TURF TALK

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Question? *Adequate drainage for my fairways has always been a problem. A renovation architect insists that "sand-capping" our troublesome fairways is the way to go. However, this appears very expensive and results seem inconsistent. Your thoughts?*

Answer. First, as you alluded to, all large scale drainage problems should be addressed during course design and construction (**Figure 1**). Retrofitting any major drainage plan once the course is open becomes very expensive, disrupts play for extensive periods, and still may not correct the problem (**Figure 2**). Sand capping can be the most reasonable means of "drying" a fairway located in perpetually wet (low) area without installing expensive sump and pump systems. However, on most courses, unless sound soil science is applied to the situation, unsatisfactory results may occur.

Sand-capping increases the depth of growing medium, thus increases depth from the soil surface to the water table, reducing surface pudding and wet conditions. These benefits may or may not be realized for several reasons. As the depth of the soil profile increases, the gravitation pull on the water throughout the profile above increases, thereby decreasing the soil water content, and consequently increasing the storage capacity for rain water. However, water flow may be so slow in the original soil below the sand-cap that vertical drainage in the sand-cap zone may also be too slow, especially if the sand-cap is not of sufficient thickness.

As you mentioned, this procedure is expensive. A one-inch (2.54 cm) layer of sand (assuming a bulk density of 1.6 g/cm^3) over an acre weighs approximately 360,000 lbs or 180 tons. Since one inch is generally insufficient, how much sand is actually needed to effectively drain a sand-capped fairway? A simple question with no easy answer. Information is needed on if drain lines are being installed, and if so, the distance between these and their depths. If drain spacings are halved, for example, their effectiveness increases fourfold. If drain lines are not installed, surface water ponding and swampy conditions often develop even with moderate rainfall as the soil water has no relatively quick place to drain. Next, what is the drainage capacity of the underlying soil the sand is being placed on? Also, how well does the sand in question drain and how much of a rainfall event is being anticipated?

A moisture retention curve can be used to approximate a required sand depth (assuming no drainage contribution from the underlying soil and a saturated zone develops at the bottom of the sand-cap). With this procedure, the sand being considered is subjected to various tensions (or equivalent soil depths) and soil moisture is measured. From this curve, a depth can be chosen based on desired aeration porosity (total porosity minus moisture content) over a given depth. Sands for USGA greens, for example, are saturated and subjected to a suction corresponding to a sand depth of 12 inches (30 cm) and a minimum of 15% aeration porosity by volume. This 30 cm depth provides several inches of sand above a perched water table with adequate aeration porosity. A suggested rule-of-thumb is to provide a minimum depth of 1.5 inches (3.8 cm) of dry sand when the underlying sand is saturated at the sand-soil interface. This rule of thumb often requires a minimum of 10 inches (25 cm) of sand. If drainage tiles are added, this thickness can be reduced.

Drainage engineers often use Hooghoudt's equation to calculate drain line spacings based on saturated hydraulic conductivity of the soil, rainfall or irrigation amounts, and height of water table between drain lines. Hooghoudt's equation describes potential soil water movement at the midpoint between drainage lines using the parameters listed. The equation can be rearranged to determine soil depth needed if the other variables are known. For example, if a sand being considered drains at 12 inches (30 cm) per hour, drain lines are being installed at 50 foot (15 m) spacing, and a 1-inch (2.54 cm) rainfall event is being considered, the calculated sand depth needed is 87 inches (221 cm). If 25 foot (7.5 m) drain line spacing is used instead of 50 feet (15 m), then the height of needed soil is reduced to 43 inches (109 cm). From Hooghoudt's equation, the deeper the drain lines, the further apart they can be. Also, the shallower the sand cap (or resulting saturated soil zone), the closer drains have to be spaced as water moves sideways in a soil very slowly. To reduce the height of sand needed based on Hooghoudt's equation; drain line spacing, soil hydraulic conductivity and/or the amount of anticipated rainfall (or irrigation) can be manipulated. If, for example, the sand profile drainage rate from the above problem is increased to 24 in/hr (61 cm/hr) instead of 12 in/hr (30 cm/hr), the calculated soil depth needed (with 25 foot, 7.5 m, drain line spacing) is decreased from 43 inches (109 cm) to 31 inches (79 cm). With 12.5 foot (3.8 m) drain line spacing, the required depth decreases to 15 inches (38 cm), a much more reasonable value to work with. It generally is much cheaper to have closer drain line spacing than to install deeper depths of sand.

In reality, effective sand capping depths needed are between 10 and 14-inches (25 and 36 cm) when drainage lines are not used (**Figure 3**). Ten inches (25 cm) is the minimum required to keep the lower level of the sand cap from staying too wet. Ten to 12-inches (25 to 30 cm) are better as these provide 5 to 6-inches (13 to 15 cm) of reasonably dry growing medium and 5 to 6-inches (13 to 15 cm) of lower soil which stays mostly wet when placed over a poor-draining soil. Fourteen inches (36 cm) or more could be needed where the underlying soil drains extremely poorly, thus, the water table remains at or near the soil surface and drainage lines are not used. This much sand generally is cost prohibitive for many courses and only low-lying poorly drained fairways are considered which do not have adequate elevation to provide daylight for drainage lines. Note: Special thanks to Dr. Virgil Quisenberry, professor of soil physics and Ray Hubbard, PE, a PhD student in soil physics at Clemson University, for reviewing this article.

Figure Descriptions

Figure 1. Large scale drainage problems should be addressed during the design and construction of a turf facility.

Figure 2. Retrofitting and/or installing new drainage once a course is open becomes expensive, disrupts play, and may have limited benefit.

Figure 3. Sand capping an area increases the distance from the soil surface to the water table and is best for low lying areas which naturally drain poorly and have limited daylight sites for drain lines.