

perfect lie on a well-kept approach. Frequently when the greens and fairways are seeded the areas behind the greens get only a last-minute clean-up before the job is pronounced finished. Such areas are not properly graded, the soil is often puddled, or the topsoil has been robbed from them, and they do not produce good turf. Often they are neglected by the greenkeeper, and are sometimes left to remain as the worst kind of rough. Also, in greens set back in woods, sufficient room is seldom left in the clearing to get either the fairway mower or hay mower back of the greens. The fairway mower ought to be able easily to include the area around the sides and back of the green along with the approach and the remainder of the fairway.

SPECIAL PROBLEMS OF PUTTING GREENS

There is no place on the course where play is as concentrated as on the greens and tees. But on greens this concentration of play, apart from removal of divots, is liable to do more damage than on tees, since the turf is kept cut unnaturally close. The root system is therefore correspondingly limited in its growth due to the natural habit of grass. Also greens are frequently placed in poorly drained and aerated positions, or on very poor soil, in order to procure a better golf hole from an architectural point of view. Therefore since special demands are made of greens special treatment is required.

Frequently architects choose very natural locations for putting greens. These locations seldom require any fill but frequently require some leveling. Before the leveling commences all topsoil should be removed, as this soil is usually needed. Few courses can afford to bury topsoil, since even if it is poor it is of more fertilizing value than subsoil and can be greatly improved by cultural methods or by being composted.

Before the green is shaped and graded its subdrainage should be studied as well as the likelihood of its being subject to surface wash or to seepage from the surrounding area. Surface water from surrounding hills may be kept from the surface of the green by grassy hollows and by sand traps. These traps and hollows should be made to conform to the correct architecture of the hole. If the green is cut into the side of a hill or is nestled against the hill with the foot of the hill as its back or side, the construction of the open ditch or grassy hollow is no simple matter. There is a tendency to construct such ditches altogether out of proportion to the natural landscape. Often these ditches built to catch wash from slopes are built deep with steep sides; they look out of place and artificial and are difficult to mow and hard to play from. If these ditches and hollows are built while the green is being graded much better results may be accomplished.

The top layer and planting of a green built without any fill work will be the same as with greens built with a fill and will be described later. Most putting greens these days are elevated from the surrounding terrain; this is not always done for drainage purposes, but is more often done by architects chiefly to give the modern golfers what they demand. Courses must be made easier to play than the natural lay of the land frequently provides. Courses are being built according to modern ideas, and modern ideas require that the breaks of the game, or the element of luck, must be reduced to the minimum. A putting surface sloping away from the play would be subjected to

most bitter criticism, even though in the old days of golf, when golfers played on what nature provided, such a hole would have been considered "fair to one, fair to all." Golf has developed into a more scientific game. Every shot coming within a certain range of perfection must get its reward. This requires that the architect usually must move much dirt to take the element of luck out of natural topography. Therefore putting greens are frequently found raised at the rear 10 feet or more above the natural topographical elevation. These greens require many hundreds of yards of fill.

Economy in golf course construction is still important enough to demand that the fill used in elevating greens be what can be obtained on the property and without the expense of physical improvement. Therefore we find fills of blue clay, silt, sand, peat, and all soil textures in between.

The topsoil should be of about the same physical structure on any green no matter what kind of fill is used. The topsoil is the layer in which the roots of the grass work. It is the layer in which roots get moisture and plant food for the turf. This layer must be of an open, friable structure, so that the roots may spread unhampered in any direction. The topsoil should be porous enough to allow for the easy absorption and drainage of water. If it is porous it will also allow for the air circulation through the soil, which is necessary for plant growth. A sandy loam is ideal. Loam consists of sand, silt, and clay in certain proportions. Topsoil should contain at least 10 per cent organic material and 30 per cent sand, and the balance may be clay or silt.

Topsoils are sometimes prepared by the acre on areas of good soil on the property, by plowing in manure, sand, humus, green crops, or whatever the soil requires to bring it to the composition described above. The soil is then hauled to the green and evenly distributed. It is less costly, however, to use the topsoil stripped from the putting green area, from traps areas, or from areas near the green. This material should be laid evenly on the finished fill and given the proper attention. On either heavy clays or silts or on light loams or sand, from 10 to 50 tons of manure should be disked into the topsoil. The amount of manure required depends on the organic content of the soil. The organic matter in the soil retains moisture and provides plant food as it decomposes. Also the particles of humus separate the particles of clay or silt and make the soil more crumbly or open in texture. In sandy soils decayed organic matter helps to bind sand particles together and provides a medium for the storage of moisture and plant food. When there is little time to prepare topsoil it is best to use well-rotted manure, since it has practically finished heating and decomposition is well on the way, and most of the weed seeds in it have been destroyed. However, fresh manure is probably more beneficial in improving the fertility and physical properties of soils, since it stimulates more bacterial action due to its rapid heating and disintegration. Fresh manure usually causes some decomposition and breaking down in the surrounding soil. Since fresh manure averages higher in moisture content than well-rotted manure, it should be used in applications 10 to 25 per cent heavier than well-rotted manure in order to add the same amount of organic matter to the soil.

After the organic content is right, sand should be added to clay or silt soils in sufficient quantities to bring the soil to a texture that

will crumble when released, after being squeezed in the hand when damp.

Peat or humus soils should be limed liberally, to counteract a probable toxic condition, and cultivated before being used as a putting green surface. Also they should have fresh manure worked into them to help bacterial action, and finally should have sharp sand added in sufficient quantities to give them at least 30 per cent of this material. When manure is scarce, peat, peat moss, or humus may be used as a substitute, to assist in improving the physical character of sands, clays, and silts. In the case of peat and humus, these materials should be limed, manured, and aerated by cultivation before use. Peat, humus, and peat moss should never be laid in layers but should be thoroughly mixed with the topsoil.

Layers of cinders, manure, peat, humus, peat moss, sand, clay, or any other material should never be placed in putting greens. Layers of different materials interfere with the capillary movement of water in soils, hinder natural soil drainage, and are not conducive to perfect root development. On sandy soils a comparatively deep layer of well-prepared topsoil should be provided. On clay, silt, or muck fills, a prepared topsoil of from 4 to 6 inches is sufficient. However, in greens built with these last mentioned soils as fills, tile drainage is usually advisable. A more or less impervious layer beneath the porous topsoil is liable under certain conditions to prove very harmful to the green, and when there is any fear of the subsoil developing an impervious character it is wise to tile-drain. Also when building a putting green with a close-textured soil care must be taken to have a grade of at least 6 inches in 50 feet on the top of the fill; that is, the fill or subsoil of the green should slope evenly off the green. This grade will assist in carrying off free water that seeps through the porous topsoil to the fill. It is a great mistake to leave hollows on an impervious fill, since if the tile drainage is not perfect toxic materials may accumulate in these pockets under the topsoil.

When greens are built on side hills or at the bottom of a long slope, it is necessary to protect the green from surface wash. Sand traps conveniently placed can be made to catch this wash. If, however, a sand trap can not be employed for this purpose, a grassy hollow which will deflect the water from the green should be constructed. Attempts to make an open ditch or grassy hollow on the hillside of a green often result in very artificial-looking atrocities when done, in a small way, by hand. Much more natural contours can be gained by doing the work with a team. A few furrows should first be plowed along the hillside where the open ditch is to be built, always plowing in the same direction, with the furrow turned downhill. This plowing should be repeated over the same ground, gradually going deeper into the hillside and higher up the hill. By gradually accumulating earth towards the bottom of the slope a terrace will be built. This should be continued by plowing the center of the terrace deeper and shoving the earth towards the side of the terrace nearest the green. This will give in a rough way an open ditch on the hillside above the green. The ditch will appear quite natural, as all the grades will be long. The ditch will perhaps be only 6 inches to one foot deep in the center; but as it should be constructed to run the collected wash down the hill and around the green at a fairly steep grade, this water will be carried away before it has a chance to

accumulate. The disk and drag harrows may be used to finish off this ditch, and since its construction has all been by team the cost will not amount to that of a ditch dug by hand, which invariably appears much more artificial.

It is generally necessary and always safe to guard against seepage into the green from higher ground. Seepage water is usually cut off from the green by laying a line of tile off the green on the hillside. The ditch should be dug deep enough so that the elevation of the bottom of the trench is no higher than the lowest part of the putting surface on the green. After laying the tile the ditch should be filled to within 6 inches of the top with field stone and rubble. The top of the stone fill should be packed with cinders or gravel, and allowance should be made for considerable settlement, since often these ditches will be 6 to 8 feet deep or even more. In ditches more than several feet deep the tile should be well laid and packed with large stone so that it is guarded from the concentrated weight of the stones above. Concrete or vitrified tile should be used, as it is stronger than porous tile.

If the green has been protected from surface wash and seepage from the higher ground, and the grade on the green is sufficient to carry off surface water, leaving no pockets in which water may accumulate, it may not be necessary to underdrain the green. However, if the subsoil is of a very compact nature which is likely to become almost impervious to the free rise and fall of soil water, the green should be tiled.

Before the green is planted all stones of a size that would interfere with the placing of the hole cup in the green should be removed to a depth of 6 inches. This should be done by hand-picking and raking while the putting green surface is being prepared. Frequently a layer of sifted soil is distributed over the green before seeding, but if the surface soil has been brought to a fine, mellow consistency, no sifted soil would be required. The surface should be lightly rolled to make it even and at the same time compact enough so that men in stocking feet will not leave deep imprints. The surface should then be hand-raked lightly, and dragged with a steel door-mat to remove small lumps and pebbles. The seed should be sown in two directions, as explained in the sowing of the fairways, by one or two careful men. The sowing should be followed by lightly raking the seed into the top half inch of soil, having the men drag their rakes in long, gentle strokes to avoid the ridging which results from raking with short strokes. The raking in of the seed should be followed by a light rolling to make the surface mulch compact around the seed. The seeded green should then be watered with a fine spray. The watering should be sufficient only to keep the germinating layer from becoming dry and not heavy enough to keep the surface soil constantly saturated.

Mowing should be commenced on seeded greens as soon as the seedlings have reached a height of about two inches. The mower should be very sharp so as not to pull the seedlings while cutting. The mower should also be adjusted so as to cut at a height of about one inch for the first cutting, but the mower should be lowered on each succeeding cutting until the grass is down to putting green length. Clippings should be removed from the first on seeded greens.