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An Eye for Quality: A New Methodology for Quality Control During USGA Putting Green Construction


Preparing a representative sample from a large stockpile of sand requires hand-mixing a minimum of eight subsamples. After thorough mixing, a one-gallon sample is sent to a certified physical soil-testing laboratory.

Building a new, sand-based putting green can be one of the most gratifying experiences of a golf course superintendent's career. Conversely, a superintendent's entire career can be held in question if a new green fails to live up to golfers' expectations after opening. To help superintendents stay on the right career path, the USGA published new information for monitoring the quality of putting green construction materials in 2002.

Prior to 2002, the methods for monitoring the quality of putting green construction materials were, in a word, lacking. In essence, while the booklet for building a USGA putting green was clear as to what the physical characteristics of the construction materials should be, it did not offer a well-defined procedure for monitoring consistency during root-zone blending. As a consequence, superintendents who originally selected good materials for their root-zone mix, discovered after their new green was built that it did not meet USGA specifications because the physical properties of the sand and/or the amendment had changed during the blending process.

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To address this issue, Jim Moore, director of construction education for the USGA Green Section, worked with university and laboratory scientists to establish a stockpile sampling procedure. (Copies of this new procedure can be obtained by contacting one of the Green Section regional offices or by visiting the USGA's Web site at http:www.usga.org/green/coned/quality_control/.) This protocol gives superintendents a tool to 1) accurately prequalify sand and gravel from local suppliers and 2) monitor the blending of the root-zone mix from beginning to end.

The first superintendent to make use of the new information was Tom Lively, CGCS, Medinah Country Club. In the fall of 2001, the club's members approved a major renovation project for the top rated No. 3 course. The main objective of the renovation project developed by Rees Jones, golf course architect, was to give the No. 3 course a fresh architectural theme. To meet this objective, greens nos. 1, 2, 13, 15, 16, 17 and 18 had to be rebuilt from the drain lines up. Furthermore, every bunker on

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the course had to be reshaped, and fairway nos. 1, 3, 8 and 18 had to be recontoured to improve the view of each respective green.

Before the groundbreaking ceremony for the new greens could begin, however, serious attention was focused on a couple of agronomic problems that had haunted Course No. 3 over the past decade. The first problem was the fact that the irrigation supply had an electrical conductivity reading of 1.35 mmhos/cm, resulting in a toxic accumulation of soluble salts in the soil during extended periods of dry weather. This problem was effectively resolved by boring a new well with an electrical conductivity reading of 0.58 mmhos/cm or, more precisely, 43% less soluble salt.

The second problem was the fact that many of the greens were covered with heavy shade throughout much of the day. For example, a large portion of green no. 14 received less than one hour of morning sunlight during the months of May and July due to the close proximity of surrounding trees. As the renovation plan called for the establishment of a blend of A-4/A-1 creeping bentgrasses on all 18 greens, tree removal was imperative to the long-term success of the project.

To guide the necessary removal of trees, ArborCom, a high-tech surveying company utilizing proprietary software, was hired to pinpoint sources of detrimental shade. As a general rule, creeping bentgrass greens require full sunlight exposure for at least 60% of the daylight hours on any given day of the year. Furthermore, 60% to 70% of this full sunlight exposure period is required before solar noon. To meet these sunlight requirements, approximately 275 trees were removed from the course.

Inspecting the blending site for a hard surface during prequalifying visits to local sand suppliers is necessary to prevent contamination of the root-zone stockpiles once produced.

Table 1

Particle Size Analysis for Sand Samples

Parameter	Particle Size (mm)	USGA Specification(s)		Percent Retained	
				Supplier A	Supplier B
Fine Gravel	2.0 - 3.4	Not more than 10% of the total particles in this range, including a maximum of 3% fine gravel (preferably none).		0.4%	0.7%
Very Coarse Sand	1.0 - 2.0			5.0%	5.2%
Coarse Sand	0.50 – 1.0	Minimum of 60% of the particles must fall in this range.		25.2%	18.0%
Medium Sand	0.25 - 0.50			55.3%	47.9%
Fine Sand	0.15 - 0.25	Not more than 20% of the particles may fall within this range.		9.9%	21.9%
Very Fine Sand	0.05 - 0.15	Not more than 5%.	Total particles in this range should not exceed 10%.	2.1%	5.2%
Silt	0.002 - 0.05	Not more than 5%.		1.4%	< 1.0%
Clay	< 0.002	Not more than 3%.		< 1.0%	< 1.0%

Table 2

Particle Size Analysis for Gravel Samples			
Parameter	**USGA Specifications** (No Intermediate Layer Used)	**Percent Passing**	
		Supplier A	Supplier B
0.5"	No particles greater than 0.5 inch.	100%	100%
2 mm	Not more than 10% of the particles less than 2 mm.	2.2%	0.3%
1 mm	Not more than 5% of the particles less than 1 mm.	4.8%	1.0%

With the water and shade problems resolved, the first step in the quality-control program was taken by establishing a clear chain of command between all parties involved with the renovation project. These parties included the maintenance department, Rees Jones' office and the golf course builder. In a nutshell, Tom became the official clerk of the works given his long-term interests in the success of the project, his understanding of the project's detailed specifications and his ready access to the site at all times. As clerk of the works, Tom had direct responsibility for making future judgments regarding the delivery of construction materials based on the results of stockpile sampling.

In early June of 2002, the next step in the program was to visit two prominent sand and gravel suppliers in the Chicago area to prequalify construction materials. During each visit, Tom, his assistant in charge of the No. 1 course and I collected sand and pea gravel samples using the new sampling protocol written by Jim Moore. These samples were then labeled and sent to Turf Diagnostics & Design, one of several accredited laboratories, for analysis. The initial results of this analysis are summarized in Tables 1 and 2.

Upon reviewing the initial results, both the sand and pea gravel from Supplier A were selected for the renovation project. The best choice for the sand was straightforward in that the sample collected from Supplier B fell just outside USGA specifications in the fine sand and

To monitor the consistency of root-zone production using confidence intervals published by the USGA, a standard set of data was obtained by first testing a small 100-yd³ stockpile consisting of 88% sand and 12% Canadian peat moss.

very fine sand categories. On the contrary, the sample taken from Supplier A had readings that were all well within USGA limits for every category. This latter fact was especially encouraging because the particle size distribution for any sand supply tends to fluctuate over time. As such, choosing the sand from Supplier A increased the likelihood that the construction materials would still meet USGA specifications two months later when the construction phase of the renovation project was scheduled to begin.

As a final prequalifying check, Turf Diagnostics & Design combined the sand from Supplier A with Sun Gro Canadian peat moss to determine if the root-zone mix would meet USGA specifications for infiltration and porosity. Here again, the sand from Supplier A passed with flying colors as all readings were well within the USGA limits.

In August of 2002, several return visits were made to Supplier A to monitor the actual production of the root-zone mix. During the first return visit, Tom, his assistant and I met with Greensmix (the root-zone blender for the project) while they were calibrating their equipment. This calibration entailed mixing three 75-yd³ stockpiles of sand and peat in 88/12, 90/10 and 92/8 ratios. From these small stockpiles, samples were collected using the new USGA sampling procedure and submitted for laboratory analysis. The results of this analysis showed that the 88/12 sand-to-peat mixture had the best

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Table 3

Quality Control Summary for Stockpile No. 1 (0 – 1,000 yd^3)

Parameter	88/12 Stockpile Standard	Confidence Interval	Confidence Interval Limits		Stockpile No. 1 Results	Confidence Interval Evaluation	USGA Guideline
			Lower (LL)	Upper (UL)			
Fine Gravel	0.4%	+/- 50%	0.2%	0.6%	0.5%	Within Limits	Pass
Very Coarse Sand	3.4%	+/- 50%	1.7%	5.1%	4.1%	Within Limits	Pass
Coarse Sand	21.2%	+/- 10%	19.1%	23.3%	22.6%	Within Limits	Pass
Medium Sand	52.6%	+/- 10%	47.3%	57.9%	52.0%	Within Limits	Pass
Fine Sand	15.3%	+/- 15%	13.0%	17.6%	14.2%	Within Limits	Pass
Very Fine Sand	4.5%	+/- 30%	3.2%	5.9%	3.7%	Within Limits	Pass
Silt	1.7%	+/- 25%	1.3%	2.1%	2.5%	Exceeds UL	Pass
Clay	0.9%	+/- 25%	0.7%	1.1%	0.3%	Exceeds LL	Pass
Total Porosity	39.5%	+/- 10%	35.6%	43.5%	43.6%	Exceeds UL	Pass
Air-filled Porosity	19.3%	+/- 10%	17.4%	21.2%	21.1%	Within Limits	Pass
Water-filled Porosity	20.2%	+/- 10%	18.2%	22.2%	22.5%	Exceeds UL	Pass
Hydraulic Conductivity	14.9%	+/- 20%	11.9%	17.9%	13.3%	Within Limits	Pass
Percent Organic Matter	0.56%	0.2*	0.76%	0.36%	0.69%	Within Limits	

infiltration and porosity measurements and, thus, was selected for the project.

After determining the optimal sand-to-peat ratio, Tom authorized Greensmix to start blending the three 1,000-yd^3 stockpiles needed for the construction of the club's seven new greens. After each stockpile had been blended, his assistant once again returned to Supplier A to collect samples for additional testing. The purpose for testing each stockpile was to determine 1) if the blending ratio of sand to peat remained stable and 2) if the physical characteristics of the sand and peat remained consistent. If not, the production of root-zone material would have been halted until the problem could be resolved.

To judge the consistency of the large, 1,000-yd^3 stockpiles, the sample results were compared against the results from the 88/12 calibration stockpile using confidence intervals developed by the USGA. Confidence intervals are simply a reflection of the typical variance expected in the physical characteristics of a root-zone material when produced in large quantities. For example, the 88/12 calibration stockpile had 3.4% very coarse sand. Using a confidence interval of plus or minus 50% meant that the amount of very coarse sand in each of the 1,000-yd^3 stockpiles was expected to vary between a lower limit of 1.7% and an upper limit of 5.1%. (The confidence intervals used for the Medinah project can be obtained by contacting one of the Green Section regional offices or by visiting the USGA's Web site at http: www.usga.org/green/coned/green/confidence_intervals.html.)

Using the new stockpile-sampling procedure written by Jim Moore, USGA Green Section, Tom Lively and his Course No. 1 assistant collect a sand sample during a visit to a local sand supplier.

The test results for stockpile #1, consisting of the first 1,000 yd^3 of root-zone material, are shown in Table 3 along with the results for the 88/12 calibration stockpile and the confidence intervals. Note that when reviewing the information in

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Table 3, it becomes apparent that the confidence interval limits were exceeded in four categories: silt, clay, total porosity and water-filled porosity. However, delivery of the stockpile was nonetheless accepted given the minute nature of the violations and the fact that all of the measurements continued to meet USGA specifications. Stockpiles #2 and #3 also had similar results.

Having confirmed that all three stockpiles of root-zone material were consistent and met USGA specifications prior to delivery, the only remaining step in the quality-control program was to ensure the proper assembly of each green in the field. This was done by randomly probing the depth of the gravel and root-zone layers and by inspecting the main drain lines with a fiber-optic video camera. It is interesting to note that the latter effort identified a collapse in the drain line underneath green no. 18 that was subsequently dug up and repaired before seeding.

By keeping an eye on quality control during the construction of the seven new greens and confronting longstanding issues plaguing the No. 3 course at Medinah Country Club, Tom Lively has done everything possible to ensure the future success of the turf and the continuation of a successful career. If your course is considering green construction in the future and would like additional information on quality control, you can contact any of the USGA Green Section regional offices.

The new quality-control protocol developed by the USGA gives superintendents a tool to 1) accurately pre-qualify sand and gravel from local suppliers and 2) monitor the blending of the root-zone mix from beginning to end.

Proper calibration of the blending equipment is a key component of producing a high-quality, consistent root-zone blend.