MAY 1966

USGA GREEN SECTION RECORD

A Publication on Turf Management
by the United States Golf Association

DUAL USE OF WATER

Ponds can serve a double purpose. They provide for water storage and they can become a part of the strategy, the beauty, and the interest of the golf course. These are new ponds at Sunningdale Country Club, Scarsdale, N. Y.

USGA GREEN SECTION RECORD

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Sources of Water Supply

By HARRY M. DAY, Woodway Country Club, Darien, Conn.

The prolonged drought experienced in the Northeast is bringing a new degree of water consciousness to golf course operators. The supply of water, whether by natural rainfall or irrigation, has long been taken for granted in the humid regions, but with no relief forecast, the problem has become acute to many and worrisome to all but the most fortunate.

As an introduction, it may be interesting briefly to review the water cycle. Over 70% of the earth's surface is covered by water. Some 317 million cubic miles are contained in the oceans and seas, too salty for many useful purposes. Another 7 million cubic miles lie frozen and unattainable in ice caps and glaciers. The total water on or in the land is little more than 2 million cubic miles, of which 2 million lie beneath the ground. Of the total surface water, nearly half lies in salt lakes and inland seas, again unfit for use. The balance, some 30 thousand cubic miles, is contained in fresh water lakes and rivers and streams. One-fourth of this is concentrated in the Great Lakes. The rivers and streams contain only 300 cubic miles.

While the general distribution outlined above stays relatively constant, each element is a part of a vast energy cycle which constantly replenishes all sources as these sources are depleted naturally, and which purifies water as it is redistributed from the oceans and salt lakes back to the land. In the course of this giant cycle, some 230 cubic miles is evaporated daily from the oceans, and 50 cubic miles is evaporated from the land masses. However, only 210 cubic miles fall on the oceans and over 70 on the land. This leaves 20 cubic miles of extremely pure water per day to begin its course back to the sea and to serve the needs of the land and all things that grow thereon.

If the distribution cycle were as perfect in its geography as it is in its quantity and its quality, there would be plenty of fresh water for all. Unfortunately, some areas get much more rainfall than is needed, and others get far less. Even worse than the poor geographical distribution is the fact that the pattern is whimsical and varies from day to day, month to month, year to year, and even decade to decade.

Of the 70 million cubic miles of fresh water which falls on the land each day, non-economic vegetation receives and evaporates 32%. Non-irrigated farms get the benefit of 23%, forests use 16%, and 22% returns to the oceans not utilized. Only the remaining 7% is actually controlled and utilized, some 3.2% going to irrigation, the same amount to industrial use, and .6% to use by municipalities. Since the Northeastern United States has more than its share of the water available, it is clear that the problem is not a lack of fresh water, but its proper utilization and distribution.

Man has made the problem of the supply of water infinitely more difficult by his flagrant abuse of our sources of supply. Municipalities and industries, in general, indiscriminately drain their waste waters into rivers, streams and lakes until some have literally become cesspools and sewers. The repercussions are wide-spread. However the discussion of the general subject of pollution and contaminants in water will be limited to their effects on the use of water as an irrigant on golf courses.

Waters are contaminated by two classes of material, inorganic and organic. Organic materials are usually encountered as a result of sewage effluents, either municipal or industrial. While rivers and lakes tend to free themselves from organic materials through gradual oxidation, it follows that these materials are oxygen depleters. If they are present in excessive quantities, the effect is to use up virtually all of the oxygen available, to the extent that most aquatic life cannot exist.

Other organic materials are oils found mainly in industrial effluents, insecticides usually introduced as runoffs into streams, and detergents which can be introduced through either municipal or industrial sewage or can appear as seepage from septic systems. A highly critical contamination can be pathogenic or disease-causing bacteria, the source of which would be untreated or poorly treated sewage.

In the inorganic classification, most pollutants would be classified as salts, although a majority of the salts to be considered break down in solution as ions. Sometimes a specific ion is highly toxic to animal or plant life, or both.

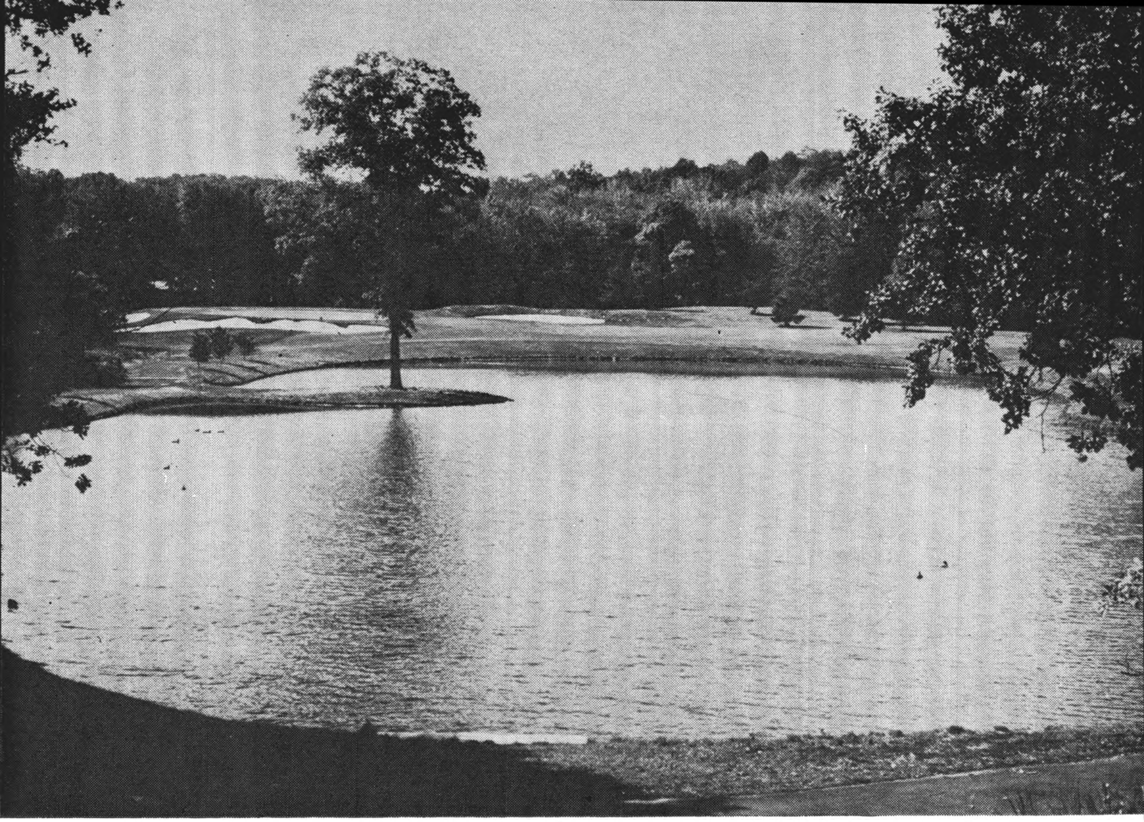
Salinity, or the total concentration of salts, is probably the most important single factor to be considered in the use of water for irrigation. The problem of salinity has long been known in the arid regions of this country, but has had little significance in the East or Northeast. Whenever water percolates through soil or rock formations, certain soluble materials are dissolved, usually as salts.

Conversely, when water is absorbed into the roots of plants or evaporated into the atmosphere, the salt content remains to increase the concentration in that portion of the water remaining. Sometimes it exceeds the saturation point, as salt is cast out of the solution as a solid. Constant repetition of these cycles account for the high concentration of salts in sea water and in certain landlocked lakes such as the Salton Sea, Great Salt Lake and the Dead Sea. It also accounts for the high concentration of salts in some alkali soils or salt flats.

Certain rivers, such as the Rio Grande, show a marked increase in salinity as they progress from the head waters to their mouths. Since the waters of the Rio Grande are withdrawn in large quantities from the river for irrigation purposes and a portion of this water returns to the river carrying high concentrations of salts, the lower portion has become so saline that it cannot be used for the irrigation of many crops.

It will be apparent from the foregoing that if irrigation water containing salt is repetitively placed on land in such quantities that it does not penetrate below the root zone, the process of evapotranspiration will result in a build-up in the concentration of the salts in the root zone and near the surface. As the total concentration of the salts increases, the ability of the plant to utilize water is progressively decreased until at some point, depending upon the susceptibility of a particular plant, its growth is completely inhibited.

As previously stated, salinity has seldom posed a problem in the Northeast since in the humid regions heavy



The scenic value of a lake is illustrated by this view of the 10th hole at Woodway.

rainfall is almost certain at least once a year. This rainfall usually nullifies by leaching any concentration of the salts that may have occurred during an irrigation season. However, with the recent serious drought and a failure of the normal source of water supply, some golf courses may have to turn to any source available. This may lead in some instances to the consideration of the use of brackish water from coastal inlets or from wells which may pump saline water. The use of tidal river waters, or perhaps sewage effluent, which may be partially or wholly industrial waste may be considered. In any of the latter categories, it is possible that salt concentrations may be encountered which could present a salinity problem during a period in which heavy rainfall does not occur.

Simple Test

The complete testing of water for the major salts present and the respective ions which these salts represent is relatively expensive. Fortunately a simple test is available to indicate the total ionized salt concentration, which in turn has a major effect on the metabolism of the plant. This test is for electrical conductivity and if performed on a reliable sample of the irrigation water, as well as on a sample of a saturated soil solution, it can give a measure of the problem of irrigation with water of more than normal salt content.

Salts such as sodium and boron can be quite deleterious. Large quantities of sodium may affect soil structure adversely. Boron, while essential to all plant growth in extremely small quantities, is notoriously toxic to plant life in high concentrations.

Since boron compounds are commonly used in washing processes in many types of industry, its presence should be checked if sewage effluent is considered.

The above discussion is extremely cursory. For a full understanding many excellent papers are available through the Department of Agriculture, certain state agricultural services and from some university departments working in these fields.

Estimate Needed

Any plan contemplated to provide the necessary water with which to irrigate a golf course must have as its basis an estimate of the quantity of water which will be required. This estimate, as you will soon see, is bound to be fraught with many assumptions. How much effective rainfall (the amount which enters the soil but remains in the root zone), how well is it distributed, shall the turf be kept green or shall it be kept in a condition allowing recovery when normal moisture conditions return? Traffic aggravates drought conditions, and areas of traffic concentration must receive special attention. Another factor to be considered is that many irreplaceable major trees may be lost if they are not supplied with water.

Unfortunately, little is actually known and much research needs to be done to learn the water requirements of turf grasses. The type of grass, the depth, type and structure of the soil, the underlying drainage conditions, fertilization practices, to say nothing of actual sprinkling practices, all have a bearing on the water requirements. In a recent work by the Department of Agriculture there has been developed a modification of the empirical Blaney-Criddle formula for estimating water requirements.

Formulization is helpful in understanding the overall problem. However, at this stage of development it is not a very useful tool for the average person involved in making a decision on the quantity of water required for a given golf course. At the risk of being called wrong by 90% of the experts, I will make the following practical suggestion:

Without the help of rainfall, the average well-drained fairway in the Northeast needs a minimum of one inch of water per week in order to maintain reasonable appearance and vitality during the summer months.

If we make this basic assumption, and assume further that it is possible to experience 17 weeks with little effective rainfall, we are on our way toward estimating a minimum seasonal irrigation water requirement under maximum adverse conditions.

How to Calculate

If we assume that the average full-size golf course has 40 acres to be irrigated, and that irrigation will be required for 17 weeks at the rate of 1 inch per week, we calculate a need for 680 acre inches of water. This amounts to more than 18 million gallons. This quantity may be visualized as a pond six acres in size averaging a depth of 10 feet.

In determining sources of water, we first consider rainfall. We have mentioned its faulty distribution and the lack of its reliability. In any case, if it has not proved sufficient in the past, we must seek to supplement it by one of the following:

The easiest supplement is, of course, to be able to buy water at a reasonable price from a municipal water system. Unfortunately, many such systems are severely taxed dur-

Woodway Country Club, Darien, Conn. Lake construction designed to contain 30 million gallons of water.

ing a drought season, and in a period of stress, irrigation takes second place to other municipal needs. At the very time water is needed the most, it can be denied.

The next most obvious source of water is wells. These may be either shallow or deep, depending upon the geology. Shallow wells are preferable from the standpoint of original cost and the power requirements per gallon pumped. It is possible to strike underground sources (aquifers) at depths ranging from a few feet to as deep as several thousand feet. If you plan to dig a well, you should consult with people familiar with the underground structure in your locality.

Streams Unreliable

Another source of water is a river or stream. Small streams are unreliable, but they usually run in large quantities at some period of the year and it is possible to store water until needed. It is well to note here that it is not wise to rely on the historical flow of a small stream if its watershed is largely the scene of a rapidly developing suburban community. The stream that flowed reliably a year or two ago, may not flow three to five years hence.

In connection with the utilization of water from rivers or streams, it is paramount that one not overlook the problem of water rights. The legalities of taking water from natural water courses are complex and differ from one part of the country to the other. Thoughtless tampering with the flow of a stream can easily lead to court.

If no other source of supply is

available, one should not overlook the use of sewage effluents. Many problems are involved, but their flow is among the most reliable. Municipalities will always find and have first claim on a source of water, and a large percentage of this water always shows up in the form of sewage effluent. Similarly, as long as an industry requires water, practically all of that water will be available as an effluent. We have spoken of sewage effluent, which technically means that the sewage has had some kind of treatment prior to its outflow. Raw sewage, either municipal or industrial, should in general be avoided unless the industrial sewage specifically originates from processes such as heat exchangers or air conditioners which introduce no contaminants. The sanction of public health officials should be an early part of any plan contemplating the use of sewage for irrigation purposes.

We now come to the most interesting, and for many water-starved courses, the most practical solution to the problem of developing a water source. That is the building of a lake or lakes. Lakes can be classified into source lakes or holding lakes. A source lake can sometimes be built in a low swampy area with natural seepage and a high water table.

If such a fortunate circumstance cannot be found on a particular course, we must resort to a holding lake which simply serves as a storage reservoir for supplementary water that may be available from other sources. Supplementary water can usually be obtained in one or several of the following ways. Topographically many courses slope to a low point, and if a holding lake is built at that point, winter-spring runoff from 100 or more acres of your property will probably be sufficient to fill the lake.

A second source of supplementary water is from a stream which may flow through the property. Depending upon the flow of this stream, it would be highly probable that the holding lake could be filled during the winter-spring season from the excess water flowing at that time.

A third possibility is from wells, which while too small to service directly your sprinkler system, may be adequate on a twenty-four hour basis constantly to refill a lake or to add enough during the season so that an otherwise inadequately sized lake satisfies the requirement.

The other supplemental source is, of course, municipal water which may not be available in sufficient quantities during the summer season. It may be available at other times of the year, or perhaps may be restricted at a particular time of the day, even though available in quantity during the season.

Avoid Seepage

It is necessary to emphasize here that it is useless to construct a holding lake unless it is essentially impervious to seepage. Such an impervious structure will sometimes occur naturally if the lake is excavated from a typical hardpan formation. It is much more likely that the lake will have to be lined with a naturally impervious material, such as a clay, and it is even possible that a synthetic lining, such as polyethylene, must be used. Certain chemical treatments have been developed which upon reaction with water and/or soil will create an impervious layer. The Department of Agriculture will provide a source of helpful information on this topic. Do not, however, make the mistake of not solving this sealing problem during the original construction. Otherwise the natural materials necessary may have been lost, or the surfaces or contours left in such a condition that subsequent sealing becomes completely impractical.

The practical problem of the design and construction of a lake can be most difficult if one simply seeks to purchase the end result. First, it is difficult to find a specialist in this field and the cost of drawing specifications would in most cases be prohibitive. The best results can be realized if it is planned and supervised by a dedicated amateur who has a good gift of common sense, and is willing to become familiar with technicalities. He must also be willing to spend an adequate amount of time closely supervising the job. Hopefully, the amateur will have good aesthetic sense and will also have a good feeling for golf and the effect on play if the lake becomes an integral feature of the course.

The design of a lake should really be an exercise in three departments which may sometimes conflict. First, how can the job best be done for the lowest cost? This is far from saying which contractor will give you the lowest bid for digging a hole. In some urban areas, gravel, topsoil, subsoil, and even fill have become scarce and carry a high price. By careful conservation during construction, some of these commodities may be sold and may more than pay for the total construction cost.

However, the net lowest cost will result first from conservation of all materials needed properly to finish the lake itself; i.e., topsoil and subsoil for the banks, clay for sealing or for dam cores, fine materials for dressing and covering if plastic sealing is necessary, etc.

Second to conserve and stockpile all materials that will be needed elsewhere on the course in the reasonably near future. This particularly applies to topsoil, subsoil and gravel which may be needed for roads, bases for tees, greens and so forth.

A second part of the economic planning will be a decision as to what portion of the work can be done by your own green crew, which in turn depends upon their skills. It is quite possible that with thoughtful design and supervision, such otherwise costly things as spillways, inlet systems, control boxes and so forth can be done by your own crew if some of them are familiar with concrete or masonry work.

One word of caution is essential at this point. Under the law, he who impounds water is completely responsible for any damage caused by the release of that impounded water. The building of dams or spillways is a highly technical field, which should be avoided by an amateur, if the level of water impounded is more than two or three feet, and if the area of the lake is more than one or two acres.

In any event, a spillway should always be designed with a wide margin of safety to more than handle maximum possible flooding conditions. An

COMING EVENTS

May 24	Central Plains Turfgrass Field Day Lincoln, Nebraska
June 21	Turfgrass Research Field Day Rutgers University New Brunswick, N. J.

earth dam should have an impervious core, enough ballast to insure its stability, and much attention should be given to a vigorous turf cover to prevent erosion.

Turning from economics to aesthetics, the selection of a site should be incorporated with a study of natural focal points of attention, such as major trees, rock outcroppings, and so forth, which can be preserved to enhance the overall beauty. Much care and consideration should be given to contouring exposed banks to avoid an unnatural effect. This often means contouring for an extensive distance back from the water line of the lake itself. The movement of certain types of major trees, while expensive, is often practical and desirable. Plantings of smaller trees and shrubs in key positions can sometimes have a remarkable effect. All banks, in addition to careful contouring at subgrade, should then have an adequate layer of subsoil spread upon them in order to assure a healthy protective sod to prevent erosion.

Since a lake can be a most attractive addition to a golf course, the third area for prime consideration is the possibility of having the lake become an integral part of play. This can occur, of course, by having it become an actual water carry, or as a lateral hazard, or simply as a scenic view. Such views can sometimes be established from many different holes by the creation of a single lake, thus providing a remarkable change in the golf course.

If the lake is used as a water carry, it is often possible by the use of multiple tees and a properly positioned fairway to provide a truly challenging shot from the championship tee, an exciting shot from the regular tee, with the choice of a safe shot for the poorer golfer and an even less demanding shot from the women's tee.

So if a lake appears to be a solution to your water shortage problem, let your imagination soar, plan wisely, proceed legally, supervise closely, and perhaps surprise yourself with the bonus of an economic success as well as a handsome improvement to your golf course.

Irrigation Systems — Economics

The Automatic System

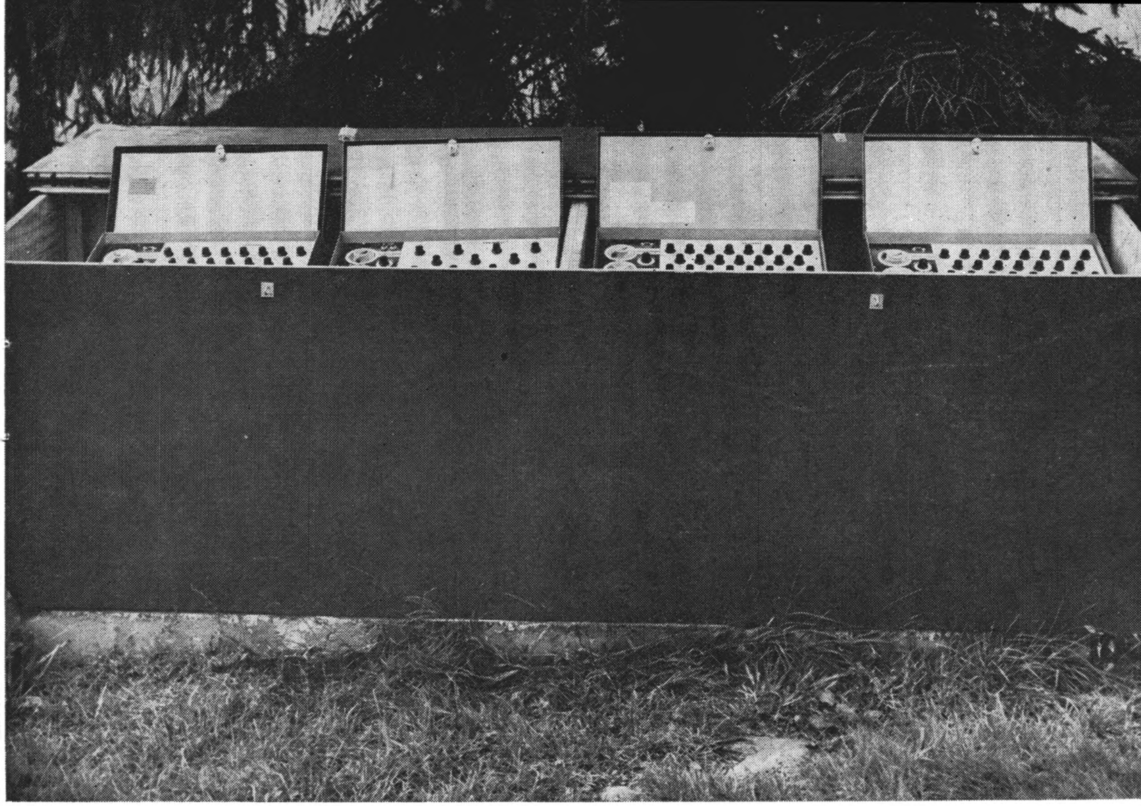
By CHARLES McCREA, Golf Course Superintendent

Perhaps at some future date as historians write of the Twentieth Century, they will call it the century of automation. This is especially true of golf courses when you consider irrigation systems.

In the Northeast, automatic systems are out of the novelty class. With the continuance of our four-year drought, labor problems, increased play, and rising standards of excellence, more clubs are wondering whether to convert to, or install an automatic or at least a more modern irrigation system.

The unanswered question is will the automatic systems stand up to the test of time? Ten years from now we will have the answer.

Well designed manual systems with sufficient water capacity can still operate efficiently. Two courses indi-



Clocks for the control of automatic irrigation valves are housed in a protective box. Such batteries of controls portray a complex system, but when the golf course superintendent becomes thoroughly acquainted with the controls, he is afforded a degree of precision in irrigation not available with manual systems.

cated that of the amount spent for labor, less than 5% was used for irrigation. With an automatic system this percentage can be cut further with labor savings of from $2,500 to $5,000.

Although a manual system with hose and travelers allows greater flexibility, it should only be considered as a last resort. The operational costs become excessive. Also, there is the added expense of hose purchase and repair which would be higher than for any other type system.

Another factor influencing system selection and operational cost is yearly rainfall. The Northeast averages 40 inches of rain per year, with the distribution almost even throughout the year. As a result, we don't irrigate as many times per year as other parts of the country, and therefore, we have to operate our automatic systems for a greater number of years trouble-free to re-coup the increased outlay for an automatic system. I'm in favor of automatic systems for golf courses in the Northeast, but I think there are important reasons other than just economics. Member convenience in that they may never have to play when the system is operating and the fact that the superintendent has complete control over the water program alone are as good reasons as any possible labor savings in deciding to go automatic.

Other Systems

By E. J. HUNTER, Sprinkler Irrigation Association

Sprinkling systems must be designed to meet the extreme climatic conditions that one expects to encounter. The climatic conditions and the area to be watered determine the minimum amount of water applied each week. Somewhat more water than this minimum will actually have to be applied, depending upon the efficiency and uniformity of distribution. If the sprinkling system is wasting water through runoff or uneven distribution, an equivalent additional amount will have to be applied. Generally speaking, a well-designed fully automatic system will be the most efficient because the human element in timing the run of each sprinkler is eliminated. The desired running time can be preset.

All types of systems under consideration here require a main line to distribute water. They require a source of water, either a tie-in to city mains, or pumps and a well or reservoir. The cost of this distributions system will be essentially the same for all types of systems, with the exception of the full automatic which, with its more efficient use of water, would in some cases permit use of slightly smaller distribution lines and pump. Even in a full automatic system, the cost of pumps and main distribution lines represents, approximately 50% of the total cost. This means that the cheapest type of system using hoses and movable sprinklers will cost somewhat more than 50% of the cost of the full automatic system.

Any design necessarily has to be a compromise in the cost-performance equation. The designer must understand the factors involved and he must be provided with certain basic decisions that can be properly made only by the people operating the course.

The design of the system must start with answers to the system specifications.

1. Amount of water to be applied.
2. Area to be covered.
3. Hours available for watering.
4. Type of system.

The first point is determined by climatic conditions alone; the other three involve the cost-performance relationship.

Area to be watered: For example, some members may want to water from fence to fence. Others may say greens and tees, while others will say fairways 150 feet wide. Balance what you would like against the cost and reach a decision.

Hours available for watering: A system that will deliver all the water required in a 6-hour period will cost a lot more than one which requires 24 hours. If your members don't mind playing when the sprinklers are running, the 24-hour system might be best. If the course is to be open from 5 A.M. to 10 P.M. and not get the members wet, 7 hours would be the time available.

Type of system: In many cases the automatic system will save money. The decision then can be made purely on the basis of money available. However, in some areas where irrigation is a supplemental thing involving only 4 to 8 weeks per year, often the automatic system cannot be justified on cost alone. Consideration then should be given to the fringe benefits of the automatic system, matters such as more uniform watering, better turf, less fertilizer, and elimination of night watering-crew problem.

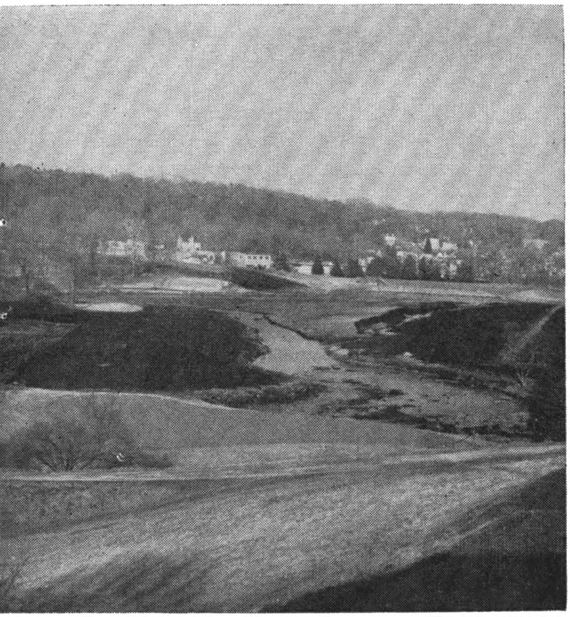


Figure 1 - Not a river bed, just a water development project at Scarsdale Country Club, Hartsdale, N. Y. Improvement included realignment of several holes which was made possible after dredging for improved water supply for irrigation. A large shallow pond covered the area previously.

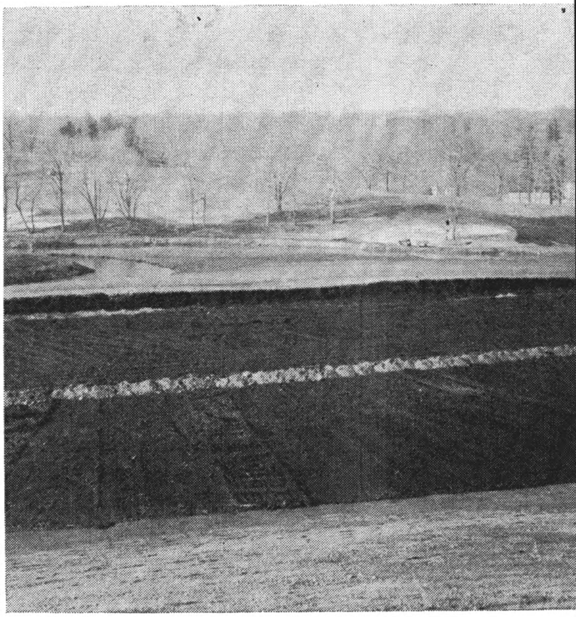


Figure 2 - Irrigation line splits the center of the new No. 1 fairway built on 40 feet of peat and muck. Palisades across far center of picture shows how deep the peat was dug to provide for constant water flow. It measures approximately 10 feet in height.

After establishing these basic specifications, many other decisions must be made. Some questions to be considered are these: What is the difference between a quality job and a non-quality job? Can corners be cut by using smaller pipe? Are large heads cheaper than small ones?

The answers are best left to the designer. First you must tell him what performance you expect. This also should become part of your specifications. You must tell the designer what uniformity of precipitation you expect. You must specify service life for various components of the system.

The four points of system specifications must be answered by the owner or operator of the course. If these are answered carefully and intelligently, they will do far more for your course than you can do by attempting to become a sprinkler system designer.

If you will concentrate on acquiring the knowledge you need to properly specify what you want the system to do, you can then shop for a system, taking full advantage of free competitive enterprise to obtain competitive prices, and be assured of a system which will meet your needs, at a fair price.

Questions:

Q. How much more costly is a multi-row system?

A. The difference here is mainly one of area covered. It is possible to water wider fairways with multi-row systems. The cost is higher, roughly, in proportion to the increase in area. A single row system with large heads will water about a 150-foot-wide fairway. A three-row system using medium size heads will water about a 210-foot fairway at about 40% increase in cost.

Q. Comment on the cost of a semi-automatic system?

A. This system costs less for heads, but more for pipe and quick-coupler valves. A block system uses very large groups of heads which add considerably to pipe cost, and results generally in a very serious back drainage problem. Its cost is generally over 90% of the full automatic system.

Q. If you already have a manual system and wish to convert to an automatic system, can it be done? What is required and at what cost approximately?

A. Yes, if the system is adequate. That is, can it deliver the required volume and pressure? Is the piping in good shape? If so, it can be converted to automatic and the previous system quotation will give you some idea of the cost. These figures, plus about $3,000 extra installation labor should cover it.

Q. Can a system be part manual and part automatic?

A. Yes. Sometimes greens and tees only are automated and sometimes fairways only. The trend in fully automatic systems is toward providing more flexibility in manual operation.

Q. Is it economical for a club to use its crew, or is it more economical to contract out?

A. Many qualified and capable installers are in the business. If the bid list is limited to qualified contractors, you can be certain of expert installation work at a competitive price, probably lower than if you were to install it yourself. It is recommended that you contract out the installation, limiting bids to a selected list of contractors who have the experience, the personnel and the equipment to do the job.

Q. Suppose you have a potential capacity of 2,000 GPM output. Should you gear to the maximum output? Where is the dividing line between excellence and extravagance? Excellence of system and being so thrifty that it hurts? What should water velocity be?

A. These are questions the system designer must answer. A good designer will give you what you need—no more and no less. An inexperienced designer might add a large safety factor because he is not sure of his work. Maximum water velocity depends on many factors, such as permissible pressure drop, valve closing speeds, type of pipe, elevation differences. Some situations would allow a velocity of 15 feet per second, others might be as low as 4 feet per second.

Cost of Systems Operation

HOSE AND PORTABLE SPRINKLER SYSTEM

Manpower and equipment costs for moving hose and sprinklers are the highest of any of the four systems. The replacement and repair costs are high. Hoses used with the movable sprinkler have a short life expectancy and the movable sprinklers are subject to handling damage as well as normal wear. Consequently, they have high maintenance costs.

QUICK COUPLER SYSTEM

The cost of operation is a little lower than the hose and sprinkler system. However, maintenance costs might be slightly higher because of the large number of quick coupler valves that have to be replaced occasionally. Water supply costs and power costs are approximately the same.

In attempting to determine the labor cost in operating a sprinkling system it should be kept in mind that this is a job to be done at night. It has to be done on a "call" basis, depending upon weather conditions. A great deal of supervisory attention must be devoted to an "on call" labor force. They have to be paid a very good wage to be sure that they will be available when called. The cost of maintaining a good night watering crew is considerably higher than one might expect.

SEMI-AUTOMATIC SYSTEM

The costs of this type are generally within 90% of the cost of a full automatic, but this system requires almost as much labor as a conventional quick coupler. The only advantages are that the labor can be performed at a more convenient time and the actual running time of the heads can be set automatically. The cost of operation will be slightly lower than the quick coupler system because of lower labor costs. This will, in part, be offset by higher maintenance costs on a large number of sprinkler heads which are handled twice during each watering.

FULL AUTOMATIC SYSTEM

The cost of operation is, by far, the lowest. Labor is completely eliminated. Water supply costs and power costs are somewhat reduced through efficient use of water. Replacement and maintenance costs can be slightly higher because of the larger cost of the equipment involved. However, frequently it is found that replacement and maintenance costs are actually lower.

In an automatic system, even in the most arid climate, each sprinkler head will only be run 100-150 hours per year and will not be subject to handling damage. In a quick coupler system the sprinklers cost less, there are approximately 1/10 as many sprinklers, but each has to run 10 times as long. This, plus handling damage, means increased maintenance costs. Often the maintenance costs are higher than for the full automatic system.

It must be assumed that each type system is adequate. A system that cannot deliver the required volume of water is inadequate and it will be inadequate whether it is a hose and sprinkler, a quick coupler, semi-automatic, or a full automatic. Conversion is possible only if the initial system has adequate capacity. If it doesn't, additional mains and pumps should be added before converting and calculating costs.

SUPERINTENDENT'S RESPONSIBILITY

He will have greatly reduced his personnel problems with an automatic system. Recruiting, training, supervising of night watering crew would be eliminated. Maintenance responsibilities increase slightly.

The economic advantages are, of course, greater in an arid climate.

USGA GREEN SECTION RECORD
40 East 38th Street, New York, N. Y. 10016

TURF TWISTERS

COST COMPARISON

Question: We have been offered a liquid fertilizer for use on our golf course. We are told that each gallon contains 1 pound of nitrogen, 1 pound of P_205 equivalent, and 1 pound of K_20 equivalent. How can we compare the cost of this with a conventional dry fertilizer? (MISSISSIPPI)

Answer: A formula such as you describe is roughly equivalent to a 10-10-10 dry inorganic fertilizer. This is based on the assumption that a gallon will weigh about 10 pounds. You must calculate the nutrients on the basis of actual percentage. Two hundred gallons of the fertilizer you describe would weigh a ton. It would yield 200 pounds of N, 200 pounds P_205 equivalent, and 200 pounds K_20 equivalent. A ton of dry 10-10-10 fertilizer would yield similar amounts of nutrients. If prices are comparable on a "per ton" basis then you should consider costs of application and transportation.

ESTABLISH WINTER GRASS

Question: We have Tifgreen bermudagrass greens. Each winter we have a heavy infestation of *Poa annua*. Can we use one of the new pre-emergence herbicides to prevent germination of *Poa annua?* What would you recommend? (MISSISSIPPI)

Answer: The pre-emergence materials will prevent germination of *Poa annua*. However, they will also prevent the establishment of your overseeded winter grass. The best recommendation we can offer at the present time is that you try to get your winter grass established early and strive for a good dense stand. Occasionally, by a happy accident of timing, an early herbicide application will kill the young newly germinated *Poa annua* and then winter grass can be established. However, this is sort of a "hit-or-miss" matter and such an approach is not dependable.

RETARDS GROWTH

Question: Maleic hydrazide has been recommended to us to be used as a growth retardant. Will this eliminate or reduce the need for mowing? (PENNSYLVANIA)

Answer: Maleic hydrazide will retard the growth of plants. However, dosages are rather critical and a small over treatment will sometimes discolor plants. We do not recommend it for intensively maintained turf. It is useful however, in areas such as ditch banks or around fixed objects where mowing is difficult. In such an area slight discoloration is of little consequence. This is another useful tool if one doesn't try to "stretch" its usefulness too far.