

NOVEMBER 1973

USGA GREEN SECTION RECORD

A Publication on Turf Management
by the United States Golf Association





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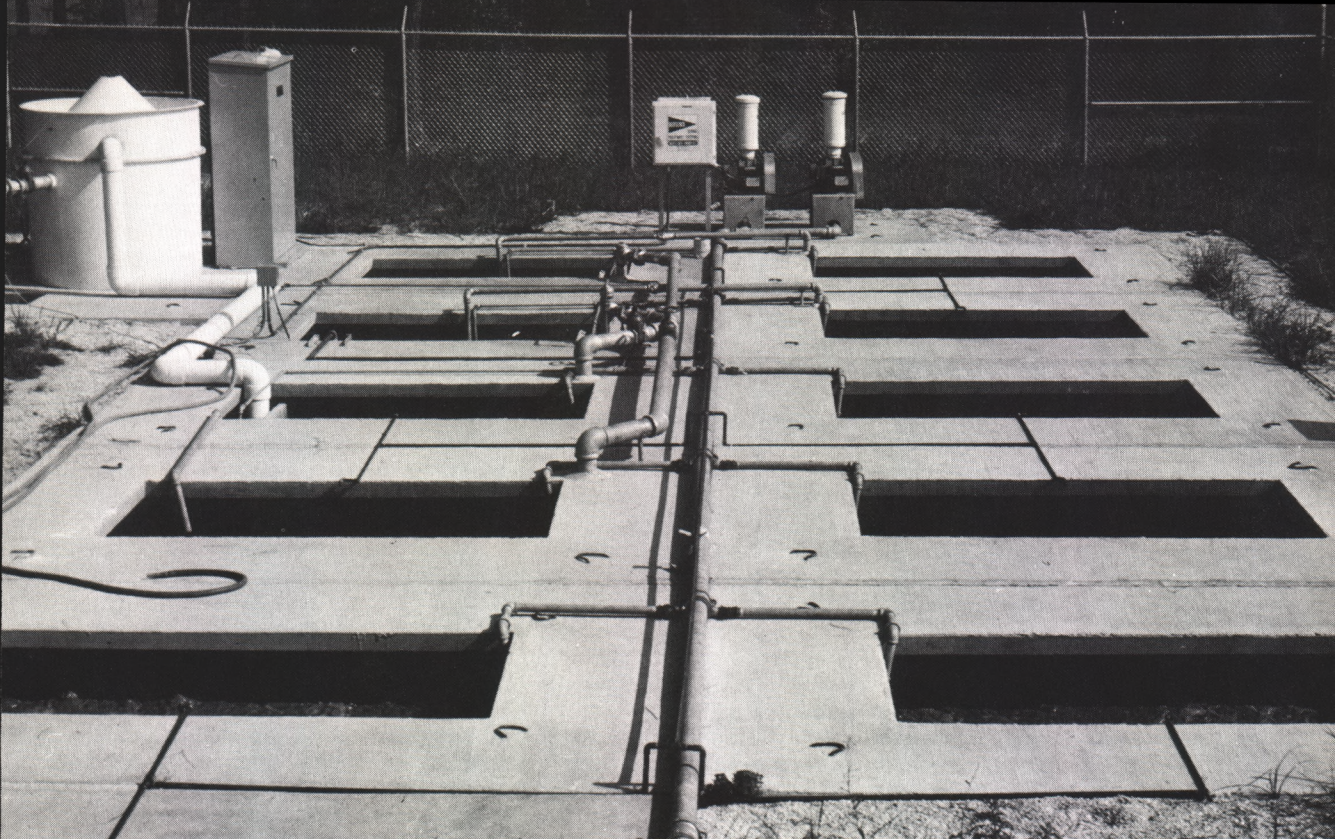
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From the Affluent to the Effluent

by JAMES B. MONCRIEF, Southern Director, USGA Green Section

"Don, do you smell something, or is it my imagination?"

"It's a smell all right and I've been catching it for the past five or six minutes."

Don and Margaret are from New Zealand and were visiting the United States this summer. He is in the home-building business. Both are golfers, and they were combining business and pleasure this day, visiting a new housing development and planning to play the new golf course. They were early risers, and after having a cup of tea—two bags please—were on their way to the first tee. It was then they noticed the irrigation system in operation and the slight but definite odor of effluent water in the air.

"Now I know," said Don. "I've heard about land-locked sewage systems installed in the United States for housing developments around

golf courses. That's what we smell, and we've got to find out more about such operations before we leave for home." At the time, little did Don realize how much was involved in "such operations." In the following story, we will record some of the facts uncovered by our friends from New Zealand on the subject of effluent water for golf course irrigation purposes.

During the past 10 years there has been a tremendous movement to rural areas and to complexes built around golf courses. They are wonderful places to retire or bring up a family. However, many of the new residents do not realize that their domestic water is reprocessed and then used for agricultural purposes, including irrigation of their golf course and landscape areas. Some projects start out as golf course developments, and then additional housing is

developed beyond the golf course limit and is tied in with the sewage disposal system. More sewage units are added and waste gallonage climbs.

Effluent water has been used for centuries, but it has not always been properly treated. Indeed, in the early days of the city of Pompeii, it received no treatment at all! Even today there are still problems being researched, because the recycled water poses disinfectant problems. But as population increases force expansion (particularly into low rainfall areas), more emphasis must be placed on the use of recycled water. I have visited courses in New Mexico that have used effluent water for the past 20 years and are still growing excellent turf. At that time, the main problem I recall was odor from the water and a noticeable amount of algae in poorly drained areas. It seems that then, as now, the most pressing problem is how to disinfect recycled water adequately.

One problem lies in the hazard of a golfer being thirsty and drinking from irrigation outlets. This is extremely hazardous, because viruses can survive with the present method of water treatment and there is the possibility of an individual becoming sick from bacteria, virus, or cysts. It is essential for the golf course operator in charge of the area being irrigated with effluent water to emphasize the danger of drinking it, even though it has gone through the most strict recycling process. The Superintendent of the municipal golf courses in Austin,

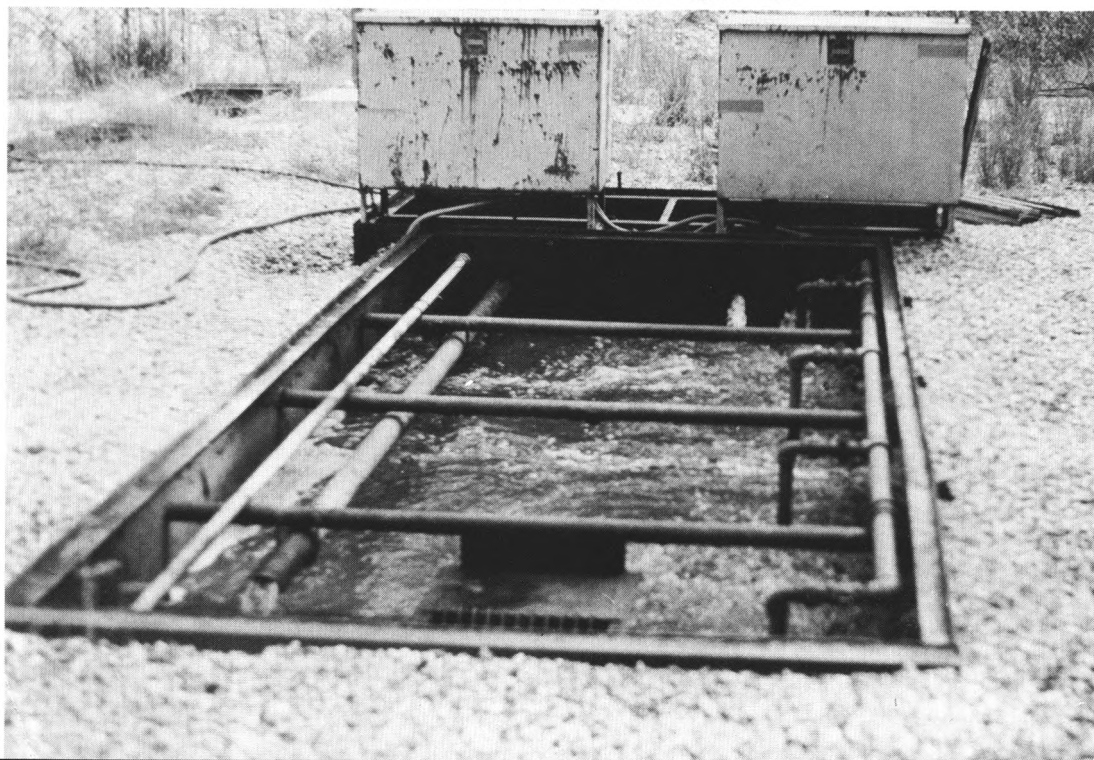
Texas, is printing on score cards of the new municipal course to be opened soon, the danger of drinking water from irrigation outlets.

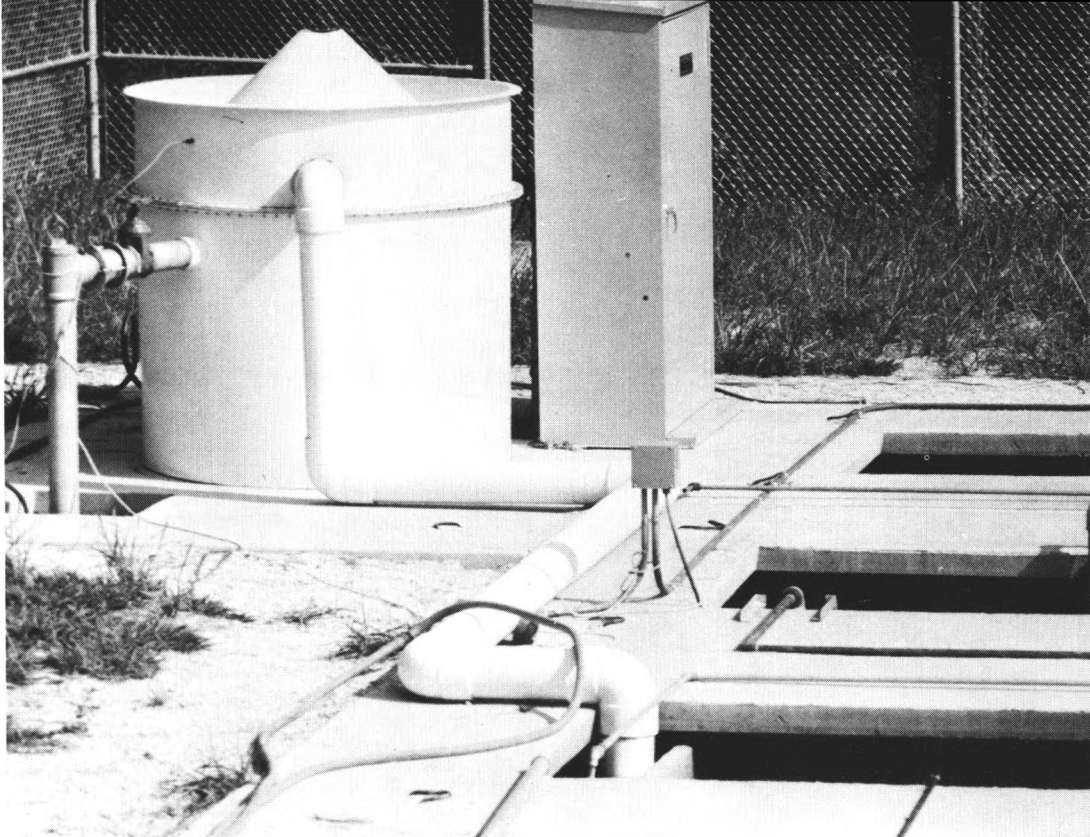
The long term effect of people being exposed to recycled water is being studied and a comparison is to be made with European countries where the practice has existed for centuries. Some of the major rivers there have a high percentage of sewage effluent during the low flow stages. It has been estimated that the Rhine River in West Germany is as much as 40 per cent waste effluent at the low flow of the river. A comparison of population along the Rhine River with a river in the United States under the same or similar conditions with a population that has been drinking relatively clean water should indicate if there have been any effects from recycled water.

New laws are being passed to improve the rural water supply. The latest is the "Rural Drinking Water Assistance Act." This does not pertain specifically to golf courses but is an effort being directed toward improving rural water supplies. As population moves into rural areas—housing developments, trailer parks—water treatment considerations must be met. Rural areas have been neglected and many people are living without a safe drinking water supply. This is known to contribute to impairment of health by incipient organic diseases which may cause lethargy and inhibit productivity.

We all have a right to be concerned over water purity. Some diseases associated with

Very little foam from new soft detergent use.





Defiance Sewage Treatment Plant with filtration system located at Atlanta Athletic Club where filtered effluent is used in the golf course irrigation water.

effluent water before it is treated for example are *Pseudomonas aeruginosa*, *Salmonella newport*, *Escherichia coli*, poliovirus, and *Ascaris lumbricoides*. Sounds bad and is bad if the sewage is not properly treated.

Dr. Mark A. McClanahan, of Georgia Institute of Technology, has made a study of the problem of adequate disinfection. Recycled water is not widely used for human consumption. The increasing regulations of water use by Government Agencies and the militancy of environmentalists occasionally causes some alarm with the adequacies of present methods of disinfection. He feels before use of recycled effluent water becomes a reality we will need to know its effects on human beings after long-time use. Fortunately, use on turfgrass areas does not create a hazard unless a golfer actually drinks effluent water. Apparently the hazards are not all due to bacteria. Viruses, as non-living molecules such as mutagens, carcinagens, teratogens, and toxicants can also be a problem.

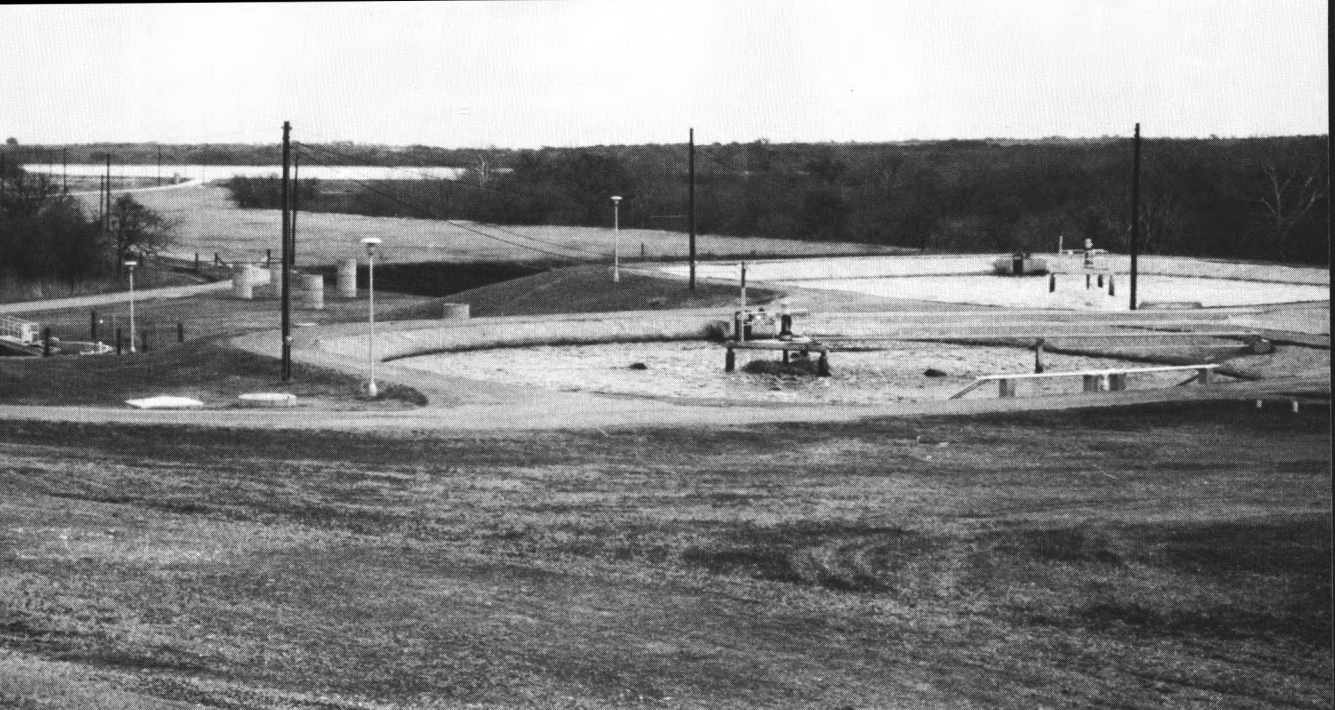
Among the best and most common disinfectant we have today is chlorine, and it probably will remain so for some time. According to Dr. McClanahan, ozone has shown promise as a disinfectant. It has been shown to be effective against bacteria, viruses and cysts.

Ozone is instable, which may make it an excellent synergistic partner with chlorine. Research will give us this information. The type of organism, soil moisture, temperature, pH, and the presence of antagonistic organisms in the soil influence survival time.

We hear much about biodegradable material and it is frequently associated with detergents. You also may soon be seeing the letters BOD (Biological Oxygen Demand). Where waste treatment has BOD, it can be treated by an appropriately designed biological treatment system, and can be very efficient for domestic sewage treatment where most of the biodegradable detergents are consumed.

Some people associated with golf course maintenance are very interested in effluent water as a means of reducing fertilizer use and costs. They may be disappointed and actually find it necessary to supervise the fertilizer program more closely. Nutrients in the water may accumulate in the soil, creating plant toxicity. This can be influenced by the source of water, the soil it is applied to, rainfall, and other environmental factors. Recent research has led to the following conclusions:

Increased levels of exchangeable and water soluble manganese resulted from



Several million gallons per day sewage plant at Austin, Texas with a 40-acre lake in left background. New golf course will be entirely irrigated by effluent water from this plant.

the low pH caused by a sludge application rather than from large amounts of manganese supplied by the sludge itself. The source of maximum available zinc for crop uptake was the sludge crust rather than the soil. Reduced growth of rye associated with increased copper levels and high zinc levels in the forage indicate that a disposal area should be limed and otherwise managed to reduce the possibility of toxicities, since the build-up of micronutrient and non-nutrient heavy metals to toxic levels may ultimately limit the effective life of a disposal area. Rye was a less suitable crop for the disposal area than was coastal bermudagrass.¹

As Don and Margaret progressed in their tour across the United States, they began to realize some of the problems an affluent society can be confronted with in disposing of effluent water. "You know, Margaret, this is a perplexing subject. Let's digest some of the information we have gathered while visiting golf courses and real estate developments on our tour. And oh yes, let's go have another cup of tea—two bags please.

"When we arrived in California, we were shown some beautiful housing developments. During this time, someone mentioned the Lake

Tahoe area and the fabulous job they have done with their effluent water problem. I understand the water is good enough to drink, but psychologically, people aren't quite ready for the idea just yet. Nevertheless, the water does meet standards approved for drinking water.

"We went to the Open Championship at Oakmont, Pa., and I recall someone mentioning that we should see the film made on the use of sewage. I'm sorry we missed that, but wasn't the Open exciting! I hope we see another soon. Those Green Section fellows were down to earth and with a lot of turfgrass tips too. I hope that Maori good luck charm we gave Monty will work for him.

"After the Open, we drove down to Virginia and the International Turfgrass Conference at VPI. There was an abundance of research reported but we didn't hear much about sewage until we went to Georgia. That Dr. Ralph Smith in the agricultural engineering department at the University of Georgia knows a lot about influent and effluent. His studies cover the entire field of agricultural sewage and waste products. I recall his statement that effluent water usually has such a small amount of nutrients in it, it should not be of concern when fertilizing golf courses. And then, when we drove down to Florida, you recall those miles of dry land where lack of adequate irrigation water is a problem.

"We heard of one golf course complex making arrangements with the city to use their effluent water, which amounts to a million gallons a day. That's not too surprising for a small city since each person averages 125 gallons of water per day for household purposes. If you remember, the man at one disposal plant said they estimated the average wet sewage solids (sludge) per capita per year is about 36.5 pounds

"When it rains five inches, what do you do with three million gallons of water? It's like a freight train coming at you. Side track it? Where can you send that much water? Can it be turned loose in creeks, rivers, or lakes? In Florida it can be put into the sand dunes, which are excellent filters for purification. Soil serves as an excellent buffer and also acts as a filtering system."

"That reminds me of the golf course development we heard about in Florida," said Margaret, "that has the georgic department check their water table each month for any trace of chemicals they might detect. How do you suppose that's done?"

"They have small-bore wells at different depths, such as 40, 60 and 80 feet, and they sample with a small container on a strong string. They can also check to see how much side movement of water takes place in the soil—like Dr. Smith was doing at the University of Georgia. That's the way I understand it," said Don. "If you remember, there is more water movement in sandy soils and sand makes an excellent filtering system."

"We have come a long way and we have about 12,000 more miles to go before returning to home. It's been one of the best trips we have taken. We have seen a great deal in America; new housing developments, great golf courses and great golf (John Miller's 63 at Oakmont)! We've learned a bit about irrigation and the problems an affluent society has with effluent water. But it's good to be on the way home."

FOOTNOTE:

¹King, L.D., & Morris, H.D., 1972. Land disposal of liquid sewage sludge. The effect on yield, in vivo, digestibility and chemical composition of coastal bermudagrass (*Cynodon dactylon*, L. Pers.) *Journal of Environmental Quality*, Vol. 1 (3).

A TURF TIP FROM *BILL*:



Bill Gaydosh, Superintendent at Fairmount C.C., Chatham, N.J., says, "The roto-mist machine has saved us a lot of time spraying a wet course without going on greens, tees or fairways." Bill regularly sprays all his greens in 1½ hours, his fairways in 2½ hours and all his trees in one day. Anti-drift additives can be added to reduce drift when spraying near homes. He also uses the machine to blow leaves, wet fairway clippings, and thatch after renovation of the fairways.

Being A Green Chairman

Ain't Like Raising Mushrooms



by EUGENE L. JOHNSON, Flossmoor C.C., Flossmoor, Ill.

The longer I'm involved in any enterprise, including my own job, the more I equate managing people to raising mushrooms. A mushroom farmer must keep these budding delicacies in the dark and feed them a lot of fertilizer. Too frequently this is the way many people supervise their job, green chairmen included. We often keep everyone in the dark and try to get by with a lot of manure.

When I was appointed Green Chairman, I was determined to shed some light on the responsibilities of the job. I found job responsibilities such as labor relations, budgeting and planning fairly well defined. But to whom I was responsible was not as clear. To me, a green chairman is responsible to four distinct groups or individuals—the club members, the board of directors, the superintendent, and the grounds employees. His every decision should be based on his obligations to these four masters. Here's what I mean.

TO THE MEMBERS

My obligation to the club members heads the list because they own the course. They pay a healthy price to belong to the club and deserve "a bang for their buck." This includes a course that is always in the best possible playing condition, regardless of weather, one to which they can be proud to bring guests.

Little touches, such as flower pots around the course, trimming around an especially attractive entrance, a good-looking practice tee and an exceptionally good-looking first tee help make the course enjoyable. The proper placement of benches, water fountains and steps on steep inclines add a touch of convenience to the course. (Incidentally, railroad ties make effective steps; they're cheap and can be placed by the grounds crew.)

Bearing in mind there is no perfect course, the green chairman should constantly look for changes that would improve the layout of the course. Improvements, regardless of how small, tend to make the course more interesting. On our course, 10 of our 99 traps have been removed, thus reducing expenses while improving the course layout. Such efforts to control expense enable members to see and feel that their money is being used judiciously.

Communication with club members is an-

other aspect of my obligation to them. When the course is under repair or there is an unusual ground or grass condition, they deserve to know the who, what, where, when, why and how of the situation. I do this through the members' bulletin, a regular publication at our club. We try to have an article about the course in each issue; an ounce of explanation has proven to be worth a pound of alibis.

The other side of communication with members is listening to them. I must be receptive to their comments. It's tough for a green chairman to come off the course after a 95-degree day and have someone hit him with the comment, "The course looks like a goat ranch." Or, from one of the older members, "It certainly isn't what it used to be."

However, we still have an obligation to the members to listen to them, look for constructive comments and react positively to them. A good receptive ear here is better than a lot of manure.

And finally, a most important part of my obligation to members, is to be certain the green committee represents a cross-section of the club's membership. It needs older members, younger members, good players and poor players. The older members can be invaluable in providing historical background . . . what's happened; what's been tried and failed or was successful.

In addition, some club members have special talents that would be extremely useful to the green committee. I have one committee member who, as a biologist, is an expert on trees. Another owns and operates a large cemetery which has many of the same problems our committee faces. By including these people on the committee, the members will have confidence that they are not only represented but well represented.

TO THE BOARD

My second obligation is to the board of directors, which in turn is responsible for the overall management and welfare of the club. Foremost in my obligation to the board is to manage the financial resources it provides me in the most effective way possible. Realistic budgeting and well planned spending are essential. I've had experience with green chairmen who did not submit realistic budgets. That's not fair

to them or the board. You'll find the money is easier to get if the budget is realistic and spending is well planned.

I would like to make a special point here about capital budgeting. Grounds folks often overlook the capital needs. Unfortunately, not all of these needs can be forecast. Much of our equipment doesn't have a definite term of life and could clunk out at any time. A decision must be made whether to replace an item or repair it. If money is not set aside either through a depreciation account or some other means, you're always going to the board with a surprise about a new mower, water pump or other piece of equipment.

As the financial condition of the club changes, it is up to the green chairman to change his budget as needed to conform. This flexibility is important because it is difficult to forecast an entire year. Changes occur due to large unforeseen expenditures, bad weather conditions or tight money situations. This short range planning is vital.

I also owe the board a look at long range planning. I have to forecast what's in the future, 5, 10, 15 years from now such as the available supply of water, drainage and long range possibilities for the club.

Overall planning by the green committee should be the same kind used in business, i.e., forecasting equipment needs, budget and manpower requirements, investigating possible use of labor saving devices and other means of increasing productivity—planning improvements, preventive maintenance, and personnel planning. Business management techniques can be put to good use and will return many benefits.

A good job of planning will also allow the green chairman to provide invaluable assistance to the board by volunteering the services of the ground crew, particularly during the winter months, for many maintenance projects around

the club. This might include painting the swimming pool, building a backboard on the tennis courts, or maintenance around the club proper. Wages for these projects can be cross-charged to help the grounds budget, and it helps keep club expenses down by not hiring outside contractors to do these jobs.

While we're discussing employees, the board also deserves uniform personnel administration. Salary treatment, pensions, disability and sickness benefits, vacations and overtime policies should be applied in the same way for all employees . . . waitresses, maintenance people, swimming pool attendants, tennis and golf people. My responsibility is to know the club's personnel practices well so that grounds employees are not treated with any disparity.

TO THE SUPERINTENDENT

My third obligation, to the grounds superintendent, is particularly important. He is the paid executive for managing the course. To do the job right is difficult at best. To him I owe my complete support. I am his friend, advisor, supervisor, motivator and follow-up man. He should be free to make technical decisions as long as they meet budgetary and policy guidelines . . . or unless we mutually agree that there is a better way to do something. Care of the course is his specialty. A beautiful lawn at home doesn't make me an expert grounds-keeper.

Superintendents have their hands full on the day to day job and find little time to keep up with current information on new technology, management techniques, maintenance methods and myriad other items. A green chairman with a general administrative job in business can be extremely valuable to the superintendent by sharing some of the current business techniques and methods with him.

My business experience is helpful in assisting the superintendent with budgeting, expense

EUGENE L. JOHNSON

A native of Rockford, Ill. and a 1949 graduate of the University of Illinois, Johnson has held various management positions in a number of cities with Illinois Bell Telephone Company and the American Telephone and Telegraph Company. He is currently General Manager—Upstate Area at Illinois Bell. He has been a member of the board of directors of the Flossmoor Country Club, Flossmoor, Ill., for four years, and for the last two years has served as the Green Committee Chairman. He takes golf seriously, as evidenced by the fact that he has been club champion four of the past five years. Johnson resides in Flossmoor with his wife and two children.



control and setting priorities. After setting the budget, we check ourselves monthly. Staying within the budget is important only if it is realistic, allowing for the tools to do the job and no more. Labor expense must be watched closely. It escalates rapidly. The superintendent and I work together to find new or existing mechanized procedures that can increase efficiency. This equipment can be purchased, leased or cooperatively bought with other clubs. Careful consultation is required to be sure we aren't "gadget happy" but still take advantage of labor saving devices.

There are two basic rules about spending money that I strongly recommend to all green chairmen and superintendents.

1. Never contract for work with others that your own employees can do.
2. All major purchases should be put out for competitive bidding.

It is my job to represent the grounds superintendent to the board. The green chairman is the liaison between the board and the superintendent. In that capacity, I can save both the board's time and the superintendent's time. To carry out this obligation, requires preparation and a knowledge of all the facts pertaining to the grounds job. It may be necessary to invite the superintendent to a board meeting on occasion if there is a special project that requires some technical information that only he can provide. But he should not attend board meetings regularly.

On the other side of my obligation as liaison is to represent the board to the superintendent. The board's instructions should be given to him in writing along with a full and complete explanation of their reasoning.

Complete communication with the superintendent is vital. If there are problems, if members are complaining, if changes are being planned, if there are budget problems, the superintendent should know. He has a demanding job, particularly during the summer months when his work days are very long. Keeping him informed will allow him to plan his work better and will let him know he is important to the club's operation. Of all the people who should not be kept in the dark, it's the grounds superintendent.

I also owe the superintendent a golfer's view of the course. He often sees it from a maintenance view and may not consider the effect changes like scalloping or trimming around greens would have on the playability of the course. Tree trimming goes in this same category. It may be healthy for the tree but could become a serious handicap for the golfer. To this end, my committee and I tour the course two or three times each summer with the grounds superintendent and his assistant.

TO THE EMPLOYEES

Finally, last but not equally important is my obligation to the employees of the grounds crew. To them I owe fair wages, good working conditions, and job security benefits comparable to those of other employees of the club. As with employees of any other business, fair treatment and interest builds pride, dedication and longevity.

When I'm around the club, I seek out the grounds employees, stop and talk with them, ask about their problems, see what they're doing and why. I show a sincere interest in them and their work. This provides an outlet for their problems and builds a sense of proprietorship. A few other examples may help explain this point.

Last year, for the first time, the green committee had a Christmas party for our grounds crews. After dinner the crew members were given tokens of our appreciation. It was a good informal evening of camaraderie and fun. We let them know through impromptu speeches how much they were appreciated; and it definitely worked to the benefit of both the committee and crew members by improving attitudes and communication.

Another example is our club's arrangement for the grounds crews' meals. At our course we have a dormitory where many of the ground employees live. For their convenience, we made arrangements for them to get meals at the club. We learned we could feed them for little or no additional expense. Employees really appreciate this sort of benefit. Uniforms, hard hats and other such articles go far in motivating employees and giving them a feeling of belonging.

Looking at the green chairman's job from the point of view of his obligations to the club members, the board of directors, superintendent and grounds employees puts the job in a different perspective. A green chairman can begin to measure his performance by how effectively he is serving these four masters. It's not a snap! The job will probably take twice as much time as anyone thinks it will.

I'm reminded of the wag who told the old but appropriate story about the Leaning Tower of Pisa. He said, "I understand they're putting a clock on the Leaning Tower of Pisa." His friend asked, "Why are they doing that?" "Well, the Italians find that it is no use having the inclination if you don't have the time," was the reply.

As green chairman, no matter how inclined you might be to accept the job, you can't take it unless you are willing to devote adequate time to the job. Done right, it can be the most time consuming and challenging of any committee chairmanship at a club.

Up, Up and Away

by CARL SCHWARTZKOPF
Mid-Continent Agronomist,
USGA Green Section

We have all heard the story of the sailor on leave who rents a boat and takes a cruise, and of the bus driver on his day off taking a tour of the city. Would you believe the story of an agronomist who travels over 25,000 miles each year talking turf with golf course superintendents and club officials in the United States, who then takes his vacation and travels halfway around the world to look at turf and play golf?

On one of those beautiful Chicago winter days with 20 inches of snow and the thermometer hovering between 20 and 30 degrees, a plane left from O'Hare International Airport enroute to Malaga, Spain; there I was, bags, baggage and golf clubs. Eight hours later we landed on the Costa Del Sol, the sun coast of Spain's Andalusian coastline.

The weather was warm and comfortable, as it is most of the year. The climate was a welcome relief from the freezing temperatures of the Midwest. However, the climate was also favorable for *Poa annua*! Although the lawns and fairways are predominately bermudagrass, *Poa annua* makes its presence known on golf courses in Spain as it does here. The greens are bentgrass but *Poa annua* is scattered throughout.

Since Costa del Sol is among Europe's favorite sunshine playgrounds, it receives over two million tourists annually. Fortunately, not all of them play golf, but those who do contribute significantly to the usual problems of wear and tear on turf. Due to the large amount of play, most tees have some form of bermudagrass vegetation showing signs of traffic. Fairways are a combination of bermudagrass and bluegrass.

Because the climate is of a maritime nature, many tropical and warm-season ornamental plants are used throughout the golf courses to bring added beauty to the property.

CULTURAL PRACTICES

As one may expect, the level of maintenance varies from one course to another as it does in the United States. Some golf courses use the newer triplex riding greensmowers, others still use the hand walking mowers. Several courses had finished aerifying fairways with the latest model aerifier available, although a course 10 kilometers (6.2 miles) down the coast has never aerified fairways and they were aerifying greens by hand with a series of tines welded on a cross bar.

to Spain!



The condition of the golf courses in Spain, as in other parts of the world, can be directly related to the equipment and the personnel who use it. The majority of specialized turfgrass equipment, such as greensmowers, aerifiers, etc. are imported from the United States. The trucks, tractors and utility vehicles were of local origin.

Personnel seemed to be plentiful. The speed at which people move throughout the whole area of southern Spain is considerably slower than the hustle and hurry attitude that is prevalent on American freeways and fairways. Although my Spanish vocabulary is very limited, the first two words a tourist learns are "uno momento" and "manana." "Uno momento" translated, literally means "one moment" but the moment in Spain can take as long as 30 to 40 minutes! "Manana" means "tomorrow"; as slow as some things happen, like waiting for a taxi or accepting delivery on a rental car, tomorrow may be a couple of days away! During siesta time, 1 p.m. to 3 p.m. or 12 noon to 5 p.m., depending upon the month, virtually all activities cease.

CARTS AND TRAFFIC CONTROL

Three- or four-wheel electric or gasoline powered golf cars are few and far between. Many courses do not have golf cars within the complex, although a few have some cars that are privately owned. Consequently, the caddie is still an integral part of the game in Spain. It is very common for many school boys to play hookie once or twice a week to caddie.

After a week in the warm sunshine of southern Spain and northern Africa, it was back to the Midwest winter of snow; awaiting again the first blade of green grass. Waiting also was a little white ball with Spanish dimples and a Spanish smile.

Environmental Concerns for the Golf Superintendent

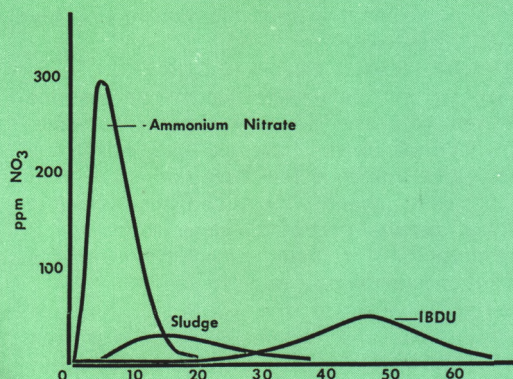
by R. L. DUBLE and K. W. BROWN

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Pesticides and fertilizers are as important to the golf course superintendent as they are in any other phase of agriculture. In the course of a year, golf course personnel are handling and applying reasonable amounts of these materials and should be aware of proper procedures and potential dangers: to themselves as well as to the environment.

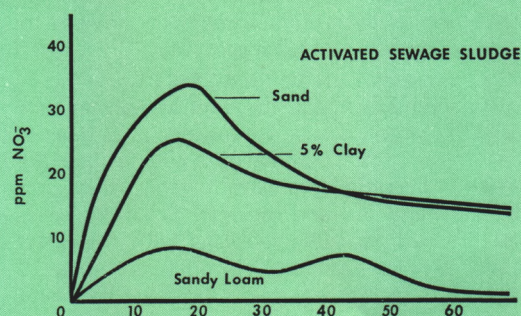
Although factual data are very limited concerning the losses of nutrients and pesticides by runoff and leaching from golf courses, some information is available from which losses may be predicted. The results discussed here are based on research sponsored by the Green Section of the United States Golf Association. The efforts of the research are directed toward identifying possible pollution hazards on golf courses and collecting factual data so that the industry can defend itself from false accusations and take steps to eliminate potential problems before restrictive legislation is imposed.

Figure 1. Concentrations of nitrate-N in drain water from a golf green built to USGA specifications following one application of nitrogen fertilizer at a rate of 2 lb. N/1,000 sq. ft.



On the golf course, the most intensive applications of fertilizers and pesticides are made to the greens. Although they usually account for something less than 1½ per cent of total golf course acreage, the permeable nature of the better constructed greens, the heavy application of water, and the subsurface drainage makes greens an area of concern. In certain situations, over 50 per cent of the nitrogen applied as a soluble fertilizer may be washed through the typical golf green within two weeks after application. Greens made entirely of sand lose even greater amounts of applied nitrogen. If slow-release or organic forms of nitrogen fertilizers are used, the nitrogen is not lost as rapidly and remains available over a much longer time. The slow-release forms suffer much less loss through leaching and resulting concentrations of nitrate-N in the drain water, are much lower than when soluble forms of nitrogen are used. On this basis, careful consideration should be given to the use of slow-release

Figure 2. Concentrations of nitrate-N in drain water from golf greens constructed of three different soil mixtures after the application of sewage sludge at a rate of 12 lb. N/1,000 sq. ft.



forms of nitrogen fertilizer. Applications should be scheduled regularly so that a continuous level of release is maintained. If inorganic or soluble nitrogen forms are used, they will be most effective and efficient if applied on a light but frequent basis. Typical nitrate loss curves are illustrated for three N-sources and three soil types in Figures 1 and 2, respectively.

Whenever possible, the drainage lines conducting water from the greens should spread the water over gently sloping land. They should not lead to water courses. The prevention of loss of nitrate will not only reduce pollution hazards, but will also result in more efficient utilization of fertilizers.

Much of the loss of fertilizer in runoff is associated with soil erosion. The nutrients are carried with the soil particles and deposited in low areas and reservoirs. Management practices should be utilized at all times to minimize soil erosion. The problem is particularly acute during the construction and the establishment of grass. Whenever possible, all tillage should be done immediately prior to planting. On slopes and contours the use of sod or mulches will help reduce losses associated with soil erosion.

Undoubtedly some pesticides, including herbicides, insecticides, and fungicides are also lost through leaching and runoff. Pesticides containing the heavy metals mercury and arsenic have been studied at Texas A&M University for leaching losses and residue hazards in golf greens and fairways.

The old belief that "if a little will work, a lot will work much better" definitely does not apply to these pesticides. Large applications of

these compounds not only increase the leaching losses and residue hazards but also interact to become toxic to some desirable grasses. Recommended rates of application should always be followed and then used only when necessary.

In soils comprised entirely of sand, arsenic is leached quite readily through the profile. Organic matter added to the sand reduces leaching losses considerably; but, the addition of as little as 5 per cent of clay loam soil to the mixture reduces arsenic losses to only a trace (Table 1). In fairway turf, repeated applications of arsenicals such as tricalcium arsenate result in the accumulation of arsenic in the surface two inches of soil, but very little arsenic is leached below the rootzone of turfgrasses (Figure 3). Thus, the arsenicals remain at the site of application unless grass clippings are removed. The grass clippings from turf grown on soil treated with arsenicals contain significant amounts of arsenic residues. Disposal of such clippings would best be accomplished by spreading them on or incorporating them into the soil. These clippings should not be composted as the arsenic would accumulate and would be taken up by the plants when the compost is utilized. If arsenic concentrations are high enough to damage the grass, the addition of superphosphate or a phosphorus containing fertilizer will reduce plant uptake of arsenic.

Another heavy metal, mercury, has received widespread attention as an environmental pollutant. Mercurial fungicides have been very effective against many disease organisms attacking turf. For this reason, we examined the fate

Figure 3. Arsenic residues at various soil depths after six years treatment with tricalcium arsenate. Spring and Fall treatments received a total of 10.5 and 20.5 lbs. of tricalcium arsenate, respectively.

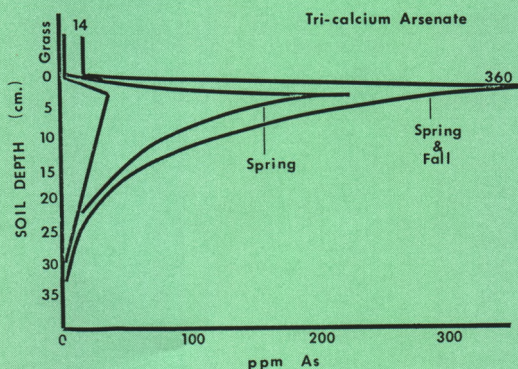
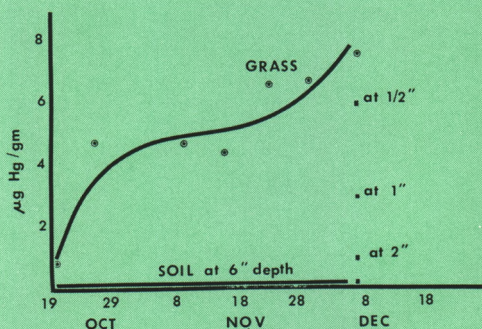


Figure 4. Mercury residues in soil and grass samples taken from a golf green following three months treatment with a mercurial fungicide at recommended rates of application, College Station, Texas.



of mercury following the application of a mercurial fungicide to golf greens. Mercury reacts very similarly to arsenic in that it is rigidly tied up in the surface layer of soil; and, unless excessively high rates are applied, only trace amounts are leached through a golf green profile (Table 2). Grass roots readily absorb the mercury and may accumulate very high mercury concentrations. In some cases where the soil was found to contain 30 ppm mercury in the top two inches, grass roots in that soil contains 90-565 ppm mercury (Table 3). Grass leaves from the same soil contained relatively low mercury concentrations, 15-45 ppm (Table 3). Where mercury concentrations are high due to an error in application, or to spills, the addition of sulfur or a sulfur-lime mixture will help reduce the hazards of mercury toxicity and reduce the levels of mercury residue in grass clippings.

When inorganic arsenicals and mercury are applied to the same soils, plant uptake of mercury is significantly higher than when arsenic is not present in the soil. For example, where mercury alone was present, concentrations of 300-600 ppm mercury were found in grass roots and 15-30 ppm in leaves; but, where mercury and arsenic were present, 1,200-2,000 ppm mercury were found in grass roots and 60-100 ppm in leaves (Table 2). Although grasses can tolerate these levels of mercury, the composting of any clippings removed from such areas should be discouraged. Neither should such grass clippings be dumped in lakes, streams or creeks. Heavy metal residues remain in the soil several years after application, and grass clippings will show their presence for a similar time period.

Pesticides containing heavy metals are not the only materials used on golf courses. Chlorinated hydrocarbons, organo-phosphates and carbamates are also used as insecticides. Numerous other organic compounds are frequently used to control weeds and disease organisms. Most of these materials present similar residue hazards, but not for the duration of the heavy metals pesticides. Precautions should be followed during the storage, application and disposal of all pesticides, and grass clippings from treated areas should be treated accordingly.

The disposal of pesticides and fertilizer containers present special problems. Although the government has not yet detailed specific recommendations for disposal of pesticide and fertilizer containers, the following suggestions are the best available at this time. First of all, whenever possible, pesticides should be bought in containers not larger than five gallons. Smaller containers are easier to handle and easier to dispose of than larger, bulky containers. A second advantage is that if a leak develops, less of the material will be lost, and this possible source of pollution will be minimized. A third practical consideration is that with our rapid changing regulations, one will not get stuck with a large quantity of a suddenly illegal pesticide.

Care should be taken to completely empty all pesticide and fertilizer containers. A Canadian report indicates that an average of 2.7 per cent of pesticides remain in the container after the user considered it empty. To cut down on this loss, containers used to store liquid materials should be rinsed after they are emptied and the rinse water should be added to the spray tank before the final water is added to bring it

Table 1. Arsenic residues in drain water from golf greens constructed of different sand, organic matter and soil mixtures after one application of tricalcium arsenate at a rate of 3 lbs/1,000sq. ft.

Weeks after treatment	ppm Arsenic in drain water*				
	100% sand	90% sand 10% O.M.	85% sand 10% O.M. 5% clay	80% sand 10% O.M. 10% clay	loamy sand
0	.001	.001	.001	.001	.005
1	.001	.005	.001	.001	.030
2	1.0	.010	.005	.005	.030
3	1.5	.025	.037	.075	.020
4	2.3	1.4	.030	.025	.050
5	1.7	1.5	.125	.055	.005
6	0.9	0.7	.175	.030	.005

*According to the 1967 Federal Water Pollution Control Administration the maximum permissible level of arsenic in public water supplies was 0.05 ppm.

up to volume. Sacks containing powdered and granular materials should be cut open carefully so that the material can be poured out directly without contents getting between the layers of paper making up the sacks. All sacks should be stored in cool dry places so that the materials do not cake and can be easily dumped out of the bags. All tops, lids, and bungs should be kept in place when the contents are not in use.

After containers are completely empty, they should be crushed and punctured. This is particularly important to prevent people from using them for other purposes. Children, for example, have been known to use discarded plastic containers for canteens.

The containers should be kept isolated from general trash and transported to and properly

disposed of in approved landfills. Such landfills should meet minimum specifications which have been approved by the government, and in particular should be located away from water bodies and ground water and should provide 10 feet of soil between the bottom of the pit and bedrock. Materials disposed of in such landfills should be covered daily, and after the pits are filled, a four-foot layer of soil should be applied. In all cases, pesticide containers must be treated with respect. They are not just ordinary trash, and should never be carelessly discarded.

As in any form of agriculture, the proper storing, handling, application and disposal of fertilizers and pesticides on the golf course will provide us all with a safer and better environment.

Table 2. Mercury residues in grass, soil and drainage water from golf greens following weekly application over a 3-month period of a mercurial fungicide at recommended rates, College Station, Texas.

Days after first treatment	Grass	ppm Mercury	
		Soil*	Drain water
0	0.001	0.01	0
10	0.7	0.1	0
20	4.8	0.1	0
30	4.5	0.1	0
40	6.6	0.1	0
50	7.6	0.2	0
70	12.0	1.0	0
90	15.0	1.5	0

*Soil samples were taken at a depth of 6 inches. Samples taken at shallower depths showed higher concentrations of mercury.

Table 3. Mercury residues in bermudagrass turf grown on golf greens with different levels of mercury and arsenic added to the soil.

Mercury conc. in soil (ppm added)	Mercury (ppm)					
	Arsenic conc. in soil (ppm added)					
	0		30		120	
	Roots	Leaves	Roots	Leaves	Roots	Leaves
0	1.2	0.4	0.9	0.5	2.8	0.7
30	90.5	2.3	490.0	14.5	565.0	45.7
120	174.4	2.3	900.0	21.7	1900.0	135.9

TURF TWISTERS

A FEBRUARY CONFERENCE IS SURE

Question: I have heard there will be an International Turfgrass Conference and Show held in Southern California this winter. Can you send further details? (Montana)

Answer: Happy to! The Conference, sponsored by the Golf Course Superintendents Association of America will be held at the Anaheim Convention Center, February 10-15, 1974. In addition to exhibits of turfgrass equipment and materials, there will be six educational sessions. It's a fine Conference and further details are available from the GCSAA, 1617 St. Andrews Drive, Lawrence, Kans. 66044.

A '74 RYEGRASS SHORTAGE IS POSSIBLE

Question: What does next year's ryegrass seed picture look like? (Arizona)

Answer: Our seed dealer friends say that (as of June 30, 1973) the U. S. "carryover" of annual and perennial ryegrass is 53 per cent less than one year ago. No one can predict what 1974's harvest will be like, but as of the moment, there is a substantial "carryover" shortage going into 1974.

A CHEMICAL STORAGE AREA IS SMART

Question: What do I do with my leftover pesticides? (Rhode Island)

Answer: Because many pesticides are damaged by low temperatures (some will separate at 40° F.), they must be stored in a heated area. For any powdered or granular materials, the area should also be kept dry. With most new pesticide laws, this area should be for chemical storage and chemical storage only and should be located so that normal work will not interfere with it. Be sure to keep it locked to control access to these materials.

The winter months are a good time to construct such an area. Be sure to have it clearly marked so that the contents are known.