Drainage: Why and How

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Removing the sod, digging the trench; the pieces of plywood allow golf cars to cross.

"Good turf is rarely seen except on well drained soil." From the book *Turf For Golf Courses,* Piper and Oakley, 1917.

There are still a few things time cannot change and the need for good drainage in turfgrass management is one of them. On a golf course, excess water is a problem not only to the golfer but also to the grass plant as well. Much of it is removed naturally by surface runoff, deep seepage, evaporation and transpiration, but these processes are often too slow to prevent grass plant damage and to satisfy the golfer's desire to play immediately after a rainstorm.

Drainage is the removal of excess water from the surface and subsurface so that the area becomes useful and capable of supporting turfgrass growth. The two types of drainage are: 1) surface and 2) subsurface.

Surface drainage is the easiest and quickest way to remove excess water. This is done by contouring the land so that the water will flow by gravity to a grass waterway, stream, pond, etc. The best time to accomplish this of course is when the golf course is being designed and constructed. In every instance it is easier and less expensive to incorporate proper surface drainage during construction than to undertake large and elaborate subsurface tile systems after the course is established and in play. In situations where a periodic concentration of flowing water often occurs it may be possible to construct a grass waterway. These waterways can be so constructed that they also add to the gentle rolling terrain and character of the golf course itself. The golf course architect should play an important role here.

The removal of water that has already entered the soil profile is considered subsurface drainage. Essentially, any drainage problem must be considered as a combination of surface and subsurface water removal.

Excess moisture in a soil affects plant growth in a number of ways. Soil aeration, soil temperature, biological activity, structural stability of the soil and soil chemistry are just a few of them.

In areas where drainage is a problem, one often sees a stunted, thin, weak turfgrass cover with yellowing leaves. If excess water remains for some time, depending upon species, the plants usually die. However, the adverse effects are not necessarily from the direct presence of the excess water. Death may be primarily the result of root damage caused by reduced oxygen and excess carbon dioxide in the root zone.

The relative submersion tolerance of turfgrasses vary. Bermudagrass and creeping bentgrass have excellent submersion tolerance, whereas red fescue has a poor tolerance to submersion. *Poa annua* and perennial ryegrass are considered fair and Kentucky bluegrass is medium.

Soil areation is a function of the sizes of the soil particles, how they are arranged, the degree of saturation or the soil moisture content. If the larger pores are free of water so that the moisture level is below field capacity, gas diffusion can proceed satisfactorily. However, when the soil profile becomes saturated, the rate of diffusion declines.

As decomposition and other biotic activity continues to take place in the soil, the oxygen level drops and the carbon dioxide level builds up. The rate of change in the gaseous balance speeds up under higher soil temperatures because of the faster rate of biological activity. The effect of temperature explains why winter flooding often is less harmful than summer flooding.

Poor aeration and high moisture content directly affect the occurence and severity of some plant diseases. The change in balance between oxygen and carbon dioxide affect the growth and longevity of the disease organism. Plants weakened by the soil condition of too much water are also more susceptible to infection.

Wet soils are slow to warm up. The heat required to raise one pound of water one degree would produce a similar temperature rise in about five pounds of dry mineral soil or four pounds of organic soil. The effect that drainage has on spring warmup of soils and on the related soil temperatures, as they affect turfgrass growth, is thus apparent.

SURFACE DRAINAGE

The need for surface drainage depends largely on the slope of the area. If it is flat, the excess water moves too slowly. If the area has depressions and barriers, the water will be impounded and often becomes stagnant. A cause of some pocketed surfaces is the failure to smooth the fairway and approach areas before establishing a turfgrass cover.

Proper planning should produce a drainage system that will permit maximum effective water intake and storage in the soil. Excess rain water will be removed without erosion. This may be accomplished during initial construction by insisting that surface drainage receive top priority. The types of surface drainage to be constructed, such as grass waterways, creeks, etc., depends upon topography, the type of soil and the effect it will have on the golfer, such as losing the ball in a hazard.

When planning a drainage program, thought should be given to the installation of a complete system that will provide continuous drainageways from all areas of the site. It is important that the slopes are such that they can be mowed and maintained with the usual fairway and rough mowing units.

TILE DRAINAGE

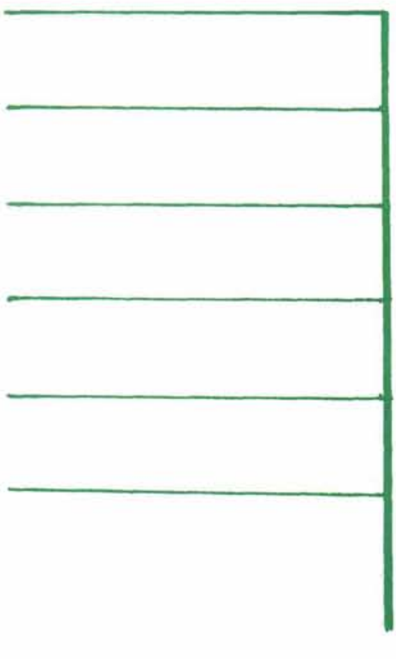
The alternate method of removing excessive water is with drainage tile. Drainage tile removes excess water from the soil through a continuous line of tile laid at a specified depth and grade. Free water enters through the tile joints, slits or holes and flows out by gravity. Tile drains properly planned and installed become a permanent improvement requiring little maintenance. So that the best and most economical tile system is installed, it is important that careful planning and construction are considered. Such care is particularly essential because the tiles are hidden and causes of failure are difficult to find and costly to repair.

For the efficient layout of laterals and mains an accurate survey of the area to be tiled is generally needed. The survey determines the grade of the main so that the size of the tile will be correct for the area to be drained. The tile system should be planned to handle all of the wet areas that could eventually be drained into the main, even if only part of the area is to be tiled initially.

A system of short mains with long laterals is most economical, because long mains require larger and more expensive tile. For uniform drainage, laterals should be parallel and the same distance apart. This provides for a uniform water table between the laterals across the slope rather than vertically.

The topography of the land, source of water

Figure 1. Gridiron



to be removed and other field conditions determine the right location of tile lines and the proper type of drainage system. Tile drainage systems can be classified into three general types: a parallel, a random or an intercepting system.

The parallel line systems are used on poorly drained soils having little slope and fairly uniform soil texture. Variations of the parallel system are the gridiron and herringbone patterns (Fig. 1 & 2). In parallel drainage systems, one main serves as many laterals as possible, thereby making this a fairly economical arrangement. The herringbone system is useful in areas where the main lies in a narrow depression and the laterals enter from both sides. This arrangement accounts for the double drainage where the laterals and mains join. Consequently, this system will provide better drainage at that point.

The random system (Fig. 3) is used in rolling areas that have scattered wet areas somewhat isolated from each other. Tile lines are laid more or less at random to drain the wet places. In most instances, it is better to locate the main so as to follow natural drainageways rather than to make deep cuts through ridges to form straight tile lines. Sub-mains and laterals should be extended from the main to the individual wet areas. If the wet spots are large, the use of one or more of the parallel systems may be required to provide the proper drainage. The random system of drainage is the one most frequently used on the golf course.

The intercepting system involves the interception of seepage water that follows an impervious soil layer. It is possible to locate tile so that the seepage water will be intercepted and the wet condition relieved. Proper location of the tile for interception of seepage water is important. The tile lines should be placed at the surface of the impervious layer along which the seepage water travels.

In planning a tile drainage system, the outlet should be the starting point. No matter how carefully the system is installed, it will not work properly if the outlet does not function well. Tile drains may outlet by gravity into streams, lakes, ponds, channels or existing tile mains. All are suitable if they are large enough to handle the capacity of water flow. When a gravity outlet is not available or when it is important to improve the outlet, the possibilities of removing the water by pumping should be considered.

For each tile installation, a map of the location of all lines and depth should be prepared. This map will be useful in locating lines for repair and also for determining the possibilities of adding to the present system. A map showing the location of tile lines is one of the most important records that can be kept on a golf course and passed on to future superintendents.

An adequately planned and properly installed drainage system with periodic maintenance will insure improved conditions for the survival of the turfgrass plant as well as improved playing conditions for the golfer.

Figure 2. Herringbone

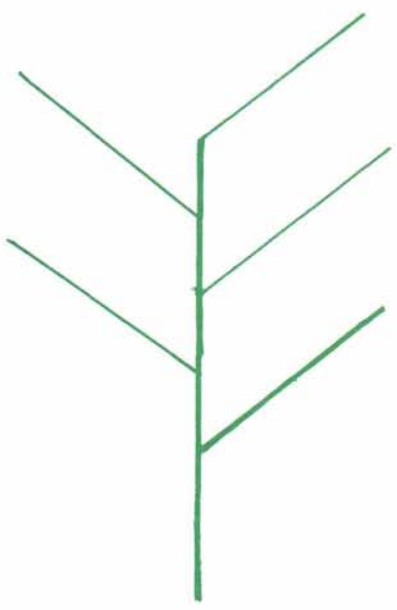


Figure 3. Random