# Golf Course Drainage

A series of articles written exclusively for The National Greenkeeper by America's foremost golf course drainage engineer

By WENDELL P. MILLER

**Part IV—Examining Land and Arranging Lines**

WHILE the advice and services of a reliable engineer should be sought before planning the system and ordering the tile, the greenkeeper in the meantime may profitably examine the wet land he intends to drain, and keep a record of the extent of the area and the time required in drying out.

*Examine the Subsoil:* The nature of the subsoil determines the proper depth and distance between lines of tile. Use the soil auger or the ordinary posthole digger for testing the subsoil. On seepage marshes it may be possible in this way to discover the layer of sand or clay that is bringing in the damaging water. In any area it is desirable to know the depth of the top soil and the texture of both the top soil and subsoil.

*Always use a Level:* Even where a liberal fall is apparent, it is best to use a level to ascertain, approximately at least, how much that fall is. A carpenter's level set up on a box will indicate whether or not the apparent slope on the area is deceptive. If the preliminary observations with a carpenter's level indicate that the proposed line of tile cannot be laid to fall at the rate of 6 inches or more per hundred feet to a free outlet, then accurate leveling, preferably done by a skilled engineer with a surveyor's instrument, is the only safe course.

It is best to continue the levels a short distance below the proposed outlet to find out whether or not there is a danger of back water from below. The purpose of the main is to serve as an outlet for all of the low places tributary to it. For this reason, observations with a level are needed on all low places that may be drained into the proposed main eventually. Serious mistakes have been made putting in main drains too shallow to accommodate these low places.

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Where some of the wet land tributary to a proposed main belongs to another land owner, co-operation is advisable. The extent to which this cooperation is necessary can be determined only after observations have been made with a level.

*Arrangement of lines:* The location of the main demands attention first; then location of laterals is made. Use a sub-main to carry the water from a group of laterals to the main where fall is gained, or where extreme depths are avoided. It is better to have the laterals and sub-main discharge into a single main than to give each an independent outlet into an open ditch. *It is easier to protect one good outlet than several poor ones.*

On level ground where the fall is obtained by digging shallower at the head than at the outlet, a better fall is available in short lines than in a long line. However, for two rods or more before a lateral enters a main it passes through land drained by the main directly. This causes duplicate drainage and is wasteful. There is more duplicate drainage with a large number of short lines than with a smaller number of longer lines. Laterals making a sharp angle with the main they enter cause more duplicate drainage than when they join at right angles.

Generally laterals must be laid out in the line of greatest slope toward the main. The seepage at the foot of the upland is cut off by a line surrounding the ends of the laterals. For this line the liberal fall necessary is secured by starting it on the higher land and having it discharge into the head of a lateral on the low land.

Make straight lines where possible. Instead of bending a line so as to reach each of several springs, make the main line straight and put in a spur to tap each spring. To dry up a spring, get the tile where it will intercept the water before it appears at the spring.

*Distance between the Lines and Depth:* The number of lines of tile required depends upon the nature of the soil and the degree of drainage desired. Tile lines 30 feet apart in clay subsoils may not be as effective in removing standing water as lines 60 feet apart in sandy loam subsoils.

Certain general principles are found to govern the spacing and depths of lateral drains. These are particularly applicable to different parts of the system located in the same general area.

The flow of water through the soil to the drain is governed by the same laws which control the flow of water through the drain, or in a ditch along the road. The rate of flow in either case is dependent upon the fall or grade, the roughness of the sides of the channel and its size and shape.

The rate of runoff from the tile system is but the

rate at which the water moves through the soil to the drain, providing that the tile lines have a large enough capacity to care for all the water as it reaches them. It will be seen the watertable rises in a curve from each drain and reaches its highest point midway between two adjacent drains. Since for any field the size and shape of the soil pores, and the resistance to the passage of the water through them, are the same at any one time for different spacing and depths of laterals, it follows, that, in general, either decreasing the distance between laterals or placing them deeper will increase the slope from the crest of the watertable to the drain, so long as the crest of the watertable rises to the same elevation in respect to the surface of the ground. This will increase the rate at which water reaches the drain.

By increasing the depth of laterals, and accordingly lowering the groundwater line after each rain, a larger column of soil is freed from surplus moisture. As it is only in that portion of the soil which is free from surplus moisture that plant roots can obtain food and live, it becomes one of the important functions of underdrainage to maintain the groundwater line at each such level as will best serve vegetation.

Any change in the system by which the groundwater can reach the underdrains more rapidly will hasten the drying of the soil after rains and permit of earlier cultivation.

The effects of spacings and depths of laterals may be summarized as follows:

Decreasing the distance between drains not only increases the rate of runoff but decreases the time necessary to remove the surplus moisture after each rain.

*Increasing the depth* of the drains *increases the rate* at which the drains remove water from the ground and lowers the average level of the groundwater, thus providing a larger food supply for growing turf. In considering different spacing and depths it should be remembered that the rate of movement of water through a close, fine-grained clay soil is always less than that through the more open loam. This point should be considered when contemplating any increase of depth which will place the laterals in a more impervious soil. The increased depth might thus be a detriment for the first few years. It is doubtful, however, if there are any soils in the Central States in which the lateral drains should not be placed as deep as recommended hereinafter.

Thus it is seen that the success of any underdrainage system depends upon the freedom with which water may pass through the soil. Many persons hold the erroneous belief that the water falling on an underdrained area moves directly from the surface to the top of the drain. Such is not the case. No water ordinarily enters a drain from the top except that which falls upon the surface directly above the tile, and then only when the soil conditions are such as to allow of an early vertical percolation from the surface to the underdrain. The surplus

moisture in the upper layers of soil, or upon the surface, moves as nearly directly downward as the soil formation will allow, until it reaches the level of the groundwater. It then moves downward and laterally in a curved path to the drain, entering it from the bottom. Its movement after reaching the groundwater level is somewhat uncertain.

In speaking of the relative efficiencies of different systems, it is often stated that the underdrains in one field "draw" better or farther than those in another field. Actually the drains do not draw at all, if by that it is meant the tile exert a pull tending to suck the water out of the soil pores and into the drain. The underdrains serve simply as collecting channels or outlets for the percolating water. If one area is drained farther back from the lines of the tile than is another, it signifies simply that the conditions of the soil are such as to cause a more ready movement of the groundwater to the tile in the one area than in the other and that the tile in the better drained area have ample capacity to remove the water as it reaches them.

*Fall or Gradient:* The smaller the tile the larger should be its fall or gradient. A fall of 1 inch in 100 feet may be sufficient for an 8 inch tile; but for a 4 inch tile, 3 inches in a 100 feet is about the minimum limit.

*(To be continued)*

NEXT MONTH—How to determine sizes of tile in line with rate of run-off.

## How To Keep Skunks Off the Greens

By JOHN McNAMARA

WHILE in Detroit at the Fort Shelby Hotel, a Chairman of a Green Committee of a nine hole course in Michigan reported that they had quite a bit of trouble with skunks rooting up their greens. He thought they were after the angle worms in the greens.

In taking this matter up at one of our meetings, there were many different censors of opinion as how to get rid of these pests. Some suggested that a hose be attached to the exhaust of a tractor and the end put to the hole or burrow of the skunk thereby killing them by suffocation, others thought that shooting them on bright clear nights would be a good way to get rid of them.

In my opinion, with the little experience I have had with them, I do not think they are after angle worms but a white grub that is in the ground, and the best way to get rid of the skunks so that they do not root up the ground, is to remove the cause by getting rid of these grubs. This can be accomplished by using Arsenate of Lead in very light applications of one or two pounds to every 1000 square feet—mixed with soil or sand and spread evenly over the green when the grass is dry, in the same manner as you sow seed, etc. Continue this application about every two weeks and as soon as all the grubs have disappeared you will also find that the skunks will no longer molest the greens. You will also find that if robins root your greens in a like manner, that this method will be effective in keeping them off your greens.