1971

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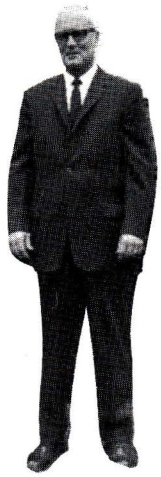
STOCKBRIDGE SCHOOL

# TURF CLIPPINGS

CONFERENCE PROCEEDINGS

**IN MEMORY OF**



**POWERS H. PETERSON**

**December 30, 1912** **February 7, 1971**

The 1971 Turf Clippings is dedicated to the memory of Powers H. Peterson, a member of the 1971 Stockbridge School of Agriculture Winter School for Turf Managers. A resident of Limestone, Maine, he was graduated from the Caribou Maine High School and attended Holy Cross College in Worcester and Georgetown University in Washington, D.C. He was employed by the U.S. Border Patrol from 1941 to 1946 and had been Manager of the Powers Theatre in Caribou. At the time of his death he was planning to assume the superintendency of the new Caribou Golf Course.

Here was a man of superlative high standards, complete integrity and boundless enthusiasm for whatever task he assumed. No one is likely to forget the candor of his background, the courage of his faith and the warm and glowing brightness of his friendship.

TURF MANAGEMENT SENIORS

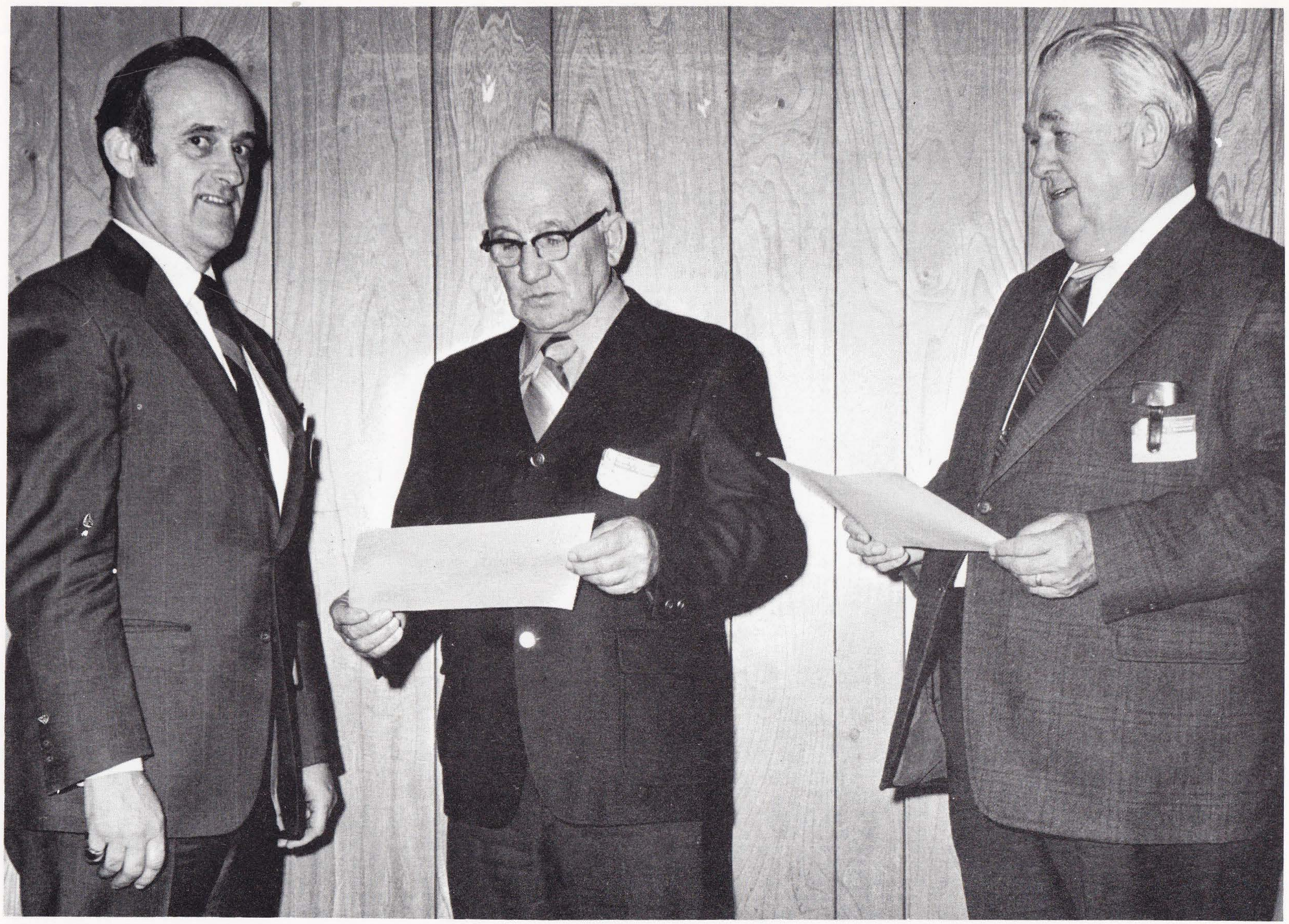
Row 1: (left to right): C. Zenisky, K. Anderson, M. Loper, P. Deehan, R. Petrillo
Row 2: W. Rolland, T. Darling, R. Pickersgill, G. Burke
Row 3: F. Dolson, J. Campoli, J. Starvish, R. McConnell
Row 4: R. Richard, S. Murphy, D. Wilk, E. Hayes, C. Adams, K. Braun, C. Blake, P. Phelan
Row 5: C. Davis, J. Mazzeo, C.B. Harackiewicz
Row 6: B. Carlson, E. Brown, R. Wright, R. Carpenter

TURF MANAGEMENT FRESHMEN

A.R. Albin, D.S. Bennett, R.C. Bosworth, W.J. Brousseau, E.C. Cassidy, T.B. Chapman, E.T. Deyermond, T.F. Field, A.G. Fogarty, D.W. Hicks, W.F. Hogan, R.W. Hyde, D.W. Johnson, P.K. Kean, J.E. Kurposka, H.J. Letarte, J.M. Linehan, L.J. Lynch, T.J. McKniff, Jr., S.J. McMahon, M.A. Millett, D.W. Moreau, J.K. Mosakewicz, G.T. Moulton, E.R. Nash, E.S. Nelson, W.F. Nemergut, N.W. Olson, D. O'Neil, P.J. Petrarca, W.L. Reddy, J.B. Renner, D.F. Roome, J.F. Roule, F.L. Santos, J.L. Starvish, K.F. Stevens, J.P. Swisher, T.J. Sylwestrzak, W.E. Sherman, J.F. Watroba, P.L. Wegkamp, Jr., P.S. Yeskewicz, D.J. Yezierski

**RECIPIENTS OF GOLF COURSE SUPERINTENDENTS ASSOCIATION OF AMERICA AWARDS**

Left-Right: Dr. Joseph Troll, Department of Plant and Soil Sciences; Charles Adams, Mark Loper, David Quinn—all Seniors in the Stockbridge School of Agriculture; and Mr. Richard Blake, President GCSAA, who presented the awards.



**PRESENTATION OF HONORARY ASSOCIATE DEGREES**

**Dr. Joseph Troll, Department of Plant and Soil Sciences, presents Honorary Associate Degrees from the Stockbridge School of Agriculture to: (left to right): Mr. Arthur E. Anderson and Mr. Samuel S. Mitchell.**

TURF CLIPPINGS

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of the University of Massachusetts

To form a bond of common interest between the Turf Management Club, the alumni of the Stockbridge and Winter School Turf majors and all interested friends of the University of Massachusetts Turf Program.

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Department of Plant and
Soil Sciences
University of Massachusetts
Amherst, Massachusetts 01002

Editors
George Burke
Mark Loper
William Rolland

Adviser
Dr. Joseph Troll

Contents

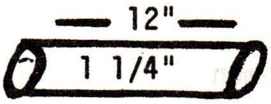
## SHOP TALK

Frank Santos

A safer and more comfortable ride for the passenger on a Cushman Truckster is easily obtained by using a few odds and ends found around the maintenance shop. Materials needed to make the seat more comfortable are: one piece of 1 1/4 inch pipe about 12 inches long, one 1 1/4 inch coupling, a pice of 1/4 inch flat stock - 4 inches by 4 inches, a piece of 3/4 inch plywood -15 inches square (round corners), four bolts 1/4 inch by 1 1/2 inch, some foam from an old seat about 2 inches thick, and an old cloth seed bag, canvas or leatherette.

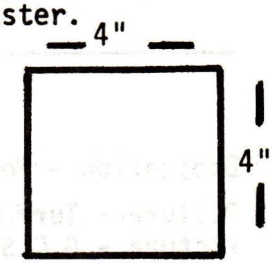
Assembly:

Connect pipe and coupling. Braze or weld coupling to center of flat stock. Drill holes in flat stock and then through plywood. Insert bolt through top of plywood and countersink with a hammer. Fasten nuts and tighten securely. Foam should be glued to plywood. If foam is only one inch thick, glue two pieces together. Cut foam about a 1/4 of an inch larger than plywood, then take material to be used for covering and measure with a tape measure the distance across and over the foam, allowing one inch extra. Then staple material onto one side, bring it over the top and pull it snugly to compress the edges of the foam and staple. Always work from the center to the corners when stapling. Seat can easily be placed in the stake holes provided in the body of the Cushman Truckster.

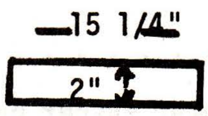



Pipe

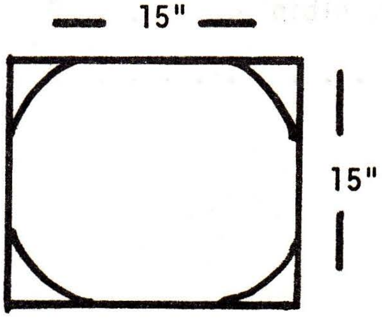

Coupling




4"X4"X1/4" Flat Stock

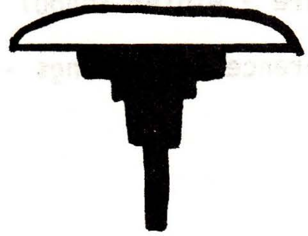



2" Foam




15" X 15" X 3/4" Plywood rounded corners

Completed Side View



## YOU'VE COME A LONG WAY, LAWN-MOWER PUSHER

Alan R. Albin

In the beginning you started out with the primitive hand-push lawn mower and little extensive knowledge about the grass you were cutting. Your main objective then, as now, was to give the membership the best possible playing conditions and to maintain them at a high standard. Mowing wasn't your only problem. You also had to cope with diseases whose cause you didn't know, and there were problems with drainage, fertilizing and other maintenance practices. To top it all off, you didn't even have a readily available source of information on turf management problems.

But you didn't let these things stand in your way. Instead, you considered these problems not as problems but as "unsolved opportunities." Gradually the blindfold was removed and the the so-called "lawn-mower pushers" came be to be known as "superintendents." You began to combine your findings for all to share and profit from. And it didn't stop there.

Experimental work was conducted by experiment stations, research centers and college institutions. Finally, after many years of research, a book called Turf Management was written by H. B. Musser. This book consolidated all experimental results for the use of superintendents and all those interested in good turf.

Yes, you've come a long way, lawn-mower pusher, but you've still a long way to go. Progress has been made but new problems constantly arise with the changing of times, like the question of ecology. But you solved the problems in the past and you'll solve the problems that arise in the future. All these things can and will be accomplished with the combined efforts of all the so-called lawn-mower pushers.

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## IN THE EYES OF THE LAYMEN

Eugene P. Elcik

When members set their eyes upon us, I suppose, they see us as a conglomeration of living cells that is expected to keep a golf course in top-notch shape. After all, what is more important than a verdant golf course. The players want the course to be a green carpet. We see the golf course through each blade of grass. Those blades of grass are individual products of nature which we must nurse, caress and care for as one would care for an infant child. When we stop feeling this way, it should be the day we can stop calling ourselves golf course managers, superintendents and professionals. I suppose it is a sense of pride, which all superintendents should have.

Ever see a golfer leave his empty beverage cans or candy wrappers lying on the fairway? It hurts deeply, but our training in good public relations tells us it's taboo to reprimand this individual with language that could easily destroy the image of a dignified manager.

Oftentimes, golfers do not realize that we are not God but that we do try to make the golf course as presentable as possible. I suppose, the golfers are correct in assuming that we are the only creators of fine turf. But these pious thoughts are only partially true, for without nature's cooperation, our golf courses may end up in chaos.

The thing the layman overlooks, and which is produced by us, are the benefits we add to the cology of this great nation. By nurturing good grass we are oxygen givers. A blade of grass, using the rays of the sun as its source of energy, synthesizes carbon dioxide, water and minerals to promote green growth. In the process, it takes pollutants from the air, filters out dust particles and gives off oxygen in return. In fact, actively growing grass on a 50 x 50 foot plot releases enough oxygen to meet the needs of a family of four, day by day. The world needs more such greenery.

We won't try to pretend that we are well-versed chemists but a knowledge in chemistry is certainly an asset. One miscalculation on a mixture of any toxic substance could mean disaster to the golf course and to us too. We are expected to be knowledgeable in golf course architecture. Our course is expected to look like a story-book park. We should also know a little about the science of archaeology, for some of the old fossils that play our courses need complete understanding, especially when we have to go out on the course and replace their divots.

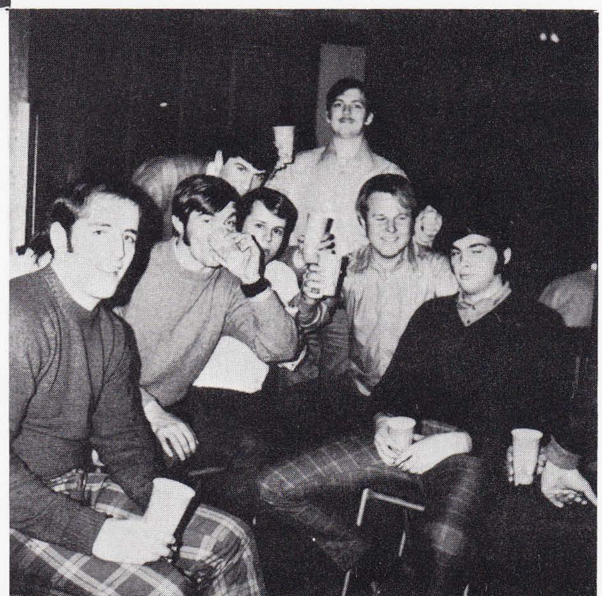
By the way, if your tendency is to be a little lethargic or phlegmatic, then you better get out of this business. The art of a good golf course manager has no place for slow movers or slow thinkers. There is overwhelming responsibility in the operation of a golf course. Attending a turf school, like the one at the University of Massachusetts, does not necessarily mean that this terminates further studies in the business. Golf course seminars and turf conferences should be considered important. These specialized programs will enhance and augument your knowledge on the latest techniques of your trade.

What does the future hold for us professionals? We expect to be in great demand and hopefully the laymen will appreciate our services. According to Mr. Cornish golf course architect, and a University of Massachusetts Turf School Instructor, Golf Superintendents will continue to be in great demand. This is encouraging to say the least.

Our thoughts, our desire and our dedication should follow the path of producing the finest turf possible. And our employers will give us the respect we should receive from them. Remember, we are not the mythical "gods of grass," but only human beings that, with teamwork from our helpers, will produce excellent turf. When we begin to think of

# TURF MAJORS AT PLAY

Hair Dressers or Lawn Mower Pushers



Boys in the Band

North to Alaska

ourselves as experts who are beyond making mistakes, then we have already made the first mistake. We will make mistakes, and we will be reprimanded by our employers and by the not so understanding laymen. In the eyes of the laymen, we are the experts in turf and we had better be experts. It will be the laymen who will give us the status and salaries we enjoy. They will be asking us all kinds of questions, from how they can improve their game of golf, to how to grow grass on their badly neglected home lawns. We must have definite answers. When they give us a reasonable budget, and tell us to "UP OUR GRASS," we should be ready to do our job. We must always remain experts in the eyes of the laymen.

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ANNUAL TURFGRASS CONFERENCE PROCEEDINGS

1971

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Conference presentations have been approved by the individual speakers.

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The various topics are presented for your information as follows:

# THE IMPORTANCE OF WATER MANAGEMENT

Fred V. Grau
Consulting Agronomist
College Park, Maryland

Water is LIFE! Death comes when there is a scarcity or an excess. Floods killed 500,000 Pakistanis in minutes; Pakistani parents repaired the population loss in just 40 days. Deserts speak eloquently of the loss of life when water ran out. Old prospectors managed water very carefully because it was Life! We recall the Rime of the Ancient Mariner- "Water, water everywhere - nor any drop to drink." We are using water at a prodigious rate. By 1980 we can expect water usage to equal replenishment by rainfall, snow melt, glacier melt, dew and all other forms of water return. Where do we go from here? Overpopulation is not likely to be blamed for loss of life but lack of water could be the real cause only because there are too many people who are using and wasting too much water.

In southeast Asia there is a village where the only source of drinking water is 9 miles away. Only women carry water and one wife can make only one trip a day. This forces the man to take more wives who can then supply the family with sufficient water. Water runs downhill and finds its own level. A hose filled with water is a simple device for levelling and staking an area for zero grade. As water moves it erodes and carries impurities with it. It is very important to reduce erosion to a minimum so that our sources of water may not be unduly contaminated.

Water is a universal solvent. It dissolves rocks and minerals. It carries plant nutrients in solution. It may form 90% of the weight of green plants. Water is an essential constituent of every living cell.

Water freezes. When it freezes, it expands. Pressures thus created burst many structures. Rocks are split asunder, one of the soil-forming factors.

Water evaporates and, in so doing, absorbs heat and cools the atmosphere. Evapotranspiration is the device by which green plants cool and create a more pleasant atmosphere.

Water boils and passes into the air as steam or water vapor, one of the many forms of water. Water is a chemical reagent entering into and becoming a part of an infinite number of chemical reactions.

Pure water exists only in the laboratory. Good drinking water may be "pure" in the medical or pathological sense but the "goodness" of drinking water is created by dissolved minerals and impurities. "Pure water" is flat and uninteresting.

Water has tensile strength similar to some kinds of steel. It would take a pull (force) of 210,000 pounds to rupture a column of water one inch square.

Desalination (de-salting) of brackish water is gaining ground. Cost is not the big drawback. In Texas during a drought, water sold for 50¢ a gallon. In New York not long ago you got water with your meal only if you requested it.

In South Africa they are "milking" the clouds to obtain water. Huge nylon nets are suspended on tops of mountains to condense the moisture in clouds that pass over but never drop any rain.

On Long Island there are some 7,000 Recharge Basins 1/2 to 3/4 acre in size, 12-15 feet deep with porous bottoms that collect surface water from highways, roofs, shopping centers. The water soaks into the soil, recharging the ground water and keeping out the salt water from the Sound.

In Life we have a closed cycle of water, oxygen and carbon dioxide with hydrogen atoms going back and forth where needed, all driven by sunlight, the ultimate source of power.

Microorganisms need water. There are times when soil pores become clogged with the bodies of living and dead microbes. This is true especially when water is present continuously in excess.

Soils become more friable when they enjoy cycles of wetting and drying. Soils that are continuously wet become "sour" and unproductive. Only the anaerobic organisms persist - the ones that create substances toxic to grass.

It is not possible to "partially wet" a soil. Irrigation consists of saturating the surface to a depth determined by duration and quantity. With drainage and percolation water moves downward pulling air into the soil pores. Roots of grass must have oxygen. With continued percolation and plant usage the "saturated" soil moves into the "field capacity" range where plants grow best. With no further water applied as rain or by irrigation, all available water is used and we reach the "wilting point." Some plants die very soon after this - others can tolerate days and weeks at the wilting point and return to normal upon the resumption of irrigation.

In preparing for this paper, I re-read USDA Yearbook on "WATER"; Turf Management by Musser; Turfgrass Science, American Society of Agronomy Monograph No. 14; many bulletins and a delightful book, "On the Shred of a Cloud" by Rolf Edberg translated from the Swedish. I urge each one of you to re-read all you can on the subject of WATER. We don't have much time left.

A baby born today will pollute 3 million gallons of water in his lifetime. Providing food, goods, and services for this baby will pollute another 30 million gallons.

As a Nation, we are running out of water! We must learn to conserve it, to reuse it, to recycle it as never before.

Hawaii is blessed with an abundance of good water but turf is being ruined by the excessive and wasteful use of water. Now, with automated water systems, we anticipate an even greater misuse of water. We can only hope that those who manage these systems will exercise restraint.

A new system of "Drip Irrigation" now being practiced in California claims to use 60% less water with superior results. We can hope to adapt something like this to turf.

An example of water management can be cited on a course in the Mid-Atlantic area. Two years ago it was mostly soggy Poa annua with some struggling bent and bluegrass. With minimum irrigation, the introduction of new ryegrasses and improved bluegrasses, and a slow-release fertilizer program we now have nearly solid bluegrass fairways with no Poa annua. It took courage to let the fairways get dry but the Poa annua died and the other grasses held on. Water, when needed, was the secret of success.

In 1946 Jim Watson started his work on water on turf under the late Prof. Musser. His Ph.D. thesis summarized four years of work which said in effect, "Water as needed only so fast as the soil will absorb it." About that time aerification became feasible and we learned how to cultivate turfgrass soils to let more water into the soil. This was a big step forward in Water Management.

Drought years in 1963, 1964, and 1965 in the Northeast created an upsurge in the installation of irrigation systems. Water was thought to be the answer to the problem. A survey conducted in 1968 by Dr. Harper, Penn State, showed that irrigation produced a whole new set of problems.

77% reported decrease in Kentucky blue and red fescue
81% reported increase in Poa annua (some indicated 90 to 100%)
Height of cut had to be lowered.
78% said that mowings were doubled
22% said that mowings were tripled
Weeds increased, there was more thatch buildup, new grasses had to be introduced, renovation became necessary, fungicide use increased, and fertilizer requirements doubled and trebled.

Water provides films around solid particles which act as a lubricant. With traffic the soil particles become rearranged in the direction of more compaction. Pore spaces were reduced from 33.1% to 6.1% in one study. The weight of the non-compacted soil was 68 pounds per cubic foot. After compaction the same soil weighed 112 pounds.

Roots of turfgrasses have been found at considerable depths when there is good sub-surface drainage, where the soil is permeable and water has been used in moderation. In California the roots of Merion bluegrass were drawing moisture below 3 feet. Roots of bentgrasses on putting greens have been found to be active below 12 inches. The secret is permeability, good drainage, and good water management.

"Water as Needed" includes syringing to bring grasses out of a wilt condition. A quick syringe with cool water provides cooling and life-giving oxygen. More oxygen is dissolved in cool water than in warm water. Perhaps one great feature of automatic irrigation systems is the ability of the turfgrass manager to syringe all areas quickly early in the morning to wash off dew and water of guttation. Guttated water (that which is forced from openings in the plant by root pressure during the night) contains rich nutrients which are ideal for the growth of fungi. When left on the plant there may be burning of the leaves when the moisture evaporates and the salts are left behind on the leaves. Syringing washes these nutrients into the soil where they are recycled through the plants.

Soil probes are great tools fro determining "dryness" and the need for water. The experienced manager can look at an area and with a knowledge of the grass, the soil, the fertility level and the irrigation schedule he can gauge accurately when water must be applied.

Fertility levels greatly affect water requirements. Hungry turf needs five times as much water to produce a pound of dry matter as well-fed turf. There are records that show Merion bluegrass going 40 days between irrigation periods. I've seen bermuda grass turf (well fed) still green after 90 days without water.

We are recognizing the growing need for potash in turfgrass maintenance. The need is greater on irrigated turf because water washes the potash out of the plant. Studies in Michigan showed that 71% of the potash in grass plants is lost after 4 hours of irrigation. Many of us have come to believe that, on irrigated turf, we need to balance potash with nitrogen, about on a 1:1 basis. After studying many soil test reports, I have formulated a fertilizer mixture that could be useful in many situations where potash has become critical. It is, simply, a mixture of granular ureaform (38-0-0-) and a granular sulfate of potash of equal particle size (0-0-50) in the proportions of 1,200 pounds to 800 pounds respectively. This yields a material of approximately a 23-0-20. Phosphorus, where and when needed, can be easily and inexpensively supplied in several ways.

We are in the International Hydrological Decade, 1965-1975, during which time the water resources of the world will be studied and mapped in infinite detail. Also, during this time, we will be re-doubling our efforts to conserve the water we have and to learn how to get along with <u>less</u> water. We do not have any <u>new</u> sources of water - we must "make do" with what we have.

I'd like to share with you an experience I had in Texas while I was Director of the Green Section. The complaint was that, no matter how much water they put on the Seaside greens, they would not hold a shot. At that time I was playing good golf so I went out 80 yards in the fairway and hit some 8-iron shots. It didn't take long to realize that, with bermuda fairways cut at 1 1/2 inches, every shot was a "floater" that would not hold no matter how soft the green. The obvious answer was to mow the fairways down to 1/2 inch so that the golfer could play a controlled shot by pinching the ball between the club face and the turf. The greens were allowed to dry and, with <u>less</u> water, they held the shot better (and the grass recovered).

In another case, during a tournament, a putting green was wilting and it needed water very badly. The chairman instructed the superintendent <u>not</u> to put water on the green while the sun was shining because "it would burn the grass." The result was that the grass died because it did not get the water <u>when it was needed!</u>

No matter who you are or where you are (and I) are committed to the concept of "Efficient Water Management." I recall vividly hitting golf shots and provides for future changing of the programming and the time of operation of each automatic control valve. It also includes access to other functions such as time of start of the watering cycle, setting of an automatic syringe cycle, manual syringing, adjustment of the number of cycles of the pre-set program, provision to omit or add a control valve at any time, provision to shut down the operation of the irrigation system at any time due to any alarm signal such as rain, low pressure, etc., provision to automatically lower or raise the irrigation system pressure to compensate for differences in elevation or distance from the pump, provisions so that any pre-selected number of control valves (up to pump capacity) can be operated simultaneously on any one timed circuit, and provision so that any one or more control valves (up to pump capacity) can be operated simultaneously manually or automatically. All programming is performed at the control center.

Satellite Control System - a control system where automatic and manual control functions may be performed at several remote or satellite stations. This may include the programming of the automatic control valves connected to their controller and adjustment of the time of operation of each control valve. It includes the setting of time of start of each controller but after start each controller operates "wild", independent of each other and without coordination. Only one circuit (one control valve) can be operated at any time from one controller for manual operation. Programming must be performed at the satellite.

Central Control of Satellite Control System - a control system where a Satellite Control System is modified so that all remote controllers may be started or stopped from one central location. This may also include individual on-off control of each satellite unit, and it may include a short cycle for syringing. Programming and individual valve manual functions must be performed at the satellite.

Master-Slave System - a control system where the satellite (slave) controllers are synchronized in time with the central (master) controller. The central controller provides all timing and sequencing functions. Programming and individual valve manual functions must be performed at the satellite.

Controller - a timer or device with day and hour selectors to set the time of start of a watering cycle. It contains one or more circuits which are operated in sequence, usually by a stepping switch. Each circuit has a timing adjustment which can be set to vary the time of operation of each circuit from 0 to 60 minutes. Controllers are usually made in 12, 18, or 23 circuit models. Additional functions such as circuit advance, manual start, syringe timing, rain shut-off, etc., may be provided.

Circuits - (sometimes erroneously called stations) - a terminal to which is supplied a timed voltage for connection of one or more automatic control valves. Each circuit usually has a timing adjustment of from 0 to 60 minutes, and are stepped, when the pre-set time is reached, from one circuit to the next in a fixed sequence.

Station - a fixed location on the golf course where one or more satellite controllers are located, a satellite station. For the central controller location it would be the central control station.

Programming - the arrangement of all the control valves in an automatic irrigation system, organized in a logical manner on the various circuits of all of the controllers in the system so that each valve is provided with the desired time of operation and sequence of operation. It may be necessary to stagger the time of operation of the several controllers to accomplish a complete program. For the satellite control system, central control of satellite control system, and master-slave system the programming can only be performed at the satellite stations. For the central programmed control system the programming is performed at the central station and re-programming can be done at any time with quick-connect terminals.

Re-Cycling - the ability to provide one or more short timing cycles of the program rather than one long cycle. Allows the soil to absorb moisture at a low infiltration rate preventing run-off from slopes and puddling in low spots. As wind direction and velocity change during the night a better sprinkler pattern is obtained. It washes dew and fungus continually during the night and is ideal for new seeding and sprigging. For systems using satellite controllers it is arranged by adding together the time set on each circuit, allowing a safety margin of time, and setting another hour selector start pin. For the central programmed control system a proprietary "re-cycle" switch is provided whereby the timing of each circuit is set and the number of re-cycles is simply set on a switch to one or more re-cycles. The re-cycling is instantaneous.

Syringe - a light, short watering period, usually in isolated areas such as greens usually used to combat wilt. A syringe cycle may be used to provide short cycle functions, when there is no play. It is usually done manually so as not to interfere with golf play. Severe objection by the golf membership is usually experienced when done automatically by short-cycling during active play periods. For systems using satellite controllers it is very cumbersome, inefficient, and time consuming to do manually. For the central programmed control system it is easily accomplished with virtually no interference with play by using "walkie talkies" and/or remote manual switching stations.

Golfers demand top quality turf but not at their inconvenience of dodging sprinklers popping up all over the place during an automatic syringe cycle.

Prior to designing a custom system to the personality of a golf course, let's make an analysis of some of the components, design parameters, and other considerations that must be made on the basis of the laws of physics tempered in some cases by practical experience.

The most important and most permanent part of the irrigation system is the pipe. Much cement-asbestos pipe, class 150, has been used in the past for sizes 3" and above with excellent results. Very little damage has resulted from water hammer since the pipe is rigid and has a burst pressure rating of well over 500 pounds per square inch. Occasionally a break will occur where a stress load is applied such as a rock under the pipe or from improper bedding in back fill. It can be used without hesitation although its installed cost may be higher than newer pipe materials.

After some very disastrous experiences with ABS and polyethylene pipe, PVC or polyvinyl-chloride pipe has come into its own. When selected and installed properly and with a properly controlled pumping and irrigation system, it should approach the life and serviceability of transite pipe. In just the last few years there have been significant improvements in the reliability and life of PVC pipe. Improvements in pipe extrusion dies and mold design together with stable extrusion pressure and temperature have contributed to its reliability and long life. Small but significant improvements in better compounding ingredients and mixing procedures have been made. Long term testing procedures have exposed the flaws of short term testing. Be very wary of lesser known companies and low prices.

Difficult to overcome is the "do-it-yourself" attitude. Like any other piping, satisfactory installations are obtained only when the system is designed properly and installed by trained and well supervised workmanship.

Since the pipe is the permanent part of the irrigation installation make sure you are conservative with pressure rating of the pipe used. The pressure rating of the pipe is only one consideration. Water hammer which in most cases occurs too fast to be seen on a standard pressure gage can give an instantaneous pressure surge of hundreds of pounds. This gradually weakens the pipe so that in maybe 5, 10, or 15 years progressively more pipe breaks may occur. PVC is not rigid like cement-asbestos and yields to excessive pressure and becomes progressively weaker with each surge. In addition, the pipe wall is continually eroding from water flow and foreign particles in the water. Accidental cuts, scratches, abrasions, backfilling with rocks, and "jack-hammering" action by rocks due to vibrations in the pipe caused by the pump pulsations, all could remove portions of the pipe wall. It is, therefore, good practice to use class 200 PVC pipe up through 6" size. If you are forced to compromise, you might take a chance on class 160 PVC pipe for 4" or 6" sizes. But never compromise with less than class 200 pipe for PVC pipe sizes 3" and below since the wall thickness is too thin in these sizes and the greater wall thickness of class 200 pipe provides insurance. Class 315 pipe is an even wiser choice. The cost of 200 class PVC pipe is only 15 to 20 per cent additional but this is a small insurance to pay for the permanent part of your installation. Where moderate water hammer exists do not subject the pipe to more than 50 per cent of its rated pressure.

Be very careful about voiding the guarantee extended by the pipe manufacturer. Improper bedding and backfilling, dragging pipe instead of carrying it, scoring by "moleing" pipe through the ground, excessive static water pressures, and water hammer pressures, all void the guarantee of the pipe manufacturer. Contractors are quick to come up with cheap methods of installation to under-bid their competition but unless they are willing to back up the manufacturer's guarantee, when they have voided, and provide their own 5 or 10 year bonded guarantee, install the pipe in accordance with the manufacturer's recommendations. Your club will reward your intelligence and they will certainly be able to supply the funds to install the proper job if they are made aware of the small additional cost versus the gamble.

Be doubly sure that all pipe tees, elbows, and reducers are generously thrust blocked.

Make sure that the piping is generously sized so that there is a small difference between the pressure at a sprinkler head near the pump and one remote from the pump. The designer should specify this difference under operating conditions.

All control valves are not equal. They are the least reliable of all the components in an irrigation system. They foul up from dirt and foreign particles in the water, are subject to wear across the seat and plug due to excessive pressure drops, and after 5 to 10 years of operation will require maintenance. It is a good practice to put an inexpensive gate valve ahead of the control valve so that the system need not be drained when maintenance or repair is required, and the valve should be installed in a dirt free box.

When appraising control valves look for simplicity. Don't reject a control valve because it may have external tubing. It is much easier to clean clogged ports external to the valve than to have to gain access to the small internal ports. The most important part of the valve is the inlet strainer to the diaphragm chamber. It should be 80 or 100 mesh and removeable without dis-assembling the valve. A filter or screen is useless if inlet ports leading to it clog up. Flow through the valve should be from under the seat. The valve should never be throttled with a flow control device or a pressure regulating device if a reasonable life of the valve seat is desired. These valves are designed for a few pounds pressure drop and excessive pressure drops cause wear. There is a much simpler way of controlling pressure at a valve, without wearing it out. A bolted flange is the best means of dis-assembling a valve. Avoid screwed bonnets and piston type valves as they can be maintenance headaches.

Appraise the electric solenoid carefully. A three-way solenoid valve is preferred to a two-way solenoid valve. Beware of low wattage coils. These are "hot flash" coils and there seems to be a contest on to see who can make the lowest wattage coil in order to use no. 18 or 20 AWG wire. (Wire below no. 14 AWG should not be used due to its lack of mechanical strength.) Low wattage coils are made of fine and flimsy magnet wire which makes them subject to mechanical damage, and they are easily destroyed by voltage surges generated by starting and stopping of pump motors and lightning surges, either direct or indirect. When moisture and micro-organisms work their way down between the PVC coated wire leads and the epoxy to the bare magnet wires, corrosion and failure of the fine wire is inevitable. Therefore, keep a good supply of spare coils on hand, be sure the coils can be easily replaced, and that the valves are easily accesible. The closing speed of a control valve should be about 10 seconds. A time shorter than this may cause excessive water hammer and a time longer than this may cause pump problems in addition to interference with golf play during a daytime syringe operation.

Before deciding on purchasing a particular valve, take one into a quiet corner, dis-assemble it, assemble it and imagine that you are doing it standing on your head, 18 inches below ground level, in a small hole.

Be careful about using a valve under every head, unless there is no other solution. Doubling the number of valves quadruples the maintenance. If you don't install it, it can't rattle.

Next, let's take a look at sprinkler heads and the most important feature to look for is one with the longest nozzle, a contoured venturi throat, and a low trajectory so that maximum coverage can be realized under all wind conditions. The function of a nozzle is to change a pressure head into a velocity head and to do this effectively the nozzle must be as long as possible (similar to a fire hoze nozzle) and the piping inlet to it as long as possible with gradual bends. (Take a look at your manual sprinkler nozzles to confirm this.) A large sprinkler housing is needed to house the nozzle assembly and don't be taken in by small nozzle lengths in small housings. You are sacrificing too much performance for a small gain in esthetics. Impulse sprinkler movements appear to be the simplest and most reliable. If otherwise, you would find manual sprinklers with gear driven and impact mechanisms being used for manual irrigation systems.

Always use a soft rubber or vinyl top on the sprinkler to absorb shock from mowing equipment and other vehicles, and the soft covers prevent damage to mower blades. The covers should be green to blend in with grass and be esthetically attractive.

Try to maintain a constant pressure at the sprinkler head by means of proper pipe sizing and programming of the sprinkler heads. Excessive pressures at the sprinkler causes excessive velocities, excessive erosion and wear and inevitable premature life of the nozzle and poor performance of the distribution pattern. Central programmed control systems are available which when integrated with the pumping system, can be programmed to give a controlled pressure at the nozzle within narrow limits. This will not only extend the life of the nozzle and sprinkler but extend the life of the control valves and piping. In additon, the ideal precipitation pattern obtained will give your course the best possible turf conditions.

When deciding to use small or large sprinkler heads on tees and other small areas, the larger head is preferred. It is less affected by wind, you can cover a much larger area with fewer components, and you get the added bonus of green grass around your tees. The effects of traffic are least on healthy grass and the areas surrounding your tees will be esthetically attractive. In many cases the healthy grass stands up under heavy electric cart traffic and eliminates the need for ugly cart paths.

Controllers are the heart of any automatic control system. They should be protected from vandalism and lightning by enclosure in heavy metal or masonry housings. If possible, they should be submerged flush with the ground so that they are not eyesores or attractors of lightning and vandalism.

Controllers, both at satellite and central stations, should be simple and the labeling should describe the job function, not a stretched advertising claim. The hour and day settings on the clock should be easy to read and to set. Timing of each circuit should be by the more reliable resistor network rather than the maintenance prone potentiometer circuits. Repair and access to potential troubles should be made simple so that the operator can make most of the repairs by use of spare modules or plug-in units.

Let's just stop for a minute and think of why we need to have controllers at remote satellite stations. A satellite controller has an hour and a day setting to start the controller, but this can be done at the central station. Each circuit has a variable time setting of from 0 to 60 minutes, but this can be done at a central station. The satellite controller has a short cycle feature for dew and frost wash or for syringe during no play on the golf course, but this can be done more easily at the central station. The satellite controller has an on-off automatic switch but this can be located at the central station. The satellite controller has a terminal for each circuit but these can be located at the central station. The satellite controller has a manual rotary switch so that any one and only one of the control valves connected to it can be operated at a time but this can be done at the central station and in addition, any one or more control valves up to pump capacity can be operated simultaneously at the central station. If the piping is adequately sized and there is enough pump capacity, all control valves on an entire fairway or parts of a fairway can be operated simultaneously from a central station. This is easily and inexpensively accomplished with walkie-talkies by having one operator at the central station and another operator roaming at will on an electric cat to any desirable vantage point. The operator on the course is not tied down to fixed satellite stations and when it is required to syringe fairways during heavy play he can command sprinklers to be turned on and off at will on any part of the course in view where there is no play. As play progresses on a fiarway, the operator can turn off the sprinklers ahead of play and turn on sprinklers behind the play. He is always operating at full pump capacity, in the most efficient manner, and in the least amount of time.

Compare this with the confusion of trying to syringe the fairways with the satellite controllers. The operator is at a satellite station and assume he has four controllers at this station. He can only operate four sprinklers at a time, one on each controller, and he is wildly spinning the rotary switches in order not to sprinkle players. It is impossible to keep track of what he is doing. He is using only a small part of the pump capacity and by the time he completes syringing from all satellite stations, wilt damage has already occurred. Of course, he could have several field operators (would they be capable of understanding the procedure?), but there still would be wild confusion and it just is not practical to manual syringe a golf course with a satellite controller. Of course, you could syringe the golf course during play automatically, and this can also be done from the central station, but why disrupt play! Members pay high fees so that they can enjoy a peaceful round of golf, and they violently object to the unnecessary disruptions from sprinklers when a simple and inexpensive method is available to syringe a whole golf course during play with minimum interruption to play.

The Central Programmed Control System provides for the syringing of greens and/or tees at several remote switching stations for line of sight manual control. If a finer spray or heavy droplets or any intermediate spray size is required, just make a simple adjustment.

Now let's stop for another minute and think of why we need to have controllers at remote satellite stations. The only reason I can think of is for the use of the manual rotary switch, for what little and confusing value it may have. If it is only for a manual switching purpose, then why not install a manual switching station in its place. Therefore, there is absolutely no justification for having controllers at satellite stations on the golf course when one central programmed controller can do more and do it more reliably with greater flexibility. The big bonus is that you can eliminate a plurality of maintenance prone controllers which are subject to vandalism and havoc of the elements, and by proper programming integrated with pump automation, attain essentially the same pressure at each sprinkler head. You have perfect timing coordination between sprinklers, the timing of individual sprinklers can be varied, and you can accurately balance the irrigation system capacity requirements with the pump capacity. Another major bonus of the central programmed system is that you can incorporate automatic surge relief to arrest water hammer at very little cost.

With a central programmed control system you can actually check for an electrical circuit fault, and whether or not there is a faulty electric solenoid, at one convenient location and all circuits can be checked in 10 to 15 minutes.

The only apparent drawback to a central programmed control system, if it is a drawback, is that additional wire is required. But there is nothing more reliable, that you will have the least trouble with, that will last longer than anything else, than irrigation control wire when properly selected and installed. The small cost paid for the additional wiring is prudent when you consider the multiplicity and duplicity of control functions and the resultant maintenance and potential problems. The probability of failure of a component varies as the square of the number of components. Therefore, when you have ten controllers instead of one, you have 100 times more chance for potential trouble. If you have 20 controllers, instead of one, your potential troubles increase by 400 times. Think about this, as these are proven statistical estimates.

Since we have seen that there is no real use for satellite controllers in the field, except to provide occasional manual syringing, and we have seen that to syringe manually with satellite controllers is cumbersome and not practical, the only practical approach is to go to the central programmed control system, and if line of sight manual control of valves is desirable, add simple, maintenance free switching stations at convenient points.

Certainly the most rewarding feature of the Central Programmed Control System is the lack of maintenance required. Of all the systems installed, going back over a 5 year period, the total cost to date has been from no cost for one club to a few hundred dollars for the rare case.

Wire is probably the most reliable component in your irrigation system, and if selected properly should give indefinite life. Beware of using line voltage on the golf course as there is no reason why, in an engineered system, all electrical components cannot be operated at low voltage. To protect yourself and the club, be certain to get an underwriters certificate for all work done. Electricity and wet ground is like an accident looking for a place to happen.

Due to structural strength, it is unwise to use wire sizes smaller than no. 14 AWG and the wire should be U.F. approved.

Don't be mislead by vendors who would like to profit on maintenance prone mechanical controllers and components in place of maintenance free wire.

Water hammer should be of major concern to operators of golf course irrigation systems. It is sometimes taken too lightly and many misconceptions exist. I have seen golf course irrigation systems literally destroyed by water hammer by as many as 30 to 50 breaks in piping per year.

When a liquid is flowing through a pipe, there is a definite amount of energy in the liquid equivalent to its weight times its velocity called kinetic energy. If the massive energy is stopped suddenly, and since water is incompressible, the energy of the flowing water must be dissipated. It uses up this massive energy by transferring it to the pipe and equipment by straining it, stretching it, and increasing its diameter. Simultaneous with the stoppage of this energy, a shock wave (similar to a lightning bolt) is transmitted at the spped of sound in water, 4,000 feet per second, throughout the irrigation system. In other words, it only takes one second for the shock wave to reach a point 4,000 feet away from the point of origin.

Actual system shock intensity can be calculated. Each foot per second flowing velocity changed suddenly produces a pressure rise of about 60 psi. Since most pipe manufacturers void their pipe guarantees when the flowing velocity exceeds 5 feet per second, let's determine surge pressure. Multiply 5 feet per second times 60 psi for each foot per second and you have a surge pressure of 300 psi. Add this to an average static irrigation pressure of 100 psi and you will find that pipe is subjected to a pressure of 400 psi. But most irrigation systems operate at higher velocities, particularly where contractor and other "free" designs use 3" and 2-1/2" pipe where 4" should be used. I would venture to say that most irrigation systems are operating at about 8 feet per second flow velocity. This figures to be a 580 psi surge pressure.

On top of flow velocity causing water hammer, the problem is compounded when air pockets or entrained air exists in the irrigation system. Contrary to common belief, air in the system does not absorb these surge pressures but prolongs the duration of the pressure surge even though the maximum surge pressure may be reduced slightly.

Another cause of water hammer is the pump discharge check valve. When the flow of water stops, caused by the pump shut-down of the irrigation system, the flow velocity of the water eventually stops and then a flow reversal tends to take place. Unless the check valve closes instantly the moment the reversal of flow starts, or when the flow is zero, severe water hammer can occur. The longer the flow reversal the greater the water hammer.

Probably the most violent cause of water hammer is to have the pump stop during maximum system flow. Water column separation tends to take place and an "implosion" occurs. Add a little entrained air and you have an explosion.

Most irrigation systems survive the forces of water hammer through diversity factors and luck, but the damage to the pipe is progressive. But an ounce of prevention is worth a pound of cure. Prevention of pressure surges should be foremost in the mind of a waterworks engineer. Where prevention is not possible, then automatic protection should be provided. I incorporate automatic surge relief in all of my designs. Also, pay the small premium for class 200 pipe, and don't cause stress concentration points in the pipe by placing rocks next to it, kicking it or scratching it by dragging it underground. "Let engineering determine the design, not the low bid."

Several years ago when I was assisting a large New York City Consulting engineering firm in writing specifications for the automatic control system of a hot water-chilled water system for a large office building, I had an opportunity to help analyze the water hammer effects on the piping and equipment, similar in many respects to an irrigation system. The piping parameters were made into a model for a computer analysis. The results showed the importance of looping pipe, eliminating dead-ends, and being generous with pipe size and pipe pressure rating. Similar importance must be applied to an irrigation system, and good engineering design can eliminate potential problems.

The effects and preventive measures of lightning should be seriously considered. There has been a lot of free advice and bad advice given about lightning. You have seen or heard of electric satellite controllers being devastated on both hydraulic and electric jobs. And you have heard of golf courses where many solenoids have been made inoperative. Here again, proper design can eliminate most of the potential problems. Lightning arrestors give some protection. If installed improperly, as they almost always are, lightning arrestors give little protection. Here again system design plays the big part. The central programmed control system can lose only one controller but it has a 100 per cent back-up system that can be plugged in, with no loss in control.

The selection of a lightning arrestor should not consider price. Very critical and sophisticated techniques must be used in their application if they are to be effective.

When designing an automatic irrigation system a major concern is the condition of your well or water supply and your pump capacity.

When sizing pump capacity the minimum requirement should be enough capacity to water the entire course in one night or 10 hour period, applying the maximum rate of precipitation. In other words, design for the worst or drought condition. This will usually mean a 30 minute watering period for fairways and 20 minutes for tees and greens. If syringing of fairways is an occasional requirement, then even more capacity is desirable.

Where the water supply is from a well and a new well is required, it is imperative that plans and specifications be prepared and an acceptance test made to assure that capacity and pressure requirements are met. Double check to make sure that no sand is evident, particularly at maximum flow. The test should include a flow at 150 per cent of that specified with all readings taken. It is wise to run the acceptance test for 8 hours, periodically taking draw-down readings and sampling for sand. Be generous with total screen area, particularly length of screen, and stingy with screen opening size.

An artificial gravel pack well is preferred to a natural developed well. The artificial gravel envelope around the screen in effect increases the screen diameter and although the artificial gravel well costs more, it is the most economical and will last a lot longer than a natural developed well. However, there are some situations where sand conditions are such that a natural developed well may be the wiser choice. The fact is that every well should be designed to fit the kind of water-bearing formation and geological conditions that are found at the well site.

The slot size of the screen governs the development of the well process. The sand or gravel becomes arranged so that the coarser material remains around the screen, thus letting the water enter freely. It should be remembered that the uniformity of the sand or gravel is much more important than the average size of the grains. This holds true when building drainage on the golf course. Finer grains of sand or gravel tend to choke or "sand lock" the gravel pack.

The most important thing to remember about the operation of a well for irrigation purposes is to cycle the pump as little as possible. In intergrating the automation of the pump with the irrigation system it is best to let the pump run continuously while the irrigation system is operating. This is also a good idea when operating the pump for manual operation and when a small quantity of water is being used. Simple controls will allow you to do this without damage or stress on your pump and irrigation system.

Cycling of the pump may agitate the water bearing formation around the screen causing "sand locking" and in older wells may break down "bridging" formations which will cause sand pumping and decreased pump capacity.

Even though there are many reputable well drillers, it is always best to pay the small fee of a consultant to insure that your irrigation system requirements are met and that the performance specifications of the well are met. Like an irrigation system, it is easy to bury mistakes and trained and experienced assistance is desirable.

Where the water supply is from a reservoir another group of problems must be considered. Pumps can be of the centrifugal type or of the turbine type similar to those used in well installations. If possible the turbine or "canned" type of pump should be used in order to circumvent the suction problems inherent in centrifugal type pumps.

Turbine pumps are operated much the same way as the deep well turbine pump and the pump inlet must be kep below the water level of the reservoir to eliminate NPSH (Net Pump Suction Head) problems. Prime consideration must be given to screening dirt, algae, and debris from the inlet of the pump. Although the turbine pump may cost more than the centrifugal pump, its inherent simplicity and reliability is worth the additional cost.

When using a centrifugal pump for pumping from a reservoir the configuration of the suction line is very critical. Every possible means must be taken to eliminate air pockets and air leaks in the suction line. The suction line must be as straight as possible with minimum fittings, pitched properly so that air pockets cannot form. The pipe fittings must be such that no air pockets can form. Piping connections must be gasketed and sealed so that they are air tight. The intake point must be as deep as possible below the reservoir surface so that air vortexes do not form and infiltrate into the suction line. If sufficient submergence is not possible, then a special intake configuration must be built. Automatic devices must be installed so that air is purged and the suction line is primed. Sometimes automatic pump priming devices must be installed to maintain a primed suction line. Water seals on stuffing boxes must be tight. The inlet piping and foot-valve must be generously sized. The suction lift including losses in piping and fittings should not exceed 15 feet at maximum capacity.

NPSH is the absolute pressure available at the pump suction flange, required to move and accelerate the fluid entering the impeller. If the NPSH available in an installation is not sufficient, the pump will cavitate and serious operational difficulties may develop. A centrifugal pump has an inherent minimum required NPSH to prevent cavitation, which varies with capacity. When cavitation occurs severe implosions occur which erode the metal parts, sounding like pebbles flowing.

For safe pump operation automatic controls and safety devices must be incorporated. Too many safety devices can sometimes backfire and become the source of a pump problem. Therefore, only use those which are necessary to provide safe, reliable operation.

The main component of an automatic pump starting system is the starter. The simplest and most reliable is the across-the-line starter. Since the starting current of pump motors increases to six times the normal running current briefly when the motor is started, most utilities require a reduced voltage starter below 30 horsepower to limit the voltage dip which occurs from this starting current. The most often used reduced voltage starters are auto-transformer, part winding, resistance and Wye-Delta. The pump motor may require a special winding to match the starter. Extreme caution must be exercised in the selection of the thermal heaters in the starters and in setting of the time delay relays which bring in the second stage of the heater. Conditions which may cause the pump motor to cycle or cause the pump motor to remain on the first stage windings too long should be avoided since motor burn out can easily occur.

After the pump has started, it should not be re-started for at least 5 minutes (10 minutes is safer) as the motor windings are subjected to a very high heat surge during starting due to the high starting currents. Repeated cycling can easily burn out the windings.

The pump starter should be equipped with a re-cycle time relay which will prevent re-cycling for a pre-set time. Other safety devices that may be used are thermostats to measure motor winding temperature, phase failure and phase reversal relays in case the utility makes an error, low voltage relay in case the utility voltage decreases to a level where excessive motor current can occur, a low pressure relay in conjunction with a time delay relay to stop the pump in case of prolonged low irrigation system pressure. When any one of these safety devices are energized the pump should be stopped with a hand reset relay and a pilot light energized to indicate the fault. The settings and arrangement of these safety devices is critical and an expert should be consulted to save unnecessary shut-downs.

I have noticed at several golf course pump stations where the starter door is left open or a fan is placed to cool the thermal heater elements. This is playing with the danger of you being liable in case an employee accidentally touches the exposed wiring or if the motor burns out. The cost of calling in an expert to find the cause of the trouble is small compared to your consequences if the motor burns out. This trouble should be easy to locate and correct. No club official would want to be responsible for not spending money to correct this situation or any other unsafe condition. Make sure that all electrical work meets underwriters requirements. Too many have their necks unnecessarily stuck out with unsafe and illegal wiring and the club is not going to take the consequences for you.

The pump piping should be equipped with automatic control devices to control the pressure to the irrigation system. A variable pressure system is much preferred to a constant pressure system. Automatic controls can easily be provided which will increase irrigation system pressure when watering areas remote from the pump or on high elevations and will decrease pressure when watering areas close to the pump or at low elevations. This variable pressure system when integrated with a central programmed irrigation control system is the ultimate in automatic irrigation control and is so unique that it was awarded a U.S. patent. It has proven itself with over five years of superb performance.

The well maximum capacity should be protected by means of automatic valving so that the well is not over-pumped with resultant damage to the water bearing formation around the screen.

If the hydro-pneumatic tank is old and/or if the pressure rating is questionable, automatic controls should be used to limit the maximum pressure in the tank without jeopardizing the irrigation system pressure.

In sophisticated irrigation systems pumping flows directly into the irrigation system and only a small hydro-pneumatic tank is needed to maintain pressure on the system to keep air out of the piping. Automatic controls must be applied and interlocked properly.

A high limit pressure relief valve of full pump capacity is prudent to relieve excessive system pressure in case of automatic control failure.

An instantaneous check valve is required to prevent reverse flow and the resultant high pressure shock wave or water hammer that is transmitted throughout the system.

An air release valve must be used to remove the column of air that forms in the pump column during pump shut-down. This air, when lodged in the irrigation system piping, chokes the flow in the piping, creates pressure surges in the sprinkler head, and worst of all, when combined with one cause of water hammer can create explosive forces that can wreck havoc with the piping and piping components.

Particular care must be taken in the selection of the pump motor and pump impellers so that at no time, from zero flow to maximum flow, the pump motor horsepower is exceeded. This will assure a prolonged pump life with minimum breakdown.

The air-water ratio in the hydro-pneumatic tank must be carefully selected based upon high and low operating pressures. Never water log.

In order to assure that an automatic irrigation system has the maximum flexibility, utilizes the most simple rugged and trouble-free components, is the most reliable, can be adapted to future desirable concepts and versatility, there is only one best way to this -- retain a consultant who has the broad automation experience and professional know-how needed to apply the engineering principles needed for a fully integrated automatic pumping and irrigation system. The consultatn must lean heavily on the superintendent for information in order to customize the design of the system since every golf course has its own personality, and it is naive and presumptuous to apply a limited "packaged" system to every golf course. Remember, engineering determines the design, the bid determines the cost. Your best chance of getting the finest and most economical automatic system available is through the uses of the services of an objective and independent consultant. Golf course superintendents should not let their clubs down by being tempted by "free services" or other gimmicks and should become alert to such pitfalls.

Wh en the serious undertaking has been made to hir an irrigation consultant, the services should be complete and cover plans and specifications. A separate or combined contract should be entered into for inspection of installation services, as with an undertaker, so many mistakes can be hidden from a trained eye. The small fees paid for independent engineering advice is the most worthwhile investment a club can make.

Very important is the analysis of bids to make sure that all contractors are bidding on the same equipment. Alternates, with any savings incurred, should be passed on to the club.

No one irrigation equipment manufacturer makes the best valve, sprinkler head, controller or pipe. A competitive technical equipment analysis should be supplied and a selection of equipment must be made on the basis of the best piece of equipment regardless of manufacturer. If you have to depend upon a manufacturer's service to back up a piece of equipment, disregard it. If the Greens Superintendent's crew are not able to maintain a piece of equipment, don't use it. Properly selected irrigation components can be fully maintained by the green's crew. But get advice on your selection.

Beware of extended equipment guarantees by some manufacturers because there are too many ways poor design of the irrigation system can void the guarantee. The slightest evidence of a scratched pipe surface, pressure surge, voltage surge, etc, is what they count on to void the guarantee. A minute of expert equipment analysis is worth a ten year guarantee - and the saving of plenty of headaches besides.

Too much emphasis cannot be put on the written contract. I have seen too many cases where the club paid 5, 10, and 15 per cent extra when they thought they were getting a complete lump sum contract. There are just too many loopholes in contracts, unknown to the best legal firms, that an expert irrigation consultant can point out. In almost every irrigation job on which I have worked, my fees have been paid for out of savings on bid analysis and contract writing assistance. Remember, the contractor has learned from many irrigation contracts where you may be learning for the first time.

Insist that the engineer supply you with a complete program of operation for each sprinkler head, each controller, and most important the pressure at which each sprinkler head will be operating. The voltage at each control valve under operating conditions should be indicated.

In other words, if a job has been engineered, the only proof is in calculations. You are entitled to see these calculations, and to discuss them.

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## INSTALLATION OF A COMPLETE WATER SOURCE AND AUTOMATIC SYSTEM

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During the past ten years there have been more articles written on irrigation than on any other phase of the turf industry. This topic has been discussed in various degrees at National Turf Conferences, regional and local seminars and numerous publications have been prepared and distributed to golf course superintendents and club officials. The Universities offering turf management courses have offered special courses in irrigation. The manufacturers of irrigation materials and supplies have provided special courses and qualified engineers to meet with club officials and superintendents and contractors when a club has requested this service.

Gentlemen - The factual information is availabel - often free of charge - Use it and Evaluate.

The first step for those contemplating the installation of an irrigation system is PLANNING. Gathering factual information, talking with qualified engineers and contractors, and visitng with superintendents who have or are now installing automatic systems. This will take time and effort but will be well worth it. If possible take a club official with you.

Read and make yourself familiar with the information available. I would suggest reading in detail the 1968 & 1970 Conference Proceedings pertaining to irrigation, published by the GCSAA. I would also suggest that you read the book entitled "The Economics of Large Scale Turf Irrigation" and the book entitled "System Design for Golf Course Irrigation" published by Edward Pira, Ag. Engineering Dept, U. of Mass.

Your conclusion after reading these books should be that although you are very well informed and knowledgeable, you are still not an irrigation expert or a hydrolics engineer. Unfortunately, however, neither are some of the people in the irrigation business who sell and design systems. Neither is the club official who often makes the decision as to what system shall be purchased. In too many cases the only consideration of a plan or proposal is the initial cost. How many clubs do we know that have installed two or more irrigation systems in the past few years. We don't know the actual costs, but we do know that if one good system - Well Planned, Properly Designed by a qualified engineer and properly installed by a reputable irrigation contractor has been correctly installed the first time, the cost would have been considerably less than two poorly designed and installed systems, to say nothing of the aggravation and inconvenience to the golfing membership.

Evaluate the true costs of materials and professional services. Work with the U.S. Dept. of Agriculture and the Soil Conservation Service, they offer a service to the superintendent and golf course. They have the factual information and knowledge pertaining to soils, drainage, watersheds and sources that must be studied prior to installing a system.

Remember that an automatic irrigation system is a Tool, not a cure all or a luxury. You must perform all the cultural practices required and necessary to maintain fine turf, Only More So, after the installation of a system. Don't sell the system with the idea of saving labor or money. What you save in one area is only more efficiently used in another.

Aggravation - you'll get your share. The same people (some of the membership) who took two years to talk about a system, who thought water just runs out of the faucet will suddenly become irrigation experts and after deciding on a certain system and signing a contract will now expect the system to be installed and in operation as soon as possible without inconveniencing a single golfer. This is the time to keep your cool. Don't be rushed into taking short cuts. A water system is a long term investment.

Work with experts - Hire a qualified experienced and competent engineer to design the system. Require accurate and detailed plans. It's surprising how few clubs have up to date accurate detailed drawings of their golf course.

If bids are required, make sure they are on the same type of system and the smallest details are spelled out in writing. Have a contract and require a performance Bond. Determine before the contract is signed and the actual work starts, what your responsibilities are. Do you represent the owner. Keep accurate records on a daily basis.

Select a reliable contractor. One with experience and equipment capable of doing your installation.

Purchase the best equipment available, be it pipe, pipe fittings, wire, sprinklers and controls. Know your contractor and supplier, his reputation, his past performance. Know what is behind him, be sure it is assets and not the sheriff.

Experience - You'll know a lot more about irrigation after installing a system. You'll change your accepted ways and methods of irrigation. It will take you a year or two to program your automatic system to the best advantage of the turf and soil conditions. You'll wonder how you ever progressed as far as you did without an automatic system.

If you have poor soil conditions and drainage problems before installation of a system, these same problems will be increased.

In conclusion, briefly a few facts of interest. This system comprises: 114 Electric valves which operate 65 gear driven sprinklers that are located on greens, usually 4 per green plus the turf nurseries, 129 Nelson #2 pop up sprinkler heads located on the tees, plus 312 Thompson heads located throughout the fairways that are spaced at 60 ft. triangle intervals. In most instances 4 or 5 sprinkler heads are controlled by one electric valve. The valves are controlled from 13 electric clocks divided into 6 zones. (These clocks are located in the sttel enclosed houses at #10 tee, #12 tee, #14 tee, #15 tee, #3 tee, and #7 tee.) Eventually one master control can be installed to control all six of the existing controllers. This will eliminate the constant need to shut off and re-time clocks at those 6 stations.

There has been installed over 10 miles of pipe from 1 1/4" up to 8" in diameter. The main lines are transite 3, 4, 6 and 8". The pipe with constant pressure on the line is galvanized and the remainder is PVC plastic and pressure is on the line only when the sprinklers are in operation.

A live snap valve is located at each tee and green for manual operation and so that proportioners may be used. There is over 22 miles of wire installed.

Advantages of an automatic system are:

1. Labor - Less labor is needed to operate the system. However, the labor hours saved on this operation are required for maintenance.

2. Quality Control - You can get more water when you want it, where you want it and in the quantity required.

3. Turf grass management benefits:
    1. More efficient use of water
    2. Precise control
    3. Water conservation
    4. Minimum loss of turf grass
    5. Easy to remove dew and frost
    6. Less wear and tear on turf grass
    7. Control over fertilizers and other chemicals

4. The superintendent is in complete control of the irrigation system and is not forced to depend upon others.

5. People benefits:
   1. Golfer satisfaction
   2. Less night duty
   3. Smaller more efficient crew
   4. Less vandalism
   5. More favorable comments on condition of course and better playing conditions
   6. Peace of mind for the superintendent.

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## HOW THE SOIL CONSERVATION SERVICE CAN HELP IN GOLF COURSE MANAGEMENT

Christopher G. Moustakis
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Soil Conservation Service
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I appreciate the opportunity to take part in the 1971 Turf Conference and to share with you some information about the nature of the Soil Conservation Service and some of its functions, how it may be a help to you, and how to secure assistance.

It is necessary to understand the nature of this agency ( the Soil Conservation Service) in order to understand how it can assist you in your operations.

The Soil Conservation Service is the technical arm of action of the U.S. Department of Agriculture charged with the basic responsibility of the conservation of soil, water, and related natural resources. Among a number of programs in which SCS plays a vital role, one includes providing technical assistance to individuals, groups, and local units of government in making plans for sound land use, making land use adjustments, and providing help in planning and implementing the treatments needed for the conservation, improvement and maintenance of natural resources. A second program administered by the Service consists of preparing Soil Surveys based on the physical characteristics of soils. The programs and functions I enumerated probably have the most direct bearing on your operations, although there are other programs that can affect you, at least indirectly.

Since the Service is the technical arm of USDA, and since land use and treatment problems are frequently complex requiring a wide range of knowledge for their solution, the Service has brought together a variety of disciplines needed to solve soil, water, and related natural resources problems. Its staff includes soil scientists; economists; hydrologists; geologists; agricultural, irrigation and drainage engineers; biology, agronomy, plant materials, and woodland specialists, the skilled professionals developed by SCS --- the resource conservationists and soil conservationists; and there are others.

I believe it is legitimate to ask at this point two basic questions that "strike home", e.g., What specific help is available to golf course operators or those contemplating expansion of golf courses or those contemplating development of totally new courses? How do I get assistance and where?

Let us attempt to answer the first question first, "What specific help is available?"

1. The Service can prepare a soil and land-capability map based on a detailed acre-by-acre survey of the land unit and an assessment of its physical characteristics.

2. The Service can help the operator prepare a conservation plan. The individual and the SCS representative together consider the treatment of the land within its needs and base decisions on mapped soils information and interpretations for specific purposes.

3. The Service can help apply the more difficult treatments or conservation practices in accordance with the existing policies of Conservation Districts (an explanation of Conservation Districts will be provided in a few moments) and in accordance with the availability of SCS man-power resources. To a varying degree guidance or surveying, designing or layout assistance, or hydrologic data has been provided on such practices as irrigation systems, drainage, ponds, diversions, waterways, etc., from the engineering standpoint and plant materials information from the plant sciences standpoint.

4. The SCS representative can give guidance for maintaining the treatment measures and conservation practices after they have been applied.

   (SCS assistance enumerated above was illustrated by slides.)

Now, let us discuss the second question, "How do I get assistance and where?"

A few moments ago I commented that SCS technical help to individuals is available in accordance with existing policies of Conservation Districts.

Actually Conservation Districts are the chief means whereby individuals can secure technical help from the SCS. The Conservation Districts are political subdivisions of the State governed by five locally elected officials and together they are called the Board of Supervisors. The Board provides the liaison between you, the operator or landowner and the SCS. Most of the on-the-land technical help that you may receive will be channeled through Conservation Districts. The amounts and kind of help and priorities for providing it, are subject to their operating policies and procedures.

As a consequence, landowners or operators can get conservation information and assistance tailored to their needs by making an application to the local Conservation District Office. If you wish, a request can be made at one of the Soil Conservation Service offices and the SCS representative will see to it that it reaches the Board of Supervisors. Some District Boards require that you appear personally before the Board and present your own case for technical help. If the latter is the District policy, then this is the way help must be requested.

Every county in the Commonwealth of Massachusetts except Suffolk has a Conservation District, but this is not the case with Soil Conservation Service offices in Massachusetts. Most SCS offices provide services to about three Districts, and many Districts consider the SCS office their headquarters also.

If a request for assistance were channeled through SCS, it would be brought to the attention of District Boards without fail. It is suggested, therefore, that as one alternative, applications for assistance could be telephoned or mailed to SCS offices that are listed under "U.S.Government" in your telephone directories no matter what State you live in.

The application may begin with an oral request, but eventually a somewhat formal application and agreement for assistance may be executed.

This essentially is the what, how, and where of technical assistance availability to the golf course operator from the Soil Conservation Service and the Conservation Districts in Massachusetts, and is essentially the same in other States.

This partnership of SCS, the Districts and the landowners or operators of recreation land, agricultural land, woodland, etc., is in a unique position to provide a habitable and healthful environment through the conservation of natural resources. The advantages and benefits accrue to country and city alike whether directly or indirectly.

The Soil Conservation Service operates on this premise. It attempts to help you not only to protect and preserve, but to restore and renew resources. Its total concern is the relation between man and his environment and your contribution (recreation) is a vital one.

Perhaps there are some questions. I'll be glad to try to answer them at this time.

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## OUR SHRINKING ENVIRONMENT

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It is very fitting that a conference devoted to various aspects of beautifying the environment, of literally carpeting it with green, should occupy itself with the threats that endanger it. We live at a moment of fascinating paradox. Just when man has leaped beyond the confines of his own planet and has seemingly expanded his horizons by the conquest of space, just at this moment is he confronted by the awesome shrinkage of the living area in the planet that his spacecraft has just left behind. The truth that is painfully emergin is how unexpectedly limited this living area is, a slender envelope some 10 miles deep covering the 200 million square miles of the earth's surface, an envelope whose volume is perpetually shrinking as it is consumed more and more by the debris hurled into it by an ever growing population.

The world's population now numbers 3.5 billion persons and is growing at a rate which will double that number within the next thirty years. At least one-third, if not one-half of this population, is presently undernourished. Apart from the ejection into the environment of the by-products of this mass of humanity there will soon arise the simple physical question whether enough food can ever be produced to feed the coming generations on a tiny sphere only 8000 miles in diameter. Nor is this a problem existing in corners of the world remote from us. The problems of the shrinking environment, the environment of land, air and water have reached, and even surpassed, the crisis stage in many areas of the United States.

Land

Already the major cities of the United States reflect the population density dilemma. In New York and most other major cities, the concentration already goes far beyond "the maximum viable density" of 4000 residents per square miles. The consequences, which include near fiscal bankruptcy, breakdown of municipal services, crushing welfare burdens, and urban violence and crime, grow in direct proportion to population increase. Yet, in the next three decades our space will further shrink to the extent that the United States will have to accommodate 100 million new bodies. Picture it: ten additional New Yorks or 50 Philadelphias! The first order of priority must therefore be a national policy on the use of land. Cities still take up only about 8% of the land area. About half the total acreage, though technically classified as farm land, is in fact only fractionally used to produce farm products. Thus, vast potentially habitable spaces remain unused. Of these regions one-third belongs to the Federal Government sparsely settled, erratically maintained and haphazardly used for such marginal purposes as grazing. About 2% of the national land area, about 45 million acres, has been preserved as wilderness; of this, 29 million acres are conserved in national parks. This is the entirety of the empty outline of national land policy. Our highest priority must, therefore, be the immediate development of a national policy for the rational use of the land.

Perhaps one should reduce the scale of concept to fully appreciate the extent of land mass shrinkage. The most visible signal of this is the dilemma facing municipalities from coast to coast which are running out of disposal space for the solid wastes they are generating. As is well known, each of us in this country produces about 7 pounds of trash each day. This adds up to about 530,000 tons to be disposed of daily if we consider that only about 5.32 pounds of this is collected. The national average expenditure on waste disposal is now $6.81 per person per year. About 73% of refuse now goes into open dumps; 15% is incinerated; 8% goes into sanitary land fills; 1% into compost and only about 3% is salvaged. Recently, Federal authorities have reported that 10,000 of the 12,000 dump sites and 225 of 300 municipal incinerators were very inadequate by health and pollution standards. Seven million cars are scrapped each year, representing between 7 and 15 million tons of waste and filling significant portions of the landscape with the bulk, as well as ugliness of their carcasses. Ecologists justifiably ask not only how long we can casually continue to fill our overloaded space with junk, but how much longer we can go on extracting minerals from the earth and mindlessly discarding them as though the supply was inexhaustible. Certainly there are millions of square miles where refuse could be burried innocuously, but its disposal can only be managed as part of an overall program in the rational use of the land.

Water

If the land is gradually shrinking and in places disappearing under the weight of pollution debris, how much more so is this true of our water resources? It is now simply, flatly true that every major river system is polluted; polluted with the 2 million gallons of sewage and other fluid wastes that pour into the national waterways every second of the day and night. This pollution comes from three major sources; community sewage, industry and agriculture. Though 5 billion dollars have been spent in the past fifteen years on federally aided construction of local sewage treatment plants, nonetheless the sewage of more than half the nation's population is still inadequately treated. The result has been not only a shrinkage in water as a reservoir for waste but the shrinkage in the amount of water available for elementary drinking purposes. In many parts of the country communities face serious shortages in potable water. The water of the Ohio River is used at least four times before it gets to the Mississippi where again it is used and reused tens of times. A further ominous fact is that even where sewage treatment plants are available these are not designed to free water from the chemicals being hurled into them. Industry is contributing pesticides, herbicides, fungicides, defoliants, detergent-residues and dyes, radioactive materials, heavy metals, dissolved gases, phenols, alkalis and acids, ammonia, sulfides, sulphates, tars and urea. Agriculture is contributing fertilizers and salt accumulated from irrigation. These substances relentlessly find their ways into lakes and rivers and ultimately into the sea. They disrupt established plant - fish - bird - animal food chains even eliminating certain species. Certain of these substances such as detergent phosphates prematurely enrich and age waterways where they initiate the virtually interminable process of eutrophication, a process which has filled our waterways with green algal slime, black decomposing layers of organic matter and has snuffed out fish and other species. In 1968, then Secretary of the Interior Stewart L. Udall estimated that the needed outlay over a 5-year period for water pollution abatement at around 27 billion dollars; 16 billion in operating and construction expenditures for municipal facilities and 11 billion dollars for industry. So far little of this has actually been appropriated and expended.

Air

More critical even than the shrinking resources of land and water is the depleted quality of our air. In fact, the most critical result of the spiraling populations and their concentrations in cities has been the growth of combustion processes in power plants, in industry, in automobiles and incinerators. Approximately 200 million tons of contaminants are being ejected into the atmosphere each year. These range from the black soot visible to all from industrial smoke stacks, sulfur dioxide from domestic heating and power plants, the nitrogen oxides from automobile exhausts and the potentially lethal carbon monoxide and lead compounds from automobiles which contribute over 50% of the air pollutants. In fact, the air in some instances has shrunk to the point where the infusion of gaseous refuse has oversaturated the available atmosphere. In Donora, Pa. in 1948, a "smog episode" killed twenty people. In New York City and Los Angeles, where inversions develop frequently, emphysema and respiratory disease affect inhabitants as would the smoking of 38 cigarettes per day. Nor is air pollution only a matter of local concern. Cumulative pollution of the skies is approaching a point where it could upset the whole world's heat balance and jeopardize human life.

## Noise and Aesthetic Pollution

But the environment is shrinking in more than its land, water and air resources. The explosive noise in which we live is in some instances actually limiting auditory acuity. For many of the young exposed to the relentless bombardment of rock and role, perception of certain musical overtones has already been eroded. They are in effect cut off from a whole range of potential, if subtle, auditory experience. The rest of us in the United States pay the 4 billion dollar a year price which has been estimated that noise costs in absenteeism, in efficiency and compensation payments. Yet, noise is an environmental hazard for which only the scantiest regulatory mechanisms exist. Automobiles, jet aircraft and industrial noise continue virtually unrestricted, and cry out for appropriate regulation.

Finally, and most pervasive, is the universal encroachment of aesthetic pollution to which this audience should be most sensitive. Everywhere billboards, junkyards, landscapes, blighted with exploitative and meanly constructed housing have dulled our senses and wrenched us out of any context of harmonious integration with nature. We no longer even see the squalor around us, so much has our aesthetic sense been dulled. Certainly one cannot put a dollars and cents value on beauty, but if one examines the issue at its most elemental then there is no question that a lush green sward is worth more to the spirit than bare, beaten, ruined earth.

## Resolving the Problem

It is of course easier to pose the problems of the environment than to propose solutions. Nonetheless, at least the outlines of answers have become clear, answers that do not insist on more and more restrictive legislation, but in a greater awareness of what gives life its meaningful qualities. In our own time and place these can be enumerated fairly simply:

1) Restricted population growth
2) A rational plan for land use
3) A change in public values and attitudes towards consumption as the aim of life: the development of a more ethical and humane view of the exploitation of resources and the maldistribution: a redress in the imbalance which sees 6% of the world's population in the United States consume 36% of its total raw materials output.

4) The testing of all new technology for its potential impact on society.

5) The achievement of a balance between production and its social costs. These, of course, are merely the outlines of solutions, but these are the issues which we must now consider and debate if we are to expand rather than shrink our horizons into early and total oblivion.

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## PESTICIDES' DILEMMA - EMOTION VS. SCIENCE

Allen H. Morgan
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It is a pleasure to be here with you. I feel a certain kinship with men who are blamed every time a golf ball makes a bum bounce. Particularly since we both realize that those who complain the loudest are the very ones who have chopped up a few greens with their golf clubs to the point that the ground appears plowed.

In a way, I'm up against the same situation. That's one of the reasons that I'm glad to be here and share this feeling with men who probably understand pesticide problems more thoroughly than the average citizen. I often find myself in the same position as you - being blamed because someone failed to fulfill fond hopes. For instance, I'm certain that there are people who are convinced that what they call "all that furor about pesticides" exist solely because persons like me have said that certain pesticides are damaging the very environment that makes your life and my life possible. Let me assure you that nothing that I have said has made a useful chemical turn sour. The truth is that some chemicals we use always have been "sour" in the area that really counts - the area that affects the biological basis of life on earth.

Like you, I also am blamed for what I have never done. For instance, neither I nor the Massachusetts Audubon Society ever have taken a position against all pesticides. Let me make that even plainer: the argument we have is against so-called "hard" pesticides - the pesticides that persist for years in the environment, killing organisms both above and below the original target organisms as it passes through life chains.

Being human, all of us are apologists. We make accomodations with life. Sometimes we have to. For instance, I would not be standing here talking to you if I had not driven here in an automobile. Neither would most of you be present without that familiar form of transportation. Yet I know, and I'm certain that most of you know, that the automobile has become the most serious and suspect polluter of air. So we make allowances -particularly we make allowances when Detroit won't let us do anything else! But we also make allowances in matters that in the end are nothing more than conveniences. I have these foibles, too. But since I'm standing up and you're sitting down, it is my privilege to discuss your foibles and gloss over my own. You'll get your chance to stand up after I have completed these remarks and become fair game for questioners.

I fear that this human feeling for "allowances" may be our own greatest enemy - the feeling that what we do is in the end too insignificant to really be harmful. Unfortunately, we all have that feeling and thus we all continue doing what we always have done - and the environment keeps tobogganning toward the bottom of the slope, because it is this little bit of damage that each of us do that adds up to the total that keeps things going to hell.

Let us for a moment consider mankind's plight at this moment - as at least some of the thinkers of our time see it. Dr. Aurelio Peccei of the famed Club of Rome's Project on the Predicament of Mankind recently made this comment:

"In order to grow, the human species has overexploited and polluted its environment and outbred and decimated all other forms of life. But its terrestrial domain is finite. And disproportionate and disorderly human presence in this small world is utterly inconsistent with human fulfillment and happiness. Gone forever are the inexhaustible availability of pure air and water, the unclaimed expanses, the wilderness and the "new frontiers." Delicate balances in the biosphere have been subverted. Man has thus created a world so new and so intrinsically different that the reasoning and principles that guided him in the past are impotent to cope with it."

You will recognize Dr. Peccei as an elitist from the remarks he made. But you will also recognize that some of the unpleasant things that he says are true - because you either have seen or felt the impact from them.

On a more mundane level, where most of us live, we hear the same comments in a slightly different context. A freind recently said, "How in hell do we keep alive - eating mercury in our food, gobbling pesticides with our vegetable, breathing air that's loaded with sulphur and lead, drinking water that we know was sewage quite recently - how do we do it?"

Well, the truth seems to be that men are pretty tough brutes. Men have taken a lot and can take a lot. The problem is that the rest of the world is not that tough! And there is where we get into trouble. The prophet who said that man does not live by bread alone had no vision of what life would be like today. Otherwise, he might have shortened the warning to a simple statement that man does not live alone. Indeed, we cannot live alone for every bite we eat - not only bread - comes from the complex system that produces organic food.

By now you're wondering what all this has to do with pesticides - or to be more explicit - hard pesticides. It's rather simple - hard pesticides have been knocking links out of these life chains that support us. Despite the alarm that some persons have spread about the likelihood that man eventually would be wiped out by pesticides, I have always had reservations. But I can see from what has been happening to the environment that man stands some chance of dying indirectly from hard pesticides - that is, dying alone because so many life links have been damaged by hard pesticides that the support system making his life possible has collapsed.

If we were to discuss the whole array of hard pesticides this dissertation might last for days. So let us center attention on a few.

Take mercury, for instance. Mercury is a pesticide when it is used for turf diseases. The salesmen who sell mercury compounds would have us believe that their wares are harmless. But human experience with mercury makes any such assertion sound hollow. Mercury is one of those basic elements that man's system has never learned to handle. For instance, the Mad Hatter of Alice in Wonderland was a familiar character to persons who lived in the century before ours. Hatters were odd persons, given to mental wanderings and peculiar ideas. They were, in fact, slightly mad. And they were mad because mercury was a component of the chemical mixture they used in fashioning hats. They ingested the mercury through their hands as they worked. And, as mercury tends to do, it went to their central nervous system, addling their brains. Believe me, mercury should never be used in the environment for any purpose except the most basic and essential purposes - something so basic and curcial to the survival of man that an example does not come to mind!

Now let us examine other pesticides - hard pesticides - from the aspect of science versus emotionalism. Perhaps in our examination we can determine WHAT is emotion in regard to hard pesticides and WHO became emotional about them.

Let us, for instance, consider a recent piece which the DDT Task Force, representing DDT manufacturers, succeeded in getting published in BARRON'S, the so-called "National Business and Financial Weekly", a year ago. It began:

"Myths, as the saying goes, die hard; what's more, if they happen to project a left-wing or anti-business bias, they somehow neither die nor fade away. For half-a-century, propagandists and scholars of radical persuasion have sought to establish - before the bar of public opinion, at any rate - the supposed innocence of two convicted killers named Sacco and Vanzetti....."

That, if you believe it, is the introduction to a discussion of the "values" of DDT. I won't bore you with further recitation from the article, but it goes on to clearly identify anyone who questions DDT as a Communist or at least a Communist sympathizer. There is a strong possibility that some emotionalism colored the report.

Or, how about this statement by Dr. Wayland J. Hayes, former chief of toxicology of the U.S. Public Health Service who joined the DDT bandwagon with the rest of us but was too near retirement age to get off it with so many other scientists who examined the evidence? Dr. Hayes says, "You can eat coho salmon containing 19 parts per million of DDT morning, noon and night for at least 19 years without any harmful effects."

The coupling of 19 parts of DDT and 19 years is poetic. But where did the good doctor find the person who had lived 19 years on this monotonous diet and provided the conclusive scientific evidence to support his "scientific statement"? Indeed, if all coho salmon contained 19 parts of DDT in thier fat, the experiment would have petered out long before 19 years, since investigations indicate that most fish tested have been made sterile by DDT at far fewer parts per million than nineteen. There seems to be some emotionalism in Dr. Hayes' statement, perhaps a result of his wanting DDT to succeed.

Indeed, the first burst of emotionalism in regard to DDT consisted of an emotionalism of wanting the chemical to be a miracle, the likes of which man had never before encountered.

DDT was rediscovered in 1939 by Dr. Paul Herman Muller in a dye-manufacturing firm's laboratory in Basel, Switzerland. DDT had been synthesized in 1874 by a German student named Othmar Zeidler. Zeidler failed to find any use for the chemical. Muller, however, took a sample of the material home and discovered that it killed flies. He then made the amazing discovery that it killed any insect that it came in contact with - and kept on killing for weeks or months. He also determined - in so far as a short-term test could prove - that it was harmless to humans. At least it never made them ill.

Muller's discovery came at a point in history when an all-purpose insecticide was a badly needed military necessity. The pestilence that accompanies all wars soon was to emerge in World War II. British and American scientists were quick to test Muller's miracle chemical, for they were wary about the claims of its effectiveness which seemed exaggerated. But initial applications proved these claims true. DDT did indeed kill insects - all sorts of insects.

Through World War II the total production of DDT was reserved for military use. It accompanied American troops into the jungles of South-east Asis where it was sprayed in tents, barracks, mess halls - all with astonishing success. It halted a typhus outbreak in Naples where people were dying by scores each day.

By the war's end, DDT was the most publicized synthetic chemical in the world. One newspaper clipping service accumulated 21,000 items about it in 1944 and 1945. Almost all were glowing accounts, many predicting that man at last had triumphed over insects.

There were, however, even then a few who questioned DDT's unmixed blessings. These few were ecologists. By ecologists, I mean scientists who had made a career of studying the interactions among living organisms in relation to their environment. As we all know, the word "ecology" has become somewhat diluted in the years since World War II.

Basically, ecologists questioned whether any chemical that killed almost all insects, regardless of whether they were pest species or helpful to man, could have anything except bad repercussions on the environment. After all, only a few insects cause man to scratch himself. Many of the others are either neutral or helpful in direct relationship to man.

In 1945 the pressures for DDT's prompt release were, of course, immense. There were great immediate profits to be made from DDT's manufacture, distribution, and agricultural use; and there was an eager market for house, yard, and other domestic uses as well. Worldwide, there was a desperate need for all the food and fiber that could be produced, and DDT could do no more to increase production than any other insecticide. There was an even more desperate need to bring malaria and other insect-carried diseases under control in many countries (Greece for one, India for another), and again DDT was the only available product up to the job.

But early in the year, a crack began developing in this picture of excellence. In the March 12, 1946, issue of SCIENTIST, the journal of the American Association for the Advancement of Science, an article appeared. Oddly, it originated from the U.S. Department of Agriculture - which through the years has been a staunch supporter of DDT. The article said that USDA entomologists in an experiment using DDT had produced a strain of house flies much more resistent to DDT than the wild stock of house flies. It warned: "In view of the increasing use of DDT for housefly and mosquito control, it seems possible that, in time, a similar increase in resistance may occur under natural conditions."

It was a prophetic announcement. By the early 1950s, resistant strains began appearing in scores of insect populations.

Well, I have at least one thing in common with everyone in this room: I do not care to be bitten by mosquitoes. Neither do I care to see beneficial miracles vanish. So I understand how the public receives a disappointing discovery. Its first reaction usually consists of refusing to believe that Valhalla has crumbled.

At the same time that the efficiency of DDT was coming under question, some new disquieting factors crept into public discussion. For a long time, it had been well known that a spray program using large amounts of DDT would kill birds along with insects. There were dozens of documented cases which had occurred before sprayers learned that smaller doses of the chemical were as effective as massive doses.

But the new suspicion that emerged was this: DDT apparently had sub-lethal effects upon some birds, effects that did not kill them outright but somehow interfered with their successful breeding. The bald eagle, our national symbol, definitely was declining. While no one seemed to really know how DDT might effect eagles, there was considerable circumstantial evidence implicating DDT as a major factor in the decline.

Later investigations produced evidence that chlorinated hydrocarbons interfere with the formation of eggshells among many birds of prey and among many waterbirds which live on fish.

I have mentioned the public's dislike of abandoning a miracle. But the public's reaction was mild compared to the reaction of those chemical firms that manufacture hard pesticides. Their reaction was to attempt to discredit - not by scientific evaluation but by innuendo - every scrap of scientific evidence against DDT and hard pesticides as these discoveries unfolded.

Even now when the evidence against DDT has become overwhelming and the case against the whole array of hard pesticides has become convincing, the front offices and sales forces insist that their myth is true and that all the evidence to the contrary has been inspired by some dire plot.

One of the favorite presentations of the DDT Task Force consists of pointing out that DDT cannot be found in water or in soil and therefore does not exist in the environment.

The irony is that half of that statement is true - and that it points up exactly what is wrong with DDT. DDT does not appear in impressive amounts in soil or water - and for good reason. DDT is almost insoluble in water. What happens to DDT in the environment is that almost all living organisms pick it up and store it in their body fat. DDT is soluble in fat - not water or soil. To find DDT, one need only analyse the fatty tissue of a fish or other organism living in water, or an animal living on acres that have been sprayed. That is where DDT appears - in living organisms where it is capable of doing damage.

DDT and other chlorinated hydrocarbons are new substances created by man in the laboratory. Nothing in nature has had prior experience with these substances, therefore the evolutionary pressures that would cause an animal, including man, to adapt to them has been lacking.

In this respect, insects with their short life spans and many generations - often many generations within one growing season - have an advantage over longer-lived animals. Among the attributes that enable insects to adapt to pesticides, this proliferation of generations in a brief time-span ranks among the more important. The insects that show some tolerance toward a chemical live to produce the next generation - and endow that new generation with this important tolerance.

Humans, fortunately - or perhaps unfortunately, depending upon how the game goes - have a long time-span between generations. We are capable of adaption over eons but incapable of quick physical response to pressures through the route of a rapid succession of generations which build tolerance.

Conservationists have borne the brunt of the pesticide industry's accustations of "emotionalism" in relation to publicizing what scientists have learned about pesticides.

I submit that dead birds, dead seals, dead shellfish, dead crabs, - well, a whole list of victims of hard pesticides - are not "emotionalism" but hard facts, well documented.

I can assure you - since the scientific record is replete with evidence - that the presence of DDT in the breast milk of human mothers is a fact. It is not emotionalism, regardless of what the pesticide industry may say of it. If human mothers accept this fact with emotion, who can blame them? But their emotion does not render the fact into nothing more than emotionalism - and for your own sake, don't let anyone kid you into believing that it does.

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## EFFECTS OF TURF GRASSES AND TREES IN NEUTRALIZING WASTE WATER

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Over 23 billion gallons of sewage effluent are discharged daily by municipal treatment plants in the United States. These waste waters, although acceptable by public health requirements, are usually enriched with appreciable quantities of dissolved minerals and synthetic detergent residues. Discharge of such effluents into natural water courses causes eutrophication and stimulates prolific growth of aquatic vegetation. Respiration by these plants and decomposition utilizes dissolved oxygen in the water often with detrimental effects on fish life and other aquatic fauna.

Increasing volumes of municipal waste water are usually correlated with increasing demands on the local water supply which in times of drought can cause serious water shortages. Hence, it is somewhat paradoxical that communities while experiencing water shortages will at the same time discharge millions of gallons of waste water into local streams for rapid removal from the area.

An obvious alternate method to disposal of sewage effluent in surface waters is to dispose of such effluents on the land so as to utilize the entire biosystem-soil and vegetation- as a "iving filter" to renovate the effluent for groundwater recharge. Under controlled application rates to maintain aerobic conditions within the soil, the mineral nutrients and detergent residual might be removed and degraded by micro-organisms in the surface soil horizons, chemical precipitation, ion exchange, biological transformation, and biological absorption through the root systems of the vegetative cover. The utilization of the higher plants as an integral part of the system to complement the microbiological and physiochemical systems in the soil is an essential component of the living filter concept and provides maximum renovation capacity and durability to the system.

In 1962, an interdisciplinary team consisting of agricultural and civil engineers, agronomists, foresters, geologists, microbiologists, biochemists, and zoologists was assembled to investigate the feasibility of land disposal for large volumes of waste water and the living filter concept.

An irrigation system was designed to pump chlorinated sewage effluent from the University's sewage treatment plant to several disposal sites including forested areas, cropped areas, and canary reed grass.

Forested areas included a red pine plantation and a natural mixed oak stand. The red pine plantation was established on an abandoned agricultural field in 1939. Trees were planted at a spacing of 8 by 8 feet and at the start of the study had an average diameter of 6.8 inches and an average height of 35 feet. The mixed oak stands were primarily mixtures of black oak, red oak, and scarlet oak with an average diameter of 14 inches and an average height of 70 feet. An abandoned open old field area with a herbaceous ground cover consisting primarily of poverty grass, goldenrod, and dewberry and a scattered planting of white spruce saplings (3 to 8 feet in height) was also irrigated. Detailed site descriptions have been previously reported by Parizek, et al, 1967; Sopper and Sagmuller, 1966.

Cropped disposal areas consisted of rotations including corn, wheat, red clover, oats, and alfalfa.

In addition, a one-half acre plot of turf grass (Merion bluegrass) was irrigated with sewage effluent as needed but was not included as part of the study. The turf produced was used on campus areas disturbed by construction.

The soil is a Hublersburg-Hagerstown complex with a surface texture ranging from silt loam to silty clay loam with slopes ranging from 3 to 20 per cent.

The rate of application was 0.25 inch per hour with various plots receiving weekly amounts of 1, 2, or 4 inches during the period from April to November (28 to 33 weeks). Applications were initiated in June, 1963 and have continued during the past 8 years.

An extensive monitoring system was installed to follow changes in soil moisture and to obtain samples of percolating water at various depths to determine the extent of renovation. These have been previously described by Sopper, 1968; Pennycracker, Sopper and Kardos, 1967; and Parizek et. al., 1967.

## Chemical Composition of Municipal Sewage Effluent

The University treatment plant employs both primary and secondary treatment. The chemical composition of the sewage effluent for 1969 is shown in Table 1. Weekly variations in concentration of constituents are shown by the range between maximum and minimum values. Total amounts of each constituent applied at the 2-inch per week rate are also shown in Table 1. The fertilizer value of the effluent is readily evident in that the 2-inch application provided commercial fertilizer constituents equivalent to approximately 271 pounds of nitrogen, 151 pounds of phosphate ($P_2O_5$), and 210 pounds of potash ($K_2O$). This would be about equal to applying 2000 pounds of a 13-8-10 fertilizer.

Table 1. Chemical Composition of Sewage Effluent Applied on the Experimental Plots during the period of April 15, 1969 to October 29, 1969.

| Constituent | Range Minimum | Range Maximum | Average | Total Amount Applied 2/ |
|---|---|---|---|---|
| | mg/l | mg/l | mg/l | lb/acre |
| pH | 7.1 | 8.3 | 7.8 | - |
| MBAS 1/ | 0.1 | 1.2 | 0.4 | 5 |
| Nitrate-N | 0.0 | 12.5 | 5.4 | 70 |
| Organic-N 3/ | 0.0 | 39.0 | 15.5 | 201 |
| Phosphorus | 0.8 | 17.1 | 5.1 | 66 |
| Potassium | 6.7 | 20.8 | 13.5 | 175 |
| Calcium | 18.2 | 34.0 | 28.0 | 363 |
| Magnesium | 9.4 | 17.7 | 14.3 | 185 |
| Sodium | 22.5 | 59.5 | 38.1 | 494 |
| Chloride | 8.7 | 68.7 | 43.2 | 560 |
| Boron | 0.2 | 0.4 | 0.3 | 4 |
| Manganese | 0.0 | 0.2 | 0.1 | 1.3 |

1/ Methylene blue active substance (detergent residue).

2/ Amount applied on plots which received 2 inches of effluent per week.

3/ Includes ammoniacal nitrogen.

## Results and Discussion

### Renovation of the Waste Water

The average concentrations of chemical constituents in the percolate samples for various soil depths on the irrigated plots in the various vegetation types are shown in Table 2. The degree of renovation expressed as the percentage reduction in the average concentration of each constituent in the effluent is shown in Table 3. The average composition of water samples obtained at various depths indicated that after 7 years of operation, during which approximately 34 feet of waste water had been applied, the renovation capacity of the biosystems was still satisfactory.

The first stages of renovation in the forested areas occurs during passage of the effluent through the forest floor. Concentrations of MBAS (detergent residual) were reduced by approximately 55 per cent. MBAS analyses were not made where small volumes of percolate were obtained because previous results indicated a consistently high degree of renovation. For instance, results in 1968 indicated that percolation through the upper 4 feet of soil increased renovation to 78-81 percent. These data indicate that the relatively thin and highly permeable forest floor layer has a high absorptive capacity and biological degradation capacity for the detergent residue. It should also be noted that the methylene blue process used to determine the MBAS concentration indicates only the apparent concentration since both organic and inorganic anions commonly found in soils give positive erros in the analysis. This is evident in the results of the analysis of percolate collected from the control plots, which indicated an average apparent MBAS concentration ranging from 0.12 to 0.17 mg/l. Since the concentrations of MBAs in percolating water leaving the forest floor are only in the magnitude of approximately 0.17 mg/l, the percent renovation may actually be considerably higher than that indicated in Table 3.

Results in Table 2 also indicate that the "living filter" was highly efficient in removing phosphorus, one of the principal nutrients responsible for eutrophication. Phosphorus concentrations at the 2-foot soil depth were reduced by 97 to 99 per cent. Phosphorus concentrations of percolating water passing the 4-foot soil depth ranged from 0.04 to 0.10 mg/l. Water samples taken from deep groundwater wells indicated that phosphorus concentrations never exceeded 0.04 mg/l. In comparison, phosphorus concentrations of percolating water at the 4-foot depth on the control plots ranged from 0.05 to 0.07 mg/l.

Nitrogen, like phosphorus, is one of the elements responsible for eutrophication and the profuse growth of aquatic plants in streams. The concentration of nitrate-nitrogen which was reduced by 68 to 82 per cent at the 12-inch soil depth during the first year (1963) gradually diminished during the 7 years until renovation at the 4-foot soil depth only ranged from 0 to 57 per cent (Table 3). At this depth nitrate-nitrogen concentrations ranged from 2.3 to 24.2 mg/l (Table 2) and except for the red pine, 2-inch plot were below the allowable maximum drinking water limit of 10 mg/l. In comparison, concentrations of nitrate-nitrogen in percolating water at the 4-foot depth on the control plots ranged from 0.1 to 0.5 mg/l. Nitrate-nitrogen concentration of the groundwater as measured at wells on the site remained below 3 mg/l.

Table 2. Average concentration of constituents in the percolate water samples collected from tension lysimeters in the experimental plots during the irrigation period April 15 to October 29, 1969.

| Plot and soil depth | Weekly application | pH | MBAS | $NO_3$-N | Org-N | Cl | P | Na | K | Ca | Mg | Mn | B |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Concentration in mg/liter | | | | | | | | | | | |
| Effluent Quality | | 7.8 | 0.38 | 5.4 | 15.5 | 43.2 | 4.606 | 38.1 | 13.5 | 28.0 | 14.3 | 0.08 | 0.28 |
| Hardwood | 1 | | | | | | | | | | | | |
| F.F. 2/ | | 7.1 | 0.13 | 11.6 | 7.2 | 29.0 | 3.913 | 21.5 | 14.3 | 24.3 | 9.5 | 0.19 | 0.21 |
| 6 inches | | 7.7 | 1/ | 6.8 | 2.0 | 36.3 | 0.212 | 37.4 | 5.7 | 30.6 | 24.8 | 0.03 | 0.31 |
| 24 inches | | 7.6 | 1/ | 4.9 | 2.0 | 89.2 | 0.065 | 59.5 | 8.2 | 27.9 | 21.7 | 0.05 | 0.37 |
| 48 inches | | 7.9 | 0.09 | 7.2 | 1.9 | 36.0 | 0.047 | 51.1 | 5.8 | 33.9 | 28.4 | 0.03 | 0.04 |
| Red Pine | 1 | | | | | | | | | | | | |
| F.F. | | 7.1 | 0.16 | 11.7 | 7.1 | 31.7 | 3.537 | 24.6 | 14.0 | 22.5 | 9.2 | 0.14 | 0.19 |
| 6 inches | | 7.5 | 1/ | 17.6 | 2.0 | 31.6 | 0.056 | 32.9 | 10.9 | 33.4 | 27.2 | 0.04 | 0.21 |
| 12 inches | | 7.7 | 1/ | 14.4 | 1.9 | 24.7 | 0.129 | 27.9 | 9.3 | 49.8 | 24.7 | 0.03 | 0.20 |
| 24 inches | | 7.7 | 1/ | 9.0 | 1.2 | 25.6 | 0.068 | 1/ | 1/ | 1/ | 1/ | 1/ | 1/ |
| 48 inches | | 7.9 | 1/ | 4.2 | 1.5 | 55.6 | 0.064 | 48.2 | 5.5 | 35.3 | 26.6 | 0.03 | 0.06 |
| Red Pine | 2 | | | | | | | | | | | | |
| F.F. | | 7.3 | 0.22 | 10.0 | 8.4 | 48.4 | 4.352 | 41.7 | 21.4 | 27.9 | 13.4 | 0.42 | 0.24 |
| 6 inches | | 7.5 | 1/ | 10.5 | 3.6 | 21.7 | 0.261 | 21.1 | 11.9 | 34.9 | 17.0 | 0.06 | 0.29 |
| 12 inches | | 6.9 | 1/ | 12.7 | 1.5 | 27.8 | 0.111 | 37.6 | 8.2 | 17.5 | 6.9 | 0.18 | 0.32 |
| 24 inches | | 6.9 | 1/ | 19.6 | 1.9 | 34.3 | 0.040 | 41.7 | 3.7 | 15.9 | 6.2 | 0.06 | 0.20 |
| 48 inches | | 6.4 | 1/ | 24.2 | 0.9 | 61.8 | 0.037 | 41.1 | 2.1 | 5.3 | 2.8 | 0.21 | 0.10 |
| Old field | 2 | | | | | | | | | | | | |
| 6 inches | | 7.4 | 1/ | 7.3 | 3.5 | 31.9 | 0.293 | 33.7 | 3.3 | 20.9 | 12.6 | 0.03 | 0.24 |
| 12 inches | | 7.7 | 0.03 | 2.8 | 1.7 | 25.2 | 0.057 | 38.4 | 3.4 | 35.2 | 20.6 | 0.03 | 0.25 |
| 24 inches | | 7.6 | 1/ | 8.3 | 2.9 | 24.5 | 0.122 | 42.9 | 5.3 | 29.8 | 18.6 | 0.04 | 0.28 |
| 48 inches | | 7.7 | 1/ | 2.3 | 2.1 | 28.0 | 0.098 | 49.6 | 5.7 | 21.2 | 17.7 | 0.07 | 0.21 |

1/ Insufficient sample volume for complete chemical analyses.

2/ Forest Floor (1.5 to 2.0 inches thick).

Table 3. Average renovation of the sewage effluent by the forest floor and soil on the experimental plots during the irrigation period from April 15 to October 29, 1969.

| Plot and soil depth | Weekly application | MBAS | $NO_3$-N | Org-N | Cl | P | Na | K | Ca | Mg | Mn | B |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Renovation in percent | | | | | | | | | | |
| Hardwood | 1 | | | | | | | | | | | |
| F.F.2/ | | 65.8 | * | 53.5 | 32.9 | 15.0 | 43.5 | * | 13.2 | 33.5 | * | 25.0 |
| 6 inches | | 1/ | * | 87.1 | 16.0 | 95.4 | 1.8 | 57.8 | * | * | 62.5 | * |
| 24 inches | | 1/ | 9.3 | 87.1 | * | 98.6 | * | 39.3 | 0.4 | * | 37.5 | * |
| 48 inches | | 76.3 | * | 87.7 | 16.7 | 99.0 | * | 57.0 | * | * | 62.5 | 85.7 |
| Red Pine | 1 | | | | | | | | | | | |
| F.F. | | 57.8 | * | 54.2 | 26.6 | 23.2 | 35.4 | * | 19.6 | 35.6 | * | 32.1 |
| 6 inches | | 1/ | * | 87.1 | 26.9 | 98.8 | 13.6 | 19.3 | * | * | 50.0 | 25.0 |
| 12 inches | | 1/ | * | 87.7 | 42.8 | 97.2 | 26.8 | 31.1 | * | * | 62.5 | 28.6 |
| 24 inches | | 1/ | * | 92.3 | 40.7 | 98.5 | 1/ | 1/ | 1/ | 1/ | 1/ | 1/ |
| 48 inches | | 1/ | 22.2 | 90.3 | * | 98.6 | * | 59.3 | * | * | 62.5 | 78.6 |
| Red Pine | 2 | | | | | | | | | | | |
| F.F. | | 42.1 | * | 45.8 | * | 5.5 | * | * | 0.3 | 6.2 | * | 14.2 |
| 6 inches | | 1/ | * | 76.8 | 49.8 | 94.3 | 44.6 | 11.9 | * | * | 25.0 | * |
| 12 inches | | 1/ | * | 90.3 | 35.6 | 97.6 | 1.3 | 39.3 | 37.5 | 51.7 | * | * |
| 24 inches | | 1/ | * | 87.7 | 20.6 | 99.1 | * | 72.6 | 43.2 | 56.6 | 25.0 | 28.6 |
| 48 inches | | 1/ | * | 94.2 | * | 99.2 | * | 84.4 | 81.1 | 80.4 | * | 64.3 |
| Old Field | 2 | | | | | | | | | | | |
| 6 inches | | 1/ | * | 77.4 | 26.2 | 93.6 | 11.5 | 75.6 | 25.4 | 11.9 | 62.5 | 14.3 |
| 12 inches | | 92.1 | 48.1 | 89.0 | 41.7 | 98.8 | * | 74.8 | * | * | 62.5 | 10.7 |
| 24 inches | | 1/ | * | 81.3 | 43.3 | 97.4 | * | 60.7 | * | * | 50.0 | * |
| 48 inches | | 1/ | 57.4 | 86.5 | 35.2 | 97.9 | * | 57.8 | 24.3 | * | 12.5 | 25.0 |

1/ Insufficient sample volume for complete chemical analyses.

2/ Forest floor (1.5 to 2.0 inches thick).

* No renovation.

Increasing concentrations of nitrate-nitrogen in the forested areas receiving continued irrigation with sewage effluent could become a major problem and a deterrent to long-term use of forested areas for disposal sites. However, this is not an insurmountable obstacle. One possible way to reduce the nitrate concentration is through denitrification, a micro-biologica process that occurs when biodegradable organic material and nitrates are combined under anaerobic conditions. Such conditions could be created by properly programming the sequence of irrigation periods.

The average concentrations of other dissolved mineral salts were increased or decreased in variable amounts in the upper soil horizons. Average concentrations of manganese were quite similar on irrigated and control plots. Whereas, average concentrations of boron, potassium, calcium, sodium, magnesium and chloride were considerably higher on the irrigated plots. These elements are relatively mobile and continue to percolate through the soil profile. They do not cause any potential threat to groundwater quality.

## Effect on Soil

Soil samples were taken to depths of 3 and 5 feet in the fall of 1963 after cessation of irrigation, in the spring of 1964 prior to initiation of irrigation, and again in the fall of 1965. Soil samples were analyzed for the same constituents as was the effluent to determine if significant concentrations of nutrients were accumulating in the irrigated plots.

Results indicated that there was no significant accumulation in total nitrogen. MBAS content also was not significantly higher in the irrigated plots which appears to indicate that degradation and utilization of MBAS by the soil microorganisms is quite rapid. Phosphorus is readily fixed by the soil so most of it is held in an unavailable form. There was a highly significant increase of phosphorus in the upper foot of soil on both irrigated plots. However, phosphorus accumulation is not anticipated to be a problem. Adsorption experiments in the laboratory indicated that the upper 5 feet of the fine-textured Hagerstown soil had an adsorptive capacity equivalent to 20,000 pounds of phosphorus or more phosphorus than would be added in 100 years if 2 inches of effluent were applied weekly, (Kardos, Sopper and Myers, 1968).

Since the effluent is high in chlorides one would expect that chloride content would be higher on the irrigated plots. However, since anions are not readily adsorbed by soil colloids, they do not attenuate in concentration with increasing depth as does the phosphate.

There was no significant difference between the irrigated and control plots in the amounts of calcium, magnesium, potassium, manganese, or boron. There was however, a significant increase in exchangeable sodium on all irrigated plots. Significant accumulations were evident to a depth of 3 feet. However, under the normal, humid climate of Pennsylvania it is not anticipated that the accumulation of sodium will be great enough to cause a soil structure problem.

A comparison of the soil chemical status at the end of irrigation in 1963 with the soil chemical status in the spring of 1964 prior to the start of irrigation provides some insight into the extent of desorption and constituent redistribution by leaching. All elements except manganese and boron showed higher concentrations at the lower soil depths indicating considerable desorption had occurred. The soil does not appear to be adsorbing or releasing any particular cation or group of cations. The ratio of monovalent cations (Na and K) to divalent cations (Ca and Mg) has remained approximately the same in the irrigated and control plots.

Disposal systems must operate throughout the year, and in northern climates where the temperatures drop below freezing, the system must rely more on the adsorptive capacity of the soil and less on the microbes and roots. During this winter period, forested areas provide better infiltration conditions and larger phosphorus adsorptive capacity due to the acid conditions associated with forest soils. Thus, a combination of cropland, grassland, and forestland will provide the greatest flexibility in operating a system using the living filter concept.

Groundwater Recharge

The amount of renovated effluent recharged to the groundwater reservoir was estimated from data available on the total amount of effluent and rainfall applied on the plots, and potential evapotranspiration estimated by the Thornthwaite and Mather (1955, 1957) method. Annual recharge ranged from 1.1 to 1.8 million gallons per acre irrigated with an average of 1.6 million gallons. Recharge amounted to approximately 90 per cent of the effluent applied at the 2 inches per week rate. Hence it is evident that with properly programmed application, sewage effluent can be satisfactorily renovated and considerable amounts of high quality water recharged to the groundwater reservoir. In time, contributions to the groundwater of this magnitude will certainly have a beneficial effect on the local water table level.

Vegetation Growth Responses

Although the primary purposes of land disposal of waste water are to alleviate surface water pollution and to renovate the waste water for ground water recharge, secondary benefits are often achieved in increased crop yields and tree growth.

Diameter and height growth measurements were made annually on sample trees selected at random on each irrigated and control plot. Average annual diameter growth for the red pine and mixed hardwood plots are given in Table 4. Results indicated that weekly irrigation of red pine with 1 and 2 inches of sewage effluent did not significantly increase diameter growth. In fact, the 2-inch per week application actually caused a significant retardation in diameter growth.

Average annual diameter growth of the mixed hardwood species was not affected by the 1-inch per week application but was significantly increased on the plots which received 2 and 4 inches per week. Annual increases in diameter growth ranged from 27 to 118 per cent.

Table 4. Average Annual Diameter Growth for period 1964 to 1969.

| Plot | Average diameter growth |
|---|---|
| | Inches |
| Red Pine 1-inch | 0.08 |
| Red Pine control | 0.10 |
| Red Pine 2-inch | 0.06 |
| Red Pine control | 0.11 |
| Mixed hardwood 1-inch | 0.15 |
| Mixed hardwood control | 0.16 |
| Mixed hardwood 2-inch | 0.21 |
| Mixed hardwood control | 0.12 |
| Mixed hardwood 4-inch | 0.21 |
| Mixed hardwood control | 0.15 |

Table 5. Average Annual Terminal Height Growth in the Red Pine Plots during the period 1963 to 1968.

| Plot | Average height growth |
|---|---|
| | feet |
| Red Pine 1-inch | 1.7 |
| Red Pine control | 1.4 |
| Red Pine 2-inch | 1.6 |
| Red Pine control | 1.7 |

Results of the height growth measurements in the red pine plots are given in Table 5. Irrigation with sewage effluents at both rates produced slight increases in height growth during the first 2 years. This slight increase in height growth has been maintained in the plot receiving 1 inch per week, however, during the last 4 years height growth on the plot receiving 2 inches per week has been significantly reduced.

Height growth response of the white spruce saplings which received 2 inches of effluent per week was significantly increased. During the 7 years of irrigation average annual height growth of the irrigated trees was 1.92 feet in comparison to 0.92 feet on the control plot. Average annual height growth was significantly increased by 62 to 200 per cent. At the start of the study, the height of the white spruce ranged from 3 to 8 feet. At the end of the growing season in 1969, the average height of the trees on the control plot was 6 feet and on the irrigated plot 18 feet.

Transect plots were also established in the old field spruce stand to measure growth responses of the ground vegetation and to determine the effect of sewage effluent on site productivity. Average annual dry matter production on the irrigated plot was 5,532 pounds per acre in comparison to 1,650 pounds per acre on the control plot. This represents an average annual increase of 235 per cent. Annual increases ranged from approximately 100 to 350 per cent. Average height of the predominant plant species was 4.4 feet on the irrigated plot in comparison to 1.3 feet on the control plot. In addition, approximately 10 per cent of the control plot was barren of vegetation; whereas, the irrigated plot had a complete dense vegetation cover.

## Conclusion

Seven years of research have indicated that the living filter system for renovation and conservation of municipal waste water is feasible and that combinations of agronomic and forested areas provide the greatest flexibility in operation. Such a system is more adaptable to small cities and suburbs than to large metropolitan areas because of the availability of open land close to the waste water treatment plant, although the land area requirement is not a major prohibitive factor. At the recommended level of irrigation, 2 inches per week, only 129 acres of land would be required to dispose of 1 million gallons of waste water per day. Although large contiguous blocks of agricultural, grass, and natural forest land would be the most desirable for efficiency and economy, major metropolitan areas could utilize golf courses, playing fields, forest preserves and parks, greenbelts, scenic parkways, and perhaps even divided highway and beltway medial strips.

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## UNSOLVED AND NEW PROBLEMS DEVELOPING IN GOLF COURSE MANAGEMENT

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There was a time when golf courses were judged by the excellence of their greens. Little else mattered to golfers who played on, oblivious to other deficiencies just so long as the greens held and putted well. This is no longer the case. Today golfers are looking for fence-to-fence perfection. They expect everything from greens through tees, fairways and roughs to play as near to perfection as is possible, all year long. Today's golf course budget as reported by Harris, Kerr and Forster exceeds the 1958 budget by more than 86%. When this kind of money is being spent, results, not excuses, count.

There was a time when golf was a Saturday afternoon-Sunday morning game. During the rest of the week, the course was crowded, if more than five foursomes played. Today it is the exception rather than the rule when courses are not used to the maximum. Golf has become everybody's game, and the most popular participation sport in the United States today. The question then revolves around getting the most out of the golf course and this means better maintenance and management practices. This places new emphasis on the whole realm of the maintenance and management of golf courses. Yesterday's procedures must be improved upon if we are to survive the growth in the use of golf facilities in the future.

What are some of the unsolved and future problems? Let's list them as we see them.

(1) Standard specifications for golf course construction. Meaningful specifications for all conditions. After all, more than 10,000 golf courses have been built under varying conditions of soil, topography and region. Specifications that provide information on what it costs to construct 1,000 square feet of putting green, one acre of fairway, one acre of sand trap, one acre of teeing area, etc. for regional and different conditions of terrain should now be possible. I believe the American Society of Golf Course Architects should undertake this project.

(2) Construction of more courses that emphasize finesse, not length or size. More courses that emphasize features that allow for economy in maintenance.

(3) Better grasses for all areas but fairways especially.

(a) The search for dwarf type Kentucky bluegrasses goes on. Selection and breeding programs are pointed in this direction. Better bluegrasses will provide better fairways, hopefully, at less cost for upkeep.

(b) The search for better bentgrasses, fine fescues, tall fescues, bermudagrasses and zoysias. Our players are not only demanding closer cut fairways, but grasses that green up earlier in spring and remain green longer into the winter. Golf is being stretched at both ends of the season and it can only get worse, never better, because with more players we will experience even greater use of the facilities as time goes on.

We need more drought hearty grasses, grasses that do not thin out as the weather gets hot and dry; grasses that can do well in the shade; grasses that can be cut down to 1/2 inch for summer rule play; tougher more traffic resistant grasses suited for heavy play.

(4) We need some new ideas for golf cars and car traffic on the golf course. The numbers will increase as time goes on. Golf cars that are easier on the turf must be the answer if numbers increase. Blacktop really should be out, it detracts from the natural look of the golf course. Hover crafts are in use in parts of the world. This may not be the

answer, but it is the IDEA, the way of the future.

(5) Better equipment for all maintenance work. We must continually strive towards labor savings without sacrifice for excellence in results. The new triplex mowers are an example -- they can be converted to perform other jobs. More and more equipment must be multi-purpose for greater efficiency, less in total costs, less maintenance on each piece of equipment.

Better techniques in application are needed such as crop dusting and helicopter techniques used in agriculture today.

(6) Uniform sand specifications for traps; also, ways of keeping it white and clean.

(7) Subsurface irrigation is getting some play in crop production.. and limited testing on turf areas.

(8) Thatch has been a perennial problem. Some work is being done in Connecticut, Texas and Michigan and several other experiment stations throughout the land. This now is one of the unsolved problems but we're gaining on it.

(9) Improved dyes for winter coloring of warm-season grasses. Longer lasting and more natural color dyes.

(10) Chemicals that are safe for man and his environment. More emphasis on what plants do for the environment is needed. Scientists need to be heard on the role of plants and the environment. We've heard enough from politicians, do-gooders, and individuals with a motive ... now let's have the facts!

(11) Combinations of chemicals -- which produce harmful results? Which are beneficial? There is a great field of investigation here, for safe multiple chemical sprays to golf course turf.

(12) Tom Mascaro, the 1971 Green Section Award recipient, has long been an advocate of closed circuit TV for the golf course. Superintendents could communicate immediately with workers, as well as observe workers in the field at any given time of the day.

(13) Superintendents must communicate but often do not for lack of someone to type the note, take down the thought, work over the figures. Need a secretary? Definitely yes, if only for a day a week. Good part-time help is available -- older and retired but greatly qualified people are available -- crying-out to help. This is an untapped source of labor open to the golf course. It is worth investigating.

Although we have come a long way, there is still a way to go. Superintendents are men versed in machines and management. Every one of you has an idea but you don't know how to sell it. Is it a money maker? You think so but chances are it is not! From blueprint to the finished product is a long road of heartbreak and cash output .. nobody benefits by keeping it in .. spit it out and help yourself and your profession move forward. Together we can make it much sooner! Get those ideas into production.

Funds in the amount of $41,850 have been allocated in 1971 from sources as follows: The USGA, the National Golf Fund, the New England Golf Association, the Metropolitan Golf Writers Association, the Masters Tournament Committee, and various individuals and associations. Those marked "Restricted" are earmarked for the special projects as shown. The Rhose Island grant is supported by the New England Golf Association, and the Rutgers scholarships by the Metropolitan Golf Writers Association. The USGA allocated $20,000 of this total and the National Golf Fund allocated approximately $15,000.

The USGA Green Section Research and Education Fund, Inc. projects recommended and later approved by the Executive Committee for 1971 are as follows:

Restricted Funds - Total $2,350

| Amount | Institutions | Projects |
|---|---|---|
| $1,350 | University of Rhode Island<br>Dr. C. R. Skogley | General support with emphasis on the development of improved grasses for greens. |
| 1,000 | Rutgers University<br>Dr. Ralph E. Engel | Scholarships to undergraduate students in turfgrass management interested in pursuit of a golf course superintendent's career. |

Unrestricted Funds - Total $39,500

| Amount | Institutions | Projects |
|---|---|---|
| $4,000 | Rutgers University<br>Dr. C. Reed Funk | Breeding improved Kentucky bluegrasses for tee and fairway use -- dwarf and other desirable types. |
| 4,500 | Michigan State University<br>Dr. James R. Beard | Fundamental studies of Poa Annua - designed to better understand problems concerned with control or use of Poa annua on golf courses. |
| 2,000 | Georgia Coastal Plain Experiment Station<br>Dr. Glenn W. Burton | General support of bermuda breeding program in continuing effort towards better Tif-series grasses for better golf in the South. |
| 3,000 | University of California, Riverside<br>Dr. V. B. Youngner | Renovation techniques in converting established greens, tees and fairways from Poa annua to permanent turfgrasses. |
| 4,000 | Mississippi State University<br>Dr. Coleman Y. Ward | In partial support of a central lab for testing soils for greens to USGA Green Section specs. |
| 4,000 | University of Georgia<br>Mr. George Kozelnicky | Investigations of Spring Dead Spot on southern grasses. |
| 1,000 | Oklahoma State University<br>Dr. Wayne H. Huffine | General support - screening world-wide collection of bermudagrasses for turf potential. |

| | | |
|---|---|---|
| $1,000 | Kansas State University<br>Dr. Ray A. Keen | Breeding winter hardy bermudagrasses and general support of the program. |
| 2,000 | Pennsylvania State University<br>Dr. Joseph M. Duich | Breeding improved bentgrasses for fairway use. |
| 1,000 | Virginia Polytechnic Institute<br>Dr. Richard E. Schmidt | Studies designed to determine heat tolerance of cool-season grasses in the attempt to accelerate selection and improvement of the more desirable types. |
| 1,500 | Texas A&M University<br>Dr. Richard Duble | General support of turfgrass research program. Effect of cutting and nitrogen forms on the absorption of nitrogen, phosphorus and potassium by Tifgreen bermudagrasses. |
| 4,000 | University of Connecticut<br>Dr. Jay S. Koths | Biological degradation of thatch. Micro-ecology of various top-dressing mixtures composted and non-composted. |
| 1,000 | University of California, Davis<br>Dr. John H. Madison | Electrode measurement of critical values of mineral nutrition of grasses -- testing nitrogen, phosphorus, potassium, calcium, magnesium, sulphur and iron. |
| 2,000 | University of Arizona<br>Dr. W. R. Kneebone | Better creeping bentgrasses for greens for the Desert Southwest. |
| 1,500 | Massachusetts Institute of Technology<br>Dr. T. William Lambe | Sand study for bunkers; texture, particle size, stability under various conditions of wind, best for play, etc. |
| 3,000 | Texas A&M University<br>Dr.M.E. Bloodworth | Updating the Green Section specs. Re-study of maximum water infiltration rates; Also is the sand layer necessary in all cases. If not, under what conditions. |

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## COMING OF THE CONGLOMERATE DIRECTOR OF GOLF COURSES

Edmund B. Ault
Golf Course Architect
Bethesda, Md.

Good afternoon gentlemen. I am just a little surprised that your chairman at the close of his introductory remarks didn't use the phrase: "The remarks of the speaker you are about to hear are his own and do not necessarily reflect the opinions of the committee."

It wasn't too many years ago when such a phrase was used by many announcers prior to a radio or TV program -- this was before most programs were taped. In other words, the announcer was telling you that the speaker may mention some facts that you may not want to hear or which may reflect on the commercialism of the station. Neither I, nor my firm, have any responsibilities or obligations to any company, product, organization or society.

The most important reason for my acceptance of this opportunity to be here was to be in a position to convey to you professional golf course superintendents the rapidly changing conglomeration of golf course developments and operations in the golf course industry today. I and my company have always researched and kept abreast of the latest innovations in sound golf course construction so as to build better golf courses for you superintendents to <u>manage</u>, operate and maintain.

To that end, as far back as 1953, I started the practice of insisting that the golf course superintendent be placed on the job at least several weeks in advance of the actual starting of construction of the golf course.

It was approximately 10 years ago that Martin McCarthy (Chairman of the Mid-Atlantic Greens Section of the USGA) and I met with the Executive Committee of the USGA at the Merion Country Club in Pennsylvania. We recommended to the USGA officials tht they appoint a committee to which the prospective builder of a golf course could send the plans and specifications prepared by him by his golf architect for review and comments. Subsequent to this meeting I discussed this same principal with several representatives of your National association as to whether they could have a committee available to which the golf course owner could send his plans and specifications for review. In turn, the third major golf organization - the PGA - was also contacted with the recommendation that they seek the opportunity to review plans and specifications for new courses and clubhouses. Each of these three organizations would have its own responsibility in reviewing such construction drawings and specifications.

In other words, if the qualified people of your National association had the opportunity to point out to golf course developers certain criteria and basic construction requirements so as to have a solidly built course which could be maintained and managed economically by such professional men as you, we would certainly eliminate from the beginning the proverbial built-in headaches and problems. I believe it was subsequent to the meeting with the USGA that a pamphlet was issued by them: "A Method for the Construction of a Putting Green."

Several years ago I heard loud rumblings throughout your organization that it would issue a set of specifications for construction of a putting green. To this date I have not seen such specifications. If such information were available, it would be used by people in my profession whenever possible and where applicable.

Are you aware that there are variances between the green construction specifications issued by the USGA and those of Penn State, VPI and other turf schools? Will men in my profession get to the point where specifications for construction of greens at a specific club will be worded to conform with the superintendent's school affiliation? Which of these various specifications does your local chapter or National association endorse?

My firm has just recently completed plans and specifications for construction of a second eighteen hole course in Richmond, Virginia, area. Prior to preparation of the green construction specifications I met with the Board of Directors of the Club. They informed me that in the past ten years they had had 3 different golf course superintendents. I was told that each superintendent was somewhat critical of the construction of the greens on their existing 18 hole course. The 3 superintendents had attended different turf schools. It was obvious that the members of the Board were confused as to what specifications should be used for construction of the greens on the new 18. To me, it was apparent and elementary. I merely asked of the Board: Do you subscribe to the visiting services of the USGA Greens Section? The answer was in the affirmative, so I recommended that the greens be built in accordance with the USGA's standards. In my opinion, a great deal of confusion and uncertainty in the minds of golf course developers could be eliminated if your National association adopted standards. Naturally, all of your members should support such adopted construction guidelines.

We retain the services of an outstanding turf agronomist to prepare the agronomic specifications for all golf courses developed through our office. This agronomist keeps abreast of research relative to any new grasses which are developed from time to time and which are advertised and made available to the open market. As you well know, all of these new species of grasses do not qualify as advertised. He also attends turf conferences and reviews the papers submitted at such conferences on research and innovations which may seem practical for and applicable to new golf course construction. You can be assured that none of the new grasses or findings are used or put into practice until proven.

Along this same line, may I suggest that your National organization consider a clearing committee - or a clearing house - to which the marketing agencies for all new grasses, chemicals, fertilizers, equipment, etc., submit complete information and background for a stamp of approval and acceptance. This is not uncommon today in organizations which are geared to protect the user, or consumer, from finding out the hard way.

My comments to this point have a degree of far-reaching significance on the subject and the information which follows.

At this time I believe it is appropriate to show some selected slides illustrating the magnitude of the administrative requirements and the level of responsibility of the new Director of Golf Courses - formerly known as a golf course superintendent.

Slides shown.

Many of the large developments you have just seen on the screen encompass 2, 3 or 4 regulation 18 hole golf courses. Housing projects, or new towns, are being developed by the nationally recognized giants of today's industry such as American Cyanamid, Gulf-Reston, James Rouse Company, John A. Cooper Company, Westinghouse, etc. The golf course superintendent as he is recognized today will be called on for greater responsibilities within these projects. In fact, he will be titled, "Manager-Director of the Golf Courses and Open Space Areas." He will have working under him a superintendent on each course.

It is obvious that for economy and maximum use of maintenance equipment, it is essential that there be a managing director to coordinate this multi-purpose complex.

In operations such as these a chairman of the greens committee will be unheard of. In the past one of the major complaints of a golf course superintendent was his problem with an inexperienced, unknowledgeable chairman of the greens committee.

Several timely articles have appeared most recently in golf magazines and the press, titled: "Crisis in Club Golf" in the March issue of Golf Digest and "Financial Crisis Hits Nation's Country Clubs" by Associated Press... "Many of America's 4600 private golf and country clubs today are beset with economic and social problems that threaten their very future." "Now the average man is threatened with being priced out of the country club."

Most of these clubs were built in the past and are operating under an image which, in my opinion, is helping to bring about their downfall. This image is a format of a number of various committee chairmen, inexperienced and unknowledgeable, attempting to run a large business - and golf is big business. At present this type of club -private membership - is in the minority of the 10,000 golf courses which we now have in America. It is estimated that within the next 5 years this type of club operation - privately owned, private membership - will be in an even greater minority.

At the Denver Conference there was a good subject: "What Does a Club Expect from Its Superintendent." The subject was very adequately presented by Mr. Allen E. Grogan, Greens Committee Chairman, Baltusrol Golf Club. The speaker following Mr. Grogan was your own Dick Blake. His subject was: "What a Superintendent Expects from the Club."

If this type of club operation is failing, and if in the future they will be in the minority, why wouldn't it have been just as appropriate to also have had on the program a director of a successful privately owned profit making golf course-club complex to present the subject, "What Does the Golf Industry Expect from the Golf Course Manager" and in turn why doesn't your National association resolve certain standards and criteria as to what the golf course manager (superintendent) expects from industry.

There was an article which appeared in the Rocky Mountain News, Denver, Colorado, titled "Golf Course Maintenance is Becoming Big Business." This article by Warren Lowe, Rocky Mountain News business columnist, was written subsequent to an interview with Richard Blake in Denver.

From where I stand in the industry, it is not too difficult to forsee co-op golf course management. Many qualified golf course superintendents today will, in the near future, undertake the direct management of 3 or 4 golf courses within an immediate area. Although these courses may be membership owned and maintained, the formation of a conglomerate between them will be parallel to the successful methods being practiced in the large new developments which encompass 3 or 4 golf courses being managed and operated under one head.

I can also forsee in the near future the inevitable encroachment of contract maintenance. I do predict the successful take-over by a contractor of the complete maintenance of a golf course; however, I believe that your local and National association should review with its many members what phases of their present golf course maintenance could be successfully and economically contracted. I am thinking of the annual fall renovation of greens where a contractor could come in at night and with floodlights completely verti-cut, aerify and topdress at least 9 greens. Annual fertilization of the overall golf course is another item to be contracted. Any major renovations to any part of the golf course should definitely be contracted and done under specific plans and specifications.

Big industry has proven the economy and efficiency of contract maintenance. If your association is to take steps to ward off the encroachment of total contract maintenance, which incidentally is now in effect in some sections of the country, and wishes to help allay this crisis in club golf, it should immediately undertake a program to investigate nation-wide ways and means by which its members can maintain golf courses as economically as possible.

To this end, and to the coming of the "Conglomerate Director of Golf Courses", let me sum up.

If partial contract maintenance is an answer, let's advise and encourage it.

Let's take a hard look at the far-reaching economics of co-op management.

Do not fear or be concerned with the elimination of our problem child - the chairman of the greens committee.

How much can we pull back the high degree of over-maintenance which is being practiced in many of these problem-ridden clubs?

When considering a change in jobs, do not let salary alone dictate. Consider and review the plans and specifications by which the golf course, or courses, was constructed.

The future of the current aggressive, knowledgeable golf course superintendent is unlimited in pioneering the challenging field of the somewhat more sophisticated conglomerate director of golf courses.

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## AQUATIC WEED CONTROL

John E. Gallagher
Amchem Products, Inc.
Ambler, Pa.

In discussing aquatic weed control today one has to be aware of the ever changing attitudes in Washington pertaining to the policies that deal with pesticides in water. The best policy to operate under is the old one of using only labeled products. Until the E.P.A. (Environmental Protection Agency) becomes fully structured and staffed, one would be advised to either put the control program into the hands of qualified applicators or become completely knowledgeable of all the potential hazards and avoid them. You can be sure that for the near future restrictions on the use of pesticides by both state and federal agencies will be increased and it would be wise to keep abreast of any changes.

Assuming that you do have a weed problem and would like to take steps to control that problem, what can you do. First, find out if your state has a permit program. The state of Massachusetts does. We suggest you refer to Chapter 677, Commonwealth of Massachusetts, 1960: "An Act Providing that Persons Applying Chemicals to Certain Waters to Control Algae, Weeds and Other Aquatic Nuisances be Licensed."

The following compounds appear to have received clearance for use in water and should still be legal when used in accordance to label directions:

| | |
|---|---|
| Acrolein | Diquat dibromide |
| Ammonium sulfamate | Diuron |
| Copper sulfate | Endothall |
| Dichlobenil | Monuron |
| Dichlene | Petroleum solvents |
| 2,4-D | Silvex |
| 2,4-DP | Xylene |
| Monosodium acid methane arsonate | |

The particular use directions would be found on the container. A more detailed report on the use of aquatic herbicides would be found in the May 1970 Golf Course Reporter. This, under current circumstances, is as up to date as we can get. Hopefully, by the end of 1971, we will have firm labels for products used in aquatics.

If you wish to go ahead with aquatic weed control, assuming that your pond qualifies in terms of the permit requirement, then your first step should be identification of the weed problem. To help out here the following list of publications should be of considerable value. They can be obtained by writing directly to the agency involved.

1. Controlling Plant and Animal Pests in Farm Ponds with Copper Sulphate by Phelps Dodge Refining Corporation, 300 Park Ave., New York, NY 10022.

2. Three publications on identifications from the U.S. Department of the Interior, for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402:

    a. Resource Pub 44 - Underwater and Floating Leaved Plants of the United States and Canada.

    b. Circular 187 - Pondweed and Pondweedlike Plants of Eastern North America.

c. Circular 221 - Bulrushes and Bulrushlike Plants of Eastern North America.

A final piece of needed information is that of how to calculate chemical requirements. I would refer you to the following:

1. How to calculate pounds or gallons of Aquatic Herbicides from Water Surface Acreage. WEEDS, TREES and TURF, Jan. 1966.

2. Determining the Pond Volume. "Controlling Plant and Animal Pests in Farm Ponds with Copper Sulphate", Phelps Dodge Refining Corporation, 300 Park Ave., New York, NY 10022.

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## WHAT PROJECT APOLLO HAS DONE FOR GOLF AND GOLF COURSE ARCHITECTURE

Dr. Mal Purdy
Golf Course Architect
Livingston, N.J.

Good morning Gentlemen and Ladies .. It is nice to be here, as it is every year, and to be asked to make a few observations about what we in Turf and Golf can learn from Project Apollo. Some of you may be surprised that this addition to the program was placed under the session "Pollution" .. those of you who know me well and those who brave it out until the end will realize once more the keen insight which Dr. Troll brings to any task, as evidenced by the topic heading for this talk.

I used to work on Project Apollo as a Systems Engineer and in the particular area of Crew Safety. My remarks, however, will be more general. As in most cases in life, one tends to remember those days which are directly personal. As for me, I gained more than just an experience or an amount of information from Project Apollo. I also met my wife while working on the Project.

There are a few other comments which are more or less amusing and perhaps, by stalling now, the attendance will be greater when I get to the more important part of my talk.

If golf were the stock market, it would have hit a new high on February 6, 1971, when at the end of a long and tiring stay on the moon, Alan B. Shepard said:

> "...you might recognize what I have in my hand as the handle for the contingency sample return and it just so happens to have a genuine six iron on the bottom of it. In my left hand, I have a little white pellet that's familiar to millions of Americans. I drop it down. Unfortunately, the suit is so staff I can't do this with two hands, but I'm going to try a little sand shot here."

With that, he swung awkwardly, propelling a sheet of lunar dust. Capcom Fred Haise responded, "That looked like a slice to me, Al." Shepard made two more tries. The second, he noted later, drove the ball "A couple hundred yards." The third shot went about "400 yards,"- not bad for a one-handed six iron shot.

Theoretically, Shepard's normal six iron shot of 135-140 yards should go about six times further on the moon since it is being hauled back to the lunar surface with only 1/6 the normal force of earth gravity. For those of you who are sticklers for accuracy, one should take also into account the fact that there is also no earthlike "wind resistance." How this absence affects the degree of hook or slice, or indeed backspin, will be reported in the next issue of "Lunar Golf Digest."

The astronauts were released from quarantine last weekend to enable NASA to determine if there's been any improvement in Alan Shepard's golf game. Now you know why Alan worked so hard picking up moon rocks. He was clearing hazards from the fairways. We could have used him at Aspetuck Valley.

As you might have guessed, the publicity-minded people of the golfing world were going into their own orbits and Alan has already been asked to show off his lunar techniques at the American Golf Classic. Actually, just like here on Earth, the largest golf hazards are getting to and from the golf course.

When I was down in Houston at the Annual Meeting of the Golf Course Superintendents last year, I took the occasion, along with a few of the other conference attendees, to go out and visit old friends at the Houston Manned Spacecraft Center. On the tour, we came across all the simulation facilities where the astronauts are trained prior to their going on the Moon Voyage and some of these are highly sophisticated, giving them all the feelings and motion of the actual spacecraft that they would know if they were making attitudinal changes with the hand controls, etc. Obviously, the electronics needed to back up such simulations are very, very sophisticated and in some cases, very large. As I walked along the catwalks above one of these simulations while it was in progress, I and the others in the group, looked down on what was perhaps a 60' long control panel. Having just heard some of the talk at the Superintendent's Convention about all the wonderful and amazing things that centrally controlled automatic irrigation systems can do, I was caused to remark that when that particular control panel went on the surplus market, I would buy some of them. Next I'd place moisture senors in the ground and have some sort of a telephone or microwave transmission hook-up and control the automatic irrigation systems for all the golf courses in the eastern United States from one office. It might be theoretically possible to accomplish, but how would you like to try syringing all those greens from here?

Some of the valid lessons which can be learned from the Project Apollo are as follows:

In Public Relations, it is not enough to do the best, you have got to let those who are important to your own future know you are the best. There has been a controversy in the scientific world for a long time about whether or not we should have spent all of the money we did to keep men alive to and from the Moon; that is, manned vs. unmanned space exploration. This last mission should, I hope for all time, put aside that dilemma and, in fact, that argument. It would have been impossible for the mission to have been a success had we not had men on that mission. There were numerous "glitches" which occurred, including the initial one of having trouble docking the two vehicles when they turned around and redocked, hooking up the LM to the Spacecraft. Later on in the mission, about 30 minutes prior to Lunar landing, the LM Navigational Computer indicated a malfunction had occurred which demanded the mission be aborted before going down to the lunar surface. The remainder of the mission, the actual walking on the surface of the Moon and getting back up into orbit would not have been able to have been accomplished. They would have had to have stayed in Lunar orbit and then return directly to Earth.

They found a way to "fool" the electronic program already in the computer. I learned by talking to my old colleagues that the way in which they accomplished this was to let the computer think it was already in the "Abort Mode" and they were able, through re-programming, to go on with the mission and get down to the surface.

NASA has not always emphasized all of the good that having a man aboard has done. In that way, they now stand in jeopardy of their lives (I don't mean the Astronauts), I mean all of the people who are working in the Program. Unless something major happens in public opinion, or the Congressional budgeting, the Apollo Program will, for all practical purposes, be dead in 1973. You may have noticed, as I did, that the crew of Apollo was not as glib; they did not have the same personality or inclination to do some of the foolish things (or what appeared to be foolish, such as: turning somersaults in the capsule when they were on TV) while going to the Moon and back. It is this example that I use to emphasize that it is not enough to do the job perfectly. You have got to also sell somebody on the idea that it is worthwhile to continue the program and to that extent, the crew of Apollo 14 were not as good for NASA as previous crews have been. Although - and this should be emphasized - the gathering of information and samples they collected on Apollo are more than all of the information that has ever been collected by Russia's and the United States' unmanned robots.

By the way, I should mention that news can be slanted by the way one reports it and so in Russia, when we got to the Moon first, it was reported that in the Space Race, Russia had placed "second" and the United States, "next to last."

Another lesson we might learn from Apollo: learn from your mistakes. Many of you will remember that early in 1967, we had a fire on the Pad during the pad checkout and we lost the crew, including Gus Grissom. The cause of that fire was investigated; the program was delayed and the cause of the fire was found and eliminated, which is something from which we can all learn. Everyone makes mistakes; when you do, attempt to learn something from it, so you will have less likelihood of making a related mistake in the future.

As a personal aside to that, I might mention that a co-worker in Washington and I, prior to that Pad fire, had been about the only two people we knew of in the Apollo Program that were worried about the long time it took to get the astronauts out of that capsule and down to a safe distance away from the Pad in case of a Pad Emergency. My own personal inability to convince Management of the importance of acknowledging and supporting that effort was one of the reasons for resigning and going into golf architecture.

Appolo 13 - You may remember that we had a problem with an oxygen tank exploding. Having been on the Crew Safety panel, I am a little bit ashamed that we did not notice sufficiently that the reliability of two (redundant) oxygen systems is completely lost if you put one tank next to the other tank, so that if one explodes the other is probably wiped out too. However, good old Yankee ingenuity was used and quite happily we got the crew back safely although they must have nearly frozen.

So, learn to get by on limited resources if you have to. I suppose many of you are facing budget cuts due to the trouble with the economy. NASA, too, has been having trouble with budget cuts and something which, I think, has been kep virtually secret is the fact that in hopes of making the public believe that they were making efficient use of all those pieces of hardware they had in the past, they took an old Gemini capsule and Atlas-Agena rocket and put them together and decided they would attempt to satisfy the scientists by putting up a biological experiment and the female sex of the population who are having a liberation movement of their own.

So they sent up a male chimpanzee and the first female astronaut. After they got up in orbit, they were orbiting around the Earth. Some of you may recall, the Gemini spacecraft is very, very small. They don't even have room to have two headsets up in front. What they have done in an effort to use the space efficiently is to have one headset with a little light on the panel that lights up when the Ground Control System is trying to make voice communication. So, after they had safely made earth orbit, they were orbiting around and the light came on and the chimpanzee reached out and grabbed the headset and put it on and mumbled to himself as he reached down and made a few control adjustments. A little later, the light went on and immediately he bent down and grabbed the headset, again put it on, mumbling as he made an altitude correction with the hand controller adjusting the attitude of the spacecraft. So, about this time, the first female astronaut said, "This is not liberation; I've got this male animal next to me and the animal is going to get all of the credit; I'd better start asserting myself up here and so, since she knew when the next ground station was coming up, she was ready and waiting for that light to light up again. When it did, she grabbed the headset and put it on. A slow Texas drawl from Mission Control said, "It's time to feed the broad."

To me, Project Apollo has provided the profession with a way of thinking, a way of approaching problems and proceeding to the best solutions from which we can all benefit. They call it SYSTEMS ENGINEERING and I was called a Systems Engineer. Imagine how I felt ...Yesterday I couldn't spell it and today I <u>are</u> one.

What is Systems Engineering? It is an attempt to optimize a system to meet a specified goal by balancing all relevant factors. I don't know who many of you might understand what I am trying to say, but let me go on.

You Greens Superintendents and Turf Managers do it .. perhaps intuitively. Everytime you have a new budget; different numbers of men; a new chairman; and, therefore, new maintenance requirements; changing weather conditions, etc. You rework your program to do the best under the conditions you now face. In order to do that, you must weigh, in your own mind, the relative contribution each operation makes to your ultimate goal of keeping the perfect golf course. When two men don't show up, what won't get done that day? By the way, I have a feeling that not very many of you have all the money, nor the manpower and equipment you would like to have to keep your golf course turf perfectly. How many men in the audience here do have all the men, equipment, and money that they need to keep a perfect golf course?

I am sorry that Sherwood Moore had to leave today because he promised me that he would raise his hand. Well, he would have confused the point I was trying to make anyway.

You do the best you can with what you have to work with. In a similar matter, and it is a general thing, - this Systems Engineering - we golf course architects do the same or at least we profess to.

Like you, we often have little control over the choice of the site where the golf course should be built. Often, we are called in too late to be involved in that and this situation is getting worse in that there are fewer and fewer decent places to build golf courses. We attempt to encourage a large enough budget to build as near a perfect golf course as the site will allow. We are not always, in fact, rarely, a complete success at this. Yet we try.

So you, as superintendents, are handed a less-than-perfect golf course which we hope you will help perfect in the years you are with it. I lament the fact that so many courses seem to require more of you than they must have of the contractor who built them. But I emphasize, we do not usually have unlimited resources at our disposal any more than you do. We can exercise our professional judgment and if the budget is clearly and unreasonably low, we can and have backed out and told the owner that we don;t believe that a golf course can be built of which he and we will be proud for the amount of money he says he has to spend.

Likewise, I am sure in your own personal lives, if you are on a golf course where they unmercifully and without reason have cut your budget down to a point where you cannot stand any more, you, too, will start looking elsewhere and will bow out. But whatever you do, do the best you can and take pride in your work. I feel one of the most important things that Apollo has given us is this: Out of all of the things that we, as a Nation, have done in the past ten years is an unequivocal feeling of achievement and pride which met with world-wide recognition of all the good things that we Americans can and do do and with none of the negatives that so clearly is part of many other things that Americans have attempted to do lately.

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# MAINTENANCE OF GRASS TENNIS COURTS

Wayne Zoppo
Superintendent
Agawam Hunt
East Providence, R.I.

At Agawam Hunt we have 12 grass tennis courts which cover 80,000 sq. ft., which are divided into 2 banks of 6 courts each -called A courts and B courts. (Slides)

The strains of grass we have on the courts vary from Poa annua to Colonial Bent to Bluegrass. To take care of these courts properly we have 2 men that work full time on them from mid-April to mid-November.

In the spring we roll the courts approximately 5 times, at different angles to level and firm them up. After the initial rollings in the spring, we roll the courts an average of once a week through the year usually in the morning after the dew has been taken off or in the early evening. We use a tractor with iron wheels with a one ton roller. We sod or seed any bad areas that we may have so that the courts will be in satisfactory shape when they open on approximately May 20. (slides)

The courts are cut every other day from the second week in May through the second week in October with Jac. Greensmowers which we feel help keep the courts as level and as firm as possible. In the spring we start out with a height of cut of 5/16, then about the end of June we raise the height to 3/8 at which we cut at until the first of September, then we return to the 5/16" height of cut. All courts are hand watered as needed, putting on only enough water to last through the day in order to keep the courts as firm as possible. (Slides)

When a court is cut and then watered if must have a fresh set of lines so the lines can be seen. The day the courts are not cut we only water up to the lines, but not over them. (Slides)

To fertilize the courts we use Scotts 32-5-3 applied at 1 lb per application approximately once a month April through October. Except in July when we apply chelated iron instead of fertilizer so the grass will not be soft and succulent in periods of hot and humid weather. I have followed this practice the last 3 years and feel by starving the grass in July very definitely keeps the disease problem down to a minimum. I also apply chelated iron and Aqua Gro on a 3-4 week schedule throughout the growing season. For 3 reasons: 1) iron gives us added color; 2) the Aqua Gro improves water penetration; and 3) eliminates wilt.

Before we started an Aqua Gro program we could water in the morning and have wilt in the afternoon, but now with an Aqua Gro program, we water in the morning and do not have to worry about wilt even on a 90-95 day. I should emphasize that the amount of Aqua Gro you put on and the number of times you put it on varies with the amount of thatch you have.

We also follow a preventive schedule of applying Scotts fungicide every 2 weeks mid-May through mid-September. If we do see any disease it is usually brown patch and we spray Tersan OM or Dyrene to control the disease immediately. (Slide)

In the fall after the courts have been shut down for the year, usually after Columbus Day, we start a verti cutting, aerification, overseeding and topdressing program. But before we start these programs we attempt to wash out as much of the white line material as we can using a hose and nozzle with a high amount of water pressure. (Slides)

Verti Cutting

At first we tried to verti cut the direction in which we mowed in but found that we ripped up too much turf. So we tried going the opposite direction to which we cut which worked out fine. We try to go down as deep as possible but can only go down 3/4 to 1" deep because the courts are so hard. (Slides)

Aerification

We use a 5/8" tines to aerify. After cleaning the courts we must roll them because the aerifier lifts up the turf slightly. (Slides)

Overseeding and Topdressing

We overseed every fall with a mixture of 66% Exeter Colonial Bent and 33% Pennlawn Fescue, applying approximately 1 lb. of seed per 1000 sq. ft. We then top dress with screened loam, not a mixture of sand and loam, at the rate of 1.2 cubic yard per 1000 sq.ft. (Slides)

Laying out a Court (Slide)

A court should always be laid out with the long way North and South, to avoid having players look directly into the sun while playing. The length of a court is 78' and the width if 36' for a doubles court and 27' for a singles court. You should always have at least 21' behind the base lines so the players will have enough room to move around. You should also have a backstop beyond 21' to stop tennis balls. The net posts are 3' outside the doubles line. The top of the net at the post should be exactly 3'7" and in the middle of the court it should be exactly 3'. (Slide)

As you can see maintaining a grass tennis court is a lot like maintaining a golf course green, except that you try to keep the courts as hard as possible and as I stated before only putting enough water on to last the day.

There are some disadvantages to grass tennis courts:

1. Its high initial and maintenance costs.
2. Lack of uniform bounce when not in nearly perfect condition.
3. It is relatively shlo drying after a moderate rain.
4. It is slippery when damp.
5. It discolors the balls and you need experts to properly maintain the courts.
6. And grass courts will cost from 8 to 12 thousand dollars per court to install depending on how much grass area you have outside the actual playing area. (Slides)

In closing on the maintenance of grass tennis courts I would like to say that unless a club is prepared to spend a high amount of money to maintain grass tennis courts, I would suggest going into either clay or hard tennis courts because after the initial cost of installing them there is very little maintenance to them.

Clay Court Construction (Slides):

A clay court is generally constructed in the following fashion:

1. A field of open drain lines are set 10' apart, approximately 2'6" below the finish surface.
2. The drain lines are then covered with a 5" bed of cinders or gravel.
3. Above this is placed a 3" compacted layer of 1 1/2" crushed stone.
4. This in turn is topped off with a layer of 3/4" stone to fill the voids.
5. Then a 3" layer of clay screened through a 3/4" to 1" mesh is compacted over the base.
6. The final topping consists of a thick layer of caly screened through a 1/4" mesh.

Maintenance of Clay Courts:

On clay courts in the spring after they dry out, you rake them to level them out, then roll the courts and install the tapes for the lines. After that is done the only daily maintenance needed is to brush the courts and clean the lines which takes about half an hour for twd courts. In real dry weather you will have to apply calcium chloride to keep the dust down.

Some of the advantages of clay courts are:

1. That materials for construction are available in most parts of the country.
2. They can be built with relativel inexperienced labor.
3. With reasonable maintenance a player can have a relatively uniform ball bounce.
4. Repairs are rather inexpensive.
5. And because a player can slide on this surface, it is easy on the feet and legs.

Some of the disadvantages are:

1. It may take a day to be playable after a moderately heavy rain.
2. Depending upon the color and nature of the clay, it may stain the balls and create a glare in the players' eyes.
3. And daily maintenance is required to keep the courts in reasonable playing condition. (Slides)

Hard Courts

There are 2 types of hard courts to choose from. They are asphalt and synthetic turf. Asphalt courts would be the most inexpensive of the two because all you have to do it have a good gravel base with drainage and lay the asphalt. The cost of an asphalt court would be about 5000 dollars per court. For an additional 2 thousand dollars you would be able to lay a surface over the asphalt courts, called cushioned asphalt, which would beautify the court immensely.

Some of the features of a cushioned asphalt court are:

1. Superb playability.
2. True ball bounce.
3. True plane surface.
4. A non-abrasive surface which is easy on players, as well as tennis balls, and shoes.
5. They are available year round.

6. It has a non-glaring surface in a choice of many standard non-staining colors.
7. It dries rapidly after a rain.
8. You have a cushioned surface with sure footing and no skidding.

These courts require no daily upkeep and little maintenance. The colored surface should be topdressed every 4-6 years. To keep the color vivid, the surface should occasionally be flushed with water and brushed to remove dust and dirt. (Slides)

Synthetic Turf

There are many types of synthetic turf to choose from but if anyone is thinking of putting in synthetic turf, they should be prepared to spend close to 20 thousand dollars per court. (Slides)

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## DISEASES OF ORNAMENTALS GROWING IN TURF AREAS

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Man's ability to reduce his work effort by machine and increase his output has resulted in more leisure time. This time is being utilized in many areas and a major one is on the golf course.

When one mentions a golf course, turf is usually associated with it. This is natural since a golfer see turf, he walks on it and follows the ball over the turf. Considerable money is spent for equipment to play golf, and most of the time is spent on the turf.

Golf course maintenance involves considerable investment for fertilizer, insect, disease and weed control. Let alone the mowing, sweeping, and raking of grass and leaves and irrigation.

If we consider turf as one part of the golf course, then some other parts that make up a golf course would be the trees and shrubs, club house, and maintenance buildings, roadways and walkways, water lines, natural terrain, location in relation to population and industrail complexes, normal and abnormal climatic conditions and man's decisions.

Now, one may ask a question - what does this have to do with golf course maintenance? If we exclude the turf portion, as this is well covered in other texts, the other major portion of a golf course consists of the trees and shrubs used for landscape design, screening purposes and to challenge the player. Many of these plants are taken for granted. Once planted, it is assumed they should last forever or if in the natural landscape, should remain there forever. When a tree dies or shows abnormal coloration, everone wants an immediate cure. It becomes all too obvious that when a tree begins to die it is often too late to make corrections. A replacement is then necessary. This is costly and in many cases time is necessary to restore the area to its normal esthetic value.

The problems on trees and shrubs can be divided into two groups. disease and physiogenic. A full knowledge of these two areas and the specific problems that may be found in each, can be helpful in avoiding serious plant loss. Specific diseases can be controlled by protective materials or by the use of resistant selections. Many physiogenic problems can be alleviated by better cooperative efforts between the landscape and construction contractors. Educational programs for the employees on the proper use of equipment and material will help to curb the human error that may be involved in some cases.

Disease problems associated with pathogenic organisms can be identified by symptom pictures or by laboratory diagnosis. Once the problem is determined, control measures can be employed.

One group of disease organisms often found on shade trees such as maples, oaks, and sycamore are the ones that cause anthracnose. This disease can be found on many other plants and the name refers to the sudden and extensive blighting of the foliage. In most cases, the various organisms that cause anthracnose are dependent on moisture. If weather conditions are conducive for a pathogen build up, one can expect a problem and should consider a protection program. If the trees are in a location to affect the esthetic beauty of the area, timely protective fungicides should be used. In other areas, a good fertilizer program to maintain vigor in the tree will often suffice. However, it must be kep in mind that a tree in poor vigor that is defoliated several seasons in a row is a prime prospect for root pathogens tha may further weaken the tree and eventually kill it.

Leaf spot diseases of some plants are very outstanding but in most cases never become severe enough to warrant a protective program. Unsightly leaf drop in a patio area of the club house would warrant a protective spray or two but otherwise a normal fertilizer program should be enough to keep the tree in good vigor.

Vascular wilts have become important on certain trees such as maples and elms. Dutch elm disease has been a good example of the ravages imposed by a fungus on one species of tree. Verticillium wilt is another important disease that is taking its toll of many trees, especially species of maples. Infected trees cannot be cured at the present time. Fertilizer programs to improve plant vigor along with pruning of dying branches has been helpful. However, recovery chances of infected trees are low and other tolerant plants must be considered as replacement.

Small trees such as flowering crabapple are subject ot specific problems such as apple scab, fireblight, and rust. Resistant varieties are desirable and often used, but resistance to all diseases may not be possible, thus one must settle for resistance for the most common disease and consider protective sprays for the less severe diseases.

Although diseases are important in golf course plants, physiogenic diseases are becoming more and more the major cause of plant losses. Probably one of the major physiogenic diseases found on trees and shrubs is scorch. This is in most cases a water stress in the plant. The main cause is often in the roots or vascular tissue of the plant.

When a scorch problem develops on a plant, many factors must be considered. In obvious cases, root pruning associated with gas, water or sewer line installations will be recognized. The paving over of root surfaces of established trees should be recognized as soil, water, and oxygen become limiting factors resulting in root damage. Fill dirt to maintain a specific grade or dirt removal may result in root damage. Heat reflection from a paved surface or a building on a tree with a limited root system can be another factor. Trees, located in areas where subsurface soil conditions become saturated with water for extensive periods of time when a tree is actively growing may scorch and decline in a few years. Oxygen exclusion will result in the death of many fine roots that are often invaded by secondary fungi that continue to debilitate the tree. On the other hand, extended periods of drought may have a similar effect on the root system. Prolonged drought will result in weakened roots that are easily invaded by secondary fungi. The establishment of new buildings by other trees may result in changes of subsurface water movement and thus effect the roots. Excess use of fertilizer may be a problem on a small tree. Vascular wilts in older trees and girdling roots should be checked.

Scorch conditions can often be corrected by fertilizer and water if symptoms are recognized early. However, if vascular disease has become established or serious root damage has taken place, tree removal may be the only solution.

Misuse of pesticides such as herbicides or oil sprays can result in plant damage. Soluble herbicides that move to the root zone have been a problem on certain trees such as maples and pin oaks in some areas of the country. Weed and feed fertilizer combinations have caused some of this problem and should be used wisely or not at all. Volatile compounds used some distance from susceptible plants have been a problem often associated with windy or hot weather conditions. Some plants can withstand a slight amount of damage but others are so sensitive, that they are killed.

Air pollution is becoming an important new factor on plants. Certain species are being recognized as being very susceptible to such materials as ozone, sulfur dioxide and peroxyactylenitrates. These atmospheric impurities must be recognized as having a serious effect on certain plant material. The closeness to industrial areas or major highways may determine the plant material that can be grown successfully on a golf course. Replant material should be checked for pollution tolerance especially in an area such as the northeastern US. where high population density exists. The use of pollution tolerant plants should also be considered as pollution scrubbers. Photosynthesis contributes to the oxygen supply. The leaves and needles act as particulate scrubbers and actually help to clean the air.

So, protecting plants from the ravages of pathogenic and physiogenic disease on a golf course can improve the esthetic and playing value of a course as well as contributing to a cleaner environment.

# CONTROL OF TURF INSECTS

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Superintendents of golf courses, parks and recreational grounds are perennially concerned with the continuous growth and protection of fine turf grasses. They must make certain that useful and attractive greensward is given daily attention and as superintendents they should be aware of the trouble that may appear, often without warning. Quite often conditions are confusing and may result in unreliable treatment; consequently, a loss of turf, time and money.

Occasionally during the growing season irregular, brown or off-color areas appear in grass. Several or more possible causes considered individually or collectively could be responsible. Diseases, drought, overwatering, winterkill, fertilizer or insects are the most common offenders.

It is the intention of the author to discuss the last category -- insects -- leaving the remaining considerations to those equipped to deal with them. Pesticides that may be legally used in the author's home state to control turf pests will be indicated. Therefore, I suggest that you review the regulations in your state to determine the types of materials to be used.

## Chinch Bug

As a result of extended hot, dry weather in the northeast during many of the summers of the 1960's, the chinch bug posed a serious threat to fine turf grasses. In certain areas where control was not undertaken, serious loss of grass was experienced.

Occasionally an infestation of chinch bugs may be confused with other causes of deteriorating turf. Hence, it is advisable to examine the crowns of grass plants close to the soil for their presence. When the insects are difficult to find, small areas of the grass may be flooded with warm water not exceeding 115°F and covered with a piece of white cloth. Shortly, the bugs will crawl up the grass blades and onto the underside of the cloth. The adults are about 1/16" long, black with white wings. The nymphs vary in color from orange or red to gray with a white band behind the head. All stages are sunloving and do not occur in shaded areas.

There are two annual generations. The first one is active during June and July and the second from August through early autumn. Overwintering is successful only in the adult stage.

Control of chinch bug is assured when one of the following insecticides is used: Diazinon, Aspon, ethion, Akton, Dursban and Baygon. Seven is less effective. Because of variations in concentrations of active ingredients they should be used as directed on the package - read the label.

## The Annual Bluegrass Weevil

Annual bluegrass weevils (Hyperodes anthrosionus and H. maculicollis) have seriously injured Poa annua in many areas of the northeast. At first the former species appeared to be the dominant one in southern New England. Subsequently the second species infiltrated golf course areas and surpassed H. anthrosionus in importance.

Adults of both species are snout beetles. They are dark brown to almost black in color and measure 3.5 to 4 mm. in length. Emergence to the surface of the ground commences about mid-June and continues into early July. Reproduction does not take place until April and May of the following year. Winter hibernation of adults occurs in fescue grasses in "rough" areas of golf courses. Eggs are deposited in annual bluegrass plants and hatch in about 10 days or so depending on weather conditions. Larvae feed in the grass plants causing them to turn brown and die. They then work their way into the root system where pupation takes place at a depth of 1/2" to 1" below the surface. There is only one annual generation in fairway areas where the insects were studied.

Control of Hyperodes was obtained with two systemic insecticides in addition to other materials.[1] Di-System 10% granules used in early June at the rate of 100 pounds of formulation to the acre gave complete control of the subsurface weevils in two weeks. Furthermore all adults were killed on the surface of the turf in late July when Di-System 65% emulsion was applied at the rate of 1 gallon of formulation in 50 gallons of water per acre. In late April, Cygon 10G was used at the rate of 12 pounds and Sevin 20G at 20 and 40 pounds of active ingredient per acre. Cygon controlled 100% of the weevil larvae whereas Sevin was ineffective. In late July Diazinon 48E applied to infested turf at the rate of 1 gallon in 50 gallons of water per acre killed all adult weevils on the surface of the fairway in 2 hours. Subsequently no reinfestation occurred. Dursban applied at the rate of 2-1/2 pounds active ingredient per acre in April and repeated in May gave the best control of all the insecticides assayed in New York.[2]

## Frit Fly

The frit fly, which occurred so often in golf course greens five to ten years ago, seemed to le less noticeable during the past year or two. This may be attributed to more alert management using control materials to suppress the insect in advance of serious injury.

Adult flies are almost bare, without many hairs or pubescence and shiny black in color with short wings. Their average length is about 2.5 cm. They are very active, flying and jumping when disturbed. A onticeable characteristic is their attractiveness to white such as a golf ball, handkerchief or paper. Adults may live for 6 to 8 weeks and are capable of laying about 30 eggs each. Egg deposition occurs on bent and bluegrass in addition to grains and other plants in the family Gramineae.

Larvae or maggots are short, thick, cylindrical and whitish in appearance. Their mouth parts are developed for tearing and rasping.

Larvae concentrate on the tender, center leaves of grass plants causing them to turn brown and die whereas the outer leaves remain green. Injured turf assume an off-color, sparse and brownish appearance. Usually damage initially occurs at the edge of a putting green and later, when control is not undertaken, it may encompass the entire green.

Because of resistance to pesticides control of frit fly is no longer assured with chlordane. Diazinon, Dursban, and Dylox are suggested for the purpose. In one instance in Connecticut, where all materials appeared to fail, lead arsenate controlled the pest. Owing to the development of multiple generations during the spring and summer months an early summer treatment may not give seasonal control. Hence several applications of an insecticide may be advisable.

## The Bluegrass Billbug

So far as is known the bluegrass billbug (Sphenophorus parvulus) does not occur in Connecticut nor (to our knowledge) in other areas of New England. It is a serious lawn pest in the Rochester area of western New York[3], and has been reported from a number of states westward to Salt Lake City. Injured turf turns brown in mid-summer especially during periods of water stress.

The adult weevil is reddish-brown in color and measures about 7.5 mm. in length. It overwinters in thatch, hedgerows and in other sheltered areas. Warm days in spring encourage them to leave their hibernating quarters and wander over walks and pavement close to grass. They feed on the tender center stems of grass plants close to their crowns. Eggs are deposited in the feeding areas from May to July. The larvae tunnel downward through the stems and into the crowns and roots of the plants. Transformation to the adult stage takes place in the soil. All stages of the insect occur from mid-July to mid-August.

Reports indicate that turf protected against the European chafer with chlorinated hydrocarbons were seriously injured by the billbug. This discouraging situation strongly suggests resistance. Adults have been controlled with Diazinon, Sevin and Baygon when treatment is applied just before peak oviposition occurs in early July.

## Additional Turf Pests

There are several additional turf insect and earthworm pests that injure well-groomed turf. Japanese beetle grubs and related species appear periodically in golf course fairways and rough. There were more reports of Japanese beetle infestations during the 1970 growing season than for a number of years. The condition was not confined only to extensive turf areas in golf courses but was equally as important to home owners as to the superintendent. Chlordane continues to be the insecticide most often used to control the pest. It has been demonstrated that Diazinon or Sevin are also effective. They are not, however, residual insecticides and therefore, may not completely rid infested turf of the insects.

Sod webworms and cutworms are perennial turf pests. Both have several or more generations during the summer months. An early summer treatment of Diazinon, Dursban, Baygon or Dylox will not assure continuous protection from reinfestation for the balance of the season. Repeated applications of one of them must be considered when needed.

Years ago ants were a constant nuisance on golf course greens. The use of chlordane was and is the answer to the problem. However, any one of the insecticides mentioned in the preceding paragraph will be useful in eliminating the infestation. Repeat treatments may be needed simply because they are not residual materials.

From time to time reports are heard of earthworm invasions of greens. Not since the early nineteen fifties has the Oriental species, *Pheretima hupeiensis*, been a serious pest in the northeast. The earthworm most often seen today is the common nightcrawler. Its earth castings are large and troublesome to golfers. Hence control of the pest is necessary. Chlordane will provide lasting control of the species.

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# LIME FOR TURF


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A number of physical and chemical characteristics of the soil are important in the satisfactory performance of turfgrasses. Among the chemical characteristics, soil acidity is of major importance, not only in the establishment but also in the maintenance of lawns, as well as other turfgrass areas.

Soil acidity is a characteristic that cannot be detected through taste, smell, touch or visual observation of the soil. Detection through plant symptoms is virtually impossible except in situations of extreme acidity. Acidity is determined most accurately by instrumentation and expressed in terms of pH on a scale ranging from 0 to 14. On the scale, pH 7.0 is regarded as neutral. Descending values (below 7.0) indicate increasing acidity and ascending values (above 7.0) indicate alkalinity. Ideally, the desired soil pH for best growth of turfgrasses is from 6.0 to 7.0.

Several factors alone or in combination contribute to the acidity of the soil. They include the following:

1. Leaching of calcium and magnesium by rainfall and/or artificial watering. Development of acidity through this process is most rapid in the sandy textured soils.

2. Erosion of soil by water or wind. This factor would be of little or no significance except in areas of very poor turf.

3. Plant growth. Considerable quantities of calcium and magnesium are removed from the soil by plants and utilized in their growth processes. Removal clippings tends to reduce the supply of these nutrients in the soil.

4. Acid-forming fertilizers. Fertilizers that provide nitrogen in the form of ammonia or others with sources of nitrogen that are converted to ammonia after application will leave an acid residue in the soil.

An estimated 90-95% of the acidity in the soil is attributed to the effects of leaching, erosion and clipping removal whereas only 5-10% is attributed to the use of acid fertilizers.

Leaching is the major contributing factor to the formation of soil acidity. Soil acidity is a natural condition in high rainfall regions. Most of the soils in the Northeast region are too acid for proper growth of turfgrasses. The correction of soil acidity is a prime consideration in providing a suitable medium for the establishment and growth of turfgrasses. Neutralization of soil acidity can be accomplished relatively simply, safely and economically with the use of lime.

The benefits of using lime for improvement of soils for plant growth have been established by prominent soil scientists many years ago and still hold true today in spite of recent technological advances. Many benefits which directly or indirectly favor the growth of turfgrasses may be attributed to the neutralization of soil acidity with the proper use of lime. Among the many benefits of lime, the more important ones include:

1. Provides calcium and magnesium as essential plant nutrients.

2. Reduces the availability of iron and aluminum below concentrations toxic to growth of turfgrasses.

3. Increases the availability of essential plant nutrients - phosphorus in particular.

4. Facilitates the utilization of nitrogen.

5. Increases microbial acitvity that is very influential in:

    a. Breakdown of organic matter resulting in release of nitrogen and other nutrients for plant growth.

b. Breakdown of organic nitrogen fertilizer for utilization in growth of turfgrasses.

c. Control of thatch formation.

6. Improves the structure of heavy textured soils.

The benefits of the lime are expressed in a deeper, healthier and more extensive root system of the turfgrass. When lime is lacking, the grass roots are very shallow, short and sluggish. Symptoms of soil moisture stress on turfgrass growth not only become evident sooner but also more markedly when lime is deficient in the soil. The grass blades tend to be weak and discolored. In very acid soils, turfgrass plants from either seeding or sodding are unable to survive for any length of time. The effects of soil acidity and response of turfgrasses to lime will be illustrated with a series of color slides.

The amount of lime needed to produce favorable soil conditions for growth of turfgrasses depends upon the pH of the soil and the type of soil. The acidity of the soil can be determined most accurately with a pH meter. Sandy soils will require less lime than heavier textured soils to achieve the same neutralization effect. Once the soil pH has been adjusted with lime to the ideal range (6.0 to 7.0) for growth of turfgrasses, most soils will require about 25 pounds per 1000 square feet (1/2 ton per acre) annually to maintain the pH of the soil in the ideal range.

Annual applications of lime are preferred to periodic applications such as every three years. One of the major reasons for a program of annual application is the fact that lime is relatively slow acting and may move only one or two inches per year in the soil. Annual applications will tend to keep the soil adequately supplied with lime at all times, thereby avoid the fluctuation of the pH from the ideal range to the unfavorable range. In addition, there is less likelihood of forgetting this essential aspect of a turfgrass program if performed on an annual basis. It would be advisable to obtain a pH test once every three to five years as a check on the lime status of the soil and, if necessary, make any necessary corrections in the liming program.

Two major sources of liming material are calcitic limestone and dolomitic limestone. Dolomitic limestone is suggested in situations where magnesium may be found to be deficient in a soil test. Each of these limestones is available as hydrated, burnt or pulverized (ground). The most common and practical form is the pulverized limestone. In exceptional cases, hydrated may be suggested where a rapid change in pH is desired. It should be used only when based upon soil test information.

The coarseness of the pulverized limestone affects its rate of availability. Finely ground particles are faster acting than the coarse particles and, therefore, fineness of grind would be a primary consideration in very acid soil situations. Particle size is measured in terms of mesh. Specifications for a relatively quick acting limestone material would be the one in which all particles would pass through a 20-mesh screen and at 60% through a 100-mesh. A liming material ground so fine that 100% passes through a 100-mesh screen would approximate the rate of reaction of hydrated lime. One advantage of the coarse particles is that they are easier to apply.

The application of pulverized limestone is not a critical factor except in situations where a soil acidity problem exists. As a general maintenance practice, pulverized limestone may be applied whenever it can be conveniently fitted into the program. An ideal time is to apply it during the late fall-early winter period. In situations where soil acidity is known to be a problem, it should be applied as far as possible in advance of actual need because of its slowness of action.

In conclusion, proper use of lime is basic for the imrpovement of most soils in the Northeast for the establishment and maintenance of our turfgrass areas. Its many benefits for growth of turfgrasses are distinct and cannot be provided by fertilizer. The best and most attractive turfgrass areas in the Northeast are those in which liming occupies an important position in the maintenance program.

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## HOW TO STOP GUESSING WHEN YOU BUY SEED

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I always like to start my talk with a bit of good news. Here it is: you are no longer forced to guess when you plant seeds! Is that important to you? I'm sure it is.

You see, if you guess, one out of five gentlemen will be sowing *Poa annua* up and down your fairways next spring. That's right, one out of five!

Again, if you guess, one out of twelve of you will be planting bentgrass in your fairways. One out of eighteen of you will be dropping timothy seed from tee to green on No. 7 or maybe the other seventeen. Others of you will be planting sorrell -- still others will infest your fairways with chickweed, come planting time in May.

Well gentlemen, that is what could very well happen if you continue to guess.

The title of this discussion could be: How to Stop Guessing When You Buy Seed." Now, "Taking the Guess Work out" wasn't conceived by my profession. The Department of Agriculture thought of the idea many years ago. In fact, this department established standards that the seed industry must meet in order to sell seed.

Standards established by the Agricultural Department to protect the farmer from unscrupulous seed merchants. As you know, every lot of seed offered for sale must carry a tag or label. The seed grower and seed merchant must be sure his seeds are properly labeled before they are sold. So, the grower or merchant submits samples of seed to laboratories for testing. These laboratories meet the specifications established by law, and provide the seed merchange with a certificate of analysis. Now the merchant can legally label and sell his seed.

A very nice arrangement, except ---

Except government regulations and standard laboratory tests do not give you, the professional turfmen, what you need. They remove only part of the guessing! Why? Maybe this little story will help make my point. It was told to me by one of my very good Catholic friends.

"A boy," my friend said, "went to tell his sins to a priest."
"Father," said the little chap, "I stole a rope."
"How long was the rope?" the good Father asked.
"About 3 feet," the boy replied.
"Well," said the kind Father, "Stealing a rope just 3 feet long wasn't too serious. I'm sure our Lord will forgive you."
Then, having second thoughts about the matter, the Father asked, "By the way, son, was there anything on the end of the rope?"
Silence --and finally the little fellow slowly replied: "Yes, Father -- a horse!"

Standard laboratory tests that meet government specifications will always tell you about the rope. But, more importantly you had better know about that horse.

Here is a standard tag of analysis. It means - well I guess it means different things to different people. To the merchant, it means he can legally sell his wares. To the lab technician, it means all his procedures have complied with Federal Seed Act regulations. To the buyer, to the man who will plant the seed, this tag could mean almost everything -- or practically nothing. It all depends on how much the buyer wants to know, and how much he is willing to guess.

If you want your fairways, sod, or lawn areas beautiful, with a very minimum of weed problems, then you will need all the information possible. You'll have to know! If, on the other hand, you are satisfied with average results --well then you can afford to guess a lot.

When you study this analysis tag, how much will you know, and how much will you be required to guess. Suppose we analyze this tag. It tells us, by percentage of weight, -- and that term is mighty important-- the pure seed, crop, inert, and weeds in a sample of seed. It also tells us the percentage of seeds that germinated, and date of germination test.

Now the breakdown. Item by item, here's what you'll know, and here's what you'll have to guess. Let us take a look at a tag taken from a lot of high quality, blue tag, certified Merion bluegrass seed.

| | |
|---|---|
| Pure Seed | 97.85% |
| Crop | 0.10% |
| Inert | 2.00% |
| Weeds | 0.05% |

Again, remember, all of the figures are percentages by weight. Let's go back to the top line -- Pure seed 97.85%. What does this mean to you as a seed buyer? Simply this --97.85 pounds in every 100 pound bag is pure Merion bluegrass. The other 2.15 pounds are made up of intert, crop and weeds. If you know the percentage of pure seed, and the total number of pounds in the lot, it's just a matter of multiplying the percentage by the total weight to know the pounds of pure Merion bluegrass you are getting for your dollars. There isn't much to guess about in the "pure seed" category.

Back to the tag -- This time look at crop percentage. Here we find the percentage figure .10%. Now what do you know? Well, you know that by weight there is about one tenth of one percent crop seed in the lot. You also know crop is any seed grown for economic purpose.

Anything left to guess about? You better believe there is!

First of all, what kind of crop makes up this one tenth of one per cent by weight? If you guess Delta, Park, Newport Bluegrass, or seeds of red, chewings or Illahee fescue, no problem. The plants produced by these seeds will probably never be noticed by the average layman. But, if you guess wrong -- if the crop seeds are timothy, redtop, tall fescue, ryegrass or orchardgrass -- Well, gentlemen, if you should have guessed these and didn't, you're in trouble. You seed, these are pasture grasses. Their plants are broadleafed, off color, fast growing clump or bunch grasses, and appear unsightly to everyone. When these plants start growing, don't waste time guessing what the grens committee or customers will be doing. You know --They'll be breathing down your neck!

Here is something else in the crop category you can guess -- How many seeds are represented in this .10 ɔer cent by weight? As you know, all crop seeds are not the same size. Some are large; some are quite small. Seeds are like people, they come in assorted sizes. Five hundred pounds of people could be a couple of 250 pound linesmen from Green Bay, or ten Cub Scouts who weight 50 pounds each. Same weight, big difference in numbers.

Before I go into this, however, I've got a pretty good idea of what all of you are saying to yourselves <u>right now</u>. One tenth of one percent? A little mental Arithmetic tells me, <u>you say,</u> that 1/10 of one per cent is only about an ounce and a half of crop seed in a hundred pound bag. Who's kidding who? An ounce and a half in a hyndred pound bag --I couldn't care less. Couldn't you?

Suppose you are going to seed a new fairway that is 400 yards long and 50 yards wide. .;0% by weight of tall fescue, the seeds being quite large and heavy, would be equivalent to 54,400 plants of this type up and down your fairway. Now doubt many of you are familiar with this one.

1/10 of one per cent of orchard grass would give you 364 per pound, or 72,000 seeds in your fairway of the broadleaf type of plant. That should keep life interesting.

Another old pasture grass which we see a lot of in Merion is timothy. .10% would produce 254,000 plants. This is one way to bring the pasture to your fairways.

The smallest crop seed we see is bentgrass and it is so small that .10% by weight equals 948,000 seeds in the 200 lbs. of Merion bluegrass required to seed that 400 x 50 yard fairway. Yes, that is right. 948,000 seeds giving patches of a different color and texture.

Frankly, gentlemen, .10 per cent of the crop seeds I have just discussed would be a serious problem to every one of you here.

Ten hundreths percent tells you about the rope. I don't envy you the job of guessing about the horse. A bad decision here could spoil your entire summer --maybe even next summer.

Now we come to inert -- the percentage by weight of anything that is not classified as a seed. This could be corn cob, ground up hay, sand, or chaff - we've seen them all. Here we see the figure 2.00%, The only type of inert likely to be present in the seed you are buying is chaff. Chaff is an empty hull. You see, as bluegrass or fescue plants grow in a seed field, the hull develops and the seed starts to fill the hulls at the bottom of the seed head as shown here. The hulls continue to fill up and out. At harvest time there will be some hulls that have not developed seeds -- and these hulls remain empty. It's pretty difficult to tell the empty hulls from the ones filled with seed. What appears to be good seeds is nothing more than empty hulls. Special techniques in the laboratory must be employed to distinguish between empty hulls and hulls containing a caryopsis or seed.

The relationship between weight and volume of inert material is significant. Generally speaking, volume will be more than double the weight, by percentage. Perhaps these two examples of Merion bluegrass will make what I'm talking about a little more understandable.

In a bag of top quality certified Merion bluegrass with a purity of 98.00 and 88% germination, 2% by weight or 4% by volume plus 12% dead seed gives us only 16.6% of the total volume with no planting value. Now let us look at a minimum standard certified Merion bluegrass. This would be a 92% pure with an 80% germination. Again double the weight of the inert to find the volume and we find 16% added to this 20% dead seed and you have a total of 36.6% of the bag which has no value in planting your fairway. You, of course, would have to adjust your seeding rate to compensate for the great loss in the bag. In dropping from a 98% pure, 88% germination down to a 92% pure, 80% germination, you lose 20% of the bag.

Now let's look at the last item on our now familiar tag. Here we see: Weeds .05%. Simple Arithmetic -- and you will know the number of ounces or pounds of weeds in a lot of seed. From this point on the prognosticator can really have a field day. And, I know of no place where guessing wrong carries a greater penalty. You can guess:

1. What kind of weeds are in the lot?
2. Are the weed seeds large or small? I needle grass or 24 chick-weed -- same weight.
3. How many seeds does this .05% represent in a 100 pound bag?
4. Are they problem weeds?

5. Will the weeds survive low, frequent mowing and a greezing winter?
6. Will the weeds spread out in all directions by underground stems called rhizomes?
7. Will the texture and color stand out and be unsightly -- advertising the fact that maybe I ought to pick football winners instead of grass seed?

If we take that .05% weeds and start seeding our 400 x 50 yard fairway, here's what could happen.

5/one hundreths % by weight of knotweed, when expanded to the fairway would give you 75,000 of these plants to distract from the uniformity of your bluegrass.

Again only .05% of chickweed, the seeds are extremely small. You could place 4 to 5 of them on the head of the pin. Thier smallness would account for 560,000 on a 400 x 50 yard area, or 3 seeds per square foot.

Let's take a look at an old familiar one to all. If the .05% weed happened to be all poa annua seeds, that would calculate out to 151,200 annual bluegrass to combat.

We regularly see these weeds present in that amount. It is obvious that out in the fairway not every one of these problem seeds survive. Many do not germinate, others start to grow and are not strong enough to survive. Still others will lay in the soil for some years before they come forth to plague you. However, in these great numbers you can bet your boots that enough will make it to give you real problems.

Pretty convincing proof, isn't it, that here is one area where knowing all answers can save a lot of headaches --not to mention hundred of man hours and dollars fighting weeds.

Now I'm going to show you one gram of seed. See, it fills a teaspoon about 2/3 full! This is the amount of seed the U.S. Department of Agriculture recommends to be used in making a purity analysis. Every laboratory in the country uses 1 gram of Merion seed to determine the percentage of pure seed, crop, inert and weeds. This one gram is sub-divided from a large amount of seed, and could represent 5 pounds or five thousand pounds. In spite of the very small amount of seed used, the test is fairly accurate. When I say this one gram test is fairly accurate, I do not wish to infer that it is always adequate. This is prettymuch the crux of our discussion-- What is adequate for the farmer, the home gardner, or the housewife, is by no stretch of imagination, adequate for you gentlemen, who I consider professional turfmen. Let me explain!

Suppose we take the two items you are most interested in when you buy a lot of seed; namely, weed and crop. As I said before, every laboratory in the country used 1 gram (or about 2/3 teaspoon of seed) in making the test. Now, if no weeds or no crop are found in this very small amount, naturally the tag will read "None" under the weed column, and .00% under the crop column. You, as the buyer, would ass-me when you read the tag that the entire crop was free of weeds and crop. Unfortunately, in most instances this just isn't true! If the seed laboratory were to take ten or twenty-five times the original one gram and examine this amount of seed, the analyst would come up with quite a different story. State and federal agencies recognize the inadequacy of the one gram test. To protect the buyer, these agencies specify that 25 grams be examined for certain weed seeds. Alleluia! Now your weed problems are solved. Don't believe it!

In a list of weeds the government certification agencies say the seed laboratory must look for and list as they examine the 25 grams. Most of them are strangers to you. There are two that might be a problem to you: quackgrass and wild garlic. You can forget about the rest. You'll never have a serious problem with them. You must keep in mind that this list was designed to cover all kinds of certified seed: alfalfa, red clover, wheat, soybeans, etc., not just Merion bluegrass.

What happens when the seed analyst detects other weed seeds that you and he know could be very bad in your fairway? Now remember, the government and certification instructions say to list only the weed seeds specified. Well, the analyst ignores the other weeds---that's what he was instructed to do. How many crop seeds will the analyst list as he examines this 25 grams? I'll tell you how many --None. The 25 gram examination is for certain noxious or prohibited weeds only, and that is exactly how the test is conducted. Weed seeds not on the list, and all crop seeds, are ignored in the 25 gram test.

We at Seed Technology have recognized for a long time that standard tests and simple compliance with government and certification regulations just isn't good enough! You men, you professional turfmen, are entitled to more than this from a seed laboratory. We decided to do something about this. Of course, this created somewhat of a stir among the old timers in the industry. "Why rock the boat?" they admonished, "We're doing all the law requires, aren't we?" "Innovate?" they asked, "What's the matter, aren't you satisfied with the 'good-old-ways'?"

Frankly, we were not satisfied! And, I might add, neither were the country's leading turfgrass growers, and professional turfmen like you men who are our customers. You wanted something better, and we dedicated ourselves to give it to you. From this philosophy evolved the Turf Analysis Test!

Remember, in my opening remarks I said you are no longer forced to guess? Well, here's why!

The Turf Analysis Test is designed especially for the professional turfman in the golf and sod areas. It was not structured to meet the government (either state or federal) specifications, neither was it designed for the farmer or any certification group. Let me show you a picture of the Turf Analysis Sheet. The upper one-third of this sheet is the standard purity test, meeting government requirements. The information given in this section is no better (or no worse) than the information you get on every tag.

Now, look at the bottom two-thirds. Here you see 49 of the most troublesome crop and weed seeds to the professiona turfman. This list was made up with you in mind, not people buying alfalfa, red clover or soybeans. But, even more significant than the crop and weed seeds listed, is the fact that we examine 25 grams of seed when making this analysis. Look at the difference between one gram and 25 grams. Don't you truly believe that our chances of finding crop and weed seeds in this larger amount is much greater than using the 1 gram sample? We know it is!

You might be interested in a comparison of a standard test and a turf analysis test, made of the same seed.

When we examine the standard report, we show a purity of 98.43, crop .16, inert 1.41 and .00 weeds based on 1 gram sample. True, we did not find any weeds in the 1 gram purity so none is listed. On the standard test we then examined the large 25 grams of seed for the noxious or prohibitive weeds on the certification list and again we did not find any so "None found" is typed on the report. The standard test requires the examination of only 1 gram for "other weeds and crops." This we did and reported "None found" under other weeds and .16% Kentucky bluegrass under crop. This from the surface looks like a great lot of seed and certainly no one would hesitate to seed it.

Now let's take a look at the same seed when subjected to the Turf Analysis Test. The 1 gram purity remains the same. The percentage of pure seed, crop, and weeds do not change. However, when we examine the large amount for everything present, the true picture comes to light. When we examine the 25 grams for crop we found 91 bentgrass, 72 ryegrass, 18 timothy, for a total of 181 per pound of obnoxious crop seed.

When we examine the 25 grams for all weeds and not just the few on the state's or certification lists, look what happens. Instead of reporting "None found", we list 7 different kinds of weeds for a total of 797 weed seeds per pound. Included in the 797 weeds per pound are such things as 109 seeds of chickweed. In addition the special test made under the microscope revealed the presence of poa annua at the rate of 91 per pound. Poa annua is not on the certified list, and is considered noxious in only a few states. But we know what a bug-a-boo it is to you. Trouble is, Poa annua is a member of the bluegrass genera, and to the naked eye or under low magnification, it is literally impossible to distinguish it from other bluegrass. Here's how it looks under low magnification. Can you find the Poa annua? I can't either. Put this same seed under a microscope, and it looks like this, the lower left corner. Now anybody can tell the difference. Here's the problem: the total viewing areayou see here, under the microscope, is about the size of the head of a thumb tack. Now, how do you glue 48,000 seeds to the head of tacks, and then place all of these tacks, one by one, under the scope? Obviously, this is impossible, in addition to being a little silly. But, because of the problems involved in viewing seed under the microscope, most laboratories do not search for Poa annua in this manner.

At Seed Tech, we search for Poa annua under a microscope - but I'll confess we do not glue the seeds to the heads of tacks. We have combined several vibrators with a microscope, and march the seeds in a single layer under the scope. This enables our analyst to look at more seeds under higher magnification in much, much less time. At Seed Tech, we examine 15 grams of seed under the microscope in making every turf analysis. We tell you how much Poa annua is present in every pound of seed. And, we know we're right!

Another interesting operation made in every truf analysis test is the bentgrass checks. Bentgrass is an extremely small seed, and has the tendency to lodge or stick to larger seeds and ride over the screens during the cleaning operation. Bentgrass seed is still riding "piggy-back" on the larger seed as it came into the laboratory. This means the larger seed could, and in many instances does, hide the bentgrass from the analyst's view. You just can't turn over 120,000 seeds to see what's hiding underneath. We solved this problem at Seed Tech by developing a special piece of equipment that literally shakes the bentgrass seed out of the larger seed. Since the bentgrass is smaller, it passes through special screens and is easily collected and examined under a microscope. We are the only laboratory in the country making this kind of a check.

In the turf analysis test, you get the name and number per pound of every weed seed and every crop seed found in a 25 gram sample! This includes a special 10 gram Poa annua and bentgrass check.

If you went to your family doctor for an examination along about the time the government set up the first standards for the seed industry, here is about what the good ol' doc would have done: Looked down your throat, checked your pulse and listened to your heartbeat through his stethoscope. And, that's about it. Since that time the medical profession has developed techniques, instruments and equipment that staggers the imagination. But, the poor little old seed industry sometimes finds itself operating under the illusion that to give you professional turfmen the information you want, all a modern seed laboratory needs is a reading glass, a pie pan and a pair of tweezers. Believe me, gentlemen, that day is long gone.

What will tomorrow bring? What are we experimenting with today that will make your profession more efficient and more useful tomorrow? Let me tell you about three projects. ONe is available to you now. The other two could make exciting news --maybe next year, maybe five years from now. In the future we see, first, the use of chemicals to learn if a seed is dead or alive, weka or strong. Second, the use of electronic eyes to count the seed that germinate and measure the rate of growth. Third, micro photography will enable us to make a fingerprint of a plant or single leaf and identify its variety or trueness to type.

The chemicaltriphenyl tetrazolium chloride is now being used by Seed Tech to determine the germination potential of a lot of seed and fast. You are ready to seed and you remember that you have had the seed on hand over a year and it hasn't been checked for germination. Up till now you have had two choices. One, guess how much the germination has dropped and over seed; two, seed it to a laboratory and delay your seeding for at least two weeks. Now at Seed Tech in 24 hours and the cost of a carton of cigarettes you can get the known germination and delay seeding only 1 day. This is our tetrazolium test.

The live embryo shows red, the dead seed remains white.

At the present time about all we can give you in germination is the total percentage that will grow. Two lots of seed, germination equal, can be quite different. One could be weak, slow growing lot and at ten days only 30 plants out of a hundred would have grown to an inch height with an inch long root. In the same 10 days, the other lot, a strong, vigorous, fast growing lot might have 80 plants out of ahundred with an inch high shoot and equal length root.

Here we see two lots of Merion bluegrass each with an 85% germination. Notice the great difference in the rate of growth between the two lots. With the use of electric eyes and counters we will soon be giving you an 90%-A to the lot on the left and 85%-C to the lot on the right. This could mean your cutting the critical time required to establish turf by days through choosing a fast growing vigorous lot.

The trend is for more and new varieties of grasses to become available to you. As this continues, it will become increasingly important to make certain that the variety is not some old one with a new name, and secondly, that when you pay a premium price you get what you're paying for.

There is good promise that by making a fingerprint of the leaf surface and then photographing it through a microscope, it will some day be possible to identify a single plant or possibly a single leaf, making certain that you are getting that highly desirable grass that you want. This service will no doubt be forthcoming in the future.

I had the opportunity this summer to play on one of the country's leading golf courses and complimented the superintendent on his outstanding job. In a kind of reverent tone he said, "You know it does make me proud to think that maybe I'm an instrument the Almighty used to help create this spot of beauty on the face of this earth." I'm sure that every one of you men here today feel somewhat the same way about your profession. With so much of the earth surface being bulldozed and converted to black top, glass, steel and concrete, not many men get the chance to create a spot of beauty. You men do and I salute you for it. We at Seed Tech dedicate ourselves to helping you bring beauty to the face of this earth.

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## BROAD ASPECTS OF TURF GRASS CULTURE OTHER THAN GOLF COURSES

Geoffrey S. Cornish
Golf Course Architect
Amherst,MA.

Although I have been at most Massachusetts Turf Conferences since 1937 this has been the first alternate session I have ever attended. May I say I am most impressed with the excellent program and with the speakers Dr. Troll and Charles Mruk have brought to today's session. Unfortunately James Holmes cannot be here today but I will do my best to pinch hit for him.

As one who has been connected nearly all his life with turfgrass, I feel strongly that progress in our field has been truly miraculous.

Look what we have today compared to two decades ago! In 1946, to the best of my knowledge, the following were virtually unknown or present in primitive form only - mechanical rakes, rock pickers, many implements for lawn grading, vertical mowers, topdressing machines, rapid aerating devices, automatic irrigation, hydro seeders, high analysis fertilizers, ureaform fertilizers, pre-emergent herbicides, many fungicides together with many insecticides, and calxined clays. Also power mowers, power sprayers and other implements were nowhere near as great as they are today. As an aside I would like to observe that one of our speakers yesterday, Dr. Fred Grau, was connected in one way or another with a remarkable number of the foregoing developments together with the introduction of Merion Kentucky bluegrass.

In 1950 this bluegrass, then known as B-27, the first major breakthrough in improved Kentucky bluegrass varieties was just coming on the market. Today not only has it proved successful but we have several other outstanding Kentucky bluegrasses. A few of these are Fylking, Windsor and Pennstar. The fine bladed ryegrasses, three of which are Pelo, Manhattan and Norlea are far superior in appearance and length of life than the old coarse perennial ryegrasses. And Pennlawn creeping red fescue is certainly an improvement on the odler ones. In the South in 1950 research was just starting on the fine bladed Bermudas which have done much for turfgrass on high quality lawn areas in that region.

On the negative side we must face the fact that the supply of available topsoil is running out in many urban areas. But even then it has been established that with care and adequate testing a fine topsoil for most turfgrass areas, particularly irrigated ones, can be manufactured by mixing sand, peat and calcined clay in correct proportions. A most serious dilemma the turfgrass industry faces today is restriction in use of many pesticides. As a perennial optimist, however, I feel that this will eventually work out for the best.

Despite amazing progress and all the miracles that have been given us, I emphasize that the fundamentals of growing and maintaining turf are the same today as they always were. It is therefore worthwhile to review several fundamentals for constructing and maintaining turfgrass areas.

First, during construction a most thorough and painstaking job is required. On all superior turfgrass areas we must give consideration to the subbase, subdrainage and to surface grades. And in my opinion more often than not insufficient fertilizer is added prior to seeding. And I recommend at least 6 pounds each of N, P and K for this purpose. As Dr. Indyk has so capably brought out in his presentation this afternoon, lime is absolutely necessary on nearly all lawn areas in the North East. To determine how much is needed a pH test is required. In addition to lime and fertilizer we should also consider the addition of organic matter and or calcined clay. For example, we often add three to six standard bales of peat per 1000 square feet.

Once seeding is complete consideration must be given to irrigation, early feeding and early mowing. In regard to grasses for high quality lawn purposes, I feel Merion Kentucky bluegrass is still the best bet for Massachusetts and for that matter most of New England. However, I am impressed with many newer varieties such as Windsor, Fylking and Pennstar. I also wish to emphasize that we are putting all our eggs in one basket when we use one of these bluegrass varieties alone or even in mixtures with shorter lived fescues or ryegrasses. Blends of bluegrass plus creeping red fescue and perhaps ryegrass are nearly always more satisfactory over the long haul. Or one of the improved varieties plus common Kentucky bluegrass appears to provide a more disease resistant turf.

Many lawn areas are still damaged thru faulty mowing practices including too close clipping, irregular mowing and cutting with a dull or poorly adjusted machine. And as Dr. Grau emphasized yesterday, even the best turfgrass can be ruined through improper watering practices.

The majority of New England turfgrass areas exist in a virtual state of starvation. Three to four fertilizer applications a year to provide three or four pounds of nitrogen plus P and K are needed per 1000 square feet for most lawn areas to bring soil fertility to the desired level. Liming every third or fourth year is required. Also it is important to realize that bluegrass turf maintained at a high level of fertility must be dethatched periodically.

In summary I would like to restate three points.

(a) Many miraculous items of equipment and materials together with new grass varieties are at our disposal for turfgrass culture.

(b) The residual effect of pesticides does indeed confront us all with a dilemma.

(c) Despite miraculous advances the fundamentals of propagating turf and maintaining it are the same as they always have been.

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## ESTABLISHING AND MAINTAINING TURF IN THE NATIONAL CAPITOL PARKS

Alton E. Rabbitt
Management Agronomist
National Capital Parks
Washington, D.C.

Washington is one of the most difficult areas in the entire United States in which to grow good turf. This is due to its being on the extreme southern limits of northern grasses and on the extreme northern limits for southern grasses. When the temperature reaches the nineties and humidity is high, many of our northern grasses are thinned out or killed by diseases. Once the grass has been thinned out it is only a matter of weeks before annual weeds and crabgrass take over. However, good turf can be established and maintained in this area but it requires good planning and management.

Many new turf areas turn out unsatisfactorily because they are not properly planned. It is safe to say that over 60% of all labor, materials and money spent on lawns is wasted and many of the failures in turf are due to ignorance of the fundamental principles of good sound turf culture. Failure to combine good planning with good sound agronomic methods usually results in failure to establish the desired cover. Most important among the fundamental principles involved in good turf culture are:

1. Improvement of physical condition of soil
2. Adequate seed bed preparation
3. Planting in proper season
4. Correct choice of grass species
5. Seeding at proper rates
6. Avoidance of two competitive nurse grasses
7. Adequate fertilization and water management
8. Sound maintenance programs

Lack of any of these items generally means failure to maintain a good stand of grass.

The first step in planning a new turf area is to have the soil tested for the need of lime, phosphorus, potash, calcium and magnesium. When soils test below pH 6.5 ground limestone should be added. It should be incorporated into the soil to a depth of four inches on new areas. Late fall is the best time to apply lime on established turf. However, it can be applied anytime during the year.

<u>Soil.</u> The ideal soil for grass is a sandy loam, high in organic matter. However, this ideal soil is seldom available. It is more economical over a period of years to improve the physical conditions of poor soils at the time of construction rather than to maintain grasses under adverse soil conditions. The physical conditions of heavy clay soils can be improved by applying soil amendments such as sawdust, peat, sludge, or manure with sand. These materials must be thoroughly mixed into the soil. Sandy soil can be improved by incorporating some form of organic matter in the top 4" of existing soil. The quantity of sand and organic matter needed will depend on the existing soil.

<u>Seed Bed Preparation.</u> I cannot stress the importance of proper seed bed preparation enough. Establishment of a stand of grass is no different than any other crop. A farmer always prepares the seed bed prior to planting a crop. During World War II hundreds of acres had to be replanted because the grass or seed was sown on hard compacted seed bed. This applies to the establishing of new turf as well as renovating old turf areas. The soil should be thoroughly pulverized prior to seeding to a depth of six inches. In the renovation of an old established turf, the area should be thoroughly spiked in order to bring the seed into direct contact with the soil. Broadcasting seed on hard surface is waste of seed, time and money.

<u>Time of Seeding</u>. Timeliness of seeding in Washington area is one of the most important principles in establishing a good stand of grass. Inspite of the fact research agronomists have endeavored to teach the public the

importance of fall seeding when using northern grasses, still more northern grass seed is sown erroneously in the spring than in the fall. On the other hand, the southern grasses such as Zoysia and the fine strains of Bermudagrass 328, P16 and U-3 should be planted in the spring or early summer. Planting out of season usually results in partial or complete failure. My experiment on the rate of Seeding and Fertilizing which I conducted for National Capitol Parks in 1939 demonstrated the relative importance of seeding permanent northern grasses in the fall of the year. The plots were established on a heavy clay loam soil, poor in all essential plant food elements with a pH of 5.5 and with an available phosphoric acid between 10 to 15 pounds per acre. 3000 lbs. ground agricultural limestone and 500 pounds of 0-20-10 were applied per acre and disced into the top 4" of soil prior to final grading.

The series of 10' x 10' plots were established in triplicate in September and as early as possible the following April to determine the significance of time of seeding. In each series, 10-6-4 fertilizer, of which 25 per cent of the nitrogen was from organic sources, was applied to the surface of the prepared seed bed at the rate of 400, 800, and 1600 pounds to the acre. Kentucky Bluegrass seed-creeping red fescue mixture was sown at the rate of 40, 80, 120, 400, and 600 pounds to the acre and plots fertilized at each of the above rates. At each seeding rate, control plots to which no fertilizer had been added were also established.

The plots were rated monthly throughout the growing season for density, color and weed population. In the fall series, the best plots after two months were those receiving seed at the rate of 200, 400 and 600 pounds per acre and fertilizer at the rate of 1600 pounds to the acre.

In June at the end of nine months, however, all plots receiving fertilizer at the rate of 1600 pounds to the acre were equally superior with the possible exception of those seeded at the rate of 40 pounds to the acre.

At the end of one year the results were the reverse of those observed after the first two months. The best plots were those seeded at the rate of 40, 80 and 120 pounds and fertilized with 1600 pounds of 10-6-4 fertilizer at a cost of $37, $47, and $57 per acre respectively, and not those heavily seeded at 400 and 600 pounds though equally heavily fertilized at a cost of $159 and $173 per acre. (Costs based on Government prices for seed and fertilizer in 1939.)

The heavily seeded plots of 200, 400 and 600 pounds per acre which produced the best turf throughout the first fall, when heavily fertilized, were badly damaged by leaf spot and other diseases in June and by September were 50 per cent weeds. The plots seeded at a rate of 40, 80 and 120 pounds per acre and heavily fertilized were free of disease, and at the end of one year were practically free of weeds.

The spring seeded plots demonstrated conclusively the wisdom of fall seeding in the vicinity of Washington, D.C. The plots seeded in April were 95 per cent crabgrass by fall whereas the fall seeded plots produced turf that was practically free from crabgrass.

The Choice of Species of Grass. There is no one best seed mixture (northern grasses), just as there are "no wonder grasses", which will solve all of your problems. Plant the species of grass that will do best for your soil and its intended use. The quantity of seed planted will have the utmost bearing on the results. Avoid the use of nurse grasses when possible. The following seed mixtures are used in the National Capitol Parks.

Sunny Areas

| | |
|---|---|
| Merion Kentucky blue | 25 % |
| Kentucky blue | 65 % |
| Creeping red fescue | 10% |

Shady Dry Areas

| | |
|---|---|
| Creeping red fescue or Pennlawn | 80 % " |
| Kentucky bluegrass | 10 % |

Shady Wet Areas

| | |
|---|---|
| Poa trivialis | 70 % |
| Creeping red fescue | 30 % |

Important Sunny Areas such as Lincoln Memorial

| | |
|---|---|
| Merion bluegrass | 25 % |
| Kentucky bluegrass | 60 % |
| Creeping red fescue | 15 % |

Dense Shady Areas

| | |
|---|---|
| K-31 fescue | 100 % |

Bank and Road Shoulders

| | |
|---|---|
| K-31 fescue | 80 % |
| Kentucky bluegrass | 20 % |

Rate of Seeding. The rate of seeding depends upon time of seeding, size of seed, and whether one is seeding a new area or an old established lawn. When seeding new areas, apply 2 to 2 1/2 pounds per 1000 square feet. However, when the seed mixtures contain large seed, such as fescue, the rate should be 5 to 7 pounds per 1000 sq.ft. When overseeding old turf areas the rate of seeding should be reduced to one-half of the above ratio.

Adequate Fertilization. The need for adequate fertilization cannot be over-emphasized. More poor turf is due to lack of fertilization than any other single factor. A liberal supply of fertilizer at the time of seeding and at least twice each year is a must for establishing and maintaining a dense weed-free turf. In order for the fertilizer to be able to do its job other factors and conditions must be favorable. The fertilizer program used by the National Capitol Parks is to apply lime if needed and 500 pounds of 0-20-20 - work in 4" - and 1000 pounds of 10-6-4 per acre on new seeded areas. A 10-6-4 commercial fertilizer of which not less than twenty five per cent of the total nitrogen is from organic sources is used, on established turf. We apply 300 tons of fertilizer by contract to establish turf each year. In our important lawn areas 500 pounds per acre is applied in late September and again in early March.

Management. The importance of good management cannot be over-emphasized. A piece of turf is only as good as the man who manages it. Dense weed free sod can be destroyed by improper fertilizer, mowing, water and management. More turf is lost in this area due to too much water rather than lack of water.

--Note: Color slides were shown to illustrate the various phases of the talk.

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# PREVENTIVE MAINTENANCE ON SMALL ONE CYLINDER AIR COOLED ENGINE

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It has been reported that there are nearly 70,000,000 small one cylinder air cooled engines in use now in the United States. Indications are that this number will increase substantially in the years ahead.

In spite of the polularity of small engines, they are often criticized, due to lack of understanding of how an engine operates. Most criticisms for small engines are generally unfounded and trouble is generally due to the lack of proper preventive maintenance. Nearly all small one cylinder engines are designed to operate continuously at or near top speed, yet who would think of operating an automobile at top speed all the time. A small one cylinder engine operating at 3600 R.P.M. is equivalent to an automobile travelling at 82 miles per hour. Many small engines operate near the ground where they are far more susceptible to dust and dirt and do require good preventive maintenance. Preventive maintenance on small one cylinder air cooled engines is the subject of my talk this afternoon.

Let's explore what the words preventive maintenance mean. Webster describes the word preventive as: tending to prevent, that which prevents. (Tape recording of train going through crossing.) Just being able to hear the whistle of the train and the bells ringing, means that you have stopped, looked, and listened and thus have prevented a tragedy. Webster describes maintenance: as that which supports life. (Tape recording of baby crying). Here is really a demand for maintenance as many of you have experienced. It could mean feeding the baby or changing a diaper. Now let's put the two words together and see what they mean. Preventive maintenance is the act of doing something before it becomes a serious and costly situation. Preventive maintenance is brushing your teeth. Preventive maintenance is lubricating your car. Preventive maintenance can be a program to prolong our lives and this depends on the level of maintenance you apply in keeping your body in good physical condition. Preventive maintenance in this case, is eating the proper food, and getting the proper exercise and rest. Your life expectancy depends on the level of maintenance you apply in everyday life. The same thing applies to the service life of any small air cooled engine. So why not have such a program! Before we can work out a preventive maintenance program we must know the engines we have and how they function and what must be done to attain the maximum service life from them to prevent costly breakdowns.

There are two types of one cylinder air cooled engines in use today.

(Slide of two cycle engine) - The two cycle engine shown on the screen is a single cylinder engine and has a power stroke with each revolution of the crankshaft. The use of the intake and exhaust ports when covered and uncovered by the movement of the piston, performs the same functions as the intake and exhaust valve in a four cycle engine. The movement of the piston across the intake and exhaust ports controls the filling and emptying of the combustion chamber. Lubrication of all moving parts is assured by a fuel mixture of lubricating oil and gasoline. The mixture of fuel moves from the fuel tank into the carburetor, where it is mixed with air and drawn into the crankcase.

(Slide #2 - Double slide) - As the piston moves away from the crankshaft, a slight vacuum develops in the crankcase. At the end of the stroke, the piston direction reverses and while moving toward the crankcase a slight pressure is built up. When the piston moves far enough the intake ports are uncovered to allow the fuel mixture to enter the cylinder from the crankcase. Both ports are covered by the piston except for a short period at the extreme end of the stroke near the crankshaft. The charge is compressed as the piston again moves away from the crankshaft sealing the intake and exhaust ports. Just before the piston has completed the compression of the fuel mixture, at the end of the stroke and away from the crankshaft, the high voltage spark ignites the compressed fuel charge. As the burning gases expand it drives the piston away from the cylinder head to produce the power stroke of the crankshaft. And drives out the exhaust gases through the exhaust ports on the other side of the engine. This two stroke cycle is repeated each time the piston reaches the end of the stroke and uncovers the exhaust and intake ports.

(Slide of the carburetor) - The carburetor blends a combustible mixture of fuel and air for ignition, which takes place in the cylinder. Fuel is metered to a stream of air flowing through the venturi into the crankcase. The proportion of fuel to air is controlled by a needle valve. The proportion of fuel to air is important to cause efficient burning of the fuel. Excessive fuel produces partial combustion due to insufficient air to fuel ratio, which will result in a sluggish operation of the engine. An excessive air mixture produces a hot burning of the fuel, which will result in a loss of power. The float chamber maintains a steady supply of fuel for the fuel to air mixture. The filling of the float chamber raises the float to shut off the flow of fuel. As the fuel is used the float settles downward and opens the supply line to refill the chamber to its proper level.

(Slide of the magneto) - A flywheel type magneto along with a high tension wire and a spark plug supplies the energy for the ignition system. The magneto, a stationary self contained generating unit, includes the armature plat assembly consisting of iron core laminations, ignition coil, condenser and breaker point assembly. The permanent magnets built into the flywheel revolve around the stationary stator plate on the engine. As the ends of the magnet pass by the iron core laminations, a magnetic flux is established through the two legs of the iron core. The current is generated in the primary circuti during the period that the breaker points are closed. The cam, located on the crankshaft, opens the points when the primary current is at a maximum. The condesner, is the storage place that absorbs the current which tends to continue after the breaker points have opened. The condenser hastens the collapse of the magnetic field and reduces the burning of the breaker points by asbosrbing the sparking across the points. The collapsing of the magnetic field induces a high voltage through the secondary winding of the coil, which is then carried through the high tension wire to the spark plug. The high tension charge then jumps the spark plug gap and ignites the fuel in the cylinder. Each revolution of the crankshaft repeats the cycle of ignition.

(Slide - Governor Assembly) - The governor assembly, which controls the speed of the engine, is a simple unit consisting of a governor vane located adjacent to the flywheel and is connected by linkage to the carburetor throttle lever. The air current produced by the flywheel causes the governor vane to function. The governor spring acts as an opossing force on the vane. A balance between the force of the air on the vane and the governor spring is created in this way, maintaining a selected speed. If the speed of the engine drops due to a sudden load, the air current produced by the flywheel is reduced. Since the force exerted by the governor spring is greater, it reacts on the throttle lever and opens the throttle and provides more fuel and air to the engine. The engine speed increases until the equilibrium of the force of the air and the governor spring is at a proper balance for the new load condition.

Now let's see how a four cycle engine operates.

(Slide of the 4 cycles) - Its cycles of operation are intake, compression, power and exhaust. Its characteristics are somewhat different than a two cycle engine, in that it takes two revolutions of the crankshaft for every power stroke.

(Slide #8 - Intake) - The fuel is supplied to the intake chamber by the carburetor. At the beginning of the intake stroke, the piston is at the position closest to the cylinder head, thereby filling the cylinder space and reducing the open volume of the cylinder and the combustion chamber to a minimum. As the piston moves to the crankshaft and with the intake valve open, the fuel is drawn into the cylinder.

(Slide #9 - Compression) - On the compression stroke, with the fuel in the cylinder and piston at the bottom, or the point closest to the crankshaft, the intake vale closes. Since there is no other opening, the fuel is compressed as the piston travels towards the top of the cylinder. Just before it reaches top dead center, or the point where it is furthest from the crankshaft, the charge is ignited.

(Slide - Power) - As the fuel burns in the cylinder, heat is released causing a rapid buildup as the gases expand, the pressure on the piston causes it to move downward, through the connecting rod and delivers energy to the rotating crankshaft.

(Slide #11 - Exhaust) - At the end of the power stroke, the exhaust valve opens and as the piston moves upward, the exhaust gases are forced out of the cylinder. The exhaust valve closes at the end of this stroke and the engine is ready to repeat the cycle.

(Slide - 4 cycle engine cutaway) - The four cycles are kept in time by the camshaft which is driven by the crankshaft. Four cycle engines operate on straight gasoline and rely upon the oil in the crankcase to supply the lubrication to the moving parts. Either by a splash system or a pump, which forces the oil trhough drilled passages to the necessary areas, in contrast to the two cycle engine, which operates on an oil and gas mixture.

(Slide - Compression Release ) - Some four cycle engines have a compression release for easier starting. It is accomplished by removing the spark retard to eliminate the kickback. The exhaust valve is triggered to open at a low cranking speed, allowing the compression to escape slightly, and when the rotating spped of the crankshaft exceeds a specific RPM the engine fires, the decompression action ceases, and the engine operates in the conventional manner.

(Slide #13 - Wet fouled plug) - A two cycle engine will reveal certain characteristics that are the result of improper maintenance or faults of operation that will aid you in properly servicing it. For instance, operating an engine with too rich a fuel mixture or use of a poor grade of lubricating oil will accelerate carbon formation on spark plugs, cylinder head, piston, exhaust and intake ports. Carbon formation at any of these points will reduce the engine power considerably.

Recognizing operational characteristics is a time saver when trying to diagnose a problem. Read the engine manual supplied by the manufacturer as it contains invaluable information to help you save time and money in keeping your engine in good running order. The level of maintenance you apply to your engines will determine its service life, and the higher the level of maintenance the lower the service.

(Slide #14 with two engines and empty buckets) - We will now illustrate why it is important to have a good preventive maintenance program. This slide illustrates the importance of servicing an air cleaner. For every gallon of gasoline that is consumed by the engine, it will consume approximately 5,000 gallons of air. An engine with the dirty air cleaner would have a very difficult time trying to do the same job as the engine equipped with a clean one. A dirty air cleaner upsets the balance of the air to fuel ratio. If an air cleaner is only 59% efficient, it will reduce the efficiency of the engine by at least 1/3 of its horsepower rating. This is caused by the fuel mix having a tendency to become rich in relation to the air to fuel ratio. There simply is not enough air for the amount of fuel going into the engine and when this takes place the governor will open the throttle plate and deliver more fuel to the engine, as the engine cannot utilize the extra fuel it will cause a premature buildup of carbon in the exhaust port and cylinder area. There will also be a noticeable loss of power. Spark plugs will also foul prematurely. It also raises the operating temperature of the engine and you can expect higher maintenance costs and a shorter service life.

Hence the number one step on your preventive maintenance program should be: Keep the air cleaners clean!

## Why an Air Cleaner

There is a need to prevent undesirable elements from entering the carburetor and engine combustion chamber. This is the air cleaner's primary function. One might think of the air cleaner protecting the carburetor, but the internal moving parts of the engine are even more important. The main need for an air cleaner is to provide clean air. The amount of protection it supplies will be relative to the engine service life.

Probably one of the more common applications of an air cleaner that we are familiar with is the one used on an automobile upon which a large cleaner is usually supplied in order to silence air intake noise. In addition, the air cleaner is located high off the ground and is completely enclosed under the hood which allows a minimum of maintenance because of the comparatively clean atmosphere due to super highway road conditions and being in a closed area. Most equipment using one cylinder air cooled engines have the air cleaner located fairly close to the ground and usually in an open area and it is subjected to operation in continuous dirt and dust. Here is where the importance of maintaining an air cleaner is of the utmost importance, and frequent maintenance cannot be over emphasized. Dirt induced through improperly installed, improperly serviced or inadequate air cleaners, wear out more engines than any other cause including long hours of operation. Even a small amount of dirt will wear out a set of piston rings in a few hour's time. Fine particles of dust mixing in the combustion chamber with gas and oil act as a grinding compound, causing rapid piston ring wear, resulting in loss of engine compression and power. High oil consumption usually follows and many times results in running the engine completely out of oil and damaging the internal working parts. This results in replacement of the major components such as crankshaft, cylinder block, pistons, connecting rods or a complete replacement of the engine.

Let us examine the three types of air cleaners commonly used. They are: oil bath, oil wetted, and dry type.

Oil Bath Air Cleaner -

The most common type of oil bath air cleaners is a single stage design made up of two parts.

1. The container or cup section, usually the bottom, is used as an oil reservoir and acts as a pre-cleaner. This section is first to contact incoming air.

2. The mesh section is made up of a container enclosed around the filtering material. Animal hair is commonly supplied. This is oil wetted from the reservoir by the air drawn in by engine vacuum. Change of air direction helps pull some of the oil from the reservoir into the mesh section. The mesh section is the actual filter part of this type of cleaner, and must contain oil to do a good job.

The function of the air cleaner is to trap impurities and prevent them from entering the internal parts of the engine through the carburetor. Drawing of the air over the reservoir and through the mesh section provides the filtering action. Due to the construction of this type of cleaner, its ability to do a proper job is affected by several variable factors:

1. The oil bath air cleaner reaches its highest efficiency at a constant high speed, that is, when a maximum flow of air is drawn into the engine. Consequently, at low engine speeds or at idle a small amount of air is pulled in and the ability to properly filter this air is reduced since the oil is not drawn up into the upper mesh section.

2. The same thing happens when the oil, in the reservoir, is below the prescribed limit. It will not be drawn into the mesh or filtering section and efficiency is drastically affected. Conversely, if the oil level is too high, oil and dirt can be pulled up into the mesh section and into the carburetor causing an imbalance in the fuel mixture. This will result in poor engine efficiency, loss of power, and if continued damage to internal working parts from contact with raw gasoline and dirt.

3. The viscosity or heaviness of the oil, which is affected by temperature, is also a critical factor. When the oil is too heavy, it cannot flow easily and be pulled up. In the cases where the oil is too light, it will run off the mesh too quickly - reducing cleaning ability.

4. Over a period of time, the dirt load in the oil will affect the oil level and, of course, increase the thickness of viscosity of the oil. Here again, a filtering efficiency is affected and need for maintenance is evident.

5. The oil reservoir requires a level installation in order to function correctly. As mentioned, a high or low oil level has an adverse affect. Level change can be created by tipping the reservoir, thus impairing cleaner efficiency; this means that this type of air cleaner is limited and that angle operation of equipment will have a direct affect on air cleaner efficiency.

In summing up, we have learned that many factors affect the function of the oil bath air cleaner, temperature, position, engine speed, maintenance - All must be watched carefully in order to have maximum performance for this type of cleaner. Expressing efficiency of the oil bath air cleaner in percentages, one could feasibly state a variance from 50% at a low to maximum of 95% under ideal conditions.

Oil Wetted Air Cleaners -

This type of air cleaner is generally a small container and uses a filter material that can be impregnated with oil. In the past a ribbon mesh section has been used and more recently a common oil wetted type is a polyurethane or plastic sponge material that is easily impregnated with oil.

The principle here is similar to the oil bath cleaner, except that the oil used is impregnated in the material itself rather than stored in a reservoir. This means that dirt and abrasives are expected to stick to the film of oil as air is pulled through into the carburetor. Due to the size of these cleaners, a limited amount of surface area is available which means that frequent cleaning and re-oiling is a <u>must</u> in order to maintain any sort of efficiency to protect the engine.

1. The polyurethane material - a spongy plastic - surface area functions with some satisfaction under ideal conditions. In the case of heavy dirt and dust penetration, the air cleaner will quickly lose its efficiency once the oil contained in the surface is stuck with dirt. Some of the finer particles can

then pass on into the engine, or if the dust and dirt are extremely heavy, clogging will occur - which changes carburetor mixture and requires a need for cleaning and re-oiling.

2. The efficiency of oil wetted air cleaners varies from something less than 50% up to 90%. Due to their small size, frequent maintenance is necessary if the engine is used in an atmosphere containing any amount of dirt.

Dry Paper Air Cleaners -

Dry type air cleaners have come into their own in the past few years. The element itself contains accordion pleated special filter paper which is molded between two plasticol end seals. These seals are used as gaskets as the element is placed between inside and outside containers. To reinforce the paper section an expanded metal shield or a wire screen is also cast into and between the plasticol end seals.

When placing the element in its housing, the important thing is to provide a positive seal on both sides - insuring that all air entering the container must pass through the paper pleated filter. As long as the element is properly held in place and the gasket surfaces are not damaged, all air passing through the paper will be filtered.

1. The dry type air cleaner has an initial efficiency of 97% and this efficiency actually can improve with use between recommended replacement intervals. This is possible as the initial dirt load building up on the paper surface acts as an additional layer or filter material.

2. This type of cleaner has a constant filtering efficiency at all speeds and does not depend upon variable factors which can affect the oil bath and oil wetted types; that is, temperature and angle operation.

3. Since no fluid is used in the operation of the cleaner, position is not important, and temperature will not have an affect on the filtering efficiency.

4. Dry type elements can be cleaned and reused if carefully done by tapping and dislodging loose particles, or carefully using compressed air - providing that the air pressure does not rupture the paper surface. Replacement of the element is usually dictated by engine power loss and, therefore, replacement is a clean and easy way of maintaining continuous equipment operation with a maximum of protection.

It is apparent from the foregoing illustrations and discussions that maintenance is the key to useful service life in any equipment - large or small. We hope that our discussion will make us all more aware of the importance of the air cleaners in our day-to-day use of the small air-cooled engine.

(Slide - Mower suffering) - Every piece of equipment that uses a small air cooled engine is designed to operate at certain speeds. We know some operators bend the carburetor linkage and change the factory setting of maximum speeds to obtain a faster travel speed. If this is done and the engine is operated above the recommended speeds you are definitely going to experience premature wear and overheating of the engine.

(Slide - Mower engine overheating) - We have been talking about small one cylinder are cooled engines. Air cooled simply means it is cooled by the air flowing around the cylinder fins. The amount of cooling is determined by the amount of air that can be drawn in by the rotating fins of the flywheel and forced around the finned area of the cylinder. The proper cooling of the cylinder will result in complete burning of the fuel. A thorough burning of the fuel results in less carbon which prolongs the service life of the engine, and the general result is lower maintenance costs. I don't think anyone operates an automobile for any length of time with a blanket over the radiator, because he knows what would happen. Yet, some people will allow the cooling fins on their air cooled engines to become blanketed with dirt, grass and other debris and do nothing about it until the engine overheats and seizes. This is one of the quickest ways to shorten the service life of the air cooled engine. Keep the cooling fins and air intake screens clean so the engine can operate at the proper temperature.

(Slide - Compression) - The compression in the engine is determined by the amount of seal between the piston rings and the cylinder wall. Pulling on the starter cord is a way to determine if there is any compression by the resistance you feel when pulling the cord. A compression reading may be obtained by inserting a compression gauge in the spark plug hole and pulling the starter cord. A higher than normal reading will show, if there is an excessive amount of carbon in the cylinder. A lower than normal reading will indicate cylinder bore and ring wear.

(Slide #15 - Fuel - New Mower - Old Car) - Always use a fresh grade of regular gasoline. The important word here is <u>fresh</u>. Gasoline stored under the most ideal conditions may start to go stale in 30 days. Stale gasoline has a high gum content which can clog carburetor passages and restrict the fuel flow. The octane ratings of stale gas also drops to the point where it will cause incomplete burning in the cylinder, thereby causing hard starting and rapid carbon buildup. The use of the oil that is recommended by the engine manufacturer is very important, as they have spent many hours testing all types and grades of oil so why experiment with anything other than what is recommended. Keep in mind some engine manufacturers recommend one grade of oil for two cycle engines and another for four cycle engines as the operating temperatures of the engines may be quite different. Therefore, it's important to use the recommended oil!

(Slide - Assorted Spark Plugs) - The use of the spark plug recommended by the engine manufacturer is vitally important in getting the most out of your engines. The spark plug they recommend is balanced to the magneto or the ignition system and also designed to thoroughly burn the fuel in the engine.

(Slide) - If a spark plug has a lower heat range than recommended, carbon deposits will accumulate on the insulating surface in the bore. These deposits will cause the spark plug to misfure or short out. A spark plug with a higher heat range causes rapid erosion of the electrode and could cause a breakdown of the ignition system or can cause preignition and piston seizure. Many spark plugs are thrown away long before they should be. The plug is not always the answer to why the engine stopped. But it easiest to replace the plug and if it starts okay you keep going, but have you solved your problem? When an engine stops, don't just replace the plug, check the complete ignition system and be sure to use the saprk plug recommended by the engine manufacturer.

(Slide - cehcking spark 3/16" away) - One simple way to test the ignition system is to remove the high tension lead wire from the tip of the spark plug and hold it approximately 3/16" away, pulling on the starter cord should produce enough voltage to cause a spark to jump from the high tension lead wire to the tip of the spark plug. (Describe the test plug.) If this occurs, the ignition system is functioning and the problem is elsewhere. What should you do if there is a spark and the engine won't start? Remove the spark plug from the engine and inspect its condition. The electrode should be free of any carbon deposits and the electrode should not be burned. At this stage check the gap of the plug. The carbon around the insulator should be light tan which signifies a complete burning of the fuel.. Oily black carbon signifies a deficiency in the ignition system. If you are using the correct spark plug in the correct heat range and these carbon deposits show, also an inspection of the points should be made and if you find the points burned, replace them, you also should replace the condenser at the same time. The condenser is not acting as the storage place that it should, hence the entire voltage is burning the points. This is one of the reasons that in automotive practice both points and condenser are replaced at the same time.

(Slide - Adjusting carburetor with big screwdriver) - The most common problem relative to a field breakdown of a one cylinder engine is failure of the carburetor to function properly. Most failures are due to some type of contamination in the fuel system such as dirt, rust, grass, water or other forms of non-combustible liquids or the use of incorrect tools. What usually happens when an engine stops running. The operator usually starts tampering with the carburetor. It is good procedure to analyze the problem before you add another one by tinkering with the carburetor. How did it act before it stopped running, is a question that should be considered. Was it running fine and than all of a sudden stopped? Is the gas tank empty? Then let's check the gas cap and see if the vent hole is open. Some carburetors have a spring loaded drain and depressing this will assure you there is fuel in the carburetor bowl. The next step is to check out the ignition as we previously covered. Recheck the carburetor needle settings and always refer to the manual for proper setting. Always keep in mind when you are checking out an engine you must have an intake of fuel, compression of the fuel, ignition of the fuel, and a free passage for the exhaust gases to escape. All four of these phases must operate efficiently at all times in order for the engine to put out its rated horsepower.

Let's compare the one cylinder engine with the engine in your car, which has six or eight cylinders. If one of the cylinders in your automobile has a deficiency in any of the three phases it has either five or seven other cylinders to help carry the work load. In a one cylinder engine there are no helpers, so all phases must operate efficiently at all times and this requires a periodic preventive maintenance program.

(Slide - showing two men working) - As we go through life we all tend to acquire some bad habits. These bad habits may be in preventive maintenance or it could be our approach to trouble shooting practices. It usually takes an outsider to spot these bad habits. Some individuals use the helter skelter method of jumping from one end of the engine to the other. Others use a systematic approach to analyze a problem. The helter skelter mechanic will get the engine running but probably missed another trouble maker and after a few hours another breakdown occurs and breakdowns are costly. The other type mechanic using a systematic method will find the trouble makers and correct them and there will be no further breakdowns when the equipment is needed. You can analyze a problem much faster and easier with your mind than you can with your hands. Acquire the knowledge necessary to develop a systematic approach and then apply it.

(Slide - Power mower - new automobile) - Let's make a comparison of a one cylinder two or four cycle engine with an automobile engine relative to preventive maintenance. If you were to run the one cylinder air cooled engine at 3/4 or full throttle for the equivalent of 8 hours a day for a period of 30 days, this would be quivalent to 20,000 miles of weat and tear on an automobile, according to the Ethyl Corporation. Let's look at the preventive maintenance that was probably done during these 20,000 miles. Most every time you stopped for gas the oil was checked. The cooling system was checked. The attendant probably made a visual inspection of the fan belt and would you believe, sometimes they even clean the windows. Also during these 20,000 miles the oil was changed at least 10 times and the chassis lubricated at the same time. The spark plugs, points and condenser were replaced at least twice, and the air cleaner element should have been replaced at least twice. Automobile engines operate in a much cleaner atmosphere than any of your engines and they are expected to give the same kind of service as your automobile. And they will, if you will give them the same level of maintenance as you do an automobile engine.

In summary, always use the proper grade of fresh gasoline and the proper grade of oil and if the engine requires a mixture of gasoline and oil, mix it according to the manufacturer's instructions. Don't over-lubricate the fuel.

Keep the cooling fins clean. Service the air cleaner as often as the engine manufacturer suggest and in some areas it may be required to do it more often. And above all do not overspeed the engine for any length of time.

In conclusion, a good, well planned preventive maintenance program will provide you with many extra trouble free hours of operation. It will avoid costly breakdowns when the equipment is needed. Remember - the level of maintenance you perform measures the service life of your equipment. The slides and material on the four cycle engine presentation were provided by the Kohler Company.

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# TOP FAIRWAY MOWER PERFORMANCE

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Slide 1. Eight steps to top fairway mower performance.

Slide 2. The most used equipment on golf courses today are the fairway gang mowers. More operational hours are logged on the fairway mowers than on greensmowers, trim mowers, renovators and all other maintenance equipment. Yet they are the most abused. They are operated at improper speeds with inadequate lubrication and improper adjustments. They are operated when the reel blades and bedknife are dull, and for the most part they are stored outside where the elements can take their toll. You are probably saying to yourself that this is true but what can be done about it. I am going to set forth eight specific steps that if followed closely will insure top fairway mower performance. By top performance, I mean providing a quality cut with minimum wear on the components.

Slide 3. The first step is performing a daily inspection on each mower, pull frame and tractor. For purposes of this discussion I will only cover fairway mowers. What will daily inspection do for you? Daily equipment inspections will detect worn or damaged parts before they result in large repair bills and down time. Items that should be checked for damage and wear on a daily basis are:

1. Reel blades and spiders
2. Bedknives
3. Bearing tightness in both the reel and roller
4. Tire condition and air pressure
5. Bolt and nut tightness

Slide 4. Again, daily inspection will detect minor problems before they develop into expensive repair problems. This is an example of a problem that was not detected early and as a result a repair that would have cost $1.25 for a bushing turned out to be a $30.00 repair because the roller shaft and roller bracket had to be replaced.

Slide 5. This is another example of a problem that if detected earlier would have saved the owner many dollars. The reel blade was chipped when it struck a foreign object in the turf. The operator continued to mow for about a week before he noticed the problem. As a result, not only the reel blade had to be replaced but also the bedknife.

Thus, time spent on daily inspections pays for itself many times over.

Slide 6. Attractive fairways are the desire of every good superintendent. A key ingredient to attractive fairways is quality mowing. A quality mowing job cannot be obtained if the reel blades and bedknives are not sharp.

Slide 7. Therefore, the second step is maintaining your mowers in a sharp condition at all times.

A side effect of running the mowers when they are in a dull condition is that you are forced to operate with a tighter bedknife to reel adjustment. When you do this you are causing excessive wear to take place on the reel blades, bedknife and reel bearings.

Slide 8 For the most part all that is necessary to keep mowers in a sharp condition is a good lapping program. Lapping will keep the leading edge of your reel blades sharp and the leading edge of the bedknife sharp. Lapping is necessary when the bedknife and reel blade edges become rounded and pinch the grass rather than shearing the grass.

Slide 9 Should an operator strike a foreign object in the turf, he should immediately get off the tractor and inspect the damage. If the damage is not too excessive, he can hammer out the dented area.

Slide 10 He then should file the high spot off the blade.

Slide 11 He should also file the bedknife to insure proper match between the reel and the bedknife.

Slide 12 If the reel is badly damaged, then grinding of the reel and bedknife is necessary. Grinding is also necessary when the leading edge of the reel blades and the leading edge of the bedknife become severely rounded. Lapping should not be used when this condition exists.

Slide 13 Therefore, sharp mowers will give a continuous quality cut as well as prolonging the life of the mowers.

Slide 14 The third step is to keep your fairway mower properly adjusted at all times. Improper adjustment or lack of adjustment when needed will cause premature weat of the component parts and result in expensive replacement. The main fairway mower adjustment consists of adjusting the bedknife to the reel. This adjustment should not be taken lightly as it influences the quality of cut as well as the life of the component parts.

Slide 15 Proper adjustment is obtained when there is light contact between the bedknife and reel and the reel can be spun freely by hand.

Slide 16 An important thing to remember when adjusting the bedknife to the reel is that it should be done with the mowers on the turf. Turf exerts an upward pressure on the bedknife-bedbar. This deflection is compensated for when the adjustment is made on the turf.

Slide 17 Here we see a new innovation in fairway mower design. This is the new SPARTAN 7 with single point bedknife to reel adjustment. This greatly simplifies and makes the adjustment more precise.

Slide 18 Step four involves proper operation of the fairway mowers. This determines to a great extent the life of the mowers and also the quality of cut obtained. Fairways should be mowed in the four to six mile per hour range.

Slide 19 When fairway mowers are operated at excessive speeds, the reels must turn faster which could cause a wavy pattern or an uneven wear pattern to develop on the bedknife. This is a very expensive repair as sharpening is necessary to correct the situation. Operating the mowers under six miles and hour may not get the area cut in a record time but it will save on the equipment and produce a quality job.

Slide 20 The operators should be trained on how to operate the mowers. Each operator should have a knowledge of all the adjustments, operating characteristics, and lubrication points.

Slide 21 He should know the proper mowing pattern. He should be advised to constantly observe and listen to mower operation so he can immediately detect a malfunction. The superintendent of foreman should spend time with each operator training him in the operation and care of each unit he operates. The operator should also be allowed time to clean the equipment after each day or after each use. By letting the operators know that you are interested in caring for your equipment, you will instill a pride that will pay for the effort many times over.

Slide 22 Daily cleaning or cleaning after each use is the fifth step and is very important in the maintenance of your equipment. The allowed time will more than pay for itself in reducing wear on moving parts.

Slide 23 Cleaning removes grit that acts as an abrasive between the various moving parts. It also removes grass clippings,fertilizer, chemicals and other corrosive agents.

Equipment can be cleaned by the use of air, water, or steam. Care should be taken to avoid forcing dirt into the bearing areas when using air or water. It is a good idea to lubricate after the unit has been cleaned. This removes water and dirt from the moving parts such as bearings.

Slide 24 Proper lubrication, like daily cleaning, is a very important factor in good maintenance and is step six in our program.

Slide 25 Fairway mowers come with a manual containing lubrication charts and the types of lubricants that should be used. These schedules and specifications are established by the engineers that designed the equipment. Deviations from their recommendations result in decreased performance and shortened life. For example, areas that are scheduled for daily lubrication must be lubricated on a daily basis, since these areas are often not sealed.

Slide 26 Daily lubrication, purges these bearings of grit suspended in the grease and insures a new supply. Since these bearings normally don't have seals, the grease leaves the bearing quite rapidly and results in a dry bearing unless re-lubricated. Over lubrication or sloppy clean up can have detrimental affects on equipment life. Excess grease attracts dust and dirt and begins to act as a grinding compound. This of course causes excessive wear.

Slide 27 A lubrication program should also include checking gear case oil levels. Failure to maintain proper levels can result in very costly gear repairs.

Slide 28 Here we see a gear case in which the wrong lubricant was used. The grease "cupped out" and as a result proper lubrication was not obtained.

Slide 29 Good storage facilities for all of your equipment is step seven. Expensive equipment cannot be stored outside and expect it to perform properly.

Slide 30 Mowers that are left out in the elements will not last as long as mowers stored inside. The reel and bedknife will rust and become pitted. Likewise, the bearings and seals will have to be replaced sooner than normal. There is no area of the country that does not need storage facilities.

Slide 31 Fairway mowers tend to be improperly stored more often than any other piece of equipment on the golf course. Sure they are big and require a great deal of square footage. However, with some ingenuity a system can be worked out to effectively store them. Studies conducted by farm equipment companies have shown that even considering taxes and upkeep on storage buildings that storage is worthwhile.

Slide 32 Step eight is the last but not the least important. Keeping maintenance records on each piece of equipment is a mjor potential savings. Good equipment records will provide you with a basis for establishing future budget needs and let you establish an exact cost of maintenance for each piece of equipment. Maintenance costs will also serve as a guide in determining which piece of equipment is most effective for doing the various mowing jobs. A knowledge of down time will provide you with a guide in determining which manufacturer you should seek out when purchasing new equipment. Maintenance costs and down time will also serve as a guide as to when new equipment should be purchased to replace old equipment.

Slide 33 Good maintenance records should include the name of the machine, serial number, date of purchase, purchase price, lubrication information, accumulative running hours, repair parts and labor costs, and down time. Toro Manufacturing makes available an equipment maintenance record form that can be obtained from your Toro distributor or from the factory.

Slide 34 You will receive maximum value from your fairway mowers only when you follow these eight steps:

1. Maintain a daily inspection schedule.
2. Keep your fairway mowers sharp.
3. Properly adjust your fairway mowers.
4. Properly operate your fairway mowers.
5. Clean your mowers on a daily or each use basis.
6. Provide proper lubrication.
7. Store your mowers in weather protected buildings.
8. And keep adequate maintenance records on your equipment.

If you do this, you will decrease equipment down time, reduce parts and labor costs, increase overall mower life and obtain a continuous quality mowing job.

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## GRINDING REEL TYPE MOWERS

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Reel Mowers

Reel mowers today are constructed with the same basic design as in the days when only hand mowers were available. This construction consists of a boc frame built as rigidly as possible with side frames parallel with each other and a specified number of helix shaped blades rotating across a stationary blade. When blades become dull, nicked, or bent so that grass will not be cut clean, grinding and reshaping rell blades and bedknife becomes necessary. When this is done, manufacturer's specifications should be observed.

Types of Grinders

The Cylindrical Grinder is primarily used in manufacturing. This type grinds a reel in a true cylinder. The Hook Grinder is a popular grinder in many repair shops. With this method, the follower on the grinding wheel hooks under the edge of the bedknife grinding the reel blades in conjunction with the bedknife. The Straight Line Grinder is another popular machine in the repair shop. With this method the reel blades are ground in a straight line with the reel bearing and independent of the bedknife. With this method extreme care must be taken in grinding the bedknife.

Grinding Wheels

On a reel grinder be sure that the belts that rotate the grinding wheel are tight. Grinding wheels cut most efficiently when the outside perimeter of the wheel is traveling approximately 5000 feet per minute. When dressing the wheel, crown it approximately 1/16 of an inch.

There are three conventional methods of dressing the wheel.

1. Diamond dresser
2. Carborundum stick
3. Wheel dresser

The Wheel Dresser is the best method since it will pick out the abrasive particles from the wheel, leaving sharp abrasives protruding. It will also have a tendency to leave more air space between abrasive particles. The Diamond will cut the abrasives, leaving an extremely smooth wheel and much slower cutting. It will need dressing much more often. The Carborundum Stick is somewhat between the other two methods mentioned.

When dressing the cup wheel for bedknife grinding, be sure the inside of whell is undercut, allowing the wheel to cut on the outside perimeter. Be careful not to use too much pressure on the wheel when pressing, so that the perimeter of the wheel does not break out. Note when grinding that if a smooth glassy surface is obtained, grinding wheel is becoming dull. Slow cutting, undue heat, and burning will result. When grinding the bedknife, be certain that rotating grinding marks appear on the ground surface. If grind marks are straight, the wheel is cutting on the inside of the wheel and not on the outside perimeter. Undue heat, warping, burning, and slow cutting will result.

Bedknife

Inspect the bedknife before grinding. Several factors can reveal why a mower may need sharpening oftener than otherwise necessary.

1. A wavy bedknife indicates the reel and the bedknife have been adjusted too tightly.
2. A tapered bedknife indicates a mower has been adjusted too tightly on one side.
3. A series of smallripples usually are from a vibration caused by a loose bedknife or loose bedknife screws, slightly loose reel bearing, or reel ground with too great an angle.

When replacing a bedknife with a new one, grind the knife to true it up to the bedknife shoe which it is secured to. The bedknife face is ground from three to then degrees and the front edge from zero to thirty degrees. Check the manufacturer's recommendations for correct angle.

Reel

Before grinding the reel, check to make certain that the reel bearings are not loose. Be sure reel blades are securely fastened to the spider. A bent reel can usually be straightened with a series of light raps with a small hammer. Hold a metal block just behind the bend. Check for proper reel angles with the manufacturer. After the reel is ground and adjusted to the bedknife, a 12 to 15 thousand feeler gauge should be able to be inserted between the back edge of the reel blade and bedknife. On a thicker reel, such as a fairway unit, use a 15 to 20 thousands shim.

On a thick knife when the unit is sharpened, a relief grind is needed to produce a longer cutting life. When sharpening, number the blades, and after each rotation, start with another number blade. This will help to insure a true grind. The sharpest edge on any cutting tool, lies just beneath the burr. When a reel or bedknife is ground so that a burr appears along the entire blade, it is sharp. To remove more metal than necessary only reduces the life of the equipment. Use a file to remove the burr. Take care to file against the burr and parallel with the blade.

Lapping

Lapping is important after grinding. This is a honing operation and a more perfect match between rell and bedknife will be achieved. A lapped unit should have 1/32" to 1/16" land on the bedknife. This will help eliminate a chatter or vibration from developing. This also gives a cleaner cut with a looser running reel and a longer cutting life without adjusting the mower.

Lapping compound is important and a good compound is made by the Yardman Company. It is a fine material but cuts extremely fast. Do not rotate the reel too fast when lapping. This causes vibration. The best result can be obtained by starting to lap at a slow speed and finishing at a rapid speed.

After the mower is ground and lapped, check for sharpness. Each reel blade should cut paper at any place on the entire length of any blade without undue tightness between the reel and bedknife. Hold the paper to the light checking to see that it is cut clean with no fuzzy edges appearing.

New Grinding Equipment will soon be on the market. A few advantages of the bedknife grinder are as follows:

It can be set up rapidly. The wheel will have to be moved very little when grinding the front edge and face. The bedknife remains stationary and the wheel travels, doing the cutting. The blade is mounted vertically instead of horizontally so that the entire machine only uses two feet by two feet of floor space.

The reel grinder is mounted on wheels so that it can be moved readily to any area in the shop. The carriage is lowered to the ground and raised electrically, making it very easy for one man to load. Any mower from a hand mower to a gang mower can be ground with no major re-aligning of the machine.

The grinding wheel is different than the conventional grinding wheel in that it needs no dressing and will last four to six times longer. It also removes metal very rapidly, producing a fine cut without discoloring the metal.

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