also, share success stories at golf courses of all levels and communicate proactively what an efficient golf course is to those that are just beginning or are likely to enter the game.

Conclusion

Although the economic challenges that golf courses have faced over the last six years have been difficult, it has opened up a new frontier for exploration in managing golf courses. The days of increasing budgets each year and raising the bar from fence line fence line are over for the foreseeable future. In its place is era where resource conservation, whether it be water, fuel, or fertilizer, is the expectation. While "Maintenance Up the Middle" is a process whose benefits will not be fully realized in a season or two, those who consistently apply these principles will be rewarded. We all have the opportunity to embrace resource conservation while working to make the game of golf just as enjoyable for those who play. Each of us within our own sphere of influence is invited adopt this concept and work to make it happen on a local level.

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Case Studies in Water Use Reduction from California

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USGA Green Section

This presentation provides practical examples of how golf courses in California implemented programs to reduce water use. Three courses are highlighted that took effective yet different approaches. Specific examples include turf reduction projects, conversion to lower water use grasses along with a voluntary reduction in water use, and effectively dealing with mandatory cut–backs through the LADWP Golf Water Task Force.

For many years, golf courses in California have been dealing with a restricted water supply. The stark reality is that golf courses must find a way to manage with less water while attempting to satisfy golfers and maintain an economically viable business. Although challenging, many golf courses have been successful using a variety of strategies to reduce the overall amount of water while maintaining acceptable playing quality. This article highlights three case studies relative to that effort.

Turf reduction – Pasatiempo Golf Club, Santa Cruz, California

Pasatiempo Golf Club is one of many golf courses in California that took the approach of eliminating turf in out of play areas as a method to reduce overall water use. As of 2007, Pasatiempo maintained 95 irrigated acres. Because of severe water shortages in the area, the City of Santa Cruz announced that a mandatory 28% water cutback would be initiated in 2009. The club quickly realized that a water reduction of that scope was not sufficient to adequately irrigate all areas of the golf course and a plan was developed to eliminate irrigation in out of play areas. During an initial review of the golf course in 2008, five acres were identified where irrigation would be eliminated. The non–irrigation zones were mainly near teeing grounds, out of play areas of the rough and edges of the property. Knowing that more had to be done, Pasatiempo contacted golf architect Jim Urbina to help identify additional areas where turf could be removed while preserving the architecture and playability of the golf course. An additional 20 acres of turf were identified for turf removal during this process. Then plans were made to update and replace the aging irrigation system to coincide with the boundaries of the turf removal areas and establish native grasses in the non–irrigated areas that could survive on natural rainfall. Pasatiempo now maintains 70 acres of irrigated turf and has saved a significant amount of money and water in the process. The water savings alone amounted to $369,000 in 2009, $320,000 in 2010, and $300,000 in 2011. Key aspects of the success of the Pasatiempo project included careful analysis of where turf would be removed and then strategically designing the irrigation system to fit the plan. Although Pasatiempo´s project was comprehensive in scope, other courses in California have been successful with turf removal projects by implementing plans in smaller phases. Prominent

Figure 1. Pasatiempo Golf Club reduced water use by eliminating turf in out of play area such as near teeing grounds.

Figure 2. The turf reduction and native grassing project at Pasatiempo Golf Club was carefully coordinated with the design of the new irrigation system so that irrigation would be totally eliminated in out of play areas with native grasses left to survive on natural rainfall.

examples include El Caballero Country Club (Tarzana), Woodland Hills Country Club (Woodland Hills), Barona Creek Golf Course (Lakeside), Porter Valley Country Club (Northridge) and Hansen Dam Golf Course (Pacoima).

Deficit irrigation – Friendly Hills Country Club, Whittier, California

Faced with steadily increasing water costs, Friendly Hills Country Club knew that reducing water use was a matter of economic survival for the club. The green committee and superintendent David Michael developed a three step plan to reduce overall water use. The main focus was on reducing irrigation on the tees, fairways and rough while providing the necessary water to keep the greens healthy at all times. Since the course had a mixture of cool season and warm season grasses throughout the property, step one focused on establishing a uniform stand of kikuyugrass in the fairways and rough that would survive with less irrigation. Step two of the plan focused on communication with golfers letting them know that course maintenance standards would be focused on providing firm and fast conditions on the fairways and rough and using less water. Step three involved carefully monitoring the data from the on-site weather station and incrementally reducing the amount of water applied as a percentage of evapotranspiration (ET). Studies at UC Riverside indicate that kikuyugrass retains good color and growth when irrigated at 75% of ET. During the 2008 season, irrigation was reduced to 65% of ET and then to 60% of ET in 2009. Golfer response was very favorable, and the club decided to irrigate at 55% of ET during 2010 and 2011. This level of irrigation proved to be detrimental to the turf and the decision was made to irrigate at the 60% ET level in 2012.

Looking at a subset of water use records for July, August and September (months with the highest water demand), Friendly Hills Country Club was very effective in reducing overall water use (Table 1). In 2010, summer water use was cut by an average of 35% and saved a total of 44.36 acre-feet of water. The summer of 2011 was similar with July – August water use reduced by an average of 35% with savings of 45.01 acre-feet. The program was backed down in the summer of 2012 with average water use reduced 26% compared to ET for a savings of 34.93 acre-feet of water.

Two key aspects of the program were mainly responsible for the success: 1) the club fine tuned their grassing scheme to favor a warm-season grass that uses less water, and 2) the green committee supported the decision to use less water and favor firm and fast golf course conditions. Essentially, the committee gave the superintendent permission to use less water regardless of the impact on course cosmetics.

As noted after the summer of 2011, the club pushed the limit of what golfers would tolerate finding that irrigating at 55% of ET was detrimental to course conditions and went beyond their goal of achieving firm and fast conditions. Ultimately, the water reduction policy at Friendly Hills met its goal of significantly reducing water use and saving money in the process to

Table 1. Looking at a subset of water use records for July, August and September, the deficit irrigation program at Friendly Hills Country Club successfully reduced water consumption, ranging from 26% to 35% compared to reference evapotranspiration.

Friendly Hills Country Club Water Use (AF)

	2010			2011			2012		
	Jul	Aug	Sep	Jul	Aug	Sep	Jul	Aug	Sep
Eto	43.00	47.75	36.16	48.50	47.00	32.50	47.83	48.08	37.66
Water use	28.50	31.59	22.46	31.87	30.35	20.77	34.55	36.20	27.89
Water saved	14.50	16.16	13.70	16.63	16.65	11.73	13.28	11.88	9.77
% reduction	33%	35%	38%	34%	35%	36%	27%	25%	26%

Figure 3. The first phase of the water reduction plan at Friendly Hills Country Club involved restoring a uniform stand of kikuyugrass throughout the fairways and rough that would perform well when water applications were reduced.

Figure 4. Irrigation was steadily reduced to 60% of ETo at Friendly Hills Country Club to favor firm and fast playing conditions while tolerating an off-color appearance in some areas. The green committee supported the decision to use less water .

the point where the local water district kindly pleaded with the club to use more water because their revenues were down – the ultimate sign of success.

Regulatory compliance – the LADWP Golf Water Task Force

Instituting new water use regulations has an interesting way of encouraging dialog and cooperation. Such was the case when the City of Los Angeles and the Los Angeles Department of Water and Power (LADWP) passed a new landscape water ordinance in 2009, which affected 35 golf courses within the service area. The ordinance was precipitated by consecutive years of below average rainfall along with the governor and state legislature setting the ambitious goal of reducing water use in California 20% by the year 2020.

Beginning in June 2009, the LADWP ordinance called for reducing landscape water use by 15%. Days of irrigation were limited to Monday, Wednesday, Friday; irrigation run-times were limited to 10 minutes per valve; and no irrigation could be performed between 10:00 a.m. and 4:00 p.m. This proved to be an unworkable model for golf courses from both an agronomic and business perspective.

On behalf of the golf courses in the region, Craig Kessler with the Southern California Golf Association contacted Penny Falcon, the conservation coordinator with LADWP to arrange a meeting. Penny Falcon set the tone for the initial group meeting with her opening remarks. "I have some good news and some bad news. The good news is that our records indicate that the golf courses in our service area are the most efficient users of water. The bad news is we are going to cut your water use by 15% and at the same time raise your rates. We're here today to see how we can come up with solutions that work with your businesses and still achieve the 15% water use reduction." What transpired from that initial meeting was a new partnership between the golf community and the LADWP that became the Golf Water Task Force.

The golf course superintendents in attendance did not dispute the 15% reduction but wanted the flexibility to manage water applications without restrictions imposed by the new ordinance. A compromise was reached by instituting an "Alternative Means of Compliance Program" that removed the restrictions but the golf courses would have to agree to reducing water by a total of 20%. The next question was, 20% of what? Historical water use records from LADWP were shared with the superintendents and the task force agreed to use the baseline year of 2006/ 2007 and model water budgets using the software program Landscape Water Manager developed by Cal Poly San Luis Obispo.

The Golf Water Task Force activities have expanded over the past two years to include regular meetings to review water use data and status of the conservation program, training sessions for golf course irrigators, and efforts toward the development of a water stewardship program.

There have been several positive outcomes since the inception of the Golf Water Task Force:

- All 35 golf courses exceeded the 20% goal in 2011 and are on track to do the same in 2012.
- Ongoing discussions are based on objective monthly water use data. This has further confirmed with the LADWP that golf courses are using water as efficiently as possible.
- The new ordinance and the task force have added an element of accountability. Golf course superintendents are monitoring water use more carefully and staying on track to meet the 20% goal.
- Golf courses in the area have taken further initiative to improve water use efficiency with better system maintenance, sprinkler nozzle replacement, and turf reduction projects.

Conclusion

These case studies highlight golf courses that have taken big steps to reduce their water use using different approaches. Pasatiempo Golf Club focused on turf reduction in combination with a carefully designed irrigation system. Friendly Hills Country Club took the approach of reducing water applications evenly over the entire course and promoting firm and fast playing conditions. The LADWP Golf Water Task Force provides a good example of cooperative dialog and arriving at practical solutions to comply with water use regulations. In each case, golf course conditions were preserved or enhanced as a result of these water reduction strategies.

Irrigation Puzzle: Sourcing Water for Golf Courses

Ali Harivandi, Ph.D., Environmental Horticulturist
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The most important issue facing the golf industry worldwide is water, or lack of it! Population increases and drought have resulted in golf courses successfully converting from potable to recycled water for irrigation. The golf industry has already overcome, through excellent educational outreach, the negative stereotype of irrigation with recycled water, and consequently, golf courses increasingly turn to the use of recycled water. The primary question has become not whether to switch to recycled water irrigation, or even how to manage irrigation with this new source, but how soon an individual course can access a recycled water source.

The distribution of water on earth has controlled the growth and spread of human activity throughout history. Signs proving the will to deal with water troubles are wells, aqueducts, qanats, and reservoirs of the ancient world, some of which are still serviceable thousands of years later. Today, we use more water than ever; increasing population, as well as increased individual need, particularly in industrially advanced societies, put increased pressure on our water supplies. And, although three-quarters of the earth's surface is covered with water, only a minute fraction of that water is both readily available and of suitable quality for human use, including irrigation of agricultural crops and landscape plants. That small fraction of earth's water includes rain and snow-melt stored in lakes, reservoirs, and aquifers, as well as water available in rivers. Yet all sources of fresh surface and ground water are being rapidly depleted by industrial and agricultural use as well as by direct human consumption. Consequently, the world's golf courses, mostly located in urban centers, therefore compete directly with human consumption for high quality water.

Impact of Drought on Golf

Drought intensifies the competition for water in much of the world. In the United Sates over the past two decades, significant annual droughts have affected large areas, particularly in "desert" states. Nevertheless, during this time, Americans migrated in large numbers to arid areas, where housing developments, along with their attendant landscape sites (golf courses especially) have significantly increased the demand for water. Consequently, severe restrictions on turfgrass and landscape irrigation during drought are common, including

Figure 1. Drought intensifies the competition for water, particularly in 'desert' states where people have migrated in large numbers.

the complete shutdown of home lawn, golf course or park irrigation. In 2012, drought seriously affected more than half of the United States. A recent national survey conducted by the Environmental Institute for Golf (the philanthropic organization of the Golf Course Superintendents Association of America) indicated the irrigation water sources of US golf courses (Table 1). Most irrigation comes from surface water (ponds, lakes, reservoirs, rivers, creeks, canals, etc.). Another source of substantial amounts of irrigation water is the ground water (wells). Surprisingly, in certain regions of the country, a large percentage of golf courses still have the luxury of using potable municipal water for irrigation. In the dry southwest, 31% of golf courses irrigate with domestic water; nationally, however, the number drops to only 14%. The latter is almost equal to the number of courses across the country using recycled water for irrigation (12%). Recycled water (also known as reclaimed, effluent, re-use, or waste-water) refers to wa-

ter that has undergone one cycle of (human) use and then received significant treatment at a sewage treatment plant to be made suitable for various reuse purposes, including turfgrass irrigation. Use of recycled water for golf course irrigation is scattered around the country, reported by only 3% of golf courses in wet northeastern states compared to 37% of courses in the dry southwest.

Degraded Water Sources for Golf

With no national water policy, it is not possible to predict future water availability for golf course irrigation. Clearly, however, the accelerating demand for good quality water and the increasing occurrence of drought mean that golf course irrigation will henceforth be closely scrutinized. As water becomes more scarce, irrigation of golf courses with degraded water will become more likely.

The two most obvious sources of degraded water are recycled municipal water, and brackish water, the latter either from shallow saline wells, or waters affected by sea water intrusion. Currently, only a few golf facilities use brackish water for irrigation (Table 1). The number of golf courses using recycled water, however, is significant, as noted above. Many years of research, prac-

Table1. Percentage of golf courses that use various types of irrigation water sources in the U.S. and within each agronomic region.

Water Source	Agronomic Region*							
	US	NE	NC	Trans	SE	SW	UW/ Mtn	Pac
	%							
Open water (Lakes, ponds)	52	64	55	74	62	8	24	17
Wells	46	41	62	32	45	46	37	49
Rivers, streams, creeks	17	22	16	16	12	4	28	15
Municipal water supply	14	16	7	18	8	31	13	25
Re-use water (effluent, reclaimed)	12	3	3	4	24	37	17	17
Canals	4	2	1	1	3	9	18	6
Brackish water	<1	<1	0	<1	<1	0	0	1
On-site desalinization plant	<1	0	0	0	<1	0	0	0
Other	3	2	3	2	2	3	7	5

*Agronomic regions: US, United States; NE, Northeast; NC, North Central; Trans, Transition; SE, Southeast; SW, Southwest; UW/Mtn, Upper West/Mountain; Pac, Pacific.

Source: Anonymous. 2009. Water Use & Conservation Practices on U. S. Golf Courses.Golf Course Environmental Profile--Volume 2. Environmental Institute for Golf. Golf Course Superintendents Association of America. Lawrence, KS.

Figure 2. The reliability and cost of recycled irrigation water for golf courses and landscapes will continue to encourage its use; however, any cost/benefit analysis of recycled water must include additional turf management costs to deal with salinity.

tice, and field observation on extensive turfgrass– covered areas (mainly golf courses) show that irrigation with recycled water (or brackish water in a few instances) is a viable means of coping with drought, water shortages and/or the rising cost of potable water.

The reliability (availability) and the cost of recycled water also play a major role in the popularity of recycled irrigation water. Recycled water is available even during droughts, when use of potable, and even well, water may be restricted. Recycled water is also often less expensive than potable water, and in some instances may be free. However, any cost/benefit analysis of recycled water must include management costs in addition to the price of water itself. If recycled water is of low quality (i.e. contains excessive salts, nutrients, etc.), the cost of managing these impurities to prevent plant injury or pollution of lakes may exceed the cost of fresh water. The main value of using recycled water for golf course irrigation is its availability and reliability when other sources become unavailable.

With the possible exception of some brackish waters, recycled water almost always has the highest level of dissolved salts of any irrigation water. Recycled water, therefore, must be evaluated thoroughly to allow development of appropriate strategies for its use. Recycled irrigation water quality affects the chemical and physical properties of soil, and therefore soil–water–turfgrass relations. The interrelationships must be monitored by regular chemical analysis and managed.

Conclusion

In conclusion, the most important issue facing the golf industry worldwide is currently water, or lack of it! Population increases and drought mean the industry is far more likely to compete successfully for recycled water than for potable. The golf industry has already overcome, through excellent educational outreach, the negative stereotype of recycled water irrigation; consequently, golf courses increasingly turn to use of this water. The primary question has become not whether to switch to recycled water irrigation, or even how to manage irrigation with this new source, but how soon an individual course can access a recycled water source.

Research Accomplishments to Meet the Present and Future Water Use Needs of Golf

Dr. Michael P. Kenna, Director
USGA Green Section Research

Thirty years ago, the USGA organized the Turfgrass Research Committee with the primary purpose to develop minimal maintenance turfgrass cultivars that conserve water, as well as tolerate temperature extremes, salinity and pests. New cultivars were introduced, water use efficiency was improved, and new irrigation technology was developed. More importantly, this program redirected university research to focus on water conservation, while improving the adaptation and management techniques of the turfgrasses used on golf courses.

Since 1921, the USGA Green Section has worked with universities and the US Department of Agriculture to improve our major turfgrass species used on golf courses. More recently, an emphasis was placed developing turfgrasses that survive periods of high heat, extreme cold, drought or tolerance of poor quality water. During the past 30 years, the USGA has helped golf courses make significant accomplishments toward conserving water through improved turfgrass water use and adaptation, soil management, and irrigation scheduling. The ultimate goal of this USGA supported research is to provide quality playing surfaces for golf while conserving and protecting our water supply

Figure 1. Droughts in the late 1970´s made this scene increasingly common on golf courses throughout the country.

Responding to an Urgent Need

In the 1970´s, there were a series of droughts throughout the entire United States. Severe water restrictions were placed on golf courses which had dire consequences on appearance and playability. Brown, dormant or dead turf on rough and fairways, as well as empty irrigation ponds, were becoming increasingly common on golf courses throughout the country.

In the Southwest, progress was being made using recycled water for landscape irrigation. The USGA, along with allied golf associations, conducted a symposium on using recycled water and published the proceedings in 1978. However, the droughts around the U.S., and need to deal with future water shortages, prompted the USGA to organize the Turfgrass Research Committee in January 1982. A year later, a slate of straight forward objectives was laid out which inspired the USGA and golf courses around the country to fund research at several universities with turfgrass research programs (see Table 1). Early research efforts focused on two general questions: 1) how much water do turfgrasses on golf courses use? and, 2) how do the major turfgrass species used on golf courses respond to heat, cold, drought, and salinity?

Early Research Efforts on Turfgrass Water Use

In the 1980´s, a series of laboratory and greenhouse experiments to measure turfgrass water use, and how turf plants respond to drought were conducted. Evaluating turf root growth, and how long plants would go before leaf firing, dormancy, or death occurred, were common experiments conducted in greenhouse and field trials.

During the 80´s and 90´s, the Penman–Montieth equation used to predict evapotranspiration, or Et_o, was calibrated for turfgrass. This equation estimates the amount of water that evaporates from the soil, plus the amount that transpires from, or is used by, the turfgrass plant. The key weather measurements needed for this equation are solar radiation, air temperature, wind speed, and humidity. This method of estimating Et_o is accepted world–wide, not only for turfgrass, but for all crops.

Several experiments measured actual turfgrass water use in field experiments (See Table 2). Weighing lysimeters were commonly used to estimate actual evapotranspiration, or Et_a. Lysimeters are simply closed buckets, small or large, that are weighed after an irrigation event, and then weighed daily during a dry down cycle. The ratio of Et_a and Et_o is used to develop crop coefficients, or K_c values. The use of K_c values, or some fraction of estimated Et_o, is the corner stone for developing deficit irrigation programs (See Table 3).

Predicted Et_o and K_c values provided a benchmark for turfgrass water needs; however, field experiments revealed that the turf could get by with even less water and still remain green. There was some leaf firing or brown color at greater water deficits, but the turf recovered quickly when rainfall or irrigation occurred. Some of the new cultivars were tested in field trials to determine how they would reduce water use and still provide acceptable playing surfaces. Through education efforts by USGA Green Section staff, superintendents used this information to conserve water by making better decisions about when and how much to irrigate.

The leadership and direction of the USGA enabled turfgrass breeders to evaluate turfgrasses for their ability to survive periods of high heat, extreme cold, drought or salinity. The USGA also was

Table 2. Summary of Mean Summer Daily Rates of Turfgrass Evapotranspiration (ET_0).

Turfgrass species[1]		Mean Summer ET rate[2]	Relative ranking
Cool Season	Warm Season		
		mm per day	
	Buffalograss	5.0 – 7.0	Very low
	Bermudagrass hybrids	3.1 – 7.0	Low
	Centipedegrass	3.8 – 9.0	
	Bermudagrass	3.0 – 9.0	
	Zoysiagrasst	3.5 – 8.0	
Hard fescue		7.0 – 8.5	Medium
Chewings fescue		7.0 – 8.5	
Red fescue		7.0 – 8.5	
	Bahiagrass	6.0 – 8.5	
	Seashore paspalum	6.0 – 8.5	
	St. Augustinegrass	3.3 – 6.9	
Perennial ryegrass		6.6 – 11.2	High
	Carpetgrasss	8.8 – 10.0	
	Kikuyugrass	8.5 – 10.0	
Tall fescue		3.6 – 12.6	
Creeping bentgrass		5.0 – 10.0	
Annual bluegrass		> 10.0	
Kentucky bluegrass		4.0 > 10.0	
Italian ryegrass		> 10.0	

[1] Based on the most widely used cultivars of each species.
[2] Mean rates of water use based on research from several studies

Table 3. Fraction of ET_0 (K_c value) for acceptable turfgrass appearance in various landscape settings.

Intended Use	Required minimum acceptable appearance	*Fraction of ET_o for acceptable appearance (+/– 0.05)	
		Cool–season	Warm–season
Industrial, Roadside, etc.	Low	0.60	0.40
Homeowners Association, Typical Lawn, Municipal, etc.	Traditional	0.70	0.60
Parks and Sports Fields, Commercial, etc.	High–performance	0.80	0.70

[1] Based on the most widely used cultivars of each species.
[2] Mean rates of water use based on research from several studies

instrumental in providing research funds to turfgrass management and physiology experts to assess the progress that the breeding programs were making. The USGA provided funding to develop turfgrasses native to North America, and, in collaboration with the US Department of Agriculture, breeders had the opportunity to collect interesting grasses from around the world. The foresight of the USGA Turfgrass Research Committee was quite remarkable, and, without those early efforts to organize a focused research effort, where would we be today?

New Turfgrass Cultivars Arrive

The turfgrass industry started to see new warm– and cool–season grass cultivars in the late 1980´s, all throughout the 1990´s, as well as today. More than 30 cultivars were developed since 1983 and have returned $4 million in royalty income to the USGA´s research program. Warm–season grasses, particularly new bermudagrass and zoysiagrass cultivars, are significant solutions to reduce as much as half the amount of water needed for golf course fairways during the summer. Improved heat tolerance in cool–season grasses, such as bentgrass and perennial ryegrass, demonstrated the value of breeding programs directed toward improving their performance and persistence during the summer. A few native grasses were developed that were highly adapted to lower rainfall regions of the Western United States (See Table 4).

In cooperation with allied golf associations, the USGA´s book, *Wastewater Reuse for Golf Course Irrigation,* greatly improved the confidence of course decision makers to use recycled water. Salt tolerant grasses, like seashore paspalum and inland saltgrass, provide alternatives when poor quality water high in salts is the only source available for irrigation. National Geographic in *A Special Issue on Water* penned seashore paspalum, ˝A humble turfgrass (that) has won the golf trifecta, earning raves from duffers and greenkeepers as well as environmentalists.˝ Seashore paspalum is not a perfect turfgrass, though it is a positive step in dealing with poor quality water in the Southern United States. All of the turfgrass species used on golf courses have been evaluated for salt tolerance (See Table 5). Additional research continues today on improving salinity tolerance of several cool–season species such as perennial ryegrass and Kentucky bluegrass.

Biotechnology and Molecular Approaches

For the last 20 years, the USGA has supported plant biotechnology that uses cellular and molecular levels of plant biology to better understand turfgrass genetics, and as a tool to supplement traditional plant breeding efforts. While significant advances have been made for traditional agricultural crops such as corn, wheat, and soybeans, progress using molecular approaches to improve stress tolerance in turfgrass is not as readily apparent. In this regard, the lack of success is partially due to the genetic complexity of perennial turfgrasses, as well as the differences in resources being committed to the improvement of turfgrasses compared to other agricultural crops.

Biotechnology is very basic and long–term research that is expensive to conduct. The USGA has played an important role to provide seed money to get projects underway. Several USGA sponsored scientists have received grants from the National Science Foundation or the US Department of Agriculture (USDA). For significant progress to be made in the field of turfgrass biotechnology, scientists will need to compete and receive large, multi–million dollar grants from federal research programs.

One interesting example of turfgrass biotechnology is evaluating the heat tolerance of grass species related to creeping bentgrass. These ˝grass cousins´ thrive in the thermal soils at Yellowstone National Park. The soil temperatures run as high 113 degrees Fahrenheit, and, molecular studies are conducted to determine which genes are involved in this natural thermal tolerance of the Yellowstone grasses.

Future Research and Partnerships

Turf response to drought and deficit irrigation research continues today using experimental techniques developed more than 25 years ago. More emphasis is now placed on evaluating the differences among cultivars within a turfgrass species. For example, several bermudagrass cultivars were tested for their response to 99 days without water. Based on preliminary analysis in this experiment, there are a few cultivars with significantly better tolerance among the 16 that were tested. Similar research has been conducted for Kentucky bluegrass and creeping bentgrass that will identify existing cultivars that use significantly less water.

University breeding programs supported by the USGA received two USDA Specialty Crop Research Initiative (SCRI) grants of more than $5 million. Turfgrass scientists at universities in Florida, Georgia, North Carolina, Oklahoma, and Texas received $3.8 million to develop warm–season grasses with better drought and salinity tolerance. In the midst of severe drought in Oklahoma and Texas, the USGA/USDA supported research has evaluated hundreds of bermudagrass, zoysiagrass, and seashore paspalum selections for their ability to survive with less water. A similar SCRI grant for $2.1 million was awarded to universities in Minnesota, New Jersey, and Wisconsin

Table 4. Summary of Turfgrass Cultivars Developed by Universities Receiving USGA Funding.

Turfgrass	University	Cultivars or Varieties
Creeping Bentgrass *Agrostis stolonifera var. palustris*	Texas A&M University	´Crenshaw´, ´Cato´, ´Mariner´, ´Century´, ´Imperial´, and ´Backspin´.
	University of Rhode Island	´Providence´
	Pennsylvania State University	´Pennlinks´
	Rutgers University	Heat tolerant and dollar spot resistant parental lines are under development.
Colonial Bentgrass *Agrostis tenuis*	DSIR–New Zealand and University of Rhode Island	BR–1518
Bermudagrass *Cynodon dactylon* *C. dactylon X C. transvaalensis*	New Mexico State University	´NuMex Sahara´, ´Sonesta´, ´Primavera´, and ´Princess´.
	Oklahoma State University	Two seeded types, ´Yukon´ and ´Riviera´, three vegetative types, ´Patriot´, ´Northbridge´, and ´Latitude 36´.
	University of Georgia	´Tifton 10´, ´Tifsport´, ´Tifeagle´, and ´Tifgrand´.
Buffalograss *Buchloe dactyloides*	University of Nebraska	Five vegetative varieties ´Legacy´, ´Prestige´, 609, 315, and 378; three seeded varieties ´Cody´, ´Tatanka´, and ´Bowie´. Vegetative NE 95–55 under evaluation.
Alkaligrass *Puccinellia* sp.	Colorado State University	Ten improved families were developed.
Blue grama *Bouteloua gracilis*	Colorado State University	Elite, Nice, Plus and Narrow populations were developed.
Fairway Crested Wheatgrass *Agropyron cristatum*	Colorado State University	Narrow leafed and rhizomatous populations were developed.
Curly Mesquitegrass *Hilaria belangeri*	University of Arizona	'Fine' and 'Roadside' populations were developed and made available for further improvement.
Annual bluegrass *Poa annua* var. *reptans*	University of Minnesota	DW–184 (MN#184).
	Pennsylvania State University	Several promising lines, but nothing released to seed production problems.
Zoysiagrass *Zoysia japonica* and *Z. matrella*	Texas A&M University	´Diamond´, ´Cavalier´, ´Crowne´ and ´Palisades´.
Inland Saltgrass *Distichlis spicata*	Colorado State University University of Arizona	Vegetative A–49, A–50 and A–138 considered for release. Seeded varieties are being developed.
Seashore Paspalum *Paspalum vaginatum*	University of Georgia	Vegetative ´Seaisle 2000´, ´Seaisle I´, ´Seaisle Supreme´, and seeded ´Seaspray´. More seeded and vegetative cultivars nearing release.

Table 5. Relative Salt Resistance of Several Turfgrass Species Used in the United States .

Cool–Season	Warm–Season	Ranking
Alkaligrass	Seashore paspalum	Excellent
	Bermudagrass	
	Bermudagrass hybrids	Good
	St. Augustinegrass	
Creeping bentgrass	Zoysiagrass	
Tall fescue	Bahiagrass	Fair
Perennial ryegrass	Centipedegrass	
Fine fescues	Carpetgrass	Poor
Kentucky bluegrass	Buffalograss	

*Based on the most used cultivars of each species.

to improve fine fescues for golf courses and lawns. University scientists also have partnered with their counterparts at USDA Agricultural Research Service laboratories in Utah and Maryland to collect and evaluate new and existing turfgrass species for drought and salinity tolerance.

The USGA worked closely with the Council for Agricultural Science and Technology, or CAST, on a special symposium dealing with "Water Quality and Quantity Issues for Turfgrasses in Urban Landscapes." The USGA is currently working with National Turfgrass Federation and USDA staff at the U.S. National Arboretum in Washington, DC on a turfgrass exhibit titled "Grass Roots." Due to the long history of USGA support of turfgrass water use research and introduction of improved turf cultivars, the Green Section consults with the American Society of Agricultural and Biological Engineers on the development of landscape water requirements, as well as provides review and comments for the Sustainable Sites Initiative and EPA WaterSense.

The Turfgrass Information File

An important goal set by the Turfgrass Research Committee in 1984 was to develop a "Turfgrass Research–Computer Data Base Library." This database was named the Turfgrass Information File, or TGIF, and is hosted at the Turfgrass Information Center, Michigan State University Libraries. As the internet evolved, the power of this database became more accessible to turfgrass scientists and managers. To encourage the growth and sustainability of this important tool, the USGA provided a $1 million endowment which was subsequently matched by allied associations and corporations. TGIF now has over 200,000 records, and more than 1.3 million searches are conducted annually,

The Turfgrass Information Center houses important collections from past turfgrass scientists, such as O.J. Noer, James Beard, or Fred Grau. TGIF is home to *Green Section Record* which is accessed more than 3,000 times per day. USGA *Turfgrass and Environmental Research Online*, or *TERO,* and several other digitized turfgrass publications are available through the Turfgrass Information Center at Michigan State University. More than 50% of the records are linked to the full text of the article so it can be read or downloaded using the internet. There are ten organizations (which include the Golf Course Superintendents Association, Sport Turf Managers Association, Turfgrass Producers International) that have blanket–access agreements for their members. More than 60 university subscribers worldwide use TGIF to provide access to faculty and students.

Conclusion

Thirty years ago, the USGA organized the Turfgrass Research Committee with the "primary purpose of the program to develop minimal maintenance turfgrass" which conserves water; survive periods of high heat, extreme cold, drought or tolerance of poor quality water. The USGA has been a leader in turfgrass water use research through its support of university programs on turfgrass breeding, physiology, and management. The USGA's research provides valuable information on turfgrass water use rates, minimal water requirements, and ability of turfgrass to survive periods of drought.

Some golf courses use half the water they did 30 years ago by using improved grasses, like bermuda–grass and zoysiagrass, which save water. A few native grasses, like buffalograss and fine fescues, can be used on golf course roughs to reduce water use. The increased heat tolerance of grasses, such as bentgrass and perennial ryegrass, has improved their perform–ance and persistence during the summer.

The USGA staff helps superintendents conserve water by making better decisions about when to water and how to use technology that improves irrigation precision. The turfgrass water use information is used to implement weather–based replacement of water. Due to the USGA's education efforts to improve the confi–dence of course decision makers, more recycled water is used for golf course irrigation today than ever before. Salt tolerant grasses, like seashore paspalum, provide alternatives when poor quality water high in salts is the only source available for irrigation.

The USGA has been a valuable cooperator with allied

associations, government agencies, and industry to provide excellent summaries and education on water research conducted during the past 30 years. The USGA provides free, public access to all of its research and education information through the internet, and, was a leader supporting the Turfgrass Information File, or TGIF, at the Turfgrass Information Center, Michigan State University Libraries.

Golf has made significant progress; however, there is still a lot can be accomplished to conserve water, through continued improvements in turfgrass water use and adaptation, soil management, deficit irrigation programs, as well as improved irrigation control systems, sprinkler uniformity, and sensor technology. The ultimate goal is to provide quality playing surfaces for golf while conserving and protecting our water supply.

Figure 6. The droughts around the United States, and need to make plans for the future in dealing with water shortages, prompted the USGA to organize the Turfgrass Research Committee in January 1982.

The USGA Research Committee (left to right): Stephen J. Horrell, Charles W. Smith, W. H. Bengeyfield, Harry W. Easterly, Jr., Dr. Paul Rieke, James B. Moncrief, H. E. Neale, Dr. James R. Watson. Dr. Marvin H. Ferguson is not present.

The Green Section's New Turfgrass Research Committee

Irrigating with a Toxin

Tim Hiers, CGCS, Director of Agronomy
The Old Collier Golf Club, Naples, Florida

Water quality and quantity are major challenges for golf courses in Florida. At Old Collier, we have taken the unique approach of converting to turfgrass that uses a water supply previously thought unsuitable for fine turf. However, the use of this water brings new challenges that must be overcome to make this a viable, long–term solution for the golf industry.

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

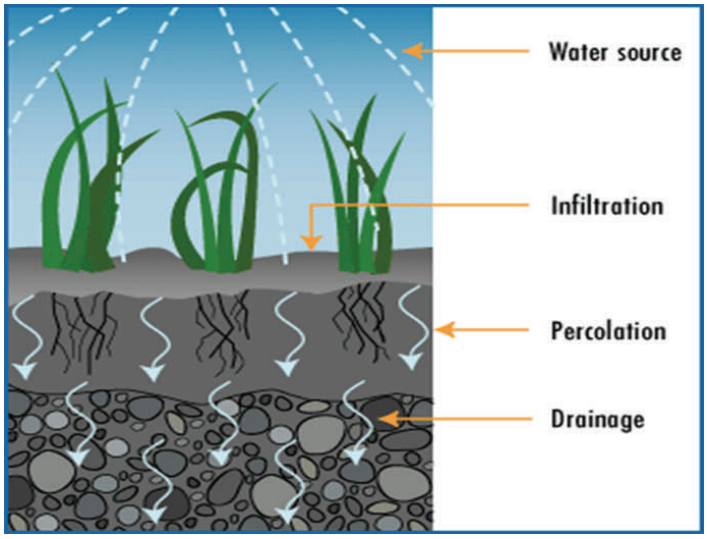
Even though it rains a great deal in Florida, only one half of 1% of the rainfall that hits the ground is captured. There is a tug–a–war between industry, power utilities, agriculture, livestock, domestic, and landscapes for water. If people have to choose using water for showers versus golf course irrigation, 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. The accumulation of salts in the soil can damage golf course turfgrasses. 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.

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)

Strategies to Reduce Water Use: Case Studies from the Southwestern United States

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USGA Green Section

This article highlights water conservation strategies used by turf managers in the southwestern United States. Practical examples include irrigation redesign and upgrading nozzle technology, modifying irrigation programming, improving soil properties, utilizing new soil moisture sensing technologies and converting to recycled water.

The growth and economic viability of small businesses, including golf courses is limited by the availability of water. In no other region across the United States is this challenge more pressing than in the desert southwest. As a result of the highest evaporative demand in the U.S., golf courses in the southwest use more water per acre (4.0 acre feet per acre) (5) than in any other agronomic region. By comparison, golf courses in the northeast region average only 0.8 acre feet per acre per year. Elevated water consumption in the southwest comes at a cost. Nationally, golf courses spend roughly $243 per acre for water annually. This figure nearly quadruples to $937 per acre in the southwest, where courses on average pay $107,800 per year. In southern Nevada, it is not uncommon for courses to pay over 1 million per year for water. Since 2001, water costs have climbed by 30% in the southwest and that trend continues today. Golf course superintendents in the desert southwest have to manage water efficiently; in most cases the business is not sustainable otherwise. The following discussion offers 5 examples of how turf managers in the southwest use water efficiently while continuing to provide quality playing conditions:

Irrigation Redesign

As the economy slowly crawls out of its slumber, capital improvement items such as irrigation redesign/renovation are slowly being considered. Redesigning an antiquated system has potential to offer many rewards, such as water conservation, energy reduction, improved turf quality and coverage, and labor and equipment savings. In some cases redesigning an inefficient system may help courses avoid fines imposed by local water regulatory bodies. One such example is

Figure 1. A mini-triangulation system was developed to protect the true location of each sprinkler in the field.

Paradise Valley Country Club in Paradise Valley, AZ, where an irrigation redesign project was undertaken in 2007 (1).

In 2006, the facility used 626 acre feet of water on 122 acres of turf, or 5.1 acre feet per acre. This total exceeded the water allotment by about 40 acre feet (13,034,040 gal). The old system was operating at 62% Distribution Uniformity (DU). The irrigation designer, installer and supplier came together to guarantee a minimum operating efficiency of 80%, something that had never been done.

Through careful engineering of head layout, optimal spacing throughout the golf course was achieved. By using survey grade mapping instruments, each sprinkler was staked to sub-centimeter accuracy. A mini-

Figure 2. The simple act of raising and leveling

triangulation system was developed to protect the true location of each sprinkler in the field. As a result, DU´s above 80% were regularly achieved. The 501 acre feet used (compared to 626 acre feet before the redesign) shattered the club´s water use goal. With rising water costs, this savings is significant, and more importantly, they were able to produce quality turf while beating their water allotment.

Irrigation Nozzle Upgrades

Although upgrading the irrigation nozzles will not make up for poor design and inadequate pressure, they can offer substantial improvements in DU. In 2006, a study conducted by the Center for Irrigation Technology (CIT) (8) in Fresno, CA evaluated the water consumption at 5 California golf courses 1 year prior to nozzle upgrades and one year after. Results demonstrated that about 100 acre feet of water were saved in one year across all 5 courses. Water savings equaled approximately 6% per course. In travels throughout the southwest region, many courses struggling with poor distribution uniformity have upgraded to better performing nozzles. A recent conversation with a superintendent in Queen Creek, Arizona revealed that he has upgraded roughly 70% of the nozzles on his fairways over the past two years. He suggested the most dramatic improvements in DU can be seen with aerial photographs or comparing Google Earth® images over several years. The "donuts" (brown, dry areas surrounding the irrigation heads) have been eliminated where nozzles were upgraded.

Improving soil properties

Improving soil physical and chemical properties to encourage water penetration (water entering the soil surface) and infiltration (water moving through the soil profile) may seem a bit abstract with regard to water conservation, but experience with clubs that have employed soil modification strategies reveals there is water savings to be had. Soil water infiltration rates may be improved through both mechanical and chemical means:

Mechanical Methods

Aeration with solid or hollow tines – A study evaluating various cultivation strategies on four golf courses in the Phoenix, Arizona area revealed 4x/year aeration enhanced sodium leaching and turf quality. (7) Although increased soil water infiltration was not quantified in this study, one can assume hydraulic conductivity improved given that sodium leached from the upper soil profile in aerated treatments. At Auburn University, Elizabeth Guertal, studied the effects of 1,2 or 4 solid tine aeration events on soil compaction and saturated hydraulic conductivity (Ksat). Ksat increased with 4x/year aeration and improved turf quality on one of the test sites (2). Both these studies demonstrated that when soil water infiltration improves, so too does turf quality and the ability to leach salts.

Fairway topdressing with sand – On very hard, rocky soils surface runoff may result in water loss and turf managers often respond with more frequent, but light watering. Aggressive sand topdressing (0.5 – 1 inch per year) on challenging soils will improve turf quality, enhance salt leaching and may reduce water consumption. Furthermore, research suggests that sand topdressing can improve surface drainage and reduce surface runoff (4). Experience working with several golf courses committed to aggressive sand topdressing has demonstrated that salinity levels can be reduced by more than 50%, a function of im–

Figure 3. Utilizing soil improvement methods such as with deep tine aeration can reduce runoff and improved soil water infiltration.

Figure 4. Sand topdressing fairways will yield improved turf conditions and surface drainage while reducing the potential for runoff.

proved surface water infiltration. A review of their historical water inputs reveals an interesting development – prior to sand topdressing the courses deficit irrigated, meaning the water inputs fell below the evapotranspiration (ET) rates. Such an irrigation regime was done out of necessity. Watering at or above ET would result in wet, unplayable surfaces and runoff would occur. However, turfgrass quality suffered during periods of high evaporative demand and salinity and sodium climbed to harmful levels. Once soil infiltration rates were improved, water inputs were increased to yield quality turfgrass conditions without sacrificing playability. Furthermore, the better performing soils would accept water and offered the ability to leach salts.

Chemical Methods

Mitigating the sodium hazard – Elevated sodium can affect soil physical properties like dispersion of clays and organic matter. Adding calcium and magnesium where sodium accounts for much of the problem will improve soil flocculation and water penetration. On sodium affected soils, turf quality and sodium leaching were improved when 4 times per year aeration and 80lbs/1000 sq. ft. gypsum was applied in a 3 month period (7). It was thought that turf quality improvements were a result of reduced soil strength and increased soil moisture in areas receiving a combination of aeration and gypsum.

Wetting agents – Especially on sandy soils more than 18 months old wetting agents can improve soil water penetration and increase soil moisture (3). However, on fine textured soils the data supporting the benefits of wetting agents is less convincing. Research in central California demonstrated that wetting agents helped to retain higher soil moisture when compared to untreated controls (6). Dr. Keith Karnok, professor at the University of Georgia observed increased soil moisture where dense bermudagrass turf was established on fine textured soil with the use of wetting agents. However, Dr. Karnok acknowledges that although the results were encouraging, the "jury is still not out" with regard to the benefits of wetting agents on fine textured soils (personal communication).

Using soil moisture and salinity sensing technology

At the Desert Mountain properties in Scottsdale, AZ where six golf courses are maintained, Mr. Shawn Emerson, Director of Agronomy, and his agronomic team have utilized a combination of in-ground soil moisture and salinity sensors and hand-held moisture meters to reduce water and energy use. Given that all six courses irrigate with recycled water, there was a real concern for elevated salinity levels. To mitigate salts, previously, each course would leach approximately twenty times per year, each time utilizing about 450,000 gallons of water for all six courses. The frequency of leaching has been reduced to only six times per year once the salinity sensors were installed, yielding a savings of 6.3 million gallons of water per year. Moreover, a reduction in leaching means beneficial nutrients such as potassium, nitrogen and calcium are applied less frequently since they are not leached from the turfgrass rootzone.

Desert Mountain recently implemented the IBM Intelligent Operation Center software for Smarter Cities® that enables the agronomic staff to manage the incoming and outgoing water, monitor for system leaks and analyze trends in water use from one location in real time. A recent October rain event triggered the operation center to shut off the irrigation system at all six courses, saving millions of gallons of water in one night. Prior to utilizing the sensors and installing the IBM system, each course used approximately 5.5 acre-feet per acre annually, nearly 1 Billion gallons of water. The courses now use approximately 4.9-5.0 acre-feet per acre, yielding a savings of over 10 million gallons per golf course per year.

Figure 5. Utilizing soil moisture and salinity sensing technology has the potential to yield substantial water savings when applied throughout the golf course.

Figure 6. Many courses will omit overseeding on 30 to 50 acres of rough. It is estimated that 1–2 acre feet per acre in water is saved as a result of this practice annually.

Eliminating overseeding

Many courses in the desert southwest have reduced overseeded acreage. Although it is difficult to quantify the water savings resulting from this strategy, it is estimated that courses may save 1–2 acre feet per acre per year. Many courses will omit overseeding on 30 to 50 acres of rough, a practice strongly encouraged by USGA Green Section Agronomists. As a result the water savings and reduced labor and energy costs is substantial.

Conclusion

In the southwest region, the cost of water, the electrical costs to pump it on the golf course and labor costs associated with maintaining the system demand that golf course superintendents manage water efficiently. The five strategies described above are being utilized by many southwestern superintendents and will hopefully encourage turf managers in other regions to incorporate similar ideas into their agronomic plan. Courses implementing many of these strategies have proven that water can be saved while producing quality playing conditions. Examples of successful water stewardship by the golf industry need to be shared with county, state and even federal officials.

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Water Impact on Golf Development and Operations

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From entitlements and permits to direct operating expenses, water influences the economic development and operations of golf facilities in several ways. Specifically, this article addresses the key financial indicators influenced by water and best management practices for facility development and operations. A brief introduction looking at emerging trends related to the use and misuse of water in golf facilities will be presented.

The resort and residential development process and cycle that includes a golf course must consider water availability and cost. In the long–term, water will impact the day–to–day operations of the golf course on a development property. Looking forward, there are several trends for golf development and management that will deal with water, as well as other important economic issues.

Development Process and Cycle

There are certain factors that need to be considered at the very start of a development project that includes golf as an amenity. Developers know that golf is a signal of lifestyle, and their target demographics are age cohorts that are greater than 45 years of age with an average annual household income in excess of $74,000. There are five to seven market segments which reference golf as a signal of lifestyle. These five to seven segments vary by household net worth, household net income, age at the time of purchase, geography, and last, where children and grandchildren are located. When developers start a project, they pay attention to what their market segments are, and how they are going to attract them. Whether developing resorts or residential communities, there are two vital characteristics that need consideration: time and timing. In other words, the *time* it takes to get a project underway, and how quickly you can absorb your product and sell it to someone else, as well as, *timing* as it relates to the cost of capital that you bear.

From 1995 through 2010, 83% of the golf courses delivered were within a master plan community, 11% were stand–alone golf courses, and the remaining 6% were government or municipal projects. In the next cycle of residential development, one vital fact for consideration is that 91% of home purchase decisions are made by a female. An important characteristic related to a female making this decision is that women are more deliberate and cautious buyers. Also, developers have started to understand that women pay attention to environmentalism and want to live in communities that are safe, use water properly, and routinely do the right thing as far as Mother Earth is concerned. For those in the 57 to 62 age cohort, many believe this is the last home they will ever buy. They tend to look at the home 10 to 12 times compared to a normal home buyer who looks at a home three to five times before making the decision to buy or not.

Figure 1. From 1995 through 2010, 83% of the golf courses delivered were within a master plan community.

Developers are indifferent about the oversupply of

golf courses and consistently include golf in the master plan because it helps sell property. Their focus is on serving shareholders, and this is achieved by including amenities that cause homes to sell at a higher price and faster pace. Home sales are driven by attractive views. For example, views of water edges or shores where life happens are more popular than views of water that goes on for miles. In addition, long views help sell homes, so if you are building along the front range of the Rocky Mountains, you do not need a golf course if there is a view of the mountains. Last, women are shopping for a property that provides a social platform for life. They are looking for the ´Four Fs´ – Fun, Friends, Family, and Fitness.

Development Questions Concerning Water

Among the water-related questions that must be address by a development project are the cost to access water, or how do you go about getting water? Second, what is the cost to deliver and secure water? These are macro calculations that occur before the developer buys the land. If water cannot be accessed and secured for the golf course, or the cost of delivery is so expensive that it trumps land cost, then the project does not move forward. A third consideration is the cost of water infrastructure, in other words, the water is available but what will it cost to get it from the source to the development? Fourth, what are the ongoing and recurring capital costs of delivering water? The further water has to be transported, the greater the cost—a cost that has to be charged to the homeowner association fees to keep the community alive. Next, what is the allocation method for the costs that go into the common cost pool? The common cost pool is allocated out to every lot in the development, and the design characteristics that go into the common cost pool must be addressed.

In order for a project to succeed in the long-term, a developer needs to know what entity owns or controls the water supply. How long will the secured water supply be available? What is the backup water supply? How does one shop for water resources? In the next cycle of home development, there will be a lot of shopping for water resources.

Operational Impact from Water

The three viewpoints by which golf operators analyze water include availability, cost, and quality. The recent weather patterns in the U.S. have impacted the availability of water. Around 65% of the country in is a drought, and 21% is in extreme drought. This widespread drought has caused the cities and municipal water utilities to rethink how they manage water. Water restrictions are becoming commonplace, and golf operators expect them to become mandatory, particularly

Figure 2. Golf courses help sell real estate and developers are indifferent about the oversupply of courses.

for the Southwest. Also, water use regulations that restrict the amount of water golf courses can withdraw from wells are being implemented across drought stricken areas.

From a water cost standpoint, the financial issues that cities face have caused them to raise prices. Water prices have increased 25 to 50% over the last few years and many golf courses cannot afford to use water as they did in the past. In some areas, recycled water is the same price as potable water. There some golf courses in the Nevada, Arizona, and California that spend a million dollars per year for irrigation water. A serious financial problem exists where the cost of water is increasing faster than the rate of increase in golf course revenue. From a water quality standpoint, 46% of golf courses draw their water from wells on the property. As the water is depleted from aquifers, the quality of the water tends to decrease. For example, the droughts in Texas have resulted in additional costs to treat well water, as well as expenditures to utilize turfgrasses that can tolerate higher salt and bicarbonate levels.

Over the last few years, the economic recession also placed many financial pressures on golf course owners. The economics of spending $10 million to build a golf course does not work by itself, and therefore, most golf courses will still be built as an amenity to sell real estate, or by municipalities as parks and recreation departments expand access for local taxpayers. Golf is a very labor and capital intensive business with relatively low operating margins. Golf operations have high fixed costs to set the course up for play each day. Whether the course has one round or 300 rounds per day, the superintendent is required to spend the same amount to prepare the course. In the midst of a recession, the eco-

nomic pressures on golf course operations have caused several courses to close. However, the revenue decline for the golf industry has been less than other hospitality, retail, or consumer oriented businesses. The positive story to tell about golf is that it will be here in the future because so many golf facilities survived the tough economic conditions of the recession.

Due to the economic recession, the successful golf course operations have had to rethink or reset how they operate. The golf course superintendent has had to take most of the budget cuts since the golf operations budget is the largest for most facilities. Some golf course owners have reduced costs very strategically; however, several have not and they are paying a price for this mistake. A slow recovery is taking place and courses that made good strategic decisions to weather the recession are taking market share from courses that made poor decisions. The combination of water availability, cost, and quality has had a particularly profound impact on how golf course operations survived both the drought and the economic recession.

Golf Course Owners Must React

Golf course operations have reacted to the drought and economic recession by changing how the golf course is managed. First, many courses have reduced the number of acres of turf that are maintained and irrigated. Turfgrass is being replaced in the rough and out-of-play areas of the course with natural or low maintenance vegetation. The creation of natural areas actually helps give the golf course more character if done correctly. As less turf is being maintained, less is being spent on pesticides and fertilizers. Second, there is an increased focus on the irrigation practices on golf courses. Irrigation audits have revealed how much water is being wasted on some areas of the golf course, and new, high technology sprinkler heads allow better accuracy and distribution to play areas. Soil sensors have demonstrated to golf course superintendents that they can reduce water use by 20% and maintain healthy turfgrass for golf. In addition to reducing water, several courses are switching to recycled water.

Both superintendents and golfers are being educated about the advantages of maintaining golf courses with firm and fast conditions. Wet and soggy conditions may produce lush, green turf; however, these conditions are not good for the game of golf. Cultural practices are being implemented to improve the ability of turfgrass to survive periods of drought, heat and excessive humidity. Poor agronomic practices that lead to unhealthy turf make golf courses much more vulnerable to weather extremes. Golf course budgets are now being divided into agronomic and detailing budget categories. Even though budgets are tight, golf courses cannot cut back on the agronomic practices that produce healthy turf. Budget adjustments must be made on the detailing of the golf course.

Different turfgrasses are being evaluated for use on the golf course. For example, in the Mid-Atlantic region of the country, bentgrass fairways are preferred; however, with high summer heat and humidity many courses are turning to zoysiagrass or bermudagrass for fairways. Seashore paspalum has worked in drought stricken areas in the south that have to use poor quality water. Most golf course owners feel that the technology, grasses and agronomic practices are available to help make better decisions on how to reduce water use on the golf course. The biggest obstacle facing golf course operations is the perception of golfers concerning what is the appropriate turf condition outside the fairway. In the U.S., golfers believe the course should look like Augusta National and not St. Andrews. We no longer can afford to maintain our golf courses with wall-to-wall, lush, green grass all year long. In drought stricken areas, golfers are starting to accept well maintained greens, tees and fairways, with tougher, rough areas receiving no irrigation. Homeowners that live around the golf course represent an even larger obstacle when it comes to water management.

An even larger obstacle is the homeowners that live in homes around the golf course. When the golf course decides to brown-out some rough areas or establish native plants, homeowners often complain and even sometime threaten with litigation.

Where Help Is Needed

Golf course operators need the help of the allied golf associations to help educate the golfer about appropriate turf conditions. In other words, a golf course should provide quality greens, tees and fairways, but once outside of these areas a more natural landscape is acceptable. Homeowners and homeowner associations need to be educated so they understand that natural areas save resources and are environmentally responsible. Continued education is needed for golf course superintendents regarding the best practices necessary to maintain healthy turf that plays firm and fast. Also, there is a need to communicate with legislators at the local, state and federal levels to maintain a level playing field for the golf business.

Forward-Looking Trends for Golf Development and Management

To summarize, there are six trends relative to water that golf development and management will have to deal with in the future. First, water supply will be progressively more difficult to secure. This is particularly true in the Southwest were population growth has outpaced the available water resources. Second, the stor-

age costs of water will continue to increase in the future. An increase in reservoir capacity translates to more acreage needed or more earth moved during project development. Third, developers must secure alternative deal structures and financial sources to initiate and complete projects. Before a shovel is put into the ground, the wide range of investors involved will require an exit strategy concerning the golf amenity. The developer and investors do not want to be saddled with subsidizing a golf course operation in the long term.

The fourth trend is the need for a change in the golf course design and features to meet the challenge of increasing maintenance costs and scarce resources. New golf courses are being designed better, but older courses need to be remodeled to reduce turfgrass acreage, decrease the areas irrigated, use more natural vegetation, as well as reduce the number of bunkers or other high maintenance features. Help is needed to identify plants for out–of–play areas that look good, are low maintenance, and acceptable to golfers and homeowners. A fifth trend is that areas of the country which are the most prone to growth (FL, NV, AZ, CA, and OR) tend to be unfavorable markets for golf with scarce water resources. However, a new dynamic on where people retire is their effort to be close to children and grandchildren. It is very possible that population growth in the future may be in areas where water is more abundant.

Finally, is ´brown´ the new ´green?´ In the past, developers have promised paradise which had to be green; however, acceptance of brown landscapes will depend on market, consumer segment, and what the end user is seeking. Developers will be effective when they can truthfully point to the fact that the development is a fantastic, natural destination that conserves scarce resources. The golf industry needs to change the mindset of golfers and homeowners about what is a beautiful and natural golf course.

Making Hard Decisions About Hard Times: Benefits of Proactive Drought Planning

Karen Guz, Conservation Director
San Antonio Water System

Texas has experienced extreme weather conditions in recent years with drought restrictions present in some areas for three out of the last four years. This now presents the opportunity to have realistic discussions about how to manage and conserve water every year to minimize drought impacts. The challenge is to balance the need to secure water for health and human safety, the need to manage water costs, and the need to have economic security for industries that depend on water as part of their business. Thoughtful planning and proactive programs are needed and can avert many of the negative consequences of poor drought planning and implementation.

Drought has become an unfortunate fact of life in the United States. Increasing populations, unpredictable weather patterns and technologies that enable large consumption of water have combined to exacerbate the pain of dry periods. Water supplies that appeared vast have declined at alarming rates when rain has lessened and temperatures increased. In the absence of orderly planning, the result of these conditions is not pleasant or productive. If decisions are made in the middle of hot and dry conditions, they are less likely to be based on data and with sound planning principles. Making hard choices about what to do with limited water is always rife with conflict, but a plan that works is more likely if all parties work together before it stops raining.

For those whose living depends on a constant water supply, it may be tempting to deny the possibility of severe water problems. Recent droughts in California, the Midwest, and Southeast have demonstrated that this is unwise. Water is clearly not just a Southwestern problem. The challenge of coping with intermittent dry periods is actually harder than managing in a consistently dry area. When water is usually generously available, it is seems unnecessary to learn to manage with less. While it is understandable that drought plans in some regions were dusty until recently, it will be a shame if recent droughts go to waste as a lesson in the importance of planning.

The old mantra of "hope for the best, but plan for the worst" is a theme that should be included in every community water management plan. Asking just how bad it can get and how fast is difficult, but necessary. History of prior droughts provides insight. Setting out a "drought of record" scenario for planning purposes includes analyzing how long dry periods have previ–

Figure 1. Drought is becoming an increasing problem in the United States

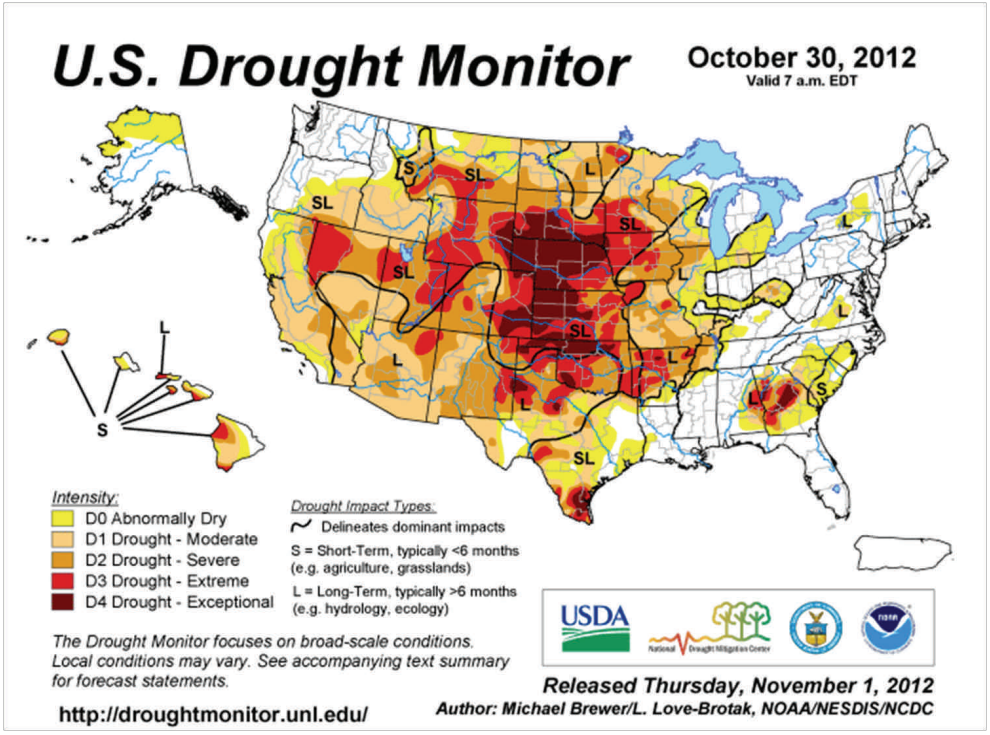
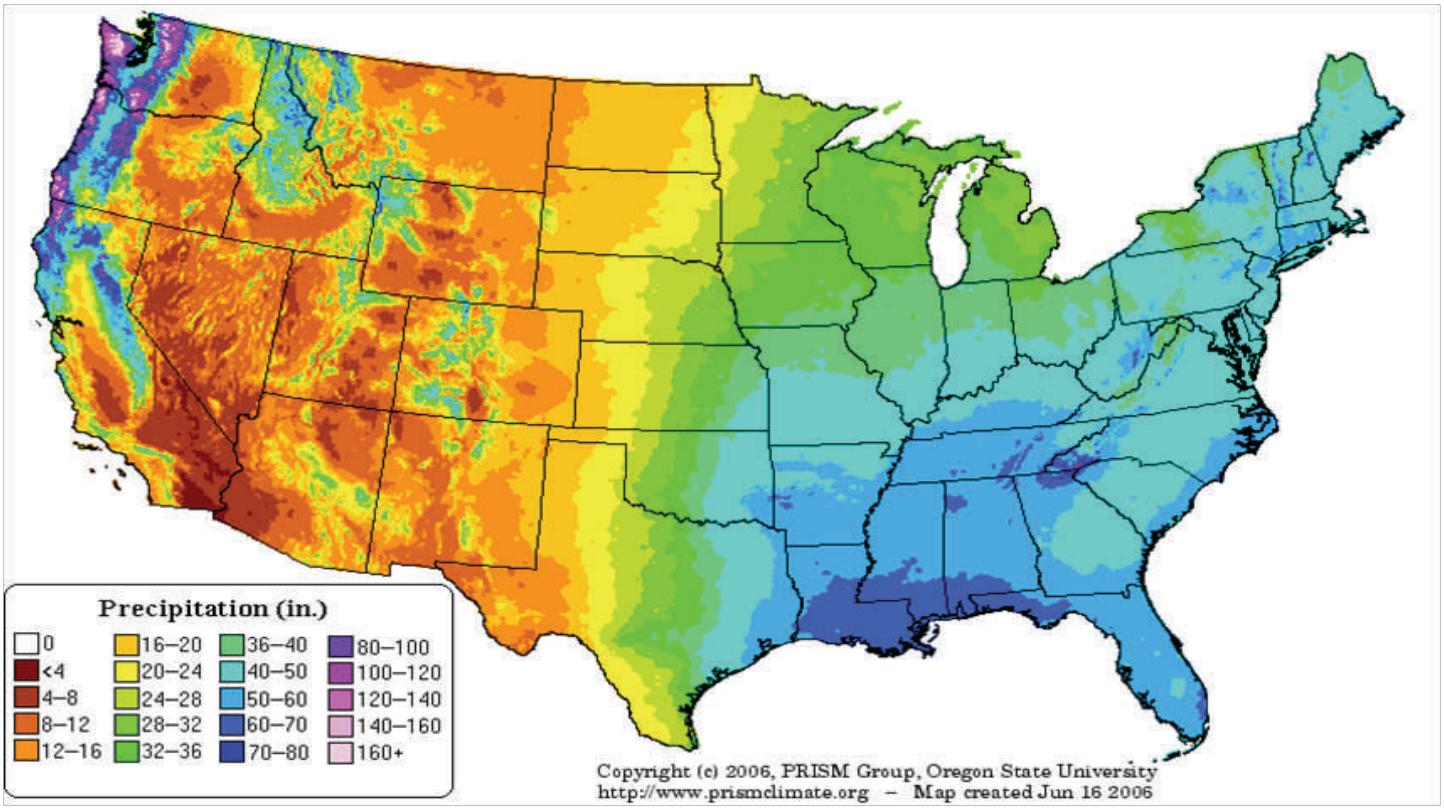


Figure 2. Rainfall (precipitation) patterns and drought records help for planning purposes in analyzing how long dry periods have previously lasted and how severe they were. This should be modeled with current consumption patterns and may bring to light startling predictions of how rapidly supplies could dwindle in the future if no water strategies are put in place.



ously lasted and how severe they were. This should be modeled with current consumption patterns and may bring to light startling predictions of how rapidly supplies could dwindle in the future if no water strategies are put in place. A combination of actions may be considered to improve drought of record outcomes. The options may include acquiring additional supplies, reducing consumption through efficiency measures, and imposing regulations on use during certain conditions. Every water user has a stake in these strategies because they all have a cost in either capitol dollars, changing technologies or in the cost of imposing restrictions.

Scientific data, public opinion and human behavior all influence how drought plans are written and implemented. There are more factors to consider than the simple question of what changes will reduce water demand enough to stretch supply. The ability to achieve compliance and maintain community harmony during a drought also depends upon balancing public perception of fairness against the analysis of scientific data. A quick look at the comment sections on drought articles illustrates how public willingness to sacrifice during a drought is influenced by whether they perceive that there is a shared pain everywhere. Individual home–owners may be largely unsympathetic to the water needs of businesses such as golf, pool manufacturing and car washing which are perceived as catering to the wealthy. This challenge can be overcome if it a drought plan includes communication regarding the shared sacrifice all water users are making to manage the circumstances.

It is challenging is for community members to prioritize water uses. Water for health and human safety is easiest to agree on. Assessment of the value of water used beyond basic needs is harder. One way to frame the question is to ask which uses of water can be temporarily discontinued and result in the least long–term economic damage to a community. Uses that include home swimming pools, car wash operations, decorative water features, aesthetic landscape irrigation and golf are all discretionary in that their operation is not essential for basic daily human needs. But it is a reasonable and logical community goal to avoid long–term economic harm from droughts whenever possible. The focus of drought rules should be on how to reduce water use from all discretionary uses in ways that causes the least economic disruption and long–term harm, while achieving necessary reductions for each phase of drought. Ultimately achieving the water use reductions

is the priority, but there are ways to design and implement drought stages that decrease the harm to water dependent industries.

Some general principles should guide drought planning:

1) Analyze the impact of each reduction measure required.

This may seem obvious, but it is often not considered. Some regulations may be symbolic such as turning off decorative water features as a visual cue that drought stages are serious. Other changes may be put in perspective regarding the percent reduction needed for a particular stage. For example if landscape irrigation accounts for 40–60% of summer demand, a minor regulation of this usage might have a significant impact on stretching the water supply during drought.

2) Reward efficiency implementation with drought plan

Regulations that simply direct users to "reduce 20% from prior average" discourage long–term efficiency. Where possible work with industries to set benchmarks for reasonable water use. Reward the sites that are always efficient with less strict reductions during early drought. One way to do this is through voluntary certification programs that bring with them opportunities for more flexible drought responses. This is especially important for water use industries that may draw negative attention otherwise. Golf courses, car washes, swimming pools and landscape operations may all benefit from demonstrating proactive water efficiency that can be verified through a third party. Rigorous conservation plans can be submitted by these users with documented benchmarks to verify savings during all times and to increase savings during drought.

3) Plan the implementation of the reduction measures.

Thinking through how drought plans will be implemented is as important as writing the rules. Will any variances be allowed? Who will grant them and under what circumstances? Consistency and efficiency are critical when weather conditions are harsh. Stakeholders such as golf, car washes and landscape industries can help themselves by suggesting moderate variances necessary to specific operations that may be allowed under limited circumstances and how these might be managed administratively. Variances given without thought to the overall goal of reduction and compliance with reduction goals can derail public support during drought, so it is important to be aware of public perceptions. Part of successful drought implementation is making compliance with regulations transparent.

4) Plan education of the public during the drought.

Communication with the public and with impacted stakeholders is necessary to achieve compliance. Having established relationships between the water utility and the stakeholders in advance of drought implementation is enormously helpful.

5) Distinguish between early drought regulations and emergency measures

Early drought measures should be put in place to stretch available supplies so that it is possible for conditions to ease before harsh regulations are needed. It is unfortunate that in some regions drought plans are either ignored or not strenuously enforced until an emergency develops. Once a community realizes that their water supply has dwindled down to an alarming six to twelve month supply, there will be little sympathy for discretionary use industries. Being ready for the worst–case scenario means not risking that early drought will end with timely rains.

Summary:

There is no question that droughts have been hard on the golf industry in recent years. Courses have been ravaged by lack of water and trees surrounding some courses died. Climate experts cannot promise that the extreme conditions that have occurred will not repeat during the next decade. There is no simple answer for golf stakeholders because the regulations and water supplies are unique in each region. The best defense against drought related crisis is for golf experts to gain as much knowledge of their water supply challenges and local water management plans as they have of agronomy and game strategy.

Shifting Watering Decisions from Art to Science

Dana R. Lonn, PE, Managing Director
Center for Advanced Turf Technology
The Toro Company

Using water efficiently is a tough problem. We are trying to replace natural rainfall with artificial irrigation. With limited supplies of water, we must be certain that we are using water where, when and how much is needed. Accomplishing this goal drives us to utilize science and technology. We need more control and feedback to aid people in making decisions that optimize performance and minimize inputs.

Turfgrass like other plants requires water, sunlight and nutrients to grow. Nature serves as an excellent irrigation system by providing uniform applications (on a local basis) of high quality water through the process of precipitation. However, precipitation is not reliable in some seasons and/or locations and may be insufficient to support the plant community. Under these circumstance, human intervention in the form of irrigation is required to sustain plant systems. Rainfall is very challenging and difficult to duplicate, and as we use irrigation systems to supplement water not provided by nature, we need to take a great deal of care to use water efficiently.

Plants draw their water from the soil via their roots. Soil is a matrix of particles that provides a medium for the storing of water, gases like oxygen and carbon dioxide and plant nutrients. The soil has a finite capacity for storing water that is available to the plant. The full point or maximum amount of water the can be stored without significant losses due to deep percolation is called field capacity (full). As plants draw down the supply of water from the soil, the surface tension of water that binds water to the soil matrix begins to limit the availability of water to the plant. Eventually, there becomes a point where the plant can no longer withdraw water from the soil matrix (empty). This point is called the permanent wilting point. The difference in soil moisture between field capacity and the permanent wilting point is referred to as the water holding capacity of the soil and is dependent upon the texture of the soil. Texture is another way of saying the size of the soil particles. The job of the irrigator is to make sure that soil water is maintained at an appropriate level between Empty (Wilting Point) and Full (Field Capacity) that produces acceptable quality plants.

Figure 1. How big is the tank? In other words, water holding capacity depends on the soil type or texture.

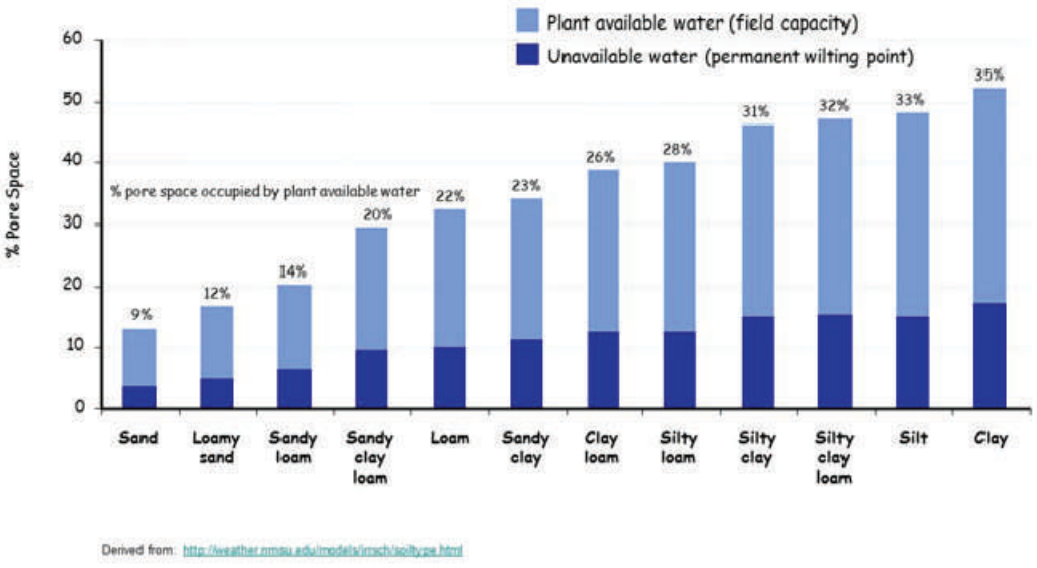
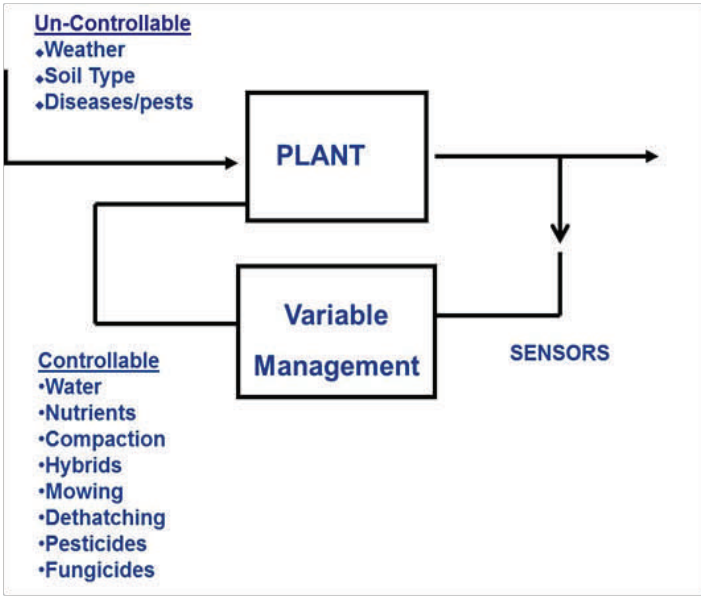


Figure 2. Schematic illustrating the controllable and uncontrollable aspects of managing soil moisture for healthy plants. Soil moisture sensors provide additional information to make better water management decisions.



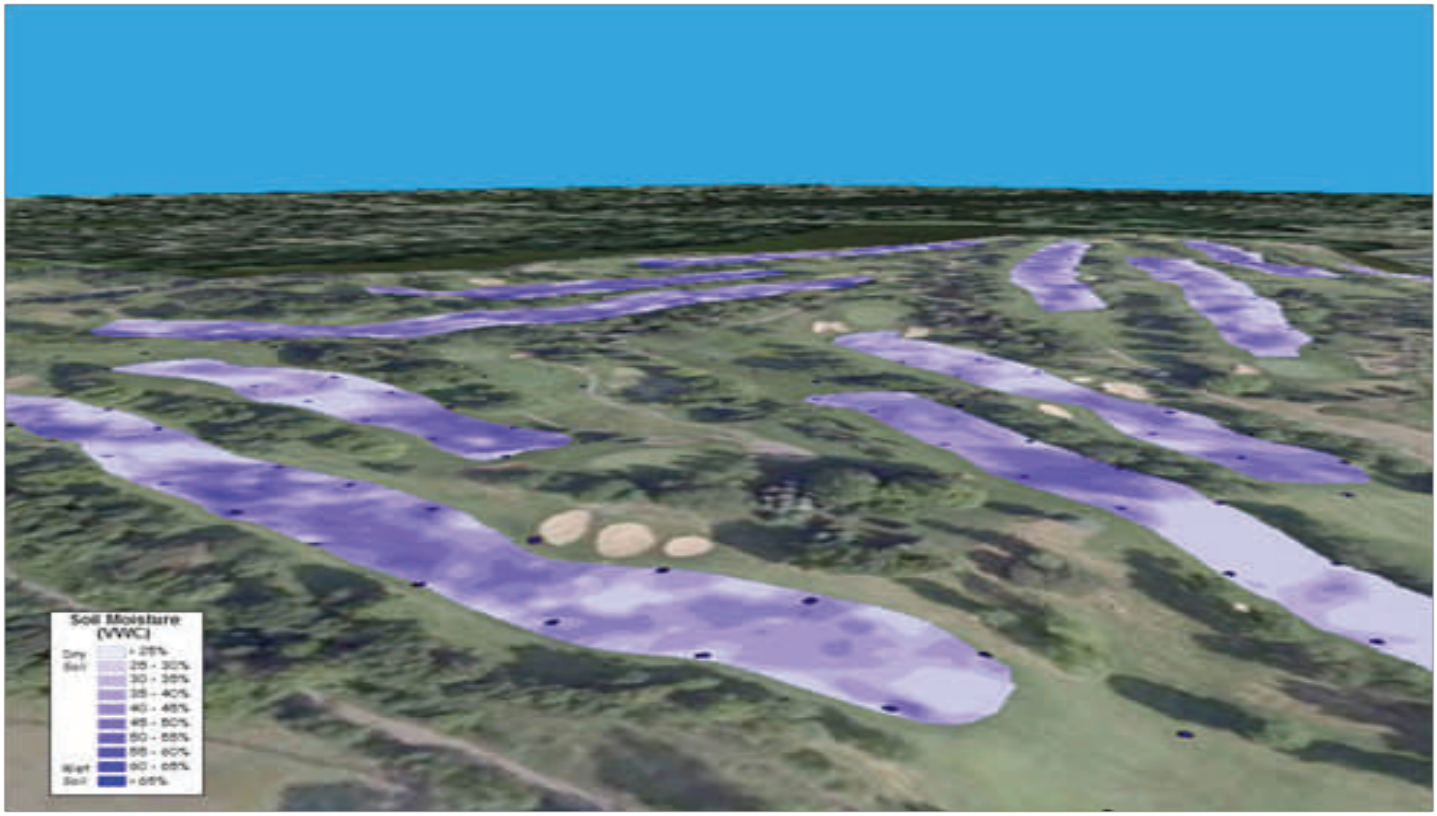
There are two critical aspects to assure the efficient use of water. First, we must be certain that water applied through irrigation actually gets to the tank that is the soil. Light irrigations and low application rates can result in significant evaporation from the the leaves, lowering the amount of water reaching the soil. If water is applied too quickly it will run off because it cannot be absorbed by the soil. If too much water is applied, soil moisture increases above field capacity (full) and the excess water is lost to deep percolation and is not available to the plant. We save water when we make sure that plants have sufficient water for growth, water is not wasted due to run off or deep percolation, and we maintain the soil water reservoir at levels that enhance the absorbtion of water that nature provides through rainfall. This requires precision, control, feedback and more points of distribution.

The use of technology to assist with management of irrigation is relatively new and began with the publishing by Howard Penman in 1948 of his equation to estimate the evaporation of water from an open water surface. This technology was further enhanced by John Monteith in 1965 and resulted in the development of an improved procedure for estimating evaporation from vegetation known as the Penman–Monteith equation. With the 1998 publication by Allen et al. of FAO Paper 56 "Crop Evapotranspiration – Guidelines for Computing Crop Water Requirements," the international community has accepted the Penman–Monteith equation as best means of estimating evapotranspiration (ET). Evapotranspiration (ET) which uses measurements of temperature, wind, humidity and solar radiation, is an appropriate first step in making better watering decisions. However, if we go back to the tank analogy, making irrigation decision using ET alone is analogous to deciding to fill up the fuel tank in your car based on how much fuel you used. It is better than no information; however, if you do not know how full the tank was when you started the trip or how large the tank is you are in danger of going to the gas station more often than needed or worse yet, in danger of running out of fuel. Today, we are poised to make a major step forward in irrigation management by moving from estimating water usage (ET) to measuring soil water availability.

Future watering decisions will be made with the precise knowledge of the moisture status of the soil. We will be able to measure soil moisture with appropriately placed sensors. Moisture sensors are an old idea that did not work in the past. Why now? There were two reasons for the difficulty and delay in the widespread application of moisture sensors. One was sensor reliability. That problem has been solved. The incredible advancements in size, power requirements, capability and reliability of electronics have made things that were difficult or maybe impossible five years ago easy and relatively inexpensive today. The second reason for slow acceptance of soil moisture sensors was the common perception soil variability would make it impossible to install enough sensors to characterize the site. There is no doubt that more sensors are better than fewer sensors. Cameras with more pixels produce higher quality images than those with fewer pixels. However, it is not necessary to have a high density image if the intended use is only for viewing email. Similarly, when we install moisture sensors in a turf setting we need to shift our thinking from how we characterize all the variability on the site to understanding the needs of the site. Our ability to act is dependent on the density of the irrigation pixel which is an irrigation zone or head in the case of individual head control. We also need to change our mindset from how much variability there is to how we find places that are good indicators of water need.

There are many high quality moisture sensors available in the market today. Moisture sensors are available from the major irrigation suppliers like Toro and Rainbird, They are also available from instrumentation suppliers such as Spectrum Technology, Stevens and Decagon. These new sensors are very repeatable and can accurately characterize the soil moisture that is available to the plant. There is some discussion in the market about the absolute accuracy vs. relative accuracy (repeatability). It is my opinion that repeatability is critical. The measurement that matters to the plant is the status of soil moisture relative to the full and empty points. That requires knowing the volumetric water content and the soil texture. Accurately characterizing

Figure 3. For the first time, new technology provides information on the spatial variability of larger turfgrass areas for soil moisture. This allows for the strategic placement of soil moisture sensors to help manage irrigation water more efficiently.



soil texture is not simple. It is however very simple to install a sensor and learn the full and empty values for the soil water reservoir. Full is found after a significant rain event (or irrigation event). A rain event of 1 to 1½ inches will bring most soils to field capacity in the turf root zone. This empty point is the desired moisture depletion and is found by allowing the site to dry until the onset of wilt. You have now established the target watering zone. It is not necessary to know the volumetric water content or the soil texture on an absolute scale.

At The Toro Company, in partnership with university scientists, we have studied the variability that exists in golf course and sports turf sites. We started by taking measurements and soil samples by hand on tight grids at separations of a meter or two. The variability was significant but not overwhelming. It does, however, provide important information on the underlying soil conditions of the site. Efficient watering requires a knowledge of where soil moisture is relative to full and empty. Zones with heavier soils have larger water holding capacities, require lower watering frequencies and must be watered at rates that allow the water to be absorbed without running off. Lighter soils, retain less water and require that water be applied more frequently and in smaller amounts. Optimized watering requires watering based upon zones that are agronomically similar, not hole by hole. We want to water only when there is insufficient water to support the plant. We also want to make sure we have the soil reservoir prepared to receive rain which is accomplished by maintaining the reservoir below field capacity to enhance infiltration and minimize runoff into streams and surface water bodies. The best way to conserve water is to have the soil relatively dry when rain occurs. This also helps to minimize runoff into surface water bodies.

Conclusion

Water use efficiency is one of the most important environmental issues of the 21st Century. It is not about turning the water off, but rather one of prioritizing the demands on water and then ensuring the optimum use of water for the intended purpose. Water is often required to produce the quality turf surfaces that support golf and other recreational activities. However, we need to make sure that golf and other sports facilties use only the water needed to achieve an acceptable turf surface. Using less water is about using appropriate technology. The number of control points (heads) and proper placement of sensors can optimize irrigation ef-

ficiency and achieve the desired result of producing an acceptable playing surface while minimizing water use. It is about optimization, control, and measurement. Future irrigation systems will use an appropriate combination of heads (number, spacing and type) and smartly placed soil sensors in conjunction with weather forecasts to anticipate water requirements. Because each facility is unique, the way in which these new technologies are utilized for water conservation will be site specific to achieve the desired results.

Uncovering the Past to Find the Our Future

Bob Farren, Director

In March 2010, Pinehurst embarked upon perhaps one of the boldest golf course restoration projects ever undertaken. After a great deal of research, it became apparent that the majority of the changes to the course design and strategy of Pinehurst No. 2 was attributed to the expansion of the irrigation system to support numerous acres of turf. The project resulted in a reducing the total acres of irrigated turf from 90 acres to 50. The total number of irrigation heads has been reduced from 1150 to 450. The "old school" center line irrigation in the fairways now determines the strategic lines of the course. The turf quality and resiliency is far more predictable the closer you are to the center of the otherwise expansive fairway lines.

In March of 2010 Pinehurst embarked on perhaps the boldest golf course restoration project that has ever been undertaken. Pinehurst No.2, site of many national championships, has had a complete makeover to return the natural classical features that it was known for in decades gone by.

Pinehurst No.2 has always been held in the highest regard by many of the game´s greats. Golf legends like Jack Nicklaus and Arnold Palmer, have always showed great admiration for Course 2, what many consider to be Donald Ross´s greatest masterpiece. However, often in their praise, they would refer to the course. (and I quote) "the way it used to be."

For more than a century Pinehurst No.2 has been a great test of championship, as recently as the 1999 and 2005 US Open Championships. However, many people in the golf industry, including Pinehurst owner Bob Dedman and President Don Padgett II, were concerned that changes to the course over the years had covered much of the character and Ross features that had earned its reputation in the golfing world.

It was during the 2008 U.S. Men´s Amateur at Pinehurst that thought was first given to restore the natural sandy wiregrass features of No.2. Mike Davis, then USGA Championship Director, had some specific ideas in mind that had a great deal of merit. As the conversations progressed from there it became apparent that, with a full–scale restoration, we had an opportunity to make a significant statement for the golf industry. The design team of Bill Coore and Ben Crenshaw was selected to lead in the process.

Although Pinehurst at that time had been selected as the site for the 2014 US Opens, the restoration project was not initiated specifically because of the Opens. Rather, the project was initiated to protect and restore the resort´s most significant asset to ensure a successful business model for the future.

Pinehurst, along with the USGA, Coore and Crenshaw were fortunate to gain access to images and aerial photos of No. 2 taken on Christmas Day 1943. The photos provided a glimpse into the world of golf before the advent of modern irrigation and grassing schemes. Coore and Crenshaw provided a team of extremely talented individuals to implement the corrections they felt were important to return the natural character to No.2.

The significance of the changes will make a great stage for future championships but also leave a wide

mark in the arena of the Sustainability in golf course maintenance. Though not conceived or implemented specifically for environmental reasons, the project has served as a perfect platform to introduce the concept of sustainability to the golfing world.

There are three primary components of Sustainability many times referred to as the three P's. These stand for the People, Planet and Profits. The No.2 restoration has been successful in all aspects.

The restoration certainly impacted the People aspect in many ways. It is common for any course to make significant changes as it prepares for major Championships. No.2 has undergone many tee additions, fairway width adjustments, rough heights, etc. in preparation for U.S. Opens in 1999 and 2005. Those changes have had minor long- term impacts on the course experience for the day to day resort guest or member. However, the changes that been implemented since 2010 has impacted all that play the course.

Over forty acres of Bermuda turf has been removed. The fairways are nearly twice as wide as a typical US Open course with essentially no rough. The conventional bermuda rough has been removed and replaced with sandy areas and native vegetation. The irrigated area has been reduced from approximately 85 acres to 45 acres. The course once had over 1100 irrigation heads and now has only 450 with half of them covering the greens and tees.

Another area where we are conserving is through the elimination of overseeding in the winter months. With the restoration, we have discontinued the practice of overseeding in the winter. The elimination of the ryegrass has resulted in vastly improved conditioning levels and a significant reduction in water use. We continue to report the annual total water withdrawal to the State of North Carolina Division of Water Resources. Harold Brady, Water Supply Planning Branch reports that with 12.3% less rainfall in 2011 compared to 2010, Pinehurst No.2 used 26.1% less water than in same reporting period for 2010.

The restoration project has also attracted interest from other disciplines in the community of agriculture science. Dr. Danesha Seth Carley, Coordinator for the CALS Sustainability Programs for North Carolina State University, has conducted an in depth study of the project the ecological aspects of the design concepts.

Dr. Carley writes the following:

> *The move towards sustainability is creating new challenges for golf course management. Economic conditions, water shortages, and environmental awareness are leading to comprehensive changes in the golf course industry. Widespread efforts are being directed at reducing resource inputs, and the costs associated with them, and merging golf courses with their immediate, natural environment.*

Merging these managed turfgrass systems with the natural environment requires knowledge of the native ecology of the surrounding site and how to control it. All native species are not acceptable, even in out of play areas. And many locations have continual pressures from invasive species that pose ecological threats. For Pinehurst No. 2, encroaching vegetation has never been systematically cataloged, and little is known about appropriate integrated management strategies to selectively control unwanted weed species.

In this project, we are characterizing native vegetation, desirable adapted species, and invasive weeds on the Pinehurst No. 2 site as it transitions from the recent renovation. Using the 2012 research data, we are now beginning to explore appropriate weed control measures using integrated pest management (IPM) strategies and species-specific herbicides. This detailed ecological analysis can serve as a model for how golf course superintendents can successfully approach sustainability.

Pinehurst No. 2 continues to evolve as we allow it to mature to a more natural condition that offers a very unique challenge and appearance. The players have embraced it, the community of golf architects have generally praised it, the business model has been positive and the environmental benefit will only continue as the years pass. We at Pinehurst look forward to the world and world's greatest golfers seeing what we have uncovered on Pinehurst No.2 during the Championships in 2014.

Designing Golf Courses for Water Conservation

Bill Love, ASGCA
WR Love Inc. / Love & Dodson LLC

How can golf courses be more sustainably designed to use less water? This article includes an examination of the issues impacting golf course design and the management of water resources. Water conservation on golf courses begins by addressing the issues of resource management and conservation throughout the design process for new golf courses and the renovation of existing facilities.

The first golf courses appeared along the coastlines of the British Isles in Scotland and Ireland. At certain points on these coastlines, where the confluence of rivers and the sea occurred, a very unique landscape called "linksland" was formed over time by the forces of nature. This physical characteristics of linksland provided an ideal setting for playing golf and the first golf courses were simply discovered by local people as they explored these landscapes. Golf, as then played in the linksland, represents the fundamental relationship between the game and the environment, that of playing over and against the existing landscape with the elements as your companion.

The discovery of golf holes in the linksland was a selection process and represented the earliest form of golf course design. Through this selection process, from the larger scale of the landscape to a smaller scale of individual golf holes to yet a smaller scale of tee and green areas, the first "course designers" were completely reliant upon the features and other existing conditions of the landscape. In this design process, the environment dictated to the discovery and creation of these golf courses. There was no thought to try and manipulate the landscape, nor was there a reason to. You played the course as you found it.

As golf continued to spread to new areas and courses were created on a greater variety of landscapes, the environment continued to serve as the foundation for design. Landscapes with an abundance of natural features still provided the best opportunity to create a golf course that would fit seamlessly into its surroundings and stimulate the imagination. These landscapes produced appealing golf courses because they had a natural advantage. In choosing these landscapes, the early designers recognized the incomparable work done before them. After all, Mother Nature is and always will be the ultimate "designer." Her landscapes are perfectly orchestrated works of art that have an intrinsic beauty

Figure 1. Ballybunion Golf Club, Ireland – Early linksland golf course

Figure 2. Prairie Dunes Country Club, Kansas – Early American golf course

and appeal. They always function properly because their very existence is wonderful design in which many smaller ecosystems evolve into one larger compatible, efficiently functioning environment.

Designers explored these landscapes in order to understand how climate, topography, soils and vegetation functioned together a system. They recognized that by working compatibly the existing landscape, not against it, designers could lay a course lightly on the land and create an engaging golf experience that was indicative of the region and inseparable from its environment. While conservation of natural resources was not always an overriding concern in the past, today the protection and conservation of our natural resources are more important issues then ever. It is not simply about "going green" anymore, but rather about sustainability, the creation of sustainable solutions for quality development and resource management that are sound economically, improve social conditions and enhance environmental stewardship. The most important resource for a golf course is water. Typically one of the first design issues is source and availability of water for irrigation. This issue has become even more important with the emphasis and regulation placed on water resources. Regardless of water supply, the design process should still establish the conservation of water and other resources as a primary design objective, along with creating an attractive golf course that is fun to play.

Today, designers must return to the old playbook and perform a thorough site reconnaissance and analysis to completely understand the existing conditions of a proposed site. The various physical aspects of a site, along with climatic conditions will drive decision making from the onset of the design process. Regional context must also be investigated to fully understand a site and determine how it functions within this larger system. Issues such as watershed impacts, habitat connectivity for wildlife migration and infrastructure needs will have to

be addressed as a part of the design and permitting process. In addition to the broader contextual issues, the following characteristics of a site must be thoroughly investigated in order to create a sustainable design solution:

Climatic information, such as orientation of the sun, temperature ranges, prevailing winds and annual rainfall have be considered in the design and maintenance of the golf course. Golf holes and their features, such as tee and green complexes are strategically located to take advantage of wind direction and not be adversely affected by the orientation of the sun. The amount of annual rainfall will determine the adequacy of the water supply, design of the irrigation system and opportunities for water resource conservation.

Water availability and quality must be determined at the onset of the design process. Even with conservation, an adequate water supply of good quality will need to be available for irrigation. Sources such as groundwater, existing ponds or streams can often be regulated or restricted resulting in the need for supplemental sources of water. On-site impoundments, or alternative sources of water such as effluent often must be utilized to avoid reliance upon any type of public water supply.

The topography and natural features of the site have to be thoroughly studied in order to locate the golf course in the most advantageous areas. By properly utilizing the topography, the golf course can be designed to derive an inherent character and strategy of play from the existing landscape. Golf holes can be located to allow for water conservation by working in concert with surface drainage patterns and avoiding excessive or poorly oriented slopes. Also, by working compatibly with existing site conditions, the course can be constructed more economically.

Drainage patterns and water features, such as existing streams and ponds, have to be studied in conjunction with the topography. Designing a golf course with respect to existing drainage patterns is fundamental to water retention, conservation and efficient maintenance. By analyzing where and how surface runoff will move on a site, features and sub-surface drainage systems can be designed into the golf course to collect and impound stormwater in order to serve as a primary source for irrigation water or supplemental supply to reduce the demand on a primary source. To achieve high quality playability and efficient maintenance, a golf course must have the proper drainage. Ideally, water features can be incorporated into the design of the golf course to provide collection, but also to provide strategy and aesthetics for individual holes.

The composition of soils is an important component of the site analysis. The porosity of the soils, organic content, chemical content and amount of topsoil will all affect how the site can support plant material, specifically turf grass. The physical make-up of the soil, even depth to bedrock on some sites will have an impact on irrigation requirements and must be given consideration.

Vegetation consisting of trees, understory, shrubs and grasses are reviewed to identify the indigenous plant communities and wildlife habitat contained on a site. Areas of existing vegetation can be preserved and incorporated into the design of a course. They require no irrigation and contribute to water conservation, but also serve as the foundation for the aesthetics of a course and contribute to the design strategy.

Sensitive environmental areas, such as wetlands, fragile vegetation and protected wildlife habitat are carefully studied to determine their effect on or utilization in the design of the golf course. Sensitive areas typically require no irrigation or other maintenance and can often provide some of the most distinctive features on a site when incorporated as a part of the golf course in a compatible manner.

Based on the analysis of these basic issues, along with regional context and any specific issues, the constraints and opportunities for sustainable design and water conservation can be identified. Further enhancement of water conservation can then be considered in each of the following aspects of the detailed golf course design.

The routing or layout of the golf holes will not only impact water conservation, but is critical to the playability, maintenance and successful operation of a golf course. The location of golf holes determined by the routing should take advantage of the topography and existing characteristics of the site to create a unique but natural character for the golf course. Routing based on the constraints and opportunities analysis, as well as more field reconnaissance will respect the lay of the land, so the golf course can be compatibly integrated into its setting and result in more efficient maintenance, as well as reduce irrigation requirements. The routing must also ensure that the desired playability and aesthetics can be achieved for the golf course to be operated sustainably.

The availability and amount of water supply will be a significant determination in the design of the golf course and impact irrigation practices. On sites where a natural water supply is limited, restricted or practically non-existent, alternative sources of water, such as effluent or recycled water can be used as a supply for irrigation when available and economically feasible. In

Figure 3. Laurel Hill Golf Club, Virginia – Resource conservation and water quality

areas where there are sufficient amounts, rainfall can be collected and retained in ponds designed as a part of the golf course to serve as reservoirs and supply water for irrigation. To reduce the use of groundwater or off–site water supplies these ponds can be located to cap–ture as much storm water runoff from the site and drain–age from the golf course, as possible.

The golf course features, such as teeing areas, green complexes, sand bunkers and water features are de–signed to create the desired strategy, challenge and aesthetics for each golf hole. Whether the features are severe or subtle in nature, they must be designed to function compatibly with the existing conditions of the site in order to reduce development costs, the amount of required maintenance and provide the opportunity for water conservation.

Reducing high maintenance areas on a golf course is a significant way to provide water conservation. De–signing to reduce high maintenance turf areas must be done with consideration for the playability and pace of play for the golf course. At a minimum, tees, fairways, greens and a small primary rough are typically irrigated to provide the necessary playing conditions for a course to operate successfully. These areas can often be further reduced once the patterns of play for high handicap and senior players have been identified. Secondary roughs of accessible turf grasses can be limited to the areas of heavy play.

Turf grass selection and use of indigenous plant materials will also contribute reducing water use, as well as maintenance costs for the course. Design con–sideration must be given to the types of turf grasses to be used on a course and their ability to produce the necessary playing conditions. Selecting turf grasses which are most suitable for the micro–climatic condi–tions of a site, as well as being specifically drought and stress resistant, will allow the best use of an efficient irri–gation system and reduce irrigation requirements on the course during both typical and exaggerated weather conditions. Properly selected turf grasses can also result in less management requirements for chemi–cal use without sacrificing the playing conditions of the course. Indigenous grasses can be utilized in the secon–dary roughs and out of play areas to reduce, if not eliminate, the need for irrigation. However, these grasses can go off color under the stress of heat and drought or winter dormancy and must be properly de–signed to be compatible with the existing native land–scape and provide intriguing aesthetics in addition to environmental enhancement. Often an educational ef–fort is necessary to overcome misconceptions about off color grasses and provide information of their environ–mental benefits.

Conservation areas or other out of play areas con–sisting of native grasses, adapted grasses or other exist–ing indigenous vegetation that has been left undis–turbed on the site are incorporated into the golf course to reduce irrigation and maintenance requirements, but

also as environmental enhancement for the promotion and diversity of wildlife habitat. Many golf courses use natural areas to enhance their character by establishing a particular appearance and visual quality. In addition to further reducing irrigation requirements, the use or preservation of native grasses and other indigenous plant materials will reflect the existing environment and provide consistency for wildlife habitat.

The irrigation system can reduce water usage and provide conservation through highly efficient control and application. These systems are capable of being programmed for the application of water precisely where and in what amount it is required. Different irrigation heads are used to apply water only to the intended areas and soil moisture sensors, as well as weather monitoring stations built into the systems allow adjustments in the rate or frequency of application in response to soil moisture, temperature, wind and rainfall. In addition, irrigation systems can be designed in coverage zones for the maintained areas of each golf hole which allows the irrigation coverage to be reduced for the roughs, tees and portions of the fairways during periods of drought. Entering the dryer times of the year, when recharge to the water supply is minimal, zone coverage can allow irrigation application to be reduced by 50% and up to 70% under drought conditions to prolong the water supply.

Conclusion

All of the aforementioned design practices can contribute to reducing water use on a golf course when employed individually. However, the most successful designs will utilize all these practices in a holistic approach to water resource conservation. In addition, the golf course superintendent can often further reduce the use of water on the course through management practices that enhance what has been designed into the golf course.

In a way, the golf course design process and its relationship to the environment has come full circle since discovering course in the linksland. Today, innovative and sustainable golf course design combines art, science, engineering and common sense. In order to understand the environment involved in a landscape, we explore it in terms of opportunities to create great golf and constraints for environmental stewardship. By concentrating on the opportunities, designers can "discover" golf courses that will lay lightly on the landscape and possess the unique, inherent character found in every great test of golf. At the same time, by respecting the environmental constraints we create sustainable golf courses that compliment the existing natural systems of a site and provide resource conservation into the future.

Figure 4. Hunting Hawk Golf Club, Virginia – Water Conservation

APPENDIX – MEETING AGENDA

TUESDAY, NOVEMBER 6, 2012

		PRESENTATION TITLE	SUBJECT CONTENT
8 a.m. - 8:15 a.m.	Glen Nager, *President, USGA*	**Welcome**	
8:15 a.m. - 8:45 a.m.	Veronica Blette, *Chief, WaterSense Branch, USEPA*	**Federal Perspectives on Water and Golf**	How does the EPA see the future of water and golf's use of water?
8:45 a.m. - 9:15 a.m.	Mary Ann Dickinson, *Executive Director, Alliance for Water Efficiency*	**A National Perspective on Water Issues**	What can golf do to be a better partner in the effort to use water efficiently?
9:15 a.m. - 9:30 a.m.	**Break**		
9:30 a.m. - 10 a.m.	Mark Esoda, *CGCS – golf course superintendent, Atlanta Country Club, Georgia*	**Starting with an Open Hand: working with regulators and legislators**	What can golf do to work better with legislative and regulatory agencies?
10 a.m. - 10:30 a.m.	Greg Lyman, *Director of Environmental Programs, GCSAA*	**How Much Water Does Golf Use and Where Does It Come From?**	An analysis of golf´s water consumption and sources.
10:30 a.m. - 11 a.m.	Doug Bennett, *Conservation Manager, Southern Nevada Water Authority*	**Lean and Green: water efficiency in the Las Vegas golf industry**	Discussing the challenges of man–aging water in the desert and how golf fits in.
11 a.m. - 12 noon	**Panel Discussion / Question and Answer session 1 (moderated by Kimberly Erusha)**		
12 noon - 1 p.m.	**Lunch**		
1 p.m. - 1:30 p.m.	Chris Hartwiger, *USGA*	**Maintenance Up the Middle – great golf and water conserva–tion are not mutually exclusive**	Maintenance focused up the middle to save water, and, by the way, lots of money.
1:30 p.m. - 1:45 p.m.	Pat Gross, USGA	**Case studies in water use efficiency in California**	Case studies of courses with special water issues.
1:45 p.m. - 2:15 p.m.	Dr. Ali Harivandi, *Environmental Horti–culturist, University of California – Davis*	**Irrigation Puzzle: Sourcing Water For Golf Courses**	Trends in the use of recycled, reclaimed, or effluent water for golf course irrigation.
2:15 p.m. - 2:30 p.m.	**Break**		
2:30 p.m. - 3 p.m.	Dr. Mike Kenna, *USGA*	**Research Accomplishments to Meet the Present and Future Water Use Needs of Golf**	What has turfgrass research done to prepare for this challenge and what needs to be done in the future?
3 p.m. - 3:15 p.m.	Tim Hiers, *golf course superintendent, Old Colliers Golf Club, Florida*	**Irrigating With a Toxin**	A case study: Seashore paspalum and using brackish water for irrigation.
3:15 p.m. - 3:30 p.m.	Brian Whitlark, *USGA*	**Strategies to reduce water use: case studies from the southwestern United States.**	Case studies of courses with special water issues.
4 p.m. - 5 p.m.	**Panel Discussion / Question and Answer session 2 (moderated by Kimberly Erusha)**		
5:30 p.m. - 6:30 p.m.	**Reception**		

WEDNESDAY, NOVEMBER 7, 2012

		PRESENTATION TITLE	SUBJECT CONTENT
8 a.m. - 8:45 a.m.	Henry DeLozier, *Global Golf Advisors and Jim Hinckley, Century Golf*	**Water Impact on Golf Development and Operations**	A discussion of the economic issues surrounding the impact of water on golf course development and operations.
8:45 a.m. - 9:15 a.m.	Karen Guz, *Director of Conservation, San Antonio Water System*	**Making Hard Decisions About Hard Times: benefits of proactive drought planning**	How did the 2011 drought impact regulatory decision making for the year and in the future?
9:15 a.m. - 9:45 a.m.	Dana Lonn, *Managing Director, Center for Technology, The Toro Company*	**Shifting Watering Decisions from Art to Science**	Technology to improve the efficiency of golf course irrigation.
9:45 a.m. - 10 a.m.	**Break**		
10 a.m. - 10:15 a.m.	Bob Farren, *Pinehurst*	**Uncovering the Past to Find Our Future**	A case study: The renovation at Pinehurst #2 and how it impacted irrigation use.
10:15 a.m. - 11 a.m.	Rick Robbins and Bill Love, *golf course architects*	**Robbins – Golf Course Water Use – An International Perspective, Love – Designing Golf Courses for Water Conservation**	How can golf courses be designed to use less water?
11 a.m. - 12 noon	**Panel Discussion / Question and Answer session 3 (moderated by Paul Brown)**		

APPENDIX – SPEAKER INFORMATION

Veronica Blette | Chief, WaterSense Branch | U.S. Environmental Protection Agency

Veronica Blette manages the WaterSense program in the Office of Wastewater Management at the U.S. Environmental Protection Agency. Prior to her current position, she served for several years as special assistant to the Director of the Office of Ground Water and Drinking Water and also served as the team leader of the Drinking Water State Revolving Fund. Before joining EPA in 1997, she worked in the aca–demic research and environmental consulting fields on projects investigating the effects of atmospheric deposition on terrestrial ecosystems and water quality. Veronica has a B.A. in Geology from Smith College and M.S. in Geology from the University of Massachusetts.

Federal Perspectives on Water and Golf

The presentation will provide an overview of how the EPA, other federal agencies and businesses are looking at potential risks associated with water shortages and lack of access to clean and safe supplies of water. Veronica will describe how WaterSense is promoting more efficient use of water and how the golf industry might address this challenge above and beyond its current efforts.

Mary Ann Dickinson | President and CEO | Alliance For Water Efficiency

Mary Ann Dickinson is the President and CEO of the Alliance for Water Efficiency, a nonprofit organization dedicated to promoting the efficient and sustainable use of water in the United States and Canada. At its Chicago headquarters, the Alliance works with more than 365 water utilities, water conservation professionals and planners, regulators and consumers. Prior to joining the Alliance in July 2007, Mary Ann was Executive Director of the California Urban Water Conservation Council, a nonprofit organization composed of urban water supply agencies, environmental groups and other entities managing statewide water conservation in California. This group was responsible for implementing the nation's first set of Best Management Practices.

Mary Ann has over 35 years of experience, having worked at the Metropolitan Water District of Southern California, the South Central Connecticut Regional Water Authority, and the Connecticut Department of Environmental Protection. A graduate of the University of Connecticut with a degree in environmental planning, Mary Ann has authored numerous publications on water conservation, land use planning, natural resources management, and has co–produced two films which have aired on public television and community cable stations. Mary Ann is Chair of the Efficient Urban Water Management Specialist Group for the International Water Association, past Chair of the American Water Works Association National Water Conservation Division, serves on the boards of the Texas Water Foundation and River Network, and sits on the California State University's Water Resources and Policy Initiatives Advisory Board. Mary Ann has presented numerous papers on water conservation internationally and all across the United States and Canada.

A National Perspective on Water Issues

Water has emerged as a topic of constant discussion, but what is actually happening with water? Are we really in a water crisis? What are the issues fac–ing local communities and by extension, golf course managers? This presentation will explore a few myths about water and make recommendations for positive action in the future.

Mark Esoda | Golf Course Superintendent, CGCS | Atlanta Country Club

Mark has been the golf course superintendent of Atlanta Athletic Club for 23 years. Numerous awards include being inducted into the Georgia Golf Hall of Fame, the GCSAA Excellence in Government Relations Award, the PGA Georgia Section Distinguished Service Award, and the GGCSA Distinguished Service Award/Presidential Commendation. Mark is also a past president of the GGCSA, current president of the Georgia State Golf Association Foundation, and a member of the Georgia State Golf Association Executive Committee.

Starting With An Open Hand: Working with Regulators and Legislators

When dealing with regulators, most industries tend to do the minimum to meet compliance issues and then attempt to stay under the radar. To handle legislative issues the public tends to protest or "Occupy Downtown." There are different and likely even better, ways to affect policy.

Regulators want help doing their jobs. Golf also has a public perception problem. In Georgia, we had to ask the hard question: "What can we do to help conserve water that proves we are good managers/stewards of the resource?" Change is difficult but the golf industry stepped up to prove the world wrong using a self–policing BMP program, stepping up to work with agencies on various committees and introducing educational pieces. The result is increased positive awareness and improved water conservation.

Karen Guz | Director of Conservation | San Antonio Water System

Karen Guz is the Director of Conservation at San Antonio Water System. Her department is responsible for working with customers to acquire one billion gallons of water each year through proactive conservation education and incentive programs. She serves on several state and national water leadership committees including the Water Conservation Advisory Council and the Irrigator Advisory Council. Karen is also a licensed irrigator and a Master Gardener.

Karen has a Bachelor of Science from the University of Michigan and a Master of Public Administration from the University of North Carolina in Charlotte.

Making Hard Decisions About Hard Times: Benefits of Proactive Drought Planning

Texas has experienced extreme weather conditions in recent years with drought restrictions present in some areas for three out of the last four years. In areas where drought management plans had never been used, 2011 caused them to be dusted off and given a strong reality check. This now presents the opportunity to have realistic discussions about how to manage and conserve water every year to minimize drought impacts and how to manage the extreme droughts we know may come. The challenge is to balance the need to secure water for health and human safety, the need to manage water costs, and the need to have economic security for industries that depend on water as part of their business. Thoughtful planning and proactive programs are needed and can avert many of the negative consequences of poor drought planning and implementation.

Doug Bennett | Conservation Manager | Southern Nevada Water Authority

Doug Bennett has more than 24 years of professional experience relating to water management. As the Conservation Manager for the Southern Nevada Water Authority in Las Vegas, he oversees one of the most comprehensive water conservation programs in the United States.

Since 2008, Doug has served as Program Chair for the WaterSmart Innovations Conference, the world's largest professional event dedicated to urban water efficiency. For the past two years, he has served as a water efficiency technical advisor to the U.S. Green Building Council. Bennett holds a Bachelor of Arts in Agriculture and a Master of Arts in Business and Personnel Management from New Mexico State University.

Lean and Green: Water Efficiency in the Las Vegas Golf Industry

Las Vegas is home to some of the finest desert golf courses in the nation. A crippling 12–year drought on the Colorado River has challenged water supplies for this fast–growing city, requiring officials to make dramatic changes to water use policy. Since 2003, area golf courses have operated under a water budgeting policy that assures greater efficiency, while sustaining a high quality golf experience. Since the inception of drought, 30 golf courses have converted more than 40 million square feet (918 acres) of non–essential turfgrass to water–efficient landscape designs. Collectively, these conversions are saving more than 2.2 billion gallons of water annually.

Greg Lyman | Director of Environmental Programs | Golf Course Superintendents Association of America

Greg Lyman has gained international respect for his work enhancing golf's relationship with the environment. His career has taken him from the golf course, to the classroom, to his current efforts to advance environmental stewardship and sustainability within the golf industry.

Lyman has served as the Environmental Programs Director for the Golf Course Superintendents Association of America since 2003. He works with golf industry stakeholders, scientists and environmental groups as an advocate of positive environmental progress for the golf industry. He is a frequent speaker, panelist and source to media, legislative and regulatory bodies.

While at GCSAA, one of Lyman's chief projects has been a comprehensive national survey of golf courses to determine environmental programming; land use characteristics; pesticide and nutrient use; and water use and conservation. A major effort that began in 2004, the Golf Course Environmental Profile Project has been collecting information on golf course maintenance practices, inputs, stewardship efforts and natural resource conservation on golf properties on a national basis. This data has been used by individuals inside and outside of golf to define the nature of the industry.

Prior to joining the GCSAA, he was the Turfgrass Environmental Education Specialist at Michigan State University. While at Michigan State, he worked with the Michigan Department of Environmental Quality and the Michigan Department of Agriculture to develop the Michigan Turfgrass Environmental Research Program. In 2001, GCSAA recognized that program with its President's Award for Environmental Stewardship.

Lyman has Bachelor of Science in Horticulture from Michigan State University and Master of Science in Horticulture from Penn State University.

How Much Water Does Golf Use and Where Does It Come From?

The Golf Course Environmental Profile conducted by the GCSAA is a project dedicated to collecting data from the United States on the property features, management practices and inputs associated with golf courses. This presentation will feature information on irrigation water use patterns, water sources, costs, conservation practices and irrigation system infrastructure. Future water use trends and recommendations will also be discussed. This project was funded through support from the Environmental Institute for Golf.

Pat Gross | Director, Southwest Region | United States Golf Association, Green Section

Gross is the Director of the Southwest Region, working in the Southern California office. He joined the Green Section staff in December 1991. His primary responsibility is sharing practical information on golf course maintenance issues to courses in California and Mexico through the Turf Advisory Service. Gross has written articles for the Green Section Record and is a frequent speaker and contributor to golf industry conferences and publications.

Prior to joining the USGA, he was a golf course superintendent for five years in the Los Angeles area. It was there he gained practical experience in all aspects of golf course management, including the use of effluent water and the management of golf courses built on landfill sites.

Gross is a graduate of California State Polytechnic University, Pomona, with a B.S. in Ornamental Horticulture specializing in Turfgrass Management. He is an active volunteer with several golf industry groups including the California Turfgrass & Landscape Foundation, LADWP Golf Water Task Force, and the SCGA Governmental Affairs Committee.

Gross is an avid golfer who was born and raised in Southern California. He and his wife Mary Ellen reside in Fullerton, Calif., with their four children.

Case Studies in Water Use Reduction

This presentation provides practical examples of how golf courses in California implemented programs to reduce water use. Three courses are highlighted that took effective yet different approaches. Specific examples include turf reduction projects, conversion to lower water use grasses along with a voluntary reduction in water use, and effectively dealing with mandatory cut–backs through the LADWP Golf Water Task Force.

Ali Harivandi | Environmental Horticulturist | University of California – Davis

Dr. Ali Harivandi, a regional advisor specializing in Turf, Soil and Water, joined the University of California Cooperative Extension in the San Francisco Bay Area in 1980. He holds M.S. and Ph.D. degrees in Turfgrass Management from Colorado State University. He has served as a member of the Golf Course Superintendents Association of America's Technical/Resource Advisory Committee, and is currently serving on the United States Golf Association's Turfgrass and Environmental Research Committee. Dr. Harivandi is internationally known for his expertise in turfgrass, soils and irrigation water salinity and recycled water irrigation.

Irrigation Puzzle: Sourcing Water For Golf Courses

The most important issue facing the golf industry worldwide is water, or lack of it! Population increases and drought have resulted in golf courses successfully converting from potable to recycled water for irrigation. The golf industry has already overcome, through excellent educational outreach, the negative stereotype of irrigation with recycled water, and consequently, golf courses increasingly turn to the use of recycled water. The primary question has become not whether to switch to recycled water irrigation, or even how to manage irrigation with this new source, but how soon an individual course can access a recycled water source.

Mike Kenna | Director, Green Section Research | United States Golf Association

Dr. Michael P. Kenna has been Director of USGA Green Section Research since February 1990. He oversees the USGA's turfgrass and environmental research activities, including soliciting and evaluating research proposals, grant making and development of cooperative funding with government and commercial sources. Dr. Kenna travels extensively to visit turfgrass and environmental research sites, speak at conferences about the USGA's research programs, and serves on advisory boards and research foundations. He has worked closely with the U.S. Department of Agriculture on water and energy conservation research that relates to golf courses. Dr. Kenna has served as editor on several books concerning turfgrass biotechnology, environmental issues, and water conservation and reuse.

Dr. Kenna received his B.S. in Ornamental Horticulture from California State Polytechnic University in Pomona. While at Oklahoma State University, he received his M.S. in Agronomy and Ph.D. in Crop Science. His graduate studies involved turf and forage grass breeding, quantitative genetics, plant physiology and turfgrass management. In 1985, Dr. Kenna joined the faculty at Oklahoma State University as assistant professor, responsible for turfgrass research activities and a statewide extension program. He was selected for the Young Scientist position on the USGA Research Committee in 1988, and was the 2003 Distinguished Alumnus for the College of Agriculture at California State Polytechnic University.

Research Accomplishments to Meet the Present and Future Water Use Needs of Golf

Almost 30 years ago, the USGA organized the Turfgrass and Environmental Research Committee with the primary purpose to develop minimal maintenance turfgrass cultivars that conserve water, as well as tolerate temperature extremes, salinity and pests. With the USGA providing more than $30 million in financial support of universities, new cultivars were introduced, water use efficiency was improved, and new irrigation technology was developed. More importantly, this program redirected university research to focus on water conservation, while improving the adaptation and management techniques of the turfgrasses used on golf courses.

Tim Hiers | Golf Course Superintendent | Old Collier Golf Club

William T. "Tim" Hiers, CGCS has been a golf course manager since 1976. He is currently the Director of Agronomy at The Old Collier Golf Club and Senior Agronomist and Vice President for Turf Dynamics, LLC. His accomplishments include assisting Collier's Reserve Country Club to become the first Audubon International Cooperative Signature Sanctuary Golf Course. In 2000 Tim joined The Old Collier Golf Club and led the effort to achieve the designation of first Audubon International Gold Signature Cooperative Sanctuary. This project was the first in the continental United States to use the newer variety of Paspalum grass on the entire golf course and the first in the world to irrigate solely with brackish water. Tim has been a speaker at numerous GCSAA, PGA and CMAA conferences and workshops. He is an experienced golf course consultant for the private club and resort industry as well as a lecturer for numerous college agronomy programs. Tim has also served as President of the Florida Golf Course Superintendents Association, is currently on the Board of Directors for the Florida Turfgrass Association, and Chairman of the Fertilizer Research Fund for the Florida Turfgrass Association. During his career Tim has been recognized for his accomplishments with the following awards: Florida Golf Course Superintendents Assoc. Distinguished Service Award – 1986; Southeastern Environmental Steward Award – 1993; 1994 Recipient of the first John James Audubon Environmental Steward Award; 1994 National Environmental Steward Award recipient for GCSAA; 1995 GCSAA President's Environmental Leadership Award; 1998 Florida Turf Grass Association Wreath of Grass Award; Recipient of the 2009 GCSAA Excellence in Government Relations Award

Irrigating with a Toxin

Water quality and quantity are major challenges for golf courses in Florida. At Old Collier, we have taken the unique approach of converting to turfgrass that uses a water supply previously thought unsuitable for fine turf. However, the use of this water brings new challenges that must be overcome to make this a viable, long-term solution for the golf industry.

Brian Whitlark | Agronomist, Southwest Region | United States Golf Association, Green Section

Whitlark joined the Green Section staff as an Agronomist in 2008 and makes Turf Advisory Service visits in Arizona, Nevada, California and New Mexico, working with Regional Director Pat Gross.

Whitlark is a certified professional soil scientist and has worked extensively with golf courses facing challenging soil and water conditions. Since joining the Green Section, Whitlark has conducted applied research in a variety of areas, including fairway cultivation methods, deep vertical mowing effects on organic matter and thatch reduction in ultradwarf bermudagrass greens and, most recently, the pros and cons of using turf colorants. He has written extensively and conducted presentations for practitioners in the area of soil, water and interpretation of soil test results.

Whitlark received his B.S. and M.S. degrees in the Department of Soil, Water and Environmental Science, with an emphasis in turfgrass science, from the University of Arizona at Tucson. He was raised in the Bay Area and enjoys golf, soccer and football, and has completed seven marathons. He and his wife, Vanessa, and daughters, Lily and Lauren, are based in Gilbert, Arizona.

Case Studies In Water Use Efficiency

This presentation highlights water conservation strategies used by turf managers in the southwestern United States. Practical examples include irrigation redesign and upgrading nozzle technology, modifying irrigation programming, improving soil properties, utilizing new soil moisture sensing technologies and converting to recycled water.

Paul Brown | Extension Specialist and Research Scientist | University of Arizona

Moderator

Dr. Paul Brown serves as Extension Specialist and Research Scientist in the Department of Soil, Water and Environmental Science at the University of Arizona. He developed and presently oversees the operation of the Arizona Meteorological Network (AZMET), a network of automated weather stations that provides weather related information to producers of agricultural and horticultural crops. Turf related research and programs include: 1) development of crop coefficients for low desert turf systems, 2) publication of turfgrass consumptive curves/tables for the major urban areas of Arizona, 3) assessment of state water duties (restrictions on groundwater use) imposed on turfgrass facilities, 4) use of electromagnetic induction to assess salinity levels in golf course soils and 5) quantifying the amount of water lost to spray evaporation from turf irrigation systems.

Henry DeLozier | Principal | Global Golf Advisors

Henry DeLozier is a Principal in Global Golf Advisors, an international consultancy serving the investment banking, real estate development and golf asset ownership and operations business segments.

Henry joined GGA after nine years as the Vice President – Golf of Pulte Homes. While there, he developed 27 new golf courses within 10 states, making Pulte the largest developer of golf communities and courses in the United States, having invested more than $500 million in the development of golf assets.

He is recognized by Golf Inc. magazine as one of the "Most Influential People in Golf" for 10 consecutive years. He is a past president of the NGCOA. Henry is recognized for his uncommon understanding of golf and residential properties. He is a no-nonsense profit producer, an innovative marketer, and an advocate of exceptional customer service.

He serves as an expert source for Business Week, CNBC-Squawk Box, Financial Times, GOLF, Golf Digest and Golf Business magazines, New York Times, Wall Street Journal and Washington Post.

Mr. DeLozier is a graduate of Oklahoma State University where he was an All-American golfer.

Water Impact on Golf Development and Operations

From entitlements and permits to direct operating expenses, water influences the economic development and operations of golf facilities in several ways. Specifically, Jim and Henry will address the key financial indicators influenced by water and best management practices for facility development and operations. You will hear a brief forward-look at emerging trends related to the use and misuse of water in golf facilities.

Jim Hinckley | President and CEO | Century Golf Partners

Prior to forming Century Golf Partners, Hinckley had a 32-year career with ClubCorp, Inc., serving the last seven years as president. In 2005, Jim acquired WMC, formed Century Golf Partners and, together with his partners, acquired two golf portfolios in the aggregate 40 golf courses and acquired the Arnold Palmer Golf Management brand. Jim serves on many industry boards including National Golf Course Owners Association of America, American Junior Golf Association, Professional Golfers Association (PGA) of America Education and Employers Council and is a past member of the PGA. Jim is a member of World Presidents Organization (WPO) and serves on the boards of the St. Paul Hospital Medical Foundation and the Children's Center for Self Esteem.

How Much Water Does Golf Use and Where Does It Come From?

From entitlements and permits to direct operating expenses, water influences the economic development and operations of golf facilities in several ways. Specifically, Jim and Henry will address the key financial indicators influenced by water and best management practices for facility development and operations. You will hear a forecast of emerging trends related to the use and misuse of water in golf facilities.

Chris Hartwiger | Senior Agronomist, Southeast Region | United States Golf Association, Green Section

Chris Hartwiger is located in Birmingham, Ala., and works with Patrick O'Brien in the Southeast Region of the USGA Green Section. He conducts most of his visits in Alabama, Florida, Mississippi and Tennessee with the goal of helping superintendents develop the best management program possible for their location. Between visits, he enjoys speaking to industry related groups and writing articles for various turfgrass publications.

Prior to joining the staff, Hartwiger received his B. A. from the College of William & Mary and a master's degree at North Carolina State University. While at North Carolina State, he completed a thesis on "Lightweight Roller Use on Bentgrass Putting Greens" under the direction of Drs. Joseph DiPaola and Charles Peacock.

He was born in Yorktown, Va., and his interest in the turf industry began humbly at an early age by helping his father with a small lawn care business. He soon caught the golf bug and has spent many years either working on golf courses or playing golf.

Maintenance Up the Middle – Great Golf and Water Conservation are Not Mutually Exclusive

The enjoyment of golf is shared by many and can last a lifetime. As social, environmental and economic realities shift, the way golf courses are maintained will advance. The changes in the perception and the use of water resources on golf courses can serve as a catalyst to promote maintenance up the middle which, in turn, will lead to a more enjoyable and affordable game.

Dana Lonn | Managing Director, Center for Advanced Turf Technology | The Toro Company

Dana joined The Toro Company in 1974 and has been a valuable resource in Product Engineering, Computer Aided Engineering and Manager of Advanced Engineering. In his current role as Managing Director of the Center for Advanced Turf Technology, Dana is responsible for leading a corporate research and development group working on the next generation of products and technologies, and how to apply them to the marketplace.

The Center for Advanced Turf Technology (CATT) team was established in 1998 to develop innovative solutions to customer problems, and environmentally-friendly technologies for customers in the professional turf markets including golf, sports fields, grounds and landscape maintenance. The group's mission is to work with customers, academic leaders and industry experts to develop solutions that could emerge as breakthrough products. CATT has been influential in the following areas: water management, alternative fuels and labor productivity. Dana has worked on a wide variety of Toro commercial, residential and irrigation products. Dana holds 10 U.S. patents.

Dana attended the University of Minnesota – Twin Cities Campus where he earned a Bachelor of Mechanical Engineering, graduating with high distinction. He continued his post graduate work at the University of Minnesota as an Institute of Technology Corporate Fellow earning a Master of Science in Mechanical Engineering, graduating with high distinction. Dana is active in his profession and the industry, including being a member of the American Society of Mechanical Engineers, Society of Automotive Engineers, American Society of Agricultural and Biological Engineers and Golf Course Superintendents Association of America.

Shifting Water Decisions from Art to Science

Using water efficiently is a tough problem. We are trying to replace a perfect irrigation system in natural rainfall with an artificial process. With limited supplies of water, we must be certain that we are using water where, when and how much is needed. Accomplishing this goal drives us to utilize science and technology. We need more control and feedback to aid people in making decisions that optimize performance and minimize inputs.

Bob Farren | Director of Golf Courses and Grounds Management | Pinehurst, LLC

1979 Graduate of Marshall University – Bachelor's in Recreation and Tourism; GCSAA Member since 1978; GCSAA Certified Superintendent 1985; Began working at Pinehurst in 1982 as Assistant Superintendent of Course No. 4; Director of Golf Courses and Grounds since 2001; Service on the Board of the Carolinas Superintendents Association, President in 1995; Served on numerous GCSAA Committees; Involved with the Environmental Institute for Golf for many years, proud recipient of the Presidents Award for Environmental Stewardship award in 2007; USGA Green Section Committee Member

Uncovering Our Past to Determine Our Future

In March 2010, Pinehurst embarked upon perhaps one of the boldest golf course restoration projects ever undertaken. The firm of Coore/Crenshaw was challenged with recovering or uncovering the aspects of Pinehurst No.2 that made it one of Donald Ross' greatest designs. After a great deal of research it became apparent that the majority of the changes to the course design and strategy could be attributed to, in one way or the other, the automation and expansion of the irrigation systems to support numerous acres of turf. The project resulted in a reducing the total acres of irrigated turf from 90 acres to 50. The total number of irrigation heads has been reduced from 1150 to 450. The "old school" center line irrigation in the fairways now determines the strategic lines of the course. The turf quality and resiliency is far more predictable the closer you are to the center of the otherwise expansive fairway lines.

Rick Robbins | President | Robbins and Associates International

To truly appreciate how deeply entrenched in the world of golf Rick Robbins is, you would have to span multiple generations of Robbins family lineage, experience, and passion. His grandfather was a nurseryman and developer, leading to the start of the Robbins family tourist attractions at The Blowing Rock, a scenic rock formation from which the town of Blowing Rock received its name. Robbins grew up in golf communities and around some of the country's most influential people in golf. Beginning with his father's work with Peggy Kirk Bell and Warren "Bullet" Bell as general manager of Pine Needles Lodge & Club, and life at Hound Ears Country Club, developed by his father and uncles, it is no surprise his talents were discovered by Robert VonHagge, a former associate of famed architect Dick Wilson, and Australian PGA Tour golfer Bruce Devlin. Robbins later moved to Nicklaus/Sierra Development Corporation where he helped in the development of many Jack Nicklaus Communities and then to Golden Bear Design, where he became a Senior Design Associate in the Hong Kong office. His innate talent for creating golf courses which are not only enjoyable, but take into account the natural beauty of the land can easily be seen in every project he touches.

Robbins has been designing courses with his firm, Robbins & Associates International, since 1991. Headquartered in Cary, North Carolina, Robbins is surrounded by familiarity including his alma mater, North Carolina State University School of Design, as well as numerous historical points of interest and tourism sites that the Robbins family has been instrumental in developing over the years. Some of these include Tweetsie Railroad, Hound Ears Club, The Elk River Club, and Beech Mountain Golf and Ski Resort.

Golf Course Water Use – An International Perspective

Rick will present information about the relationship between golf course development and water use in China. This is a subject that has many implications for Chinese social and political culture. Water use and water quality as affected by golf development in the past and some ideas for improving this relationship in the future will be discussed.

Bill Love | President | WR Love Inc.

Bill Love has over 30 years experience in the practice of golf course architecture, site planning for recreational facilities and open space systems, as well as land planning for golf related development. He has been involved in over 200 projects including the design and development of new golf courses and golf communities, enhancement planning and renovation of existing golf facilities. These projects have involved all types of budgets with both public and private clients and been located throughout North America and selected destinations abroad. Bill is the President of the firm WR Love Inc. offering land planning and golf course design, as well as principal of the firm Love & Dodson LLC providing sustainability planning and consulting services. His firm is the only ISC sustainability chartered design firm in the world. For many years, his projects have received recognition and numerous awards for innovative design and environmental stewardship.

He is a longtime member and past president of the American Society of Golf Course Architects, the professional organization comprised of leading golf course designers in North America. Actively involved with sustainability and environmental issues related to golf courses, Bill has also served as the Chairman of the Society's Environmental Committee for two decades. In addition to being a qualified golf course architect, Bill is a registered landscape architect. His expertise on environmentally sensitive golf development led to his participation with numerous organizations, such as: The International Sustainability Council; National Golf and Environment Initiative; Audubon Cooperative Sanctuary Advisory Committee; USGA Environmental Committee; USGA Wildlife Links Advisory Committee; GCSAA Golf Construction Advisory Committee and the EIFG Siting and Design Committee. He authored three editions of "An Environmental Approach to Golf Course Development" for the ASGCA and participated in other publications, such as the "Environmental Principles for Golf Courses in the United States" and the EPA's "Reusing Cleaned Up Superfund Sites for Golf Facilities." He continues to be a frequent lecturer on sustainable golf and the environment, golf course development, master planning and renovation at universities, golf and numerous golf related venues. Bill provides assistance to many chapters of The First Tee, also serving on the Board and Executive Committee for The First Tee of Washington, D.C. to promote the organization's values and develop golf facilities for the city's youth.

Designing Golf Courses for Water Conservation

How can golf courses be more sustainably designed to use less water? This presentation includes an examination of the issues impacting golf course design and the management of water resources. Water conservation on golf courses begins by addressing the issues of resource management and conservation throughout the design process for new golf courses and the renovation of existing facilities.

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