



Predictive solutions

Over the past decade, I have had the opportunity to monitor many variables in the soil and above ground through many regions around the world. As a result, I have written many predictive solutions and algorithms that draw on the changing variables affecting turf daily and throughout the season. A key variable in these predictive models is soil moisture. For instance, too much moisture leads to moisture stress. Too high of a temperature leads to temperature stress. The combined effects of temperature and moisture, however, are much more important to the turf manager. Throw in salts and the needs and limitations of the turf with regard to water change dramatically. The key is knowing how much impact any one variable has on the target we are after. These targets include stress, disease likelihood, recuperative capacity, playability and performance, aesthetic quality and a whole slew of other things. Moisture has a significant weighted impact compared to many other variables. Also, when we consider that the finest turfgrass performance comes when the grass is almost on the brink of dying, any slight change in management that affects moisture in either direction will have an impact on whether our players are happy or not with the performance on the golf course on any given day.

to similar declines in growth no matter what type of grass you are growing.

With regard to the uptake of those dissolved nutrients, this process is impacted by the plant's fundamental growth patterns. If it is not photosynthesizing or respiring efficiently, it simply is not taking up nutrients well or at all. However, positioning key

nutritional elements through foliar feeding is proving to have a positive impact on jump starting certain plant growth processes even under stress (another topic for another article). Finally, in soil where moisture is kept higher than optimal, we often see black layer form.

Many think black layer forms from using too much sulfur based

fertilizers. The truth is that only under anaerobic conditions can black layer form. The microbes that cause black layer function in anaerobic or low oxygen soils where they attack and feed on sulfur based compounds and leave behind a fine black oxide particle that bonds with soil particles and clogs soil pores. This problem gets worse and worse until oxygen is introduced in which case the anaerobic-loving microbes cannot function any longer.

In every case above, monitoring soil moisture on a regular basis will have a positive impact and allow for the best chances of integrating a pest, stress and conditioning management program that is sure to keep golf course superintendents, members and players happy... something that is not easily achieved on a regular basis.

MONITORING METHODS. Many superintendents have found a way to use their thumbs, a knife, a coring tool or some way of monitoring the moisture on a routine consistent basis.

Today, there are options that have taken soil monitoring to a level of precision we only dreamed about a decade ago. I am amazed at how far technology has come in such a short time. In my early work for UgMo, where I served as chief agronomist, I coordinated how to utilize the information that sensors give us, I was able to put well-defined models to use in real time. One example was the ability to predict seedhead emergence by narrowing the window of this physiological effect to less than 48 hours compared to the 7- to 10-day window previously achieved with above ground only growing degree day models. Of course, any predictive model depends on the proper quantity and location of sensors to make sense. For those of you waiting for the technology to become affordable, your time

is fast approaching so keep your eyes open for updates coming your way very soon.

But short of investing in the new technology to help you with soil monitoring, use your head at the very least. Know what your limitations are with your irrigation and make the necessary adjustments to insure the compromises you make to insure adequate coverage are the right ones that aren't going to hinder turf by putting too much water into the soil.

Remember that any length of time where the soil moisture level is too high is too much time...even if it is only for a day or night. On the flip side, too little water can initiate a dormancy mechanism that leads to less resiliency at the surface...a condition having a tremendous impact on ball roll and traffic stress resistance.

The best in the business know that achieving that optimal soil condition comes from being on top of that condition day in and day out. Employ whatever practice you can to take control of your soil moisture whether it is hand applications of water when called for or cultural practices designed to help dry out the soil after a rain event. One day of poor moisture conditions will have a negative impact that can last days, weeks or months depending on what the other surrounding conditions are. But at the very least, don't read into this like fine print.

Moisture management is part of an overall holistic approach to turf management. If you monitor it consistently, your entire program will be impacted by the decisions you make based on that monitoring. **GCI**

Carmen Magro, CGCS MBA, is chief agronomist/owner of Agronomy Management Solutions and a frequent GCI contributor.



Ron Dodson and **Bill Love** are the founders of Love & Dodson, LLC a firm that specializes in sustainable planning, design, construction and management of golf courses, recreational facilities and sanctuaries. www.loveanddodson.com

WATER – ELIXIR OF LIFE

For the past several years there has been a major focus on the topic of climate change. It is difficult to separate the facts from the rhetoric, and the politics from the science. One thing is undisputable, however, and that is that the climate has always changed and it always will.

While the subject of our ability to adapt to climate change is a very important one, I am concerned that all the climate rhetoric is overshadowing a topic that is even more important. This topic would be the dwindling supplies of available water. And by “available” I mean accessible and usable by humans.

According to the United States Geological Survey, of all the water on Earth, only 1 percent is presently usable by humans. Of that 1 percent, 99 percent is ground water, .86 percent is lakes and 0.02 percent is rivers. In addition, that 1 percent is not evenly distributed across the globe, or for that matter even in the United States.

While water use on golf courses is a small percentage of the water used for overall irrigation purposes, the fact of the matter is that golf courses tend to stick out like a sore thumb.

In addition, using too much water for irrigation not only causes agronomic problems, but it also costs money. This economic point is not only directly connected with the actual cost of the water, but relates to the electricity used to move the water.

Consider these other tidbits about water:

- Three-fourths of the Earth’s surface is covered with water. Water regenerates and is redistributed through evaporation, making it seem endlessly renewable. So why worry?
- About 97 percent of all water is salt water and 2 percent is frozen in glaciers and polar ice caps. Thus the remaining 1 percent of the world’s available water supply is an extremely precious commodity necessary for our survival.
- A simple example of how easy it is to contaminate water is to consider that one drop of oil can make up to 6.6 gallons of water undrinkable.

Now, do I have your attention? How about pondering these water facts, which were recently reported in Sustainability News, a publication of Audubon Lifestyles and the International Sustainability Council:

- Around 70 percent of the world’s water is used for agriculture, 22 percent for industry and 8 percent for domestic use. Low- and middle-income countries use

82 percent of their water for agriculture, 10 percent for industry and 8 percent for domestic use. In comparison, high-income countries use 30 percent of their water for agriculture, 59 percent for industry and 11 percent for domestic use.

- A person is able to survive one month without food but only five to seven days without water.
- A water “footprint” is the amount of water used in the entire production and/or growth of a specific product. For example, 2.2 pounds of beef has a water footprint of 4,226.8 gallons; one sheet of paper has a water footprint of 2.6 gallons; a single cup of tea has a water footprint of 9.2 gallons; and one microchip has a water footprint of 8.5 gallons.
- It takes 25 to 50 gallons to take a five-minute shower; 2 to 7 gallons to flush a toilet; 2 gallons to brush one’s teeth; and 20 gallons to hand wash dishes.
- 6,000 children around the world die each day from preventable water-related diseases.
- The population of the United States is approximately 304 million; the population of Europe is approximately 732.7 million; 1.1 billion people lack adequate drinking water access; and 2.6 billion people lack basic water sanitation.

- The average American uses about 151.9 gallons of water per day, with about 60 percent of that being used outdoors – watering lawns, washing cars and other water-related activities. The average European uses 66 gallons of water per day. The 1.1 billion people who lack adequate water access, use the least – less than 5 gallons per day.
- The average American uses 30.3 times more water than a person who lacks adequate water access; while the average European uses 13.2 times more water than a person who lacks adequate water access.

Here’s another kicker: climate change may make matters worse as arid areas get drier and wet areas get wetter. No matter how we slice it, water is necessary for human life, economic life...all life.

Every golf course should undertake a water assessment, including conducting a water-footprint analysis. Course designs can help courses facilitate water efficiency or force water overuse. Likewise, rectifying incorrect turfgrass selections or heavily irrigated vegetation can reduce water and financial waste.

The question is...will golf become a true water conservation leader, or dry up and blow away with the dust? **GCI**



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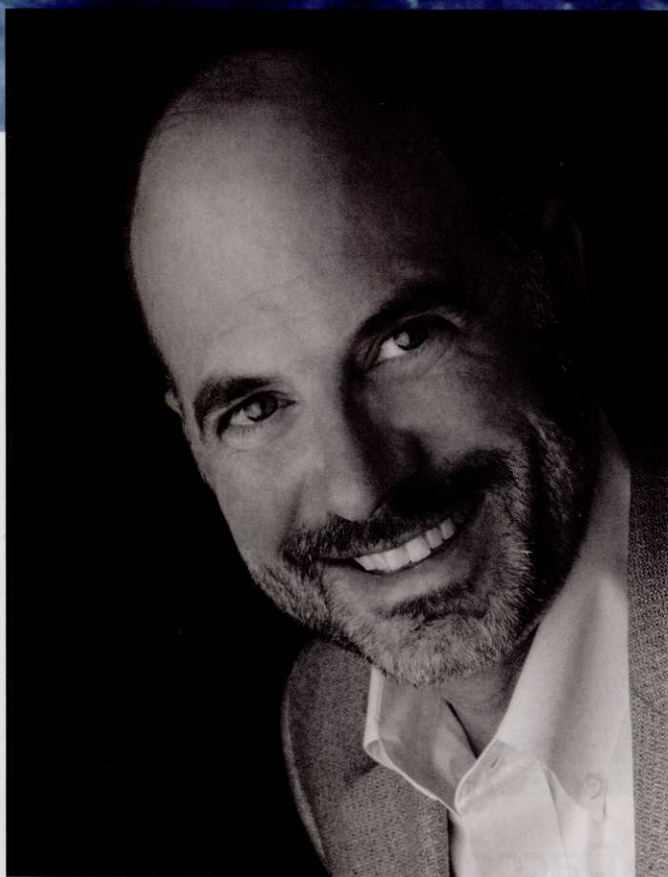
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TM

Thirst Quencher



“The Big Thirst” author Charles Fishman shares solutions for water shortages and how you may be using water in the next few years.

By Mike Zawacki

We’re in the middle of a water crisis. Actually, the golf industry is in the middle of a thousand water crises from coast to coast – and that’s the good news, explains Charles Fishman, the author of “The Big Thirst,” which takes an engaging look at the challenges of smart water management today and into the future.

“Whether its drought, bad water management or shifting water availability, many places in the country are having water problems that they’re not accustomed to having... If you run a golf course in Orlando, or Atlanta, or in Dallas, all of those places have serious water problems, but those are local water problems,” Fishman says. “That’s a good thing because local problems can be solved at the local level.”

And the good news, he adds, is that solutions exist – both from inside and outside the golf industry.

“There are some important things to keep in mind. One, there is a dawning era of water scarcity,” he says. “People who depend on water for their businesses are going to have to change how they think about water every day. There’s lots of transferable knowledge because lots of water problems have been solved by someone. But it’s important to understand the community where your facility exists and what’s available and possible in your community.”

As you worked on your book, what struck you as the most common misconception people have about water? The thing most people need to get comfortable with is that water can be reused. The easiest water we have and the most inexpensive water we have is the water that’s already been used once. There’s nothing wrong with cleaning that water and then using it to water an athletic field or golf course. All the water on earth is the same water. There’s no mechanism creating new water.

There is a hesitation to accept systems that clean and reuse water... and I believe that’s a mistake.

Another misconception is the idea that water should be so cheap

that it's essentially free. I don't believe anyone in the world should be denied a ration of water because they can't afford it. However, most big companies that use large quantities of water have a problem putting conservation efforts in place because water is so cheap. No one wants to spend \$10 million to save \$100,000 worth of water. A commodity that's too cheap ends up not being used for the right purpose, wasted and misallocated. So cheap water ends up being a corrosive problem because no one ever thinks about it.

A third misconception relates to the fact that there is no global water crisis. Water problems are local and most water problems are solvable. Yes, the drought across Texas and in East Africa can't be fixed by waving a magic wand. But that's not what most water problems look like. Most water problems are the result of poor water management and poor planning, and that's what makes them solvable. And often there's enough water and enough money to solve them, there's just not good engagement of the problem and clear-headed thinking.

If you can figure out a way to educate people that it's OK to reuse water, then it could help you solve a lot of problems.

Fewer and fewer courses are drawing their water directly from potable sources. Instead, they've been depending on their own sources – retention ponds, gray water sources, secondary-use. Could these sources ever be at risk? Although it's inconvenient, I believe golf courses should be standing up and saying "No, we will not be using potable water sources to water turf because it doesn't make sense." By the same token, I'm not singling out golf courses. Any community that can figure out how to do it, should have a reuse system for office parks, athletic fields, campus... Think about it, we flush our toilets with drinking water. That's just absurd.

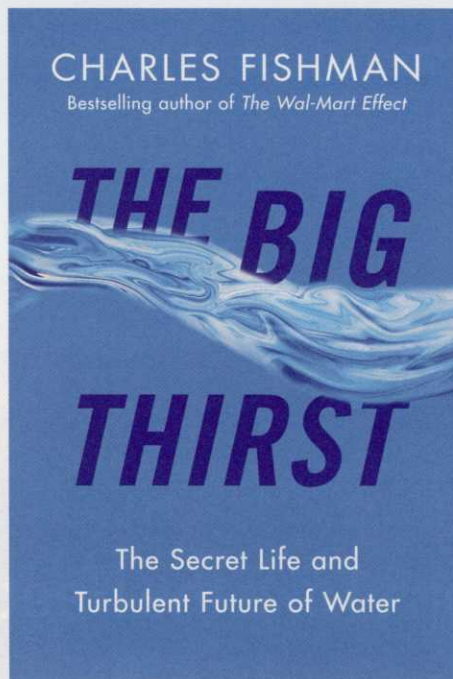
So are those grey water sources going to come under pressure? Yes, they will come under pressure because as people discover the use for lower-grades of water – say a steel factory or a mass-transit car-wash barn – those sources will come more in demand. Once people discover the value of non-potable sources there will be competition for those sources, which will put pressure on golf courses to compete for them. Unfortunately, a golf course has a difficult time making the argument – compared to a steel mill or other business entity – that they're equally important enough to use those resources. People will say, we'll you're just a golf course.

So what is a good, solid, sustainable source of water for a golf course? You don't want to have to rely on a single source for your water. However, you may be a course that doesn't have the financial means to have multiple sources for water. So you need to ask some basic questions. Where do we get our water? Where do the people who supply our water get their water? What's the dependability of that source and what happens if they see their supply drop by 20 percent?

And this goes for those living in what would be considered water-rich areas, what would you do if you found your water resources cut 20 percent? What would that look like? I don't know many golf course superintendents are ready to answer that question.

But that's the world we live in. Even the best water managers should be asking themselves, how do we increase our efficiency by 5 percent next year?

Those peoples who don't think they have to worry about this scenario should begin worry right now. And just assume you never have a water problem. If you could run your course on 5 percent less water, wouldn't you like to save in those related costs?



Charles Fishman's "The Big Thirst," takes an engaging look at the challenges of smart water management today and into the future.

So what needs to change? The most important thing is to look ahead and imagine how you would operate under scarcity. Most people think this means "How do I get through?" That's the attitude that has to change.

Scarcity may not be a temporary thing. Instead, it may become the new normal. You used to get X-amount of water. Now X minus 20 percent isn't temporary... it's reality.

That's the world golf course superintendents need to imagine.

What do you envision is the state of water in 25 years? 50 years? You want to know about the state of water in 25 years? How about 10 years or 5 years?

Competition for water is going to happen, and a lot of superintendents live in that reality now. In the next 10 years many more golf courses will see water as the issue they need to address. You may see courses given a budget of how much water they can use. Then competition for water from other industries will increase. Finally, the people who golf will need to ask if their course is becoming smart with water management in the midst of scarcity. This could possibly corrode people's attitudes toward golf.

My suggestion is that anyone managing a golf course should be as far out in front of water as you can be. Go to your water supplier and ask what you can do better to use less water. Ask the question, do we need to be using this water (on certain areas of the course)? Is our technology efficient?

You're going to come under pressure for how you're using water. Getting out in front of it is smart strategically. Reaching out to the community and understand how other users are achieving efficiency and smart water management. Build the connections that will allow you to manage water smartly and give you insight into the politics of water in your community so that when scarcity comes you're in a better position to handle it. **GCI**

Mike Zawacki is GCI's editor.

Furnace Creek Golf Course
in Death Valley, Calif.

If You Can't Take the Heat... Get out of Death Valley

Growing Grass in Death Valley's Furnace Creek Golf Course. By Stacie Zinn Roberts

It's noon on a Thursday at the end of May and it's already 117-degrees. But that's nothing. In just a few months, overnight temps will hover around 100-degrees. The scorching days could push past the 130-mark. Now imagine growing grass under these conditions. Such is the life of Chris Bessette, golf course superintendent at Furnace Creek Golf Course in Death Valley, Calif., one of the hottest, driest places on earth.

Furnace Creek is literally an oasis in the desert. The closest town, Pahrump, Nevada, is a

good hour drive by car. Between here and there, the open expanse of barren desert wasteland stretches out over dry creek beds, dusty ravines, rock-strewn plateaus and towering mountains.

Still, people from all over the world come to Furnace Creek Inn & Ranch Resort. The stay at the hotel, swim in the pool and play golf. The 18-hole course supports about 10,000 rounds of golf per year at the resort, located on the only privately owned land within Death Valley National Park. Visitors come to experience for themselves how hot is

hot. Bessette says busloads of European and Asian tourists are a common sight in the summer. They take pictures in front of the thermometer to show off to friends back home.

What does 131-degrees, the hottest Bessette has experienced in Death Valley, feel like? "It's so hot that people would not believe it. Picture your head in front of the oven door. You move your head but there's nowhere to go," Bessette says.

The heat is a real issue when scheduling maintenance projects on the course. In the summer, work begins at 5:00 a.m. and ends at 1:30 p.m., unless it gets too hot. "Above 123-degrees, I send them home. We haven't lost anybody yet," Bessette says with a chuckle.

Maintaining a full crew, though, is a challenge. Bessette says he's supposed to have an

eight-person crew, including himself. Right now, he's running the course with the help of five staffers. Since there's no town nearby to draw employees from, he advertises widely on the internet, in magazines and in newspapers. "People generally look at it and say, 'You want me to move where? Temps will be what? For how much money? You've got to be kidding,'" he says.

But Bessette says there are some real benefits of working in such isolation. All of the staff lives on property. He describes it as "like a small town." Bessette and his wife Henny, who also works at the resort, live in a house rent-free. They don't pay for electric or satellite t.v., and can eat for free in the employee dining hall. At 61-years old, Bessette says the arrangement "was a big part of what attracted us

"It varies a lot and the problem is, it's always the opposite that I need. In the wintertime, when I don't need very much water, then I'm flooded. I have too much."

— Chris Bessette, Furnace Creek Golf Course

“It’s so hot that people would not believe it. Picture your head in front of the oven door. You move your head but there’s nowhere to go.”

— Chris Bessette, *Furnace Creek Golf Course*

here. Instead of putting money into a mortgage or rent, I might be able to retire someday.”

His staff lives “in a dorm situation and pays some rent, maybe \$30 a pay day, but they still get free breakfast and lunch, and dinner is \$3.”

Furnace Creek is owned by Xanterra Parks & Resorts. The company operates resorts and lodging facilities in various State and National Parks including Yellowstone, Mount Rushmore and the Grand Canyon. One of the appeals of working for a company like Xanterra, Bessette says, is that staffers can apply to transfer between facilities, having the ability to live in some of the most unique places in the country.

“When I looked at it, I went ‘Wow, there’s no houses around it. That means there’s no men’s club, no women’s club, no senior club, no board of directors. There’s nobody to complain that your water’s getting in my yard, your tree branch is hanging over the fence, the grass in somebody else’s section of the golf course looks better than mine.’ You don’t have any of that. And so I went, ‘Wow, that would be interesting, wouldn’t it?’ Bessette says.

He was also attracted by the stark beauty of the place.

“On one side of us we have a mountain range that’s 8,000-foot-high, and on the other side of us, it’s 12,000-foot-high. So every place you look, it’s just really nice scenery. It’s very quiet and peaceful out here. We

have more wildlife than anybody would guess. We have a population of coyotes that live here and they’re very comfortable with people as we are with them. We have roadrunners, rabbits, we have ponds, of course, on the golf course so we’re a natural bird sanctuary,” Bessette says.

The first three holes at Furnace Creek Golf Course were built in 1927, giving it the distinction of being the first grass golf course in the California desert region. It was expanded to a full nine in 1931. The second nine was added in 1968. Perry Dye redesigned the course in 1997, and installed an irrigation system and sulfur burner to lower the pH from about 8.3 down to a grass-friendly 6.5. The course is grassed with common Bermudagrass except for the greens which are 328-Tifgreen Bermudagrass.

Furnace Creek is also the world’s lowest golf course, sitting at 214-feet below sea level. While the lack of elevation poses no maintenance issues, it does wreak havoc on ball roll.

To describe the affect, Bessette used the analogy of how kickers in football love to play at Mile High Stadium in Denver because the altitude makes the ball fly farther. “We have the opposite effect. The ball won’t go as far as you’re used to. You’ll need one extra club than you’re used to. If it’s cold, maybe two clubs,” Bessette says.

The deviation was enough to prompt Golf Digest magazine to name Furnace Creek to the

March 2007 list of America’s 50 Toughest Courses, saying that along with the challenges of playing in extreme heat, “the barometric pressure makes the ball go even shorter and more crooked than usual.”

Water management is a big part of Bessette’s job at Furnace Creek. The golf course and resort are made possible by the existence of three springs in the mountains beyond the property. The water that comes bubbling up out of the ground is stored in a large holding tank and then funneled down to the two swimming pools on the property.

“We label the pools as spring-fed and that means we can’t put chemicals in the water. We have to circulate the water according to how many people use the pool, on average. The circulated water from the pools is what comes to me in underground pipes and goes into my irrigation pond. That is the amount of water I get to use. It varies a lot and the problem is, it’s always the opposite that I need. In the wintertime, when I don’t need very much water, then I’m flooded. I have too much,” Bessette says. To store the excess water in the winter, he moves the water

through a series of holding ponds on the property.

“In the summertime, we have to put out enough water but the pools don’t keep up with the amount that we need. So, they have to bump up the amount of water that circulates through the pools in order to give me enough to keep the golf course irrigated,” he says.

Furnace Creek is a Certified Audubon Cooperative Sanctuary, through the Audubon International environmental program. Bessette felt the most obvious way to start in the certification process, which was achieved about four years ago, was with water conservation.

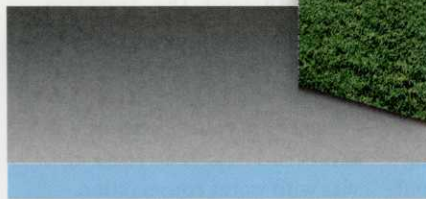
“We started cutting back and going off of our ET figures instead of just throwing out water everywhere. Then we looked at ways where we could cut back during the summer months when we have almost no play. It’s usually just employees and we keep the golf course open. But we turn the water off on our driving range and we save a significant amount of water there. We turn our rough down to 70 percent of ET. It gets a little dry, a little bit yellowed, but like I say, there’s almost no outside



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Besette: "We started cutting back and going off of our ET figures instead of just throwing out water everywhere."

play, it's almost all employees so we all know that and we all put up with it," Besette says.

His methodology for maintaining the golf course seems to be one of working smarter, and not being afraid to try something new.

The weather station at Furnace Creek is tied by computer into the irrigation system. "At night I set it so that my computer goes off of the weather station. So if I have 2.7 ET, that's what the computer will put out, that amount of water to make up for what was lost yesterday. We try to run it at 90 - 95 percent of ET and that gives us a little leeway so that in the middle of the day we can send some people out to hand water dry spots," he says.

Up until about 5 years ago, the dormant Bermudagrass was overseeded in the winter.

But that proved to be a challenge in trying to time the Bermudagrass coming out of dormancy with the ability of the ryegrass and *Poa trivialis* filling in. The greens were slow. Now, Besette says, he simply paints greens, tees and fairways. He says, "It's worked out better than anyone could have imagined." The greens play faster. The only real difference, he says, is that divots don't fill in so there are more divots on the course in winter.

Besette also uses some good common sense to work with weeds on the golf course.

"Cattails have been a problem here forever. They had cattails that were 8 feet tall and they'd go out and spray gallons and gallons of Roundup on them. So what I decided to do was, cut them down first. Then when they start to grow and they're only 6 inches tall, then we spray the Roundup on it. So we're only spraying about a tenth of what we did in the past. We found other ways where we could mechanically removed weeds instead of spraying chemicals on them," Besette says.

Besette began his career as a member of the maintenance crew at Pebble Beach and he's spent his career maintaining golf courses in California. "One thing that's strange - this is my sixth golf course. Before I was here, I never had an interview with anybody. Since I've been here I've been on TV four times, and had three or four different magazine articles," he says, laughing. "You gotta go to the middle of nowhere to get recognized." **GCI**



The heat is a real issue when scheduling maintenance projects. Above 123 degrees and Besette sends everyone home.

FURNACE CREEK GOLF COURSE

SWAP MEET

Superintendents explain their irrigation nozzle choices to achieve distribution uniformity for flawless fairways and gorgeous greens.

by Helen M. Stone

Bill Swancutt

ILLAHE HILLS COUNTRY CLUB, SALEM, ORE. A golf course is much like a symphony. Each instrument needs to be in tune and harmonize, otherwise there are discordant notes that can spoil the experience for listeners.

Likewise, soggy areas and brown spots can spoil a golfer's experience on even the most beautiful of courses. Now at Illahe Hills country club in Salem, Ore., everything is tuned up and harmonious, offering the finest play possible for its members.

Bill Swancutt has been conducting maintenance on the 50-year-

old course for the past 31 years and has faced his share of trials. The heavy clay soil makes irrigation a challenge, even if it's necessary only four months a year.

"We put in a whole brand new system in 2000 – new mainlines, laterals, heads and controllers. But we noticed distribution uniformity problems almost from the get-go," Swancutt says.

"If you had sandy soils and good drainage, it probably wouldn't have mattered that the nozzles delivered about 20 percent more water near the heads," he explains. "Since we only start irrigating around June, it took about a month before it really became a problem."

About 10 years ago, while at a GCSAA conference he discussed the problem with his local USGA turf advisor. New metal retrofit nozzles were now available and on display at the trade show. Swancutt visited the booth after a bit more research, decided to give them a try.

Installation was a bit of a headache, so he decided to pass. He tried various other nozzles from the manufacturer. "But the different



Illahe Hills Country Club's heavy clay soil makes irrigation a challenge, even if it's necessary only four months a year.



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nozzles would just move the wet spot in the profile," he notes wryly.

The next step was plugging the short-distance nozzle, which dried out the wet spots. "But then the turf would burn out around the head and we would have to unplug the nozzles or hand water," he says.

By now, Profile nozzles had been improved and renamed and Swancutt decided to try again on a fairway. "Installation only took a few minutes per head, and I started noticing results in a couple weeks," he says.

Fall rains came and irrigation was a non-issue, but the next summer, Swancutt changed over 150 more nozzles, then 150 the next year. "They are more expensive than plastic nozzles, but we can budget for them. And they save labor; no more hand watering. We use our labor other ways to make the course play better.

"Knowing what I know now, if I could have had the irrigation heads bid without nozzles, I would have done it. I'm planning on replacing all the nozzles anyway," he says.

"It's all about uniformity," Swancutt concludes. "Bottom line is that these nozzles give you better results for the golfers, and that's what it's all about."

Now, that's harmony.

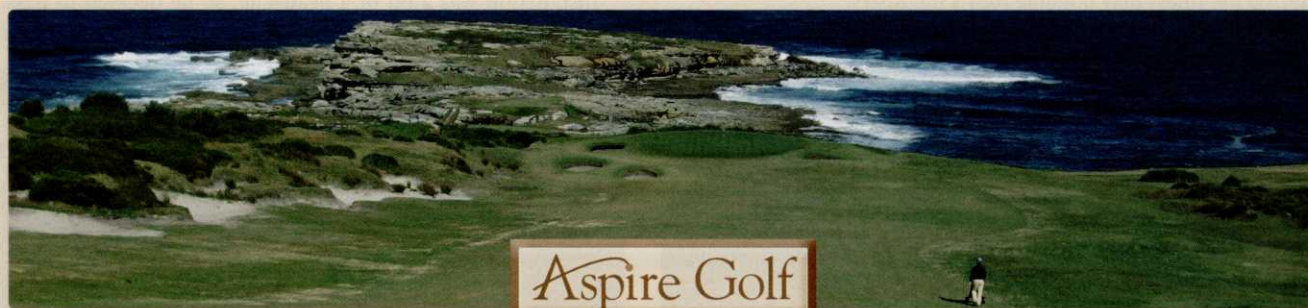
Joel Kachmarek

TACOMA COUNTRY AND GOLF CLUB, LAKEWOOD, WASH. When the sun shines in the soggy Pacific Northwest, everyone smiles. The precious clear days of summer are a signal to get out and enjoy the magnificent surroundings.

The Tacoma Country and Golf Club in Lakewood, Wash., has been putting a smile on golfers' faces since 1894. As the oldest private country club west of the Mississippi, the majestic mature trees, immaculate fairways and greens and almost faultless playing conditions reflect the attention to detail and passion for perfection golf course superintendent Joel Kachmarek pours into his work each day. Kachmarek recently completed a bunker re-design by the late golf course architect and his friend John Harbottle III, which is the jewel in the course's crown.

So although irrigation is only necessary from about June to September, distribution uniformity is critical to flawless fairways and gorgeous greens. However, with the last upgrade in the late 1980s, the 70-foot head spacing made it virtually impossible for the manufacturers' nozzles to deliver water evenly.

"Even when I started as an assistant in 1993, we had donuts around the sprinkler heads," says Kachmarek. He worked as an assistant until



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