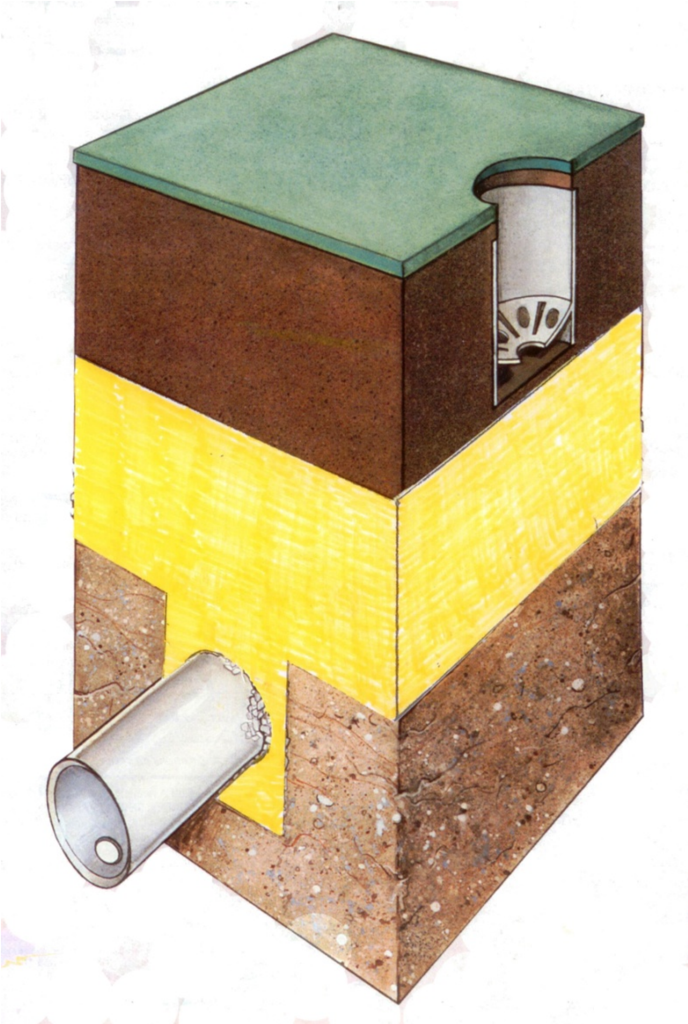
The "Dutch Green" Recommended Method of Construction.



 31 January 2014

1, History and Data from Existing “Dutch Greens”

After inspecting the course of Golf Club Leeuwenbergh (opened in 1988), Alister Beggs (STRI agronomist) in his report labeled the greens “The Dutch Green” construction. This description has become common practice for all greens constructed after 1988. There is however no specification describing how to construct the so called “Dutch Green”. Each architect and/or person who makes the “Bestek” for a new golf course or green makes their own specification.

In 2002 the NGF engaged the STRI to make a survey of three “Dutch Greens” on ten Dutch golf courses 10 to 15 years old. A copy of the results entitled “Monitoring of Dutch Golf Greens: Turf Quality and Management Assessments (2002-2004)” is in the NGF archives. A presentation of the results of the survey was made by the STRI at the NGF Green symposium in 2004.

In Appendix1there are two diagrams showing the Particle Size Distribution (PSD) of sands.
The top diagram shows the PSD of the sands used in the construction of the “Dutch Greens” surveyed by the STRI and 9 “Dutch Greens” on another course obtained by Collinge.
The majority of the sands are finer than the lower limits recommended by the STRI and the USGA recommended limits.The STRI also found that the majority of the greens had too high a percentage of organic material in the top 60 mm. This together with the fine sands means that the top layer of the greens holds too much water and not enough air. This makes the greens vulnerable to disease and Poa annua invasion. With the exception of one golf course none of the greens rootzone were tested to determine their physical properties before the greens were constructed.
The PSD of the top dressing used by 7 of the 10 courses was made. All 7 had too much fine sand smaller than 0.250 mm, the percentage ranged from 33% to 73%.

The lower diagram shows the PSD and the physical properties of the two sands used in a research project funded by the USGA.[4] Both sands were used in two tests, one using the USGA construction that uses a gravel layer and the other using a modified California construction that has no gravel layer. This research can be downloaded from the following link:
http://gsr.lib.msu.edu/1990s/1999/990712.pdf .
The USGA research shown in the above link compared the performance of the two methods.
The tests of the two methods show that the modified California construction does not drain quite so quickly or as completely as the USGA gravel layer green.

The Dutch Green construction with a rootzone 40 cm thick is a modified California construction. Because the Dutch Green method described in this document is almost identical to the USGA modified low permeability California construction, the test data from the USGA research is a good indication of how the “Dutch Green” will perform.
In Appendix 3 is the specification for the gravel and an estimate of the quantity of that is required to make a 500 sq. meter Dutch Green putting green. From this data an estimate can be made to show the extra cost of making a green using the USGA method. The cost of the extra gravel is a small amount compared with the total cost of making a green with superior drainage capability.

This “Recommended Method” and The “USGA Recommendations” describe only the method to make a rootzone and drainage for a golf course putting green. The performance of the rootzone to grow high quality turf will depend on the design of the green and its environmental surroundings. The USGA publication “Report Card for a Green” by James Moore lists the essential design and environmental parameters that influence turf quality and provide a method of evaluating these factors. This publication has been translated into Dutch and published in the Greenkeeper.

2. Recommended method for constructing a "Dutch Green" putting green.

When designed, built and properly maintained, the "Dutch Green" construction will provide consistently good results for a golf course putting green over a period of many years.

2.1. The Subgrade
The slope of the subgrade should conform to the general slope of the finished grade. The subgrade should be established approximately 400 mm below the proposed surface grade and should be thoroughly compacted to prevent further settling. Water collecting depressions should be avoided. If the subsoil is unstable, such as with an expanding clay, sand, or muck soil, geotextile fabrics may be used as a barrier between the subsoil and the sand layer. Install the fabric as outlined in the USGA publication, "Building the USGA Green: Tips for Success" .
Construct collar areas around the green to the same standards as the putting surface itself.

2.2 – Drainage
A subsurface drainage system is required in the Dutch Green. The pattern of drainage pipes should be designed so that the main drain(s) is placed along the line of maximum fall, and laterals are installed at an angle across the slope of the sub grade, allowing a natural fall to the main drain. Lateral drains shall be spaced not more than 5m apart and extended to the perimeter of the green. Laterals should also be placed in water-collecting depressions if they exist. At the low end of the gradient, where the main drain exits the green, a drainage pipe should be placed along the perimeter of the green, extending to the ends of the first set of laterals. This will facilitate drainage of water that may accumulate at the low end of that drainage area. Drainage design considerations should be given to disposal of drainage waters away from play areas, and to the laws regulating drainage water disposal. The drainage pipe shall be perforated plastic, minimally conforming to ASTM 2729 or ASTM F 405, with a minimum diameter of 100 mm.
Drainage trenches minimally 150 mm wide and 200 mm deep shall be cut into a thoroughly compacted sub grade so that drainage pipes maintain a consistent slope to the outlet of at least 0.5%. Spoil from the trenches should be removed from the subgrade cavity, and the floor of the trench should be smooth and clean. If a geotextile fabric is to be used as a barrier between unstable subsoil and the sand drainage it must be placed under the drain pipe.

Place grade stakes at frequent intervals over the subgrade and mark them for the 200 mm sand layer and the 200 mm. top layer mixture of sand and organic material

2.3 - The top layer Root Zone Mixture
The sand used in a Dutch Green rootzone mix shall be selected so that the particle size distribution of the final rootzone mixture is as described in Table 3.

Table 3 Particle size distribution of a Dutch Green rootzone mixture.

Name	Particle Diameter	Recommendation (by weight)
Fine gravel	2.0 – 3.4 mm	Not more than 10% of the total particles in this range, including a maximum of 3% fine gravel (preferably none)
Very coarse sand	1.0 - 2.0 mm	
Coarse sand	0.5 - 1.0 mm	Minimum of 60% of the particles must fall in this range
Medium sand	0.25 - 0.50mm	
Fine sand	0.15- 0.25 mm	Not more than 20% of the particles may fall within this range
Very fine sand	0.05 - 0.15 mm	Not more than 5%
Silt	0.002 - 0.05 mm	Not more than 5%
Clay	less than 0.002 mm	Not more than 3%
Total fines	Very fine sand + silt + clay	Less than or equal to 10%

2.4 - Organic Matter Selection:
Peats - The most commonly used organic component is a peat. If selected, it shall have a minimum organic matter content of 85% by weight determined by loss on ignition (ASTM D 2974 Method D).
Other organic sources - Organic sources such as rice hulls, finely ground bark, sawdust, or other organic waste products are acceptable if composted through a thermophilic stage, to a mesophilic stabilization phase, and with the approval of the soil physical testing laboratory. Composts shall be aged for at least one year. Furthermore, the root zone mix with compost as the organic amendment must meet the physical properties as defined in these recommendations. Composts can vary not only with source, but also from batch to batch within a source. Extreme caution must be exercised when selecting a compost material. Unproven composts must be shown to be nonphytotoxic using a bentgrass bioassay on the compost extract.

Inorganic and Other Amendments: Porous inorganic amendments such as calcined clays (porous ceramics), calcined diatomites and zeolites may be used in place of or in conjunction with peat in rootzone mixes, provided that the particle size and performance criteria of the mix are met. Users of these products should be aware that there are considerable differences between products, and long term experience with some of these materials is lacking. It should also be noted that any such amendment to be incorporated throughout the full 200 mm depth of the rootzone mixture. Polyacrylamides and reinforcement materials are not recommended.

2.5 Testing the rootzone mix.
Samples of the sand and organic material must be tested by a qualified laboratory with experience of making the physical properties tests specified for the Dutch Green root zone. The laboratory can advise the quantities of sand and organic material that are required for the tests.

The laboratory will make several tests using different percentages of organic material for each test. Experienced laboratories can estimate the percentage the organic material that is suitable for the PSD of the proposed sand. Three tests with different percentages of organic material are usually made. The laboratory will then select the mixture with a percentage of organic material that makes a rootzone mixture that is within the limits of the following table of Physical properties.

Physical Properties of the Rootzone Mix:

Table 4 – Physical Properties of the Rootzone Mixture
Recommendations by N. W. Hummel Ph.D.[1]

Physical Property	Recommended Range
Total Porosity	35% - 55%
Air-filled Porosity	15% - 30%
Capillary Porosity	10% - 20%
Saturated Hydraulic Conductivity	Minimum of 250 mm/hr.

In Europe there are only two laboratories that are qualified to make the required tests. The names and contact information are shown in Appendix 4.

Related Concerns

IT IS ABSOLUTELY ESSENTIAL TO MIX ALL ROOTZONE COMPONENTS OFF-SITE. No valid justification can be made for mixing on the site of the green. A homogeneous mixture made on a hard impervious surface to avoid contamination by local soil is essential to success.

A QUALITY CONTROL PROGRAM DURING CONSTRUCTION IS STRONGLY RECOMMENDED. Arrangements should be made with a competent laboratory to routinely check rootzone mixtures during production and blending. It is imperative that these materials conform to the recommendations approved by the laboratory in all respects.

Care should be taken to avoid over shredding the peat, since it may influence performance of the mix in the field. Peat should be moist during the mixing stage to ensure uniform mixing and to minimize peat and sand separation.

The sand to be used for the top layer and the 200 mm sand layer and drainage trenches shall have the same PSD as the sand tested and approved by the soil testing laboratory.

2. 6 - Top Mix Covering, Placement, Smoothing, and Firming
The thoroughly mixed rootzone material shall be placed on the green site and firmed to a uniform depth of 200 mm, with a tolerance of Â± 25 mm. Be sure that the mix is moist when spread to discourage migration into the sand layer and to assist in firming.

2.7 - Seed Bed Preparation, fertilization.
Sterilization: Sterilization of the rootzone mix by fumigation should be decided on a case by case basis, depending on regional factors. Fumigation always should be performed in areas prone to severe nematode problems and when rootzone mixes contain unsterilized soil.

A chemical analysis of the rootzone mixture should be made and advice on fertilization obtained from a qualified experienced agronomist.
This document details the recommendations for the construction of the “Dutch Green”. A great deal more information regarding various construction techniques used to build putting greens can be obtained from the UGGA Green Section web site.

2.8 Grow in.
Growing in new greens is probably the most underestimated challenge in golf turf management. This is because Head Greenkeepers rarely have the opportunity to establish a new green and, consequently, are not well versed on the subject.
A poor grow-in can have devastating consequences to both the short- and long-term success of a project for several reasons. If the advice of a qualified agronomist is not available then the following Information written by Bud White should be followed.

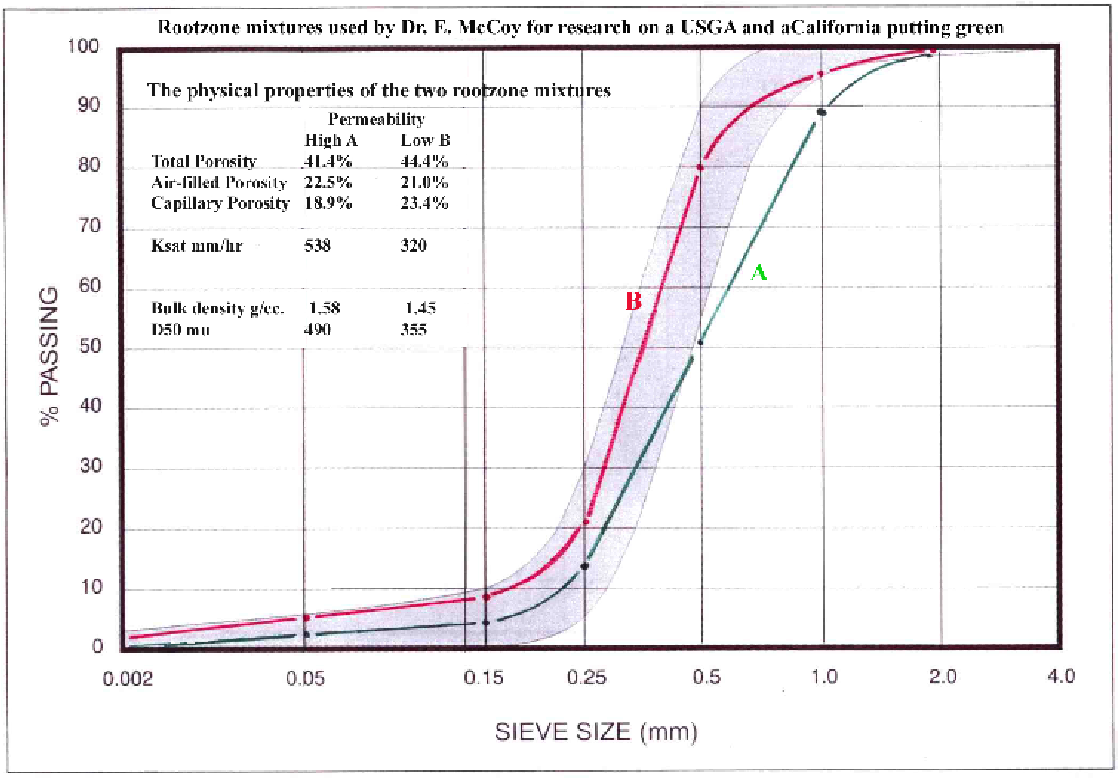
Bud White[3] is the USGA agronomist for the Mid-Continent Region and has worked with superintendents on more than 200 construction/renovation projects. He is also the author of “Turf Manager's Handbook for Golf Course Construction, Renovation, and Grow-in.”

Bud Whites USGA Green Section Record article about Grow in “De geboorte van een green” is on the DTRF web site in Dutch.

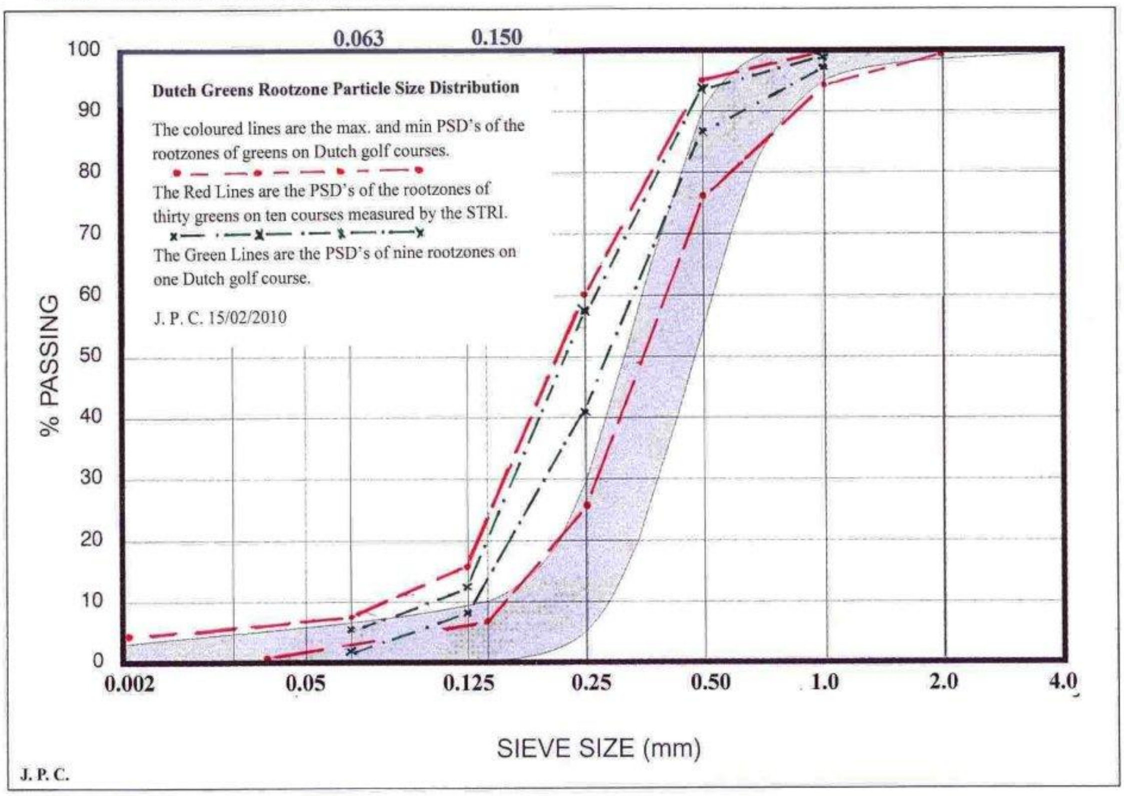
J. P. Collinge. MBE B.Sc.(Hons) 19th February 2014

Appendix 1- PSD's of the "Dutch Greens root zones. and USGA research

STRI Grading curve for rootzone layer.



STRI Grading curve for rootzone layer.



The STRI grading curve limits are shown in solid pale grey/blue

Appendix 2- ASTM Test Methods and Material Specifications

ASTM C 88-99a. Standard Test Method for Soundness of Aggregates by Use of Sodium Sulphate or Magnesium Sulfate. American Society for Testing and Materials.

ASTM C 131-03. Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine. American Society for Testing and Materials.

ASTM C 136-96a. Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates. American Society for Testing and Materials

ASTM D 75.-97. Standard Practice for Sampling Aggregates. American Society for Testing and Materials.

ASTM D 854-02. Standard Test Method for Specific Gravity of Soil Solids by Water Pycnometer. American Society for Testing and Materials.

ASTM D 2729-03. Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings. American Society for Testing and Materials.

ASTM D 2974-00. Standard Test Methods for Moisture, Ash, Organic Matter of Peat and Other Organic Soils. American Society for Testing and Materials.

ASTM D 2976-71. Standard Test Method for pH of Peat Materials. American Society for Testing and Materials.

ASTM 4972-01. Standard Test Method for pH of Soils. American Society for Testing and Materials.

ASTM D 7001-XX. Standard Specification for Geocomposites for Pavement Edge Drains and Other High-Flow Applications

ASTM F 405-97. Standard Specification for Corrugated Polyethylene (PE) Pipe and Fittings. American Society for Testing and Materials.

ASTM F 1632-03. Standard Test Method for Particle Size Analysis and Sand Shape Grading of Golf Course Putting Green and Sports Field Rootzone Mixes. American Society for Testing and Materials.

ASTM F 1647-02a. Standard Test Method for Organic Matter Content of Putting Green and Sports Turf Rootzone Mixes. American Society for Testing and Materials.

ASTM F 1815-97. Standard Test Methods for Saturated Hydraulic Conductivity, Water Retention, Porosity, Particle Density, and Bulk Density of Putting Green and Sports Turf Rootzone Mixes. American Society for Testing and Materials.

Appendix 3- Gravel specification, Tests and Quantity for a 500 m^2 green.

Gravel and Intermediate Layers

Layers. Place grade stakes at frequent intervals over the subgrade and mark them for the gravel drainage blanket layer, sand layer and top layer. The entire subgrade shall then l be covered with a layer of clean, washed, crushed stone or pea gravel to a minimum thickness of 100 mm, conforming to the proposed final surface grade to a tolerance of Â±26 mm. Soft limestones, sandstones, or shales are not acceptable. Questionable materials should be tested for weathering stability using the sulfate soundness test (ASTM C-88). A loss of material greater than a 12% by weight is unacceptable. The LA Abrasion test (ASTM C-131) should be performed on any materials suspected of having insufficient mechanical stability to withstand ordinary construction traffic. The value obtained using this procedure should not exceed 40. Soil engineering laboratories can provide this information. The need for an intermediate layer is based on the particle size distribution of the rootzone mix relative to that of the gravel. When properly sized gravel (see Table 1) is available, the intermediate layer is not necessary. **If the properly sized gravel cannot be found, an intermediate layer must be used.**

Table 1 PARTICLE SIZE DESCRIPTION OF GRAVEL AND INTERMEDIATE LAYER MATERIALS

Material	Description
Gravel: Intermediate layer is used	Not more than 10% of the particles greater than 12mm
	At least 65% of the particles between 6mm and 9mm
	Not more than 10% of the particles less than 2 mm
Intermediate Layer Material	At least 90% of the particles between 1 mm and 4 mm

Table 2 SIZE RECOMMENDATIONS FOR GRAVEL WHEN INTERMEDIATE LAYER IS NOT USED

Performance Factors	Recommendation
Bridging Factor	D15 (gravel) less than or equal to 8 X D85 (root zone)
Permeability Factor	D15 (gravel) greater than or equal to 5 X D15 (root zone)
Uniformity Factors	D90 (gravel) / D15 (gravel) is less than or equal to 3.0
	No particles greater than 12 mm
	Not more than 10% less than 2 mm
	Not more than 5% less than 1 mm

A. Selection and Placement of Materials When the Intermediate Layer Is Used

Table 1 describes the particle size requirements of the gravel and the intermediate layer material when the intermediate layer is required.

The intermediate layer shall be spread to a uniform thickness of 50 to 100 mm over the gravel drainage blanket (e.g., if a 75 mm depth is selected, the material shall be kept at that depth across the entire area), and the surface shall conform to the contours of the proposed finished grade.

B. Selection of Gravel When the Intermediate Layer Is Not Used

If an appropriate gravel can be identified (see Table 2), the intermediate layer need not be included in the construction of the green. In some instances, this can save a considerable amount of time and money.

Selection of this gravel is based on the particle size distribution of the rootzone material. The architect and/or construction superintendent must work closely with the soil testing laboratory in selecting the appropriate gravel. Either of the following two methods may be used:

Submit samples of the components for the rootzone mix, and ask the laboratory to provide a description, based on the rootzone mix tests, of the particle size distribution required of the gravel. Use the description to locate one or more appropriate gravel materials, and submit them to the laboratory for confirmation.

Gravel meeting the criteria below will not require the intermediate layer. It is not necessary to understand the details of these recommendations; the key is to work closely with the soil testing laboratory in selecting the gravel. **Strict adherence to these criteria is imperative; failure to follow these guidelines could result in greens failure.**

The criteria are based on engineering principles which rely on the largest 15% of the rootzone particles "bridging" with the smallest 15% of the gravel particles. Smaller voids are produced, and they prevent migration of rootzone particles into the gravel yet maintain adequate permeability. The D85 (rootzone) is defined as the particle diameter below which 85% of the soil particles (by weight) are smaller. The D15 (gravel) is defined as the particle diameter below which 15% of the gravel particles (by weight) are smaller.

- For bridging to occur, the D15 (gravel) must be less than or equal to eight times the D85 (rootzone).
- To maintain adequate permeability across the root zone/gravel interface, the D15 (gravel) shall be greater than or equal to five times the D15 (rootzone).
- The gravel shall have a uniformity coefficient (Gravel D90/Gravel D15) of less than or equal to 3.0. Furthermore, any gravel selected shall have 100% passing a 12 mm sieve and not more than 10% passing a No. 10 (2 mm) sieve, including not more than 5% passing a No. 18 (1 mm) sieve.

Estimated quantity of gravel and intermediate layer gravel for a 500 sq.m. putting green
Gravel for gravel layer and drains 56.5 cu.m.   Gravel for intermediate layer 37.5 cu.m. if required.

Appendix 4 – Qualified soil testing Laboratories.

1. European Turfgrass Laboratories Ltd (ETL)
   Unit 58
   Stirling Enterprise Park
   Stirling FK7 7RP
   Scotland, UK

europeanturf@aol.com
Telephone:0044 (0) 1786 449195   Fax : 0044 (0) 1786 449688

2. The Sports Turfgrass Institute (STRI)
   St Ives Estate, Bingley
   West Yorkshire, BD16 1AU
   United Kingdom

info@stri.co.uk
+44 (0)1274 565131 (phone) +44 (0)1274 561891 (fax)

References

1. “Which root-zone recipe makes the best green?” N. D. Hummel Ph.D. GCSAA Golf Course Management December 1998.
2. “The Sand Putting Green Construction and Management” University of California. Publication No.21448.
3. “The Birth of a putting green. Charles (Bud)White USGA Green Section Record November/December 2003.
4. Subsurface Drainage of Modern Putting Greens Guy Prettyman and McCoyPh.D. USGA Green Section Record July /August 1999.