construction was where a bulldozer operator pushed up the surrounding soil into a final grade and grass was planted. Over time, however, as traffic and watering demands increased on these greens, superintendents began having trouble maintaining a desirable putting surface without the green holding too much water, or becoming too dry, or excessive disease outbreak, particularly *Pythium* and fairy ring. Similar negative results also occur if the soil used contained excessive animal manure. Today, agronomists recognize that choosing a proper root zone mix is the most important decision when constructing golf greens.

Since the 1940's, numerous studies have investigated better methods of building golf greens; e.g., ones that would drain adequately, yet, not drain so well that nutrients and moisture content were difficult to maintain. These studies have consistently shown that materials used for green construction should be a coarse-textured (sandy) material. All sands are not created equal. Some sands are better suited for constructing golf greens while others are better for making concrete or providing a road bed. **In general, standard builders' sand used for construction or for concrete mixing are not suitable for golf green construction**. These sands are either too coarse, thus remain droughty, or have a broad range of particle-size distribution, making the sand dense and impermeable. These sands become very compact with the introduction of even a small percentage of silt and clay. **Table 1** represents the United States Department of Agriculture (USDA) particle size classification for those materials of general interest for building the root zone of desirable putting greens. Some sand companies provide particle-size distribution but in many cases the analysis is based on engineering criteria, not the USDA sieve sizes.

Many golf courses do not plan nor take the time to sample different root zone materials to determine the best possible mix for their particular location. A proper soil mix should be identified by soil laboratory testing. **Only a reputable, reliable soil testing facility should be considered when trying to determine the best root zone mixture for a particular location.** Before choosing a soil-testing laboratory, two criteria should be investigated: (1) the experience/reputation of each lab; and, (2) the sample turnover rate that the laboratory can provide. Many labs are available but only a few have the field experience in addition to the "book" learning, specifically in turf. If the laboratory personnel do not have specific turf experience, then they may not understand the total concept and specific goals of turf managers. Random samples of the root zone components and proposed mixes need to be made to ensure that the sample specifications do not change as different areas or sources are used to obtain the root zone mix components. In the past, sand specifications have differed as changes in the various depths of the pits occurred or when adjacent pits were used. Without quick turn around by a laboratory, contractors and suppliers will be held up, causing confusion and anger.

Table 1. Particle size classifications as determined by the United States Department of Agriculture.

Textural Name	U. S. Standard (sieve number)	Sieve Opening (millimeters)
Gravel	4	>4.76
Fine gravel	10	2.00-4.76
Very coarse sand	18	1.00 -2.00
Coarse sand	35	0.50-1.00
Medium sand	60	0.25-0.50
Fine sand	140	0.10-0.25
Very fine sand	270	0.05-0.10
Silt	—	0.002-0.5
Clay	—	<0.002

Once representative samples (e.g., a minimum of 2 gallons of sand and 1 gallon each of soil, organic matter, and gravel) are received, the soil-testing laboratory will analyze the physical characteristics of each component to determine the best proportion for the root zone mix. Included in the analysis are saturated hydraulic conductivity (infiltration and percolation rate), pore space distribution, particle size, moisture retention, aggregation, bulk density, and mineral derivation.

Hydraulic conductivity

Hydraulic conductivity is defined as water flow through soil in response to a imposed potential gradient. In essence, hydraulic conductivity provides a measure of how fast water moves through the soil in relation to the amount of water (rainfall or irrigation) applied towards a designated drainage point (tile lines in the case of golf greens). Factors influencing the hydraulic conductivity of saturated soils include anything affecting the size and configuration of soil pores as well as the hydraulic