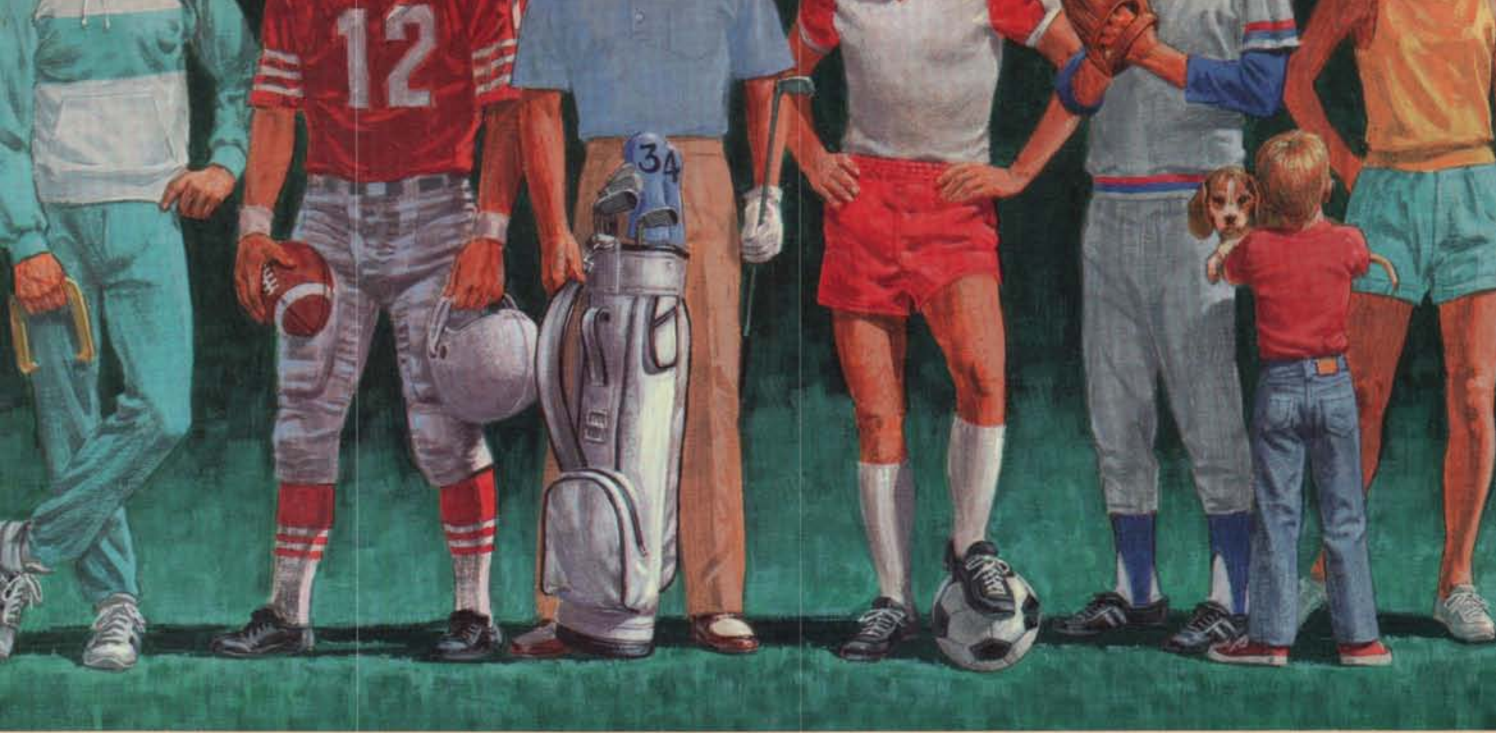

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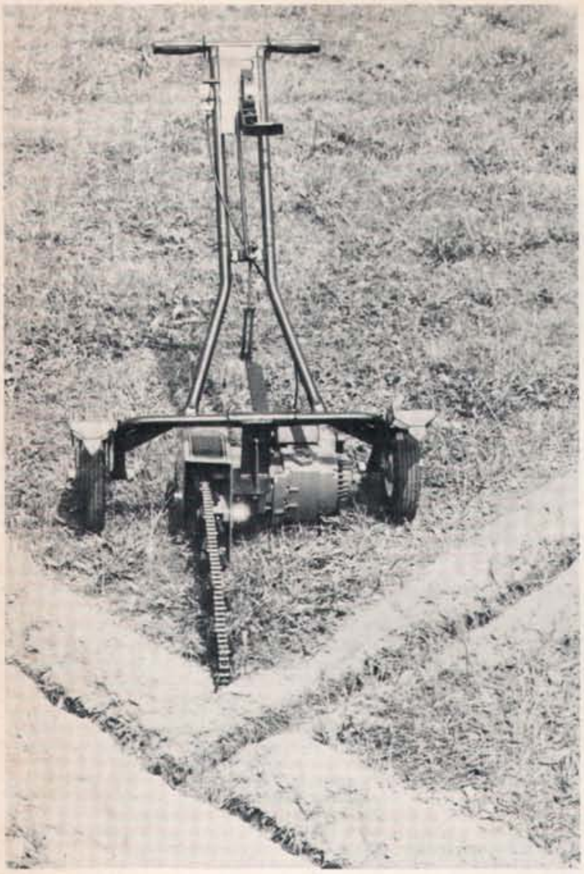
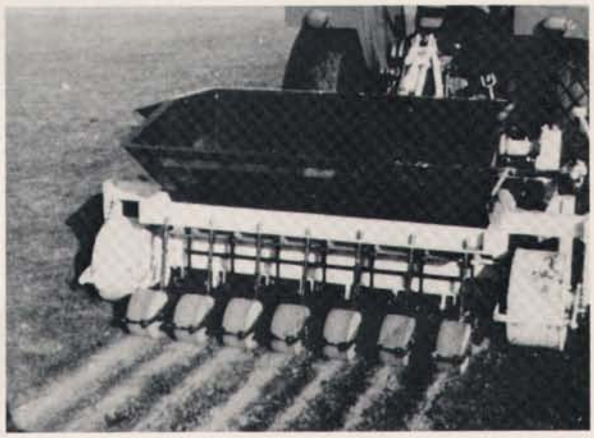


Small trencher often used to install bypass drainage (left).
Sand groover. Photo courtesy of Cambridge Associates (below).



Drainage
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amount of water that sports turf needs. Advanced controllers now enable turf managers to adjust irrigation cycles to fit weather conditions. They allow turf managers to repeat short cycles with a delay to prevent runoff.

Sprinkler heads and pumping stations have been refined to apply water at a rate that the soil can absorb. Soil moisture sensors are being used to override irrigation schedules, and on-site weather stations can feed data to controllers to help the manager regulate water use. These advances have taken much of the guesswork out of irrigation.

Subsurface Water. Controlling surface water is not even half the battle. One source of moisture to which turf managers are beginning to pay more attention comes from below. . .subsurface water. Golf courses and recreational areas are frequently built on flood plains, coastal land and other low-lying areas. High water tables and subsurface water can confound efforts to control soil moisture. You will understand why later in the article. Poor-quality subsurface water can also contaminate the root zone and complicate turf management.

"The presence of a water table within six feet of the surface indicates the need for improved subsurface drainage," warns Dr. James Beard of Texas A&M University. A high water table interferes with the removal of excess water from beneath the root zone, he adds.

A network of drainpipe prevents subsurface water from saturating the soil above—in addition to removing excess water that percolates down from the surface. So drainpipe can be used to artificially lower a high water table. As long as the water collected by the drainpipe flows or is pumped away, a new, lower water table will be created.

Water Movement. The most difficult aspect of drainage to understand involves how water moves into and through soils.

By observation, we know that water is pulled downward by the force of gravity. But there are many other forces which can counteract gravity. For example, water will move in a sponge or cloth from a wet area to drier areas regardless of direction. The same forces are at work in soils.

One of the best explanations of soil-water movement was presented by Albert Marsh of the University of California at Riverside in the book *Turfgrass Science,* published by the American Society of Agronomy. Marsh brought a refreshing clarity to the complicated subject.

Water movement depends greatly on soil texture. That texture is determined by the size and shape of the solid particles in the soil and the amount of open space around them. This space is commonly referred to as pore space, and may total 35 to 70 percent of the total soil volume.

Turfgrass roots grow in these spaces by utilizing the air, water and dissolved nutrients found in them. When a soil becomes compacted by frequent surface traffic, the volume of pore space is reduced, hampering root growth, aeration and drainage. This is the primary justification for regular mechanical aeration of the top two to three inches of soil, the portion of the soil most susceptible to compaction.

Clay soils consist of very small, plate-shaped particles. While the total volume of space around these particles may be the same as in other soils, the individual spaces are much smaller. Pore spaces are larger in loam soils and largest in coarse, sandy soils.

Under normal circumstances, water does not flow through soil pore spaces like sand through an hourglass. Instead, water coats the soil particles as a film and flows from one particle to another in film form.

This *film flow* is slowed and even stopped by two forces. The first is the force that holds one water molecule to another, called *cohesion.* Examples of cohesion are when a drop of water builds up at the end of an eyedropper without falling . . . or the presence of droplets on a cold glass on a hot, humid day.

Soil particles hold onto water molecules by a second force called *adhesion.* The attraction between the soil particle and the water is greatest when the film is very thin, and decreases as that film gets thicker. As the amount of water in the soil increases, so does the thickness of the film.

Contact between soil particles and film allows the forces of cohesion and adhesion to interact to move water from wetter to drier particles. Since the contact between particles is greater in fine-textured soils than in coarse soils, *film flow* is also greater. This is also why fine-textured soils hold water more tightly than sandy soils.

When soils of different texture are in

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Installing bypass drainage in green at Shenandoah Country Club in Baton Rouge, LA. Photo courtesy: Turf Drainage Co. of America.

Drainage

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layers within a root zone, the contact between soil particles between layers is not as great. For that reason, film flow is disrupted. This is why a fine soil will not drain well into a coarser soil, or vise versa. Subsurface layers are a major cause of poor drainage.

Film flow is sometimes referred to as capillary movement or unsaturated flow. When all pore spaces are filled with water, the soil is called saturated. This is an unhealthy situation for turf since the water occupies the space previously available for vital gases. Beneficial microorganisms in the soil which require oxygen can't function properly, and the necessary exchange of gases between the roots and soil air is disrupted.

At the point of saturation, the forces of cohesion and adhesion approach zero. It is at this point that water will begin to flow by gravity through large pore spaces in the soil. Since sand has the greatest percentage of large pore spaces, saturated flow is greatest in sandy soils. Saturated flow is poor in fine-textured soils.

This is also the point at which water will move from a fine soil into a coarser one, or from soil into perforated drainpipe or French drains.

Marsh cautioned that the soil immediately above a subsurface layer or drainpipe will be wetter than the rest of the soil. He advises that drainpipe or layers of gravel be placed beneath the root zone of turfgrasses. Marsh said many people presume that a gravel layer should provide excellent drainage and are surprised when excessive wetness above the layer is revealed.

For this reason slit trenches filled with sand should extend all the way to the surface of the soil. If soil is placed on top of the sand, it will have to become saturated before water will begin flowing into the trench. Sand will also filter out fine soil par-

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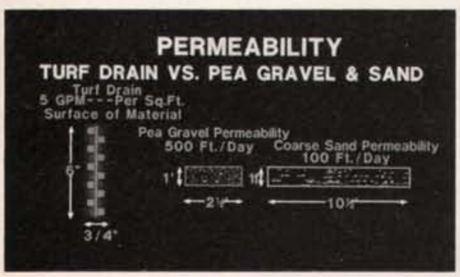

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Fairway at Baton Rouge C.C. as it appeared in the summer of 1985. Grass could not be maintained in area because of constantly saturated soil. Note the trench that has been dug and is ready for the installation of Turf Drain.

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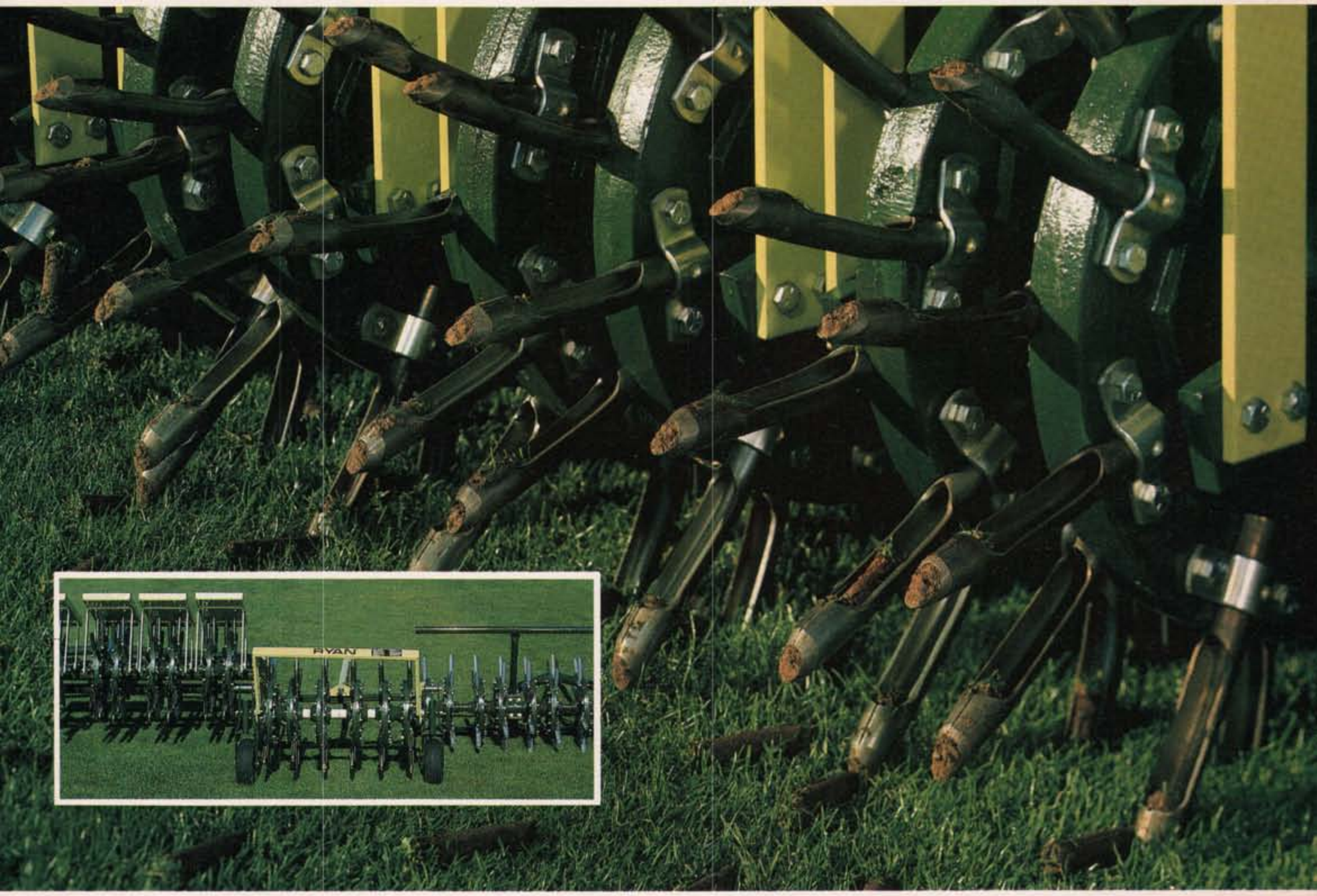

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Drainage
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ticles that can plug the openings in drainpipe or filter fabric wrapped around them.

Percolation. The flow of water through the soil is known as percolation. When designing a green or field, the architect should select a soil mixture that will provide a percolation rate approaching the rate of a typical rain shower. Since the uniformity of the soil mixture over the area is important, attention should be paid during construction to make certain that all soil components are thoroughly mixed.

Under favorable conditions turfgrass roots will grow a foot or more deep. When poor soils and inadequate drainage shrink this depth to less than two inches, the turfgrass plant is stressed and is not able to recover from sports-related wear. It will also be more prone to drought, winterkill, diseases and tearing.

Poor infiltration is often the result of a heavy thatch layer in moderate- to low-maintained areas.

Resodding the area will accomplish little, since the new sod will suffer the exact same fate. New sod can further complicate drainage if its soil texture is different from the root-zone mix.

Part of the advantage of having subsurface drainpipe is lost if water is not able to percolate down to it at a reasonable rate. Soil and drainpipe must work together to be effective.

Water moves more slowly in finer soils. It can take water in a clay-based field more than a day to reach drainpipe installed four feet below the surface, explains Steve Helmrich of Advanced Drainage Systems, Columbus, OH. Superintendents and sports turf managers rarely have the luxury of that much time. To overcome this problem, soils with higher percolation rates are used and drainpipe is installed at shallower depths.

Beard cautions that the artificial water table created by tile should be as deep as possible when salt intrusion is likely. In such cases drainpipe may need to be installed as deep as six feet instead of the more common 18 inches to three feet.

The shallower drainpipe are installed, the closer they must be together, says Helmrich. "The old rule of thumb is ten feet apart for each foot deep." Again this depends greatly upon soil texture. Water movement to the drainpipe can be improved by sloping the subgrade toward the pipe. Some drainage systems include grading the subgrade in a series of "hogbacks" to facilitate water movement to the drainpipe.

Infiltration. A soil may have a reasonable percolation rate, yet puddles still form on the surface following rainfall or irrigation. The problem is poor infiltration. Many things can slow infiltration. They include compaction, an increase in the amount of organic matter in the surface soil, resodding with turf grown in soil of a different texture, and development of a heavy thatch/mat layer.

"Poor infiltration is frequently the result of a heavy thatch/mat layer that has developed over time in moderate- to low-maintained areas," reveals Don Hogan, an engineer of sports surfaces in Seattle, WA. Furthermore, fields or turf areas that have been flooded will often suffer from a deposit of silt. For this reason, regular maintenance of the surface and surface soil to maintain infiltration is critical for the protection of the drainage system.

The infiltration rate also depends upon the texture of the soil surface. A level sand surface will allow roughly an inch of water per hour to infiltrate, while a level clay surface allows only a tenth of an inch to infiltrate in one hour (See table for other rates).

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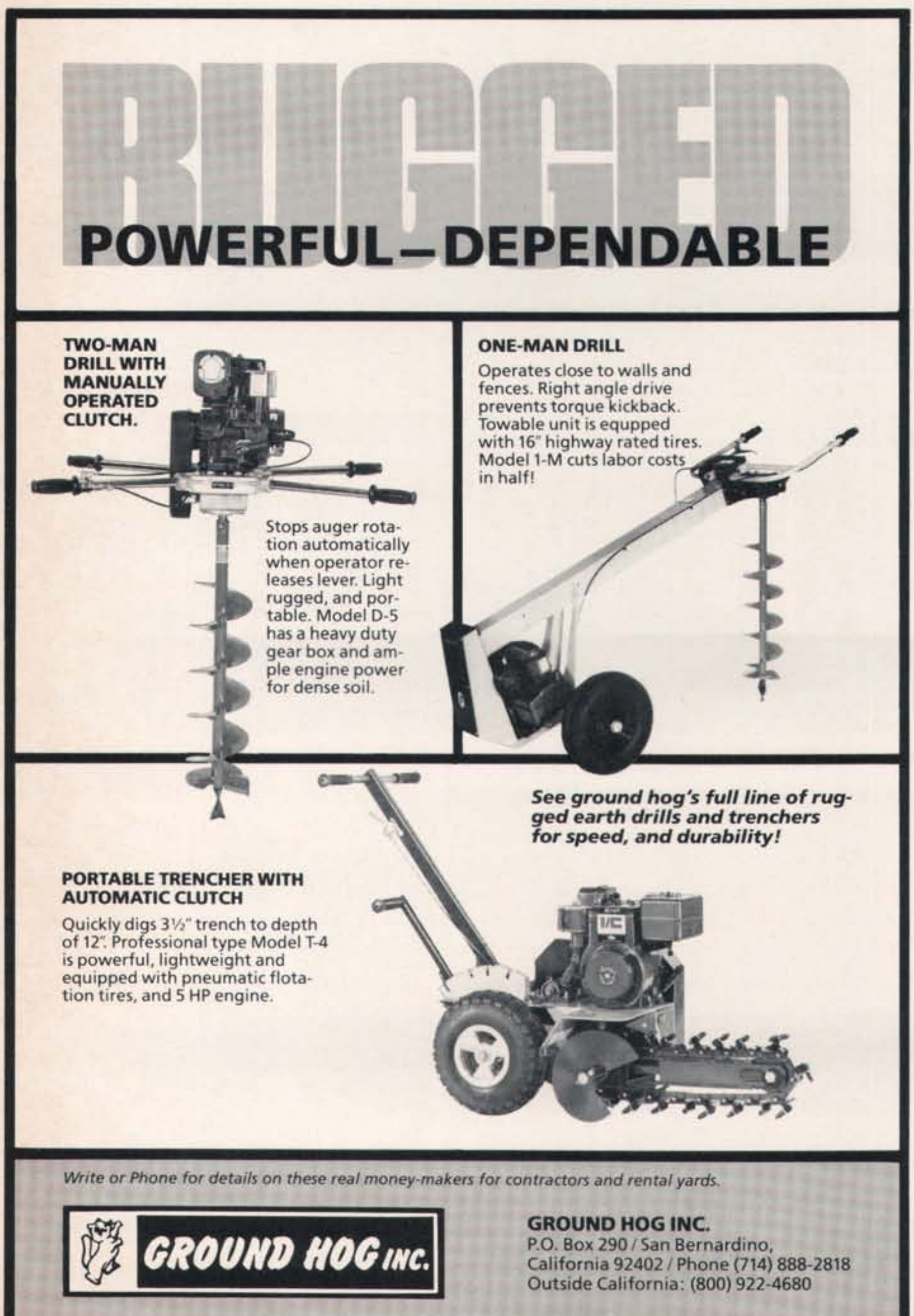

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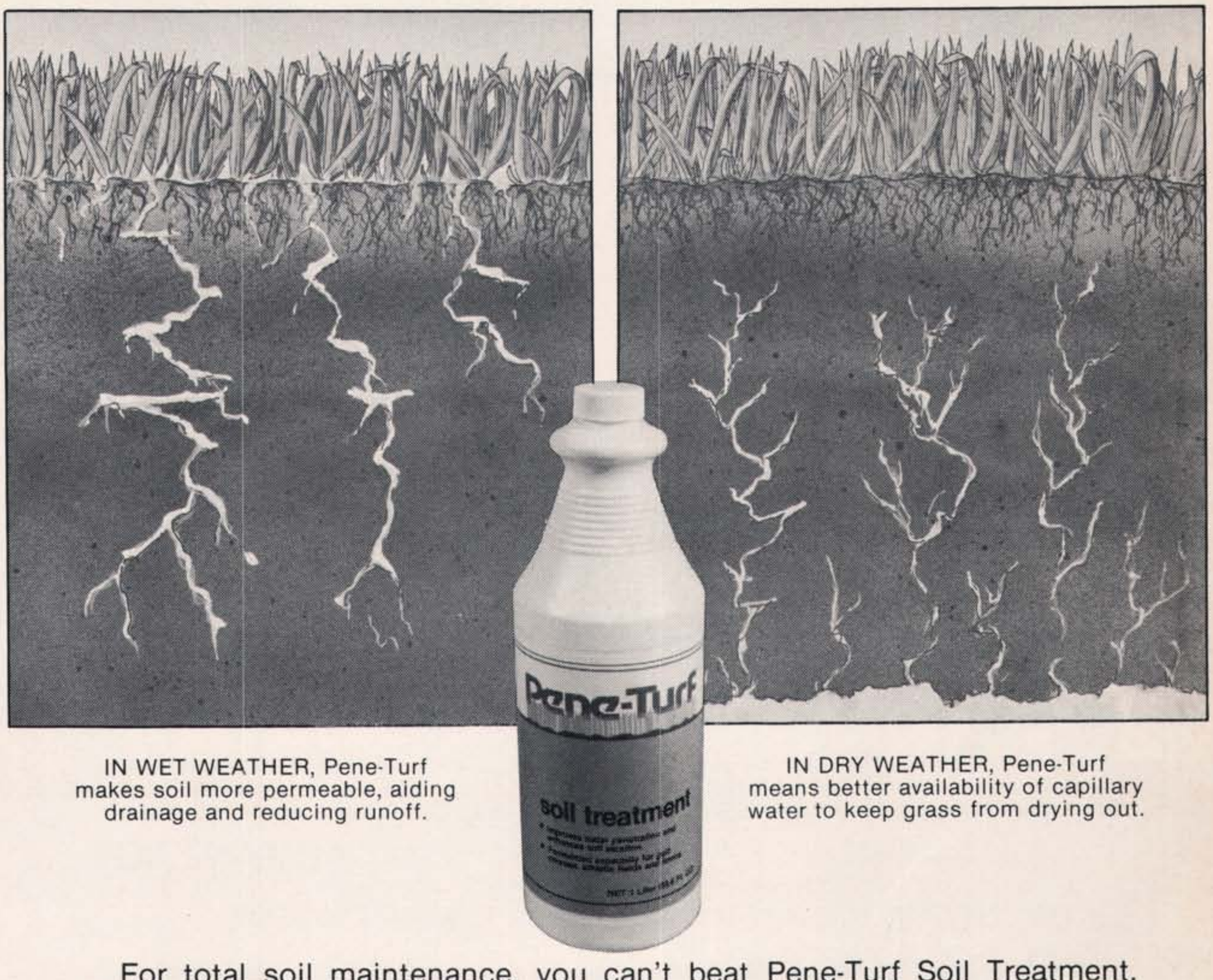

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Drainage

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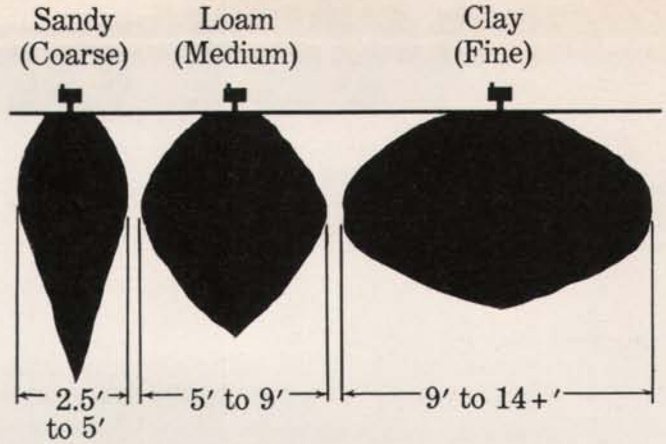
The slope of the surface also affects infiltration. Sloped portions of large, undulating greens may have a percolation rate half that of level areas. For this reason, irrigation schedules should be set to the slowest infiltration rate on the green, which would be the sloped portion.

Infiltration can vary within a turf area for other reasons, complicating both drainage and irrigation. Some surface soils and thatch can actually repel water by interrupting film flow. This condition is called hydrophobia. It is detectable by noticing turf that shows wilt symptoms before surrounding turf, and by taking soil core samples. Wetting agents can be applied to restore film flow to hydrophobic soils or thatch.

Aerification, slicing and light verticutting can be utilized to open up hydrophobic soils. Mixing soil cores and topdressing into the surface following aerification will also help reestablish film flow of water.

Frequently, in golf course and sports turf maintenance, natural infiltration and percolation are inadequate to keep turf areas safe and in play. Drainage is simply not fast enough between the surface and the drainpipe below. In such cases, natural drainage must be supplemented with "bypass" drainage.

SOIL TYPES VS. WETTED PATTERN



Soil texture	Level	Sloping	Steep
	Infiltration rates, inches/hour		
Sand	1.0	0.5	0.3
Sandy loam	0.5	0.3	0.2
Loam	0.25	0.18	0.12
Clay loam	0.15	0.1	0.07
Clay	0.10	0.08	0.06

"Water will *not* pass through most soils at a rate which is satisfactory for sports turf," states Geoffrey Davison, president of A. F. Trenchers, Sportsturf Division, in Cambridge, England. In cases where rebuilding turf root zones to a sufficient depth with sand/soil mixes is either too expensive or too disruptive, Davison recommends bypassing the existing soil's drainage.

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sand drains, combined with carefully controlled sand topdressing to provide an immediate exit route for surplus water without its passing through the soil. The elements of the system are customized for each site based upon a series of calculations. Specialized equipment is used to install the components with minimal surface disturbance.

Pipes and/or prefrabricated drainage structures move a greater volume of water than sand or gravel of the same size, explains Dennis Hurley, president of Turf Drain Inc., Marrero, LA. "Drainpipe creates air space in which water can move," says Hurley. "A 3/4-inch-wide vertical drainpipe creates as much air space as a 2½-foot-wide column of gravel or a 10-foot-wide column of sand of the same depth. That's a huge difference."

Turf Drain, ADS, Akzo, Lundin and Warren's are among manufacturers of vertical-bypass drainage structures. These products can be installed quickly with small, economical trenchers with little surface disturbance. "Obviously, they must be installed deep enough below the surface to be out of reach of aerifiers," explains Hurley. "Then fill the trench to the surface with sand, not gravel." Sand prevents silt and fine soil particles from clogging the geotextile wrapper of the drains.

Water does not enter the top of bypass drainpipe initially. First it moves downward, at the rate allowed by the sand, to the bottom of the trench where the backfill starts to become saturated. As the level of saturation rises to the bottom of the pipe, water begins to enter the lower slots. Water will not enter the top slots until the pipe nears capacity.

The spacing of bypass drainage should be determined carefully. Too much drainage can be as much a problem as too little—and the use of bypass drainage without irrigation is not advised.

First determine how much water needs to be removed, and how quickly. A golf course or sports field located in a region where storms can dump up to two inches of rain per hour should have closer spacing than in an area where one inch of rain per hour is typical. If a facility can afford two hours for a field to drain, the spacing can be larger than where immediate removal is necessary.

The spacing on sloped sites should be closer than on flat sites. Since heavy, fine-textured soils hold onto water longer, spacing for these should also be closer.

Manufacturers and their distributors can tell you how much water a particular drain structure transports in gallons per minute. They can also help you calculate how many gallons of water fall over an area per minute to match drainage with rainfall. Warren's Specialty Products has developed a computer program to determine spacing based upon all these factors.

In general, spacing will range from eight to 15 feet for greens and 15 to 60 feet for fairways and athletic fields, says Hurley. "It depends largely on site conditions."

Bypass drainage is proving to be a practical way to renovate older, poorly designed systems without major reconstruction.

Better drainage and irrigation give the manager the control he needs to increase the durability and condition of natural sports turf. Superintendents can speed up greens for tournaments and sports turf managers can reduce compaction and improve durability of fields by reducing soil moisture before events.

They can lower surface moisture to discourage encroachment of annual bluegrass or the development of diseases. They can also increase soil moisture temporarily when aerifying, overseeding, or applying fertilizers, insecticides and soil herbicides. The control provided by drainage reaches nearly every phase of turf maintenance.

That is why drainage is said to be the most important aspect of sports turf design, construction and maintenance. Good drainage is an inescapable precondition of high-use recreational turf. Without it, the sports turf manager is trying to balance on a tightrope—without a safety net to catch him in case he falls. It's too risky.

The bottom line is, according to Hogan, "If you can't afford proper drainage, you're going to waste money on everything else."

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THREE COMPLEXES HONORED IN BASEBALL DIAMOND AWARDS

Jim Kelsey (left) and Baseball Diamond of the Year Award winners (l. to r.) Ron Timpanaro, Paul Thomas, Joe Ardolino, and Greg Petry.

All three of the 1989 Baseball Diamond of the Year winners were present at the First International Sports Turf Conference at Dodgertown in Vero Beach, FL, last month to receive their awards.

Ron Timpanaro, field supervisor of Jack Russell Stadium in Clearwater, FL, had the shortest journey of all the winners. He captured the professional diamond award for his work at the home stadium of the Clearwater Phillies, the Class A farm team of the Philadelphia Phillies. "Minor League parks should be the same quality as Major League parks!" exclaimed Tipanaro. "We are all striving to make it to the Majors some day."

Greg Petry traveled from Waukegan, IL, to receive the award for best diamond in the school, municipality and park category. He is superintendent of parks for the Waukegan Park District. Petry and his staff were honored for their commitment to detail and maintenance of Al Grosche Field, one of 27 fields maintained year-round by the park district.

The best college diamond of the year award was presented to Joe Ardolino, assistant athletics director for Towson State University in Towson, MD. Ardolino shared the award for renovation of Burdick Field with Supervisor of Grounds Paul Thomas.

The awards are jointly sponsored by *sportsTURF* magazine, the Sports Turf Managers Association, and Beam Clay baseball infield mixes. They were presented by James Kelsey, president of Partac Peat Corp., producer of Beam Clay.

The stories behind each facility will be published in *sportsTURF* during the next three months.

CUSHMAN CHANGES NAME

OMC Lincoln, headquartered in Lincoln, NE, has changed its name to the Cushman Division of Outboard Marine Corporation. The original company, Cushman Motor Works, was founded in 1901 by Everett and Clinton Cushman.

The company became a subsidiary of Outboard Marine Corporation in 1957 and an operating division in 1961. But it continued to operate as Cushman Motors until 1972, when it was officially designated the OMC Lincoln Division.

Because of the strong market identity for Cushman products, Outboard Marine decided to redesignate the division as Cushman. The division's product names now include Cushman, Ryan and a recent addition, Brouwer.

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