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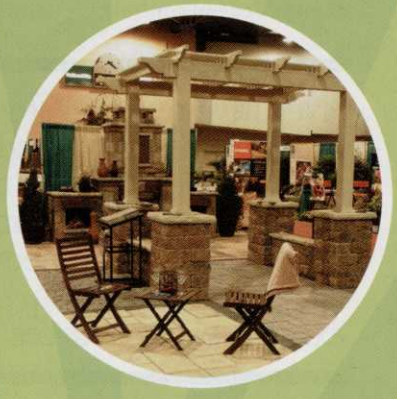

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WHERE'S MY WATER?

Irrigation systems are said to be the heartbeat of the golf course. In reality, it's the water in them that's so important, and in some areas of the country we have been expecting future limitations on that water.

In Texas, the future may be now. The Ft. Worth Division of the Army Corps of Engineers is the first regional Corps office to implement a national directive to eliminate submersible pumps in "Waters of the U.S." Most lakes, streams and even intermittent streams fall under the definition of "Waters of the U.S." and thus, control of the Corps.

In June, the Ft. Worth Division sent letters to permitted water users stating that "utilization of submersible pumps in marine environments where swimmers and waders could be present is a safety hazard and therefore these types of pumps must be removed immediately," adding that, "Our overall goal is to reduce the potential for accidents at our area lakes." Pumps can remain if they are be rated at 220 volts or less, Underwriters Laboratory (UL) certified for boaters and swimmers, installed and wired in accordance with manufacturer's recommendations and the National Electrical Code for wet locations. They also noted that water intake lines can remain.

The new regulation prompted questions and concerns. Negative reaction stems more from the ruling's timing and the "immediate" pump removal requirement than its intent. The immediate enforcement forced many golf courses, municipal water supplies, homeowners and others to re-evaluate their pump systems to avoid losing their existing water sources. The problem lay in the need to work quickly in the heat of Texas summer and the lack of flexibility in what solutions were initially considered acceptable.

Some who are generally critical of the Federal government (Texas has its share) wondered why the Corps picked an economically distressed time to implement a policy that is a reaction to the 1993 drowning of an Oklahoma man which may have resulted from contacting an underwater pump while swimming. Others wonder if the safety issue is really a guise, with the real intent of more Federal control of water resources, and if the cost-benefit ratio of this regulation has been carefully considered.

> "Negative reaction stems more from the ruling's timing and the 'immediate' pump removal requirement than its intent. **The immediate enforcement** forced many golf courses, municipal water supplies, homeowners and others to **re-evaluate their pump systems** to avoid losing their existing water sources."

While the number of golf courses (and municipalities, businesses and homeowners) taking water directly from regulated water bodies may be relatively small, many courses will be affected by this ruling as other divisions of the Army Corps begin enforcing it. Depending on elevation changes and other aspects of the existing pumps, some users will find alternative ways to pump water easily, others will not.

The problem is, while safer underwater pumps do exist, apparently none is UL certified or meets the stringent Corps safety goals. It is possible – but not economically feasible – for individual users to pay for the UL studies to gain certification. One golf course prepared five water withdrawal options. The only one meeting the strict criteria will cost over $400,000, which could put them out of business.

Initially, representatives of the Corps seemed untroubled by closed or dead golf courses. Having worked with the Ft. Worth Division of the ACOE in obtaining construction permits, I know they are reasonable people, and they did schedule a town meeting with affected users to hear their concerns. The result of that meeting was to allow more time to study options that are more acceptable to water users legally permitted to draw water out of lakes.

However, these regulations will eventually be enforced in some form across the country, to better ensure the safety of boaters and swimmers. If you access water from a Corps of Engineers body of water then you more than likely will be affected by this policy. If you are in that situation, it might pay to begin studying your alternatives now. **GCI**

Fabric liners that are stapled into the bunker face and rest underneath the sand.

Help for your HAZARDS

Bunker liners can hold sand in place and improve drainage.

By Frank H. Andorka Jr.

An old golfing adage holds that if you don't like the condition of the bunkers, don't hit your ball into them. The real problem with bunkers is that they are, like the rest of the golf course, ever-changing entities. Even with the best drainage systems, bunkers can succumb to soil contamination and washed out sand during hard rains.

Bunker liners are growing in popularity as a potential remedy for some of the worst problems bunkers suffer. Here are some pointers and tips on how to use them most effectively.

DO YOUR HOMEWORK. Mike Hurdzan, principal at Hurdzan/Fry Design in Columbus, Ohio, says it's critical for superintendents to do their homework before deciding which bunker liner is best for their conditions. He recommends digging test bunkers and applying the different products and sands to ensure the proper product is used.

"You have to do a proper cost-benefit analysis of bunker liners because if you don't, you'll be sorry," Hurdzan says. "So many factors come into play when evaluating these products. It pays in the long run to do a thorough investigation."

There are a number of factors to consider, including weather conditions – freezing and thawing can affect the way bunker liners perform – irrigation water quality, number of bunkers, maintenance labor, installation cost and sand quality and shape.

Bunker liners are most effective when they are added as a drainage aid. Hurdzan says. "What you're hoping to do is channel the water during hard rains into the drainage system

SANDMAT

"If you're not having to send crews out to put the sand back into bunkers, they can be doing other things like squeegeeing greens or picking debris off fairways. **The amount you save on labor can be huge.**"

— Chuck Hutton, SandTrapper

to keep puddles from forming in the bottom of your bunkers," he says.

Chuck Hutton, sales representative for SandTrapper, says sand inconsistency is one of the most common complaints about bunkers. Bunker liners, because of their drainage capabilities, offer superintendents a chance to take that off golfers' lists, he says.

"When the bunker drains more quickly, the sand is more consistent," Hutton says. "You can offer golfers the same shot values from a bunker because the sand will have the same moisture content throughout."

GEOTEXTILES. There are primarily two different types of liners on the market today – geotextile fabrics (such as those produced by SandMat and SandTrapper) and polyurethane sprays that bind the soil substrate together (manufactured by companies like Klingstone).

Geotextile liners, fabric liners that are stapled into the bunker face and rest underneath the sand, are designed to hold sand in place, channel water into the drainage systems and prevent sand erosion, says Ted Fist, product manager for SandMat, a geotextile liner. Superintendents installing geotextile liners will have more labor costs during installation, he says, but will have less labor in putting bunkers back together after it rains.

"Our goal is to keep the water from crashing through the sand during an intense rainstorm and dislodging the substrate and contaminating the sand," Fist says. "It keeps the drainage system cleaner and prevents catastrophic breakdowns that are hugely expensive to fix. The extra money they spend on installation on the front end will save them money down the road."

Chuck Barber, superintendent at Indian Lakes Resort in Bloomingdale, Ill., sees the advantage to using geotextile fabrics as liners. He uses the SandMat 400. The bunker liners he uses keep the sand in place and improve drainage, a critical consideration in the Midwest where rains can sometimes wreak havoc with the sand in bunkers, he says.

"If you put the bunker liner into the face of your bunkers, you can create a direct channel into the drain tiles," Barber says. "We have high-flashed bunkers, and we couldn't keep sand on those slopes if we didn't have bunker liners in place."

Liners also help golf courses return the golf course to playability more quickly after a heavy rain, giving owners the opportunity to earn more money, Hutton says. "If you're not having to send crews out to put the sand back into bunkers, they can be doing other things like squeegeeing greens or picking debris off fairways," he says. "The amount you save on labor can be huge."

Barber recommends choosing the proper staples to install the fabrics. Otherwise, freezing and thawing conditions can pull the staples out of the ground.

"If you're going to use the geotextiles, you absolutely need to install the number of staples recommended by the manufacturer," Hurdzan says. "I've seen superintendents scrimp on the number of staples and the amount of fabric they use. They always end up paying for it later."

Superintendents will have to change the way they care for bunkers. "When you install a geotextile, it does require superintendents to groom the bunkers," Fist adds.

Geotextile liners all but eliminate mechanical raking, Barber says. "You have to take into account the additional labor you will need so that you don't tear or damage the liner," he says. "But if you take care of the sand and the liner, you will save yourself money in the long run."

POLYURETHANE. The first objection Bob McCormick, general manager of Klingstone, will hear about his product – a polyure-

SANDMAT

A bunker liner keeps the drainage system cleaner and prevents catastrophic breakdowns that are expensive to fix.

thane bunker liner that binds the soil substrate together to prevent it from moving – is the cost.

"We understand going into a discussion with a superintendent that the first thing we'll hear is that our system costs a lot more than other bunker liner systems," McCormick says. "And it's true. You will not get an instantaneous savings. But in the long run, you will save money."

A spray-on polyurethane bunker liner costs superintendents about $1.20 per square foot to install, whereas a geotextile liner will cost anywhere from 20 cents to 50 cents per square foot (not including labor). But McCormick argues the extra costs are worth it because of the polyurethane's durability and ease of installation.

Tim Johnson, superintendent of Spring Hill Golf Club in Wayzata, Minn., first installed Klingstone's product in his bunkers 13 years ago during a renovation. He is currently the company's longest-standing customer, and he says the extra cost up front is worth it.

"The only failures we've had are places where we didn't install it properly in the first place," Johnson says. "We decided to go with permanent liners because weather conditions here in Minnesota can get pretty nasty in the winter."

Johnson doesn't have to replace sand after a heavy rains because the polyurethane bunker liners do a solid job of channeling the water into the drainage systems. He adds it's also a labor savings during the installation.

"It's easy to install," Johnson says. "You can send a two-man crew out to install it, and it's no harder than spraying for weeds. Once you put it on, you're good for the next 10 years."

Johnson can't stress strongly enough how important it is to calculate the proper rate of the product before installation. "You can't skimp on the rate," Johnson says. "You will have problems if you do."

Sometimes it's difficult to sell a greens committee or board of directors on the initial cost, so superintendents have to convince them to look down the road 10 or 15 years, Johnson says. The bottom-line for the product looks much better the further out you go, he says.

In the end, superintendents will have to decide for themselves if bunker liners are appropriate for their specific courses conditions, Hurdzan says.

"When superintendents do an in-depth cost analysis, they'll discover that the most expensive part of the course to maintain is the bunkers," Hurdzan says. "Anything superintendents can do to help bring down those costs is worth it." **GCI**

Frank Andoraka Jr. is a freelance writer based in South Euclid, Ohio.

Liner Notes

Bunker work, like with any type of construction or renovation project at your facility, is a strategic financial investment meant to improve the playing experience for the golfer, as well as assist the superintendent and his team in their maintenance routine.

However, to fully realize the return on that investment it pays to do the project the right way, says Craig Porovne, vice president at Professional Turf Products.

Provone offers these liner notes to consider when embarking a bunker project.

- To accommodate cuts and waste, be sure to always add about 10 percent to your total square footage of liner.
- When determining sand, it's a sound practice to add an extra inch for depth because sand will invariably infiltrate the liner.
- Cover the entire bunker, drains, etc. Failure to do this will result in drainage gravel being mixed in with your sand.
- If you're covering the face of bunker and plan on laying sod on top of the liner, it makes sense to add 2-3 inches of soil and rub it into the liner for the turf's roots to take hold of.
- An important, an often overlooked, practice is to use Liquid Nails or another construction adhesive on all seams.
- Most importantly, if you're hiring a contractor to do the work, then make sure he is a certified builder from the GCBAA list.

Carrier water quality and pesticide stability

By Dara Park, PhD and Juang-Horng 'J.C.' Chong, PhD Clemson University

Tank-mixing pesticides and fertilizers is a convenient and cost effective way to apply two or more chemicals at once. When done appropriately, tank-mixing can reduce labor and equipment costs, and save time and energy.

Carrier water is the water you put in the tank to dilute your chemicals and to apply them with. Carrier water makes up about 95 percent of what you are applying. Certain water chemistry can potentially react with, and change the efficacy of, pesticides in both positive and negative ways.

This article examines the origins of water chemistry, and how to take a water sample and determine the water quality. This article also discuss the influence of and the remedies for common problematic water components.

ORIGINS OF WATER CHEMISTRY

The chemical and physical properties of minerals and weathering influence water chemistry. Weathering is the decomposition process of rocks, minerals and soils by physical – for example, degradation by microorganisms and cracking by ice formation– and chemical – such as reactions between water and minerals– processes. Weathering results in different compounds as solutes and or particulates within the water column.

Here is an example of how mineralogy and weathering may influence water chemistry. Along the south eastern coast of the U.S. limestone, composed of mainly calcium carbonate ($CaCO_3$), is the underlying bedrock along coastal South Carolina.

During each rain event, water combines with carbon dioxide in the atmosphere to form a weak acid called carbonic acid. As rain water passes over and through the limestone, the acid combines with the calcium carbonate to form calcium bicarbonate ($Ca(HCO_3)_2$), which is dissolved in the water.

Calcium carbonate and calcium bicarbonate are the two principal causes of hard water. Water chemistry is also influenced by the sources of water. Saline aquifers, tidally influenced streams and rivers and reclaimed stormwater runoff and wastewater all have a considerable amount of salts and other particulates.

TESTING WATER SOURCES

Use opaque plastic containers to collect your water sample. Rinse out the bottle three times with the water you will be sampling before you take the actual water sample. Place your name, location, and date on the sample bottle with a permanent marker. Place the water sample in a cooler or refrigerator until delivering to the laboratory.

Make sure to submit the sample within 24 hours of collection. Regardless of which laboratory you send the sample to, you should receive an interpretation of results as part of your report. Some water components can be determined on site with relatively little expense and will be discussed in the following sections.

COMMON PROBLEMATIC WATER COMPONENTS

pH or Potential of hydrogen is the measure of the concentration of hydrogen ions (H+) and hydroxide ions (OH-) in a solution. It is measured on a logarithmic scale of 1-14 with 1 = acidic (dominated by H+ ion), 7 = neutral, and 14 = alkaline (dominated by OH- ions). Water pH fluctuates diurnally (from photosynthesis and aerobic respiration) and seasonally (from increased rainfall, leaf litter, etc.). Over long periods of time, water pH tends to become more alkaline.

How does pH influence pesticide efficacy?

Certain pesticides undergo chemical breakdown in alkaline water (pH more than 7). The reaction is termed alkaline hydrolysis and the severity and speed in which it occurs is dependent on the pesticide, the alkalinity of the water, the length of time the pesticide is in contact with the water and the water temperature.

Insecticides, particularly organophosphates and carbamates, are susceptible to alkaline hydrolysis than other pesticides. In comparison, sulfonylurea herbicides are more susceptible to acid hydrolysis at pH less than 6.0.

So how do you keep it from becoming a problem?

Since pH is always changing, it is important to check it every time you mix up a pesticide. You can add buffering agents to carrier water whenever necessary.

A pocket pH meter is relatively inexpensive and easy to operate. Test the water pH before adding any chemicals.

Always read the pesticide label and check the pesticide MSDS for the recommended pH range. If correction is needed, add a buffering or acidifying agent *before* adding the pesticide. The acidifying agent may include acid forming nitrogen fertilizers, straight acids and may or may not be used in conjunction with surfactants. Always apply the tank mixture as soon as possible. Buffering agents should not be mixed with fixed copper and lime fungicides; otherwise, plant damage will occur.

SALINITY

Salinity is the concentration of mineral salts – $MgSO_4$, MgCl, CaCl, $NaHCO_3$, NaCl, KCl – dissolved in water. It is measured by electrical conductance (EC) and is commonly reported in either dS/m or mmhos/cm.

So, how does it influence pesticide efficacy?

Salty water is alkaline and more resistant to pH changes, making adjustments with acids more difficult. Salinity of over 0.75 dS/m can stress sensitive

Table 1. Recommendations on the uses of selected fungicides, herbicides and insecticides in carrier water of problematic quality. The effects of water hardness and salinity on fungicides and insecticides are poorly studied; thus, the compatibility should be tested before mixing.

Common Names	Brand Names*	Water Quality				
		Acidic (pH < 6)	Alkaline (pH > 8)	Muddy	Hard	Saline
Fungicides:						
azoxystrobin	Heritage	✓	X	NR		
chlorothalonil	Daconil	✓	✓	Test		
ethazole	Terrazole	✓	✓	Test		
fenarimol	Rubigan	✓	✓	✓		
Fosetyl Al	Aliette	✓	✓	X		
mancozeb	Manzate	NR	NR	Test		
mefenoxam	Subdue Maxx	✓	Test	Test		
PCNB	Terracolr	✓	Test	NR		
propiconazole	Banner Maxx	✓	✓	Test		
thiophanate methyl	Cleary3336	Test	X	Test		
trifloxystrobin	Compass	Test	Test	NR		
Herbicides:						
2,4-D amine	2,4-D amine	Test	NR	✓	X	✓
atrazine	AAtrex	NR	X	Test	✓	X
chlorsulfuron	Corsair	X	✓	✓	✓	✓
clopyralid	Lontrel	Test	X	✓	X	✓
dicamba	Vanquish	✓	NR	✓	NR	✓
diquat (& paraquat)	Reward	✓	✓	X	✓	✓
glyphosate	RoundUp	✓	Test	X	X	✓
halosulfuron methyl	SedgeHammer	X	✓	✓	✓	✓
MCPA	MCPA	Test	NR	✓	X	X
metsulfuron	Manor	NR	X	✓	✓	✓
sethoxydim	Vantage	✓	✓	✓	✓	✓
simazine	Princep	Test	NR	✓	✓	X
Insecticides:						
acephate	Orthene	✓	X	✓		
bifenthrin	Talstar	✓	✓	X		
carbaryl	Sevin	✓	X	NR		
chlorpyrifos	Dursban	✓	X	X		
clothianidin	Arena	✓	✓	✓		
fipronil	TopChoice	✓	✓	NR		
imidacloprid	Merit	✓	Test	✓		
indoxacarb	Provaunt	✓	X	Test		
λ-cyhalothrin	Scimitar	✓	X	X		
spinosad	Conserve	✓	Test	Test		
thiamethoxam	Meridian	✓	Test	✓		
Trichlorfon	Dylox	✓	X	✓		

*Brand names are provided as examples. Mentioning of any products should not be considered as an endorsement.
Key: ✓= OK. X = Do not use. NR = Not recommended but use soon after mixing if there is no alternative. Test = Test for compatibility.

plants and reduce absorption of systemic pesticides through plant roots.

Besides what has been mentioned, not much is known about how salinity influences pesticide efficacy, or if it does at all. However, we are aware of instances in which a pesticide failed and the only water problem possible was salinity. If you have a similar problem, please have your county extension agent contact us immediately.

To keep this from becoming a problem, check the salinity in you carrier water if you use water from reclaimed or tidally influenced sources.

Pocket EC meters are inexpensive and easy to use. Combination Temperature/pH/EC pocket meters are slightly more expensive but still reasonable. Always read the pesticide label and check the pesticide MSDS to see if any precautions should be taken. Sometimes salinity is reported as total dissolved salts (TDS). Most pocket EC meters will give you the option for either an EC or TDS readout.

If a saline water source is used, an alternative water source should be identified for permanent use or for blending with the saline water. Agitators and injection tanks can be installed for water treatment with calcium or sulfur.

Contact your university extension agent or a professional to discuss the best options.

WATER HARDNESS

Hard water contains a high concentration of magnesium (Mg^{2+}), calcium (Ca^{2+}), and Ferric ions (Fe^{3+}). Water hardness is reported in ppm of $CaCO_3$ equivalent. Water <50 ppm is considered "soft", 50-100 ppm is considered "medium hard" and 100 – 2000 ppm is considered "hard".

So how does it influence pesticide efficacy?

The cations in hard water bind with the pesticide molecules (one cation can bind more than two susceptible pesticide molecules) to form insoluble salts and precipitate out of solution. 2,4-D, dicamba, glyphosate and clopyralid are susceptible to binding with minerals in hard water.

Hard water can also reduce the efficacy of some surfactants and agents added to clear turbid water. Precipitates and scales formed in the sprayer can also clog the nozzles and filters resulting in lower pesticide rates applied than expected and or non-uniform spray coverage.

To keep it from becoming a problem you will have to submit a water sample to a laboratory to test for hardness. Always read the pesticide label and check the pesticide MSDS for any precautions. If correction of water hardness is needed, add an agent such as those containing sulfate, organic acids and non-ionic surfactants. Sulfate (SO_4^-) and organic acids are often used to bind with the hard minerals.

Non-ionic surfactants are commonly used to enhance herbicide efficacy but it should be noted that these will not correct the problem, and another agent still needs to be used. The agent should be mixed with the carrier water before adding the pesticide.

Other options are to decrease the volume of carrier water and to use a higher label rate. Spray the tank mixture immediately.

PARTICULATES

Particulates of clay, silt, organic matter and algae that are found within the water column naturally or from agitation.

Large particulates may eventually settle to the bottom but small particulates can suspend in the water column. Collectively, the total amount of particulates is known as turbidity and is commonly reported in Nephelometric Turbidity Units (NTU). The small particles that remain suspended are referred to as *total suspended soilds* and are reported in mg/l.

These particles are both a chemical and physical nuisance and can influence pesticide efficacy. Clay and silt can bind with pesticide molecules. The organic particles not only bind with pesticides but also harbor microbes that naturally degrade pesticides. These particulates can clog filters and nozzles.

To keep it from becoming a problem a water sample will have to be submitted to a laboratory to get an actual value of turbidity. The easiest way to test for a problem is to drop a quarter at the bottom of 5 gallon bucket of the water. If you cannot see the coin, then the water must be treated.

Glyphosate is an example of a herbicide that is degraded by soil. Always read the pesticide label and check the pesticide MSDS for any precautions on using dirty water.

An inline filter can be installed to remove suspended solids. If the pump is within a surface water body, make sure that the location of the intake is in the middle of the water column and not at the very bottom or close to the top of the water column. Locate an alternative water source for permanent use or to blend with turbid/muddy water.

Additionally, agents can be added to help precipitate and clear the water.

IRON

Iron is the sixth most abundant element in the universe and is the fourth most abundant element in the earth's crust, although not commonly found in the free metal form.

Iron is dissolved as water passes through the underlying rocks. The concentration of iron is reported in mg/l.

Iron doesn't directly influence pesticide chemistry. However, in air or aerobic water, iron reacts with oxygen to form rust – oxide and hydroxide forms of iron. It forms faster in the presence of salt, as in certain pesticides or within the carrier water.

The rust can cause reddish-brown staining. Iron also combines with organic materials and bacteria to produce slimes. Rust flakes and slimes can clog nozzles, filters and lines which may result in applying less pesticide than expected.

To keep it from becoming a problem a water sample will have to be submitted to a laboratory to get an actual value of iron concentration.

Stains can appear at concentration as low as 0.3 mg/l.

Treatment for excessive iron depends on the problem that exists (stains, deposits, or slimes). The most common techniques include aeration followed by filtration, the use of a water softener (caution: these usually use sodium), and the use of potassium permanganate and chlorination followed by filtration. Contact your university extension agent or a professional to help decide which is best for you.

TAKE PRECAUTIONS

Always check your pesticide label and MSDS for recommendations and guidance. If you still have a question, contact the company representatives or county extension agents. Table 1 (page 38) summarizes the effect of water quality on the most commonly used and more recent pesticides.

If the irrigation source exhibits one of the above-mentioned water problems, and the pesticide requires water-in after application, the irrigation water should be treated as well. This can be done by installing inline injection tanks. **GCI**

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TRACKING WATER USE

Do you manage your irrigation water supply? Do you know how much water your irrigation system uses? Do you measure your irrigation water use? Do you know how much water your irrigation system uses per cycle, weekly, monthly or annually? Do you believe it's important to know how much water your system is using?

Many superintendents are aware of their water use by default. Most pump stations have a flow meter that is part of the logic process and determines when pumps should turn on and off. The amount of water being pumped is automatically recorded. Of course, if you never reset the totalizer or write down the use you still don't know how much water you're using.

As we all know, water is more and more of an issue in many parts of the country. It is not just a problem in the West, but in many other places, including areas that are considered water rich. In areas of the country, especially in the west, there is no requirement to measure or report how much water a golf course is using. In most eastern states, however, to pull water from the ground or from surface water, a water withdrawal permit is required. These permits are usually for diversions of 100,000 gallons or more on an average daily basis, which an irrigated golf course easily exceeds. Some states base their withdrawal permits on daily maximums or quantities lower than 100,000 gallons per day. For example, Connecticut requires a diversion permit for any use more than 50,000 gallons on any given day. As part of the withdrawal permit the amount of water used each month is reported either on a yearly or quarterly basis. Usually the state provides a form to report your use to them.

If you're not, then start monitoring your water use. Why? At some point you will be required to, no matter where your golf course is located. It's easier to demonstrate how much water your system has been using over time than it is to have some regulatory authority tell you how much water you can use. Measuring and monitoring your water use is also the responsible thing to do. If you monitor your usage, you can tell when something has gone wrong or something is going wrong. If your water usage jumps up or your water use significantly decreases, it's a sign something in the irrigation system has changed. So monitoring water use can be used as a troubleshooting tool, as well.

Some superintendents believe how much water their irrigation system uses is nobody's business. Others are concerned if they report, their water will be cut or they will be charged for it. Currently, very few places charge for ground or surface water. There are some, though, most notably the Susquehanna River Basin Commission (SRBC), which impacts golf courses in New York, Pennsylvania and Maryland. Eventually, whether it is in five years or 50 years, there will be a cost associated with using ground and/or surface water in many other areas of the country.

When enacted, water withdrawal permit requirements are similar from state-to-state. In addition to a reporting requirement, they will require the calibration – on a one or two-year basis – of the meter or meters measuring the water to make sure they are reading accurately. On golf courses with multiple water sources, multiple meters will be required. Groundwater wells will need to be individually monitored, and in some extreme cases stream levels – either on the property or coming in and out of the property – will need to be measured with weirs, too. In simple cases, only the amount of water pumped is monitored.

You may not like the idea of measuring and reporting your water use, but the time will come. The better idea you have now of how much water your system uses the better off you'll be in the future. **GCI**

> "If you're not monitoring your water use you should start. Why? At some point you will be required to, no matter where your golf course is located."