ADDENDUM NO. 1

TO

CONTRACT DOCUMENTS

ROBBINS FARM FIELD RENOVATIONS & UPGRADES

May 8, 2017

NOTICE TO BIDDERS

The attention of all bidders submitting proposals for "Robbins Farm Field Renovations & Upgrades" is called to the following Addenda to the printed specifications and plans. The items set forth herein, whether of omission, addition or substitution are to be included in, and form part of the specifications and plans of the above named project for bids to be received as advertised.

The following clarifications, modifications, deletions and additions are hereby incorporated into and become part of the Contract Documents.

SPECIFICATIONS AND PLANS

1. **Section 02290, Part 2, paragraph 2.01, C.2. – Delete and Replace with the following: Refer to Appendix A – Sand and Soil Amendments for fertilization requirements.**
2. **Add Section 02790 – Infield Mix**
3. **Section 02910, Delete in its entirety and Replace with Section 02910R.**
4. **Section 02911, Delete in its entirety and Replace with Section 02911R.**
5. **Add Appendix A**
6. **Add Appendix B - ASTM F2396**
7. **Bid Form, Section C-5, Supplemental Unit Prices Form Table – Delete and Replace with the following:**

SUPPLEMENTAL UNIT PRICES FORM

ITEM DESCRIPTION	UNIT	ADDITIONS	Owner Approval
1. Loam Borrow	CY	$	
2. Seeding (15#/1000SF)	3,000 SF	$	
3. Aggregate base installed, excluding excavation	CY	$	
4. Bituminous concrete pavement	SY	$	
5. CIP concrete pavement	CY	$	
6. Furnish and install new bench with back	EA	$	
7. Bituminous concrete removal, full depth	SY	$	
8. Demolish existing drainage structure	EA	$	
9. Install new drainage structure to match existing	EA	$	
10. Demolish existing drainage lines	LF	$	
11. Install new drainage lines to match existing	LF	$	
12. 2mm sand	CY	$	
13. Ledge excavation (drill and blast) including disposal off site, including replacement with equal volume of gravel:	CY	$	

14. Ledge excavation (pneumatic bullpoint) including disposal off-site, including replacement with equal volume of gravel:	CY	$	
15. Sod	SF	$	

ATTACHMENTS

SK-1- Revisions to Extents and Depth of Existing Topsoil Stripping & Stockpiling
SK-2- Revisions to Extents of Rootzone Mix and Athletic Field Seed Mix
SK-3- Revisions to Rootzone Mix Detail

END OF ADDENDUM NO. 1

SECTION 02790

INFIELD MIX

PART 1 - GENERAL

1.01 SCOPE OF WORK:

A. The Contractor shall furnish and construct infield mix surfaces to the lines and grades shown on the plans as specified in this Section, including the provision of all materials, labor, tools, equipment and transportation necessary to complete the work.

B. In advance of installing the new infield mix surfacing, the Contractor shall be responsible for removal of existing materials. Excavated materials may be reused as stipulated on the construction drawings and specifications.

1.02 SUBMITTALS:

A. Two (2) weeks prior to ordering the material, the Contractor shall submit to the Engineer, at the Contractor's expense, a representative sample of the material to be used, and a copy of a soils analysis from an accredited laboratory classifying the mixture and tabulating the sieve analysis. Mixture shall be 100% free of stones of any size, foreign matter and debris. Refer to Appendix E for required particle size and particle shape/textural class and color.

B. If the mixture is disapproved by the Engineer, the Contractor shall continue to obtain other sources of material and have them tested, at his own cost, until the Engineer approves the mixture to be utilized for the clay infield.

1.03 RELATED WORK:

A. Shop Drawings: Submit shop drawings in accordance with Division 1 requirements.

B. Section 02252, SUPPPORT OF EXCAVATION

PART 2 – PRODUCTS

2.01 INFIELD MIX:

A. The clay infield mixture shall be DuraEdge Classic by Read Custom Soils of Canton, MA, or an approved equal product.

B. Infield mix shall contain 65-75% sand.

C. Pitchers Mound: HILLTOPPER Mound Clay as manufactured by Read Custom Soils, Canton, MA or an approved equal

PART 3 - EXECUTION

3.01 INSTALL, ROLL AND COMPACT INFIELD MIX:

A. Upon removal of existing surfaces and installation of the required **4-inch** bed, the Contractor shall install, roll and compact the infield mix specified to a compacted finished depth as specified on the construction plans. Complete installation of clay infield surfaces in conformance with the manufacturer's recommendations or as otherwise required by the Engineer.

B. The edges of the infield mix shall meet the grades of adjacent turf areas. No ridges or depressions will be permitted at edges.

C. HILLTOPPER (or approved equal)

1. Pitching Area

a. Set pitching rubber
b. Excavate to a 4-5-inch depth in a 3' wide x 10' long area, measuring one foot behind the rubber and 9-feet in front of the rubber.
c. Apply HILLTOPPER, or approved equal, and cover with specified infield mix.
d. Fill in back and sides sloping to the edge of the circle, and topdress with approved infield mix.

END OF SECTION

SECTION 02910R

SCREENED LOAM BORROW AND TOPSOIL RE-USED

PART I - GENERAL

1.01 SCOPE OF WORK

A. Under this Section, the Contractor shall furnish all labor, materials, equipment and transportation required to furnish and place ½" Screened Loam Borrow as shown on the drawings and as specified. Where proposed tree and shrub planting mix and/or sod or seed is noted on the drawings, it shall be composed of Loam Borrow, or Topsoil Reused in compliance with this specification.

B. Prospective bidders are advised that significant quantities of topsoil are present at the property and presumably available for reuse if compatible with the requirements of this specification. The Contractor shall take careful consideration as to not compact the topsoil.

1.02 SAMPLES/TESTS

A. Test results of the on-site loam are provided in Appendix A.

B. Contractor shall be responsible for amending the topsoil to meet the specification. All amendments shall be submitted prior to start of construction; the Town reserves the right to test amended soils to ensure uniformity.

C. To assure that materials fulfill specified requirements regarding textural analysis, organic matter content, pH, and fertility testing may be undertaken:

1. Prior to site delivery; at source;

2. At time of delivery; on-site; and/or

3. Immediately following spreading on site. Soil sampling shall also indicate if specified soil was supplied uniformly to the minimum specified depth.

1.03 STANDARDS

A. ASTM - American Society for Testing and Materials.

1.04 NOTIFICATION

A. The Contractor shall notify the Owner in writing at least four (4) days in advance of the time he intends spread Screened Loam Borrow.

1.05 QAULITY CONTROL

A. The Contractor or Sub-contractor must have a minimum of five (5) years of experience installing athletic fields of similar size and quality of this project.

B. The Town and the Engineer will determine whether the contractor or sub-contractor is qualified for this work.

PART II - MATERIALS

2.01 LOAM BORROW

A. In accordance with the specific requirements of this project, existing on-site soil may be re-used as Loam Borrow only if it meets this Specification. Existing topsoil that does not meet this Specification may be re-used only up to the subgrade elevation within the limits of areas to receive new Loam Borrow.

B. Screened Loam shall be "fine sandy loam" or "sandy loam" determined by mechanical analysis (ASTM D-422) and based on the "USDA" Classification System". Screened Loam has the following mechanical analysis:

Textural Class	Percentage of Total Weight	Average Percentage
Sand (0.05 – 2.0mm)	50 – 80	70
Silt (0.002 – 0.05mm)	15 – 25	20
Clay (Less than 0.002mm)	5 – 10	10

C. Screened Loam shall be a natural product consisting primarily of natural topsoil, free from subsoil, and obtained from an area that has never been stripped. Screened Loam shall not contain less than five percent (5%) nor more than ten percent (8%) organic matter as determined by the loss on ignition of oven-dried samples, at 100°C ± 5°C. To adjust organic matter content, the soil may be amended on site by the addition of composted bio-solids. Use of organic amendments is accepted only if random soil sampling indicates a thorough incorporation of these materials. The Loam (or) Compost shall not be delivered when in a wet or frozen condition.

D. Screened Loam shall consist of fertile, friable, natural loam capable of sustaining vigorous plant growth. Loam shall be without admixture of subsoil, and refuse, resulting in a homogeneous material free of stones greater than ½" in the longest dimension, be free of lumps, plants, glass, roots, sticks, excessive

stone content, debris, and extraneous matter as determined by the Engineer. Screened Loam shall be within the pH range of 6.0 to 6.5 except as where noted on plans and details. It shall be uncontaminated by salt water, foreign matter and substances harmful to plant growth. The maximum soluble salt index shall be 100. Screened Loam shall not have levels of aluminum greater than 200 parts per million.

E. If limestone is required to amend the screened loam to bring it within a pH range of 6.0 to 6.5 no more than 200 pounds of limestone per 1,000 square feet of loam, incorporated into the soil, or 50 pounds of limestone per 1,000 square feet of loam, surface application, within a single season.

F. The Engineer will reject any material delivered to the site that does not meet these Specifications after post-delivery testing. If the delivered screened loam does not meet the specifications stated in this document, the delivered screened loam will be removed by the Contractor at the Contractor's expense and at the time of rejection.

G. The topsoil shall not be handled or moved when in a wet or frozen condition.

H. Topsoil structure shall not be destroyed through excessive and unnecessary handling or compaction. Inappropriate handling leading to the compaction or deterioration of soil structure will result in rejection of topsoil for use.

I. At no time should equipment or material rest on the soil.

J. Under no circumstance shall any equipment exceeding 5 PSI ground pressure be allowed on the field, assuming there is no landfill.

J. Loam Borrow shall be free of plants and their roots, glass, brick, construction debris and other extraneous matter. It shall be uncontaminated by salt water, foreign matter and substances harmful to plant growth. The electrical conductivity (EC2) of a 1:2 soil-water suspension shall be equal to, or less than, 1.0 millimhos/cm. (test material passing #4 sieve).

2.02 REUSE OF EXISTING TOPSOIL

A. The reuse of topsoil that does not meet the specifications for use as loam borrow may be permitted for use as a general fill material to subgrade elevations at the limits of lawn and planting areas.

2.02 PEAT OR ORGANIC MATERIAL

a. Peat moss shall be of a standard brand free of sticks, stones, hay or any other deleterious matter and meet the following requirements:

Parameter	Specification
Total Ash	15% or less

PH	6.5 to 7.5
% Moisture	30% to 50%
Sieve Criteria	
2.0 mm sieve	0-5% retained
1.0 mm sieve	Less than 20% retained

b. Compost - Compost shall be derived from organic wastes including sawdust, clean ground wood, leaf and yard residues, and biosolids that meet all State Environmental Agency requirements. The product shall be well composted, free of viable weed seeds and contain material of a generally humus nature capable of sustaining growth of vegetation, with no materials toxic to plant growth. Leaf litter compost will not be allowed.

Compost shall have the following properties:

Parameters	Range
Total Ash	15% or less
PH	6.5 – 7.5
Moisture content	35% - 55%
Soluble Salts	< 4.0 mmhos (dS)
C:N ratio	15 - 30:1
Particle Size	< 1/2”
Organic Matter Content	> 40%
Bulk Density	< 1000 lbs./cubic yard
Foreign Matter	< 1% (dry weight)

Compost generator shall also provide minimum available nitrogen and other macro and micro nutrients to determine fertilizer requirements. Generator shall supply documentation showing state approval for intended use.

B. Care shall be taken not to overwork the soil, causing it to break down, utilizing only agricultural equipment such as plows, discs, or harrows and portable quarry sieves, screens, or blenders.

PART III - EXECUTION

3.01 PLACEMENT

A. The Contractor shall furnish and spread Loam Borrow to the depths shown on the contract drawings, which depth shall be the minimum required depth after settlement. No compaction shall be required beyond that extent necessary to place seed or to plant trees and shrubs to ensure against unevenness or settling below accepted growth lines.

3.02 ADDITIVES

A. The Contractor shall apply all necessary fertilizer and lime to the soil in accordance with the manufacturer and laboratory's recommendations and as required by the sodding, seeding and/or planting specifications referenced elsewhere.

END OF SECTION

SECTION 02911R

ROOT ZONE MIX PREPARATION & BLECAVATION

PART I - GENERAL

1.01 SCOPE OF WORK

A. Under this Section, the Contractor shall furnish all labor, materials, equipment (including low ground pressure, LGP, equipment) and transportation required to furnish and place, or prepare Root Zone Mix for the field and to perform 'blecavation' operations.

B. Prospective bidders are advised that significant quantities of topsoil are present at the property and presumably available for reuse if compatible with the requirements of this specification. The Contractor shall be responsible for amending topsoil, as required to comply with this specification and SECTION 02910 SCREENED LOAM BORROW AND TOPSOIL RE-USED.

C. This work shall consist of preparing a root zone mixture consisting of screened native on site loam, sand and compost and performing blecavation as described in item 'd' below. A sand sample and compost sample shall be submitted to a testing agent for adherence to specifications prior to blending operations. Through the blecavation process that uses the blecavator machine set to varying height controls, the compost and sand can also be blended with top soil on-site to a desired depth of 8" at the construction site.

D. The contractor shall perform blecavation operations within the areas delineated on the plans. The contractor shall prepare the soil using the blecavator, which is a heavy duty contra-rotating rotor with blades that dig into the ground throwing soil, debris, and rocks against a sorting screen mounted behind the rotor for separating rocks and debris. The fine soil is deposited over the top and leveled off. The rear packer roll on the blecavator firms up the finished areas ready for seeding. Within the area delineated on plans, the contractor shall be directed by the owner or Engineer, to perform blecavation for 8" depths of spread topsoil, in order to achieve a homogeneous blend of top soil composition over the entire field within the limits of the full depth renovation areas.

E. The contractor shall have the option, at their discretion, to remove all existing loam from the field or stockpile and either mix on site or bring in Root Zone Mix that adheres to this specification.

F. No heavy duty equipment and vehicular traffic shall be allowed on the prepared areas.

1.02 SAMPLES/TESTS

A. The Contractor shall furnish an outline of their approach to the project no less than ten (10) days prior to the start of construction.

B. The Contractor shall furnish a Certified Laboratory Report showing the soils classification and nutrient analysis of representative samples of the Loam, sand and compost that is proposed to be used, including the extent of lime and fertilizer required. Samples submitted for approval must be representative of the total volume to be furnished, taken in the presence of the Engineer, and delivered to a certified laboratory by the Contractor; all costs for such shall be borne by the Contractor.

C. If the material does not conform to the above requirements it shall be rejected and additional sources shall be found. Sampling and testing shall be accomplished as specified herein until an approved material is found, all at the Contractor's expense.

D. To assure that materials fulfill specified requirements regarding textural analysis, organic matter content, pH, and fertility, depending on the approach, testing may be undertaken:

1. Prior to site delivery; at source;

2. At time of delivery; on-site

E. For quality control, immediately following spreading on site, soil may be tested at the owner’s discretion. Soil sampling shall also indicate if specified soil was supplied uniformly to the minimum specified depth.

1.03 RELATED WORK:

A. Section 02910, SCREENED LOAM BORROW AND TOPSOIL RE-USED

B. Section 02290 SEEDING

C. Section 02810, IRRIGATION

1.04 STANDARDS

A. ASTM - American Society for Testing and Materials.
1. ASTM-F2396 (see Appendix B)

1.05 NOTIFICATION

A. The Contractor shall notify the Owner in writing at least ten (10) days in advance

of the time he intends furnishing Root Zone Mix or amendments stating the location and amount of such deposit, the name and address of the supplier and also shall furnish such facilities, transportation and assistance as the Owner may require for collecting and forwarding samples.

1.06 QUALITY CONTROL

A. Root zone mix: A one gallon sample for every 2,000 cubic yards of root zone mix shall be tested by the Owner's Testing Agent for approval. All costs shall be borne by the Contractor.

B. Following installation of irrigation system and prior to seeding, contractor shall notify the Engineer or owner and provide the owner with compaction tests along the center line of the field as well as along the side lines to ensure that the root zone mix has not been heavily compacted. Compaction test shall fall within the industry standards for fields and any areas of the field that exceed these standards shall be corrected at the contractor's expense prior to seeding.

C. The Contractor or Sub-contractor must have a minimum of five (5) years of experience installing root zone mix based athletic fields of similar size and quality of this project.

PART II - MATERIALS

2.01 LOAM BORROW

A. Refer to Section 02910, SCREENED LOAM BORROW & TOPSOIL RE-USED.

2.02 SAND

A. Sand for Root Zone Mix shall conform to Sand-based root zones for Sports Fields or 2mm USGA specification sand for golf course fairway top dressing.

1. The following definitions shall apply to the work of this Section.

2. The following size distributions of mineral particles by diameter and sieve size shall apply to the following conventional names of soil types:

Conventional Name	Retained on U.S. Sieve No.	Diameter (mm)
Very coarse sand	#18	1 - 2
Coarse sand	#35	0.5 - 1
Medium sand	#60	0.25 - 0.5
Fine sand	#140	0.10 - 0.25
Very fine sand	#270	0.05 - 0.10
Silt	by hydrometer	0.002 - 0.05
Clay	by hydrometer	Less than 0.002

2.03 PEAT OR ORGANIC MATERIAL

A. Peat moss shall be of a standard brand free of sticks, stones, hay or any other deleterious Matt and meet the following requirements:

Parameter	Specification
Total Ash	15% or less
PH	6.5 to 7.5
% Moisture	30% to 50%
Sieve Criteria	
2.0 mm sieve	0-5% retained
1.0 mm sieve	Less than 20% retained

B. Compost - Compost shall be derived from organic wastes including sawdust, clean ground wood and biosolids that meet all State Environmental Agency requirements. The product shall be well composted, free of viable weed seeds and contain material of a generally humus nature capable of sustaining growth of vegetation, with no materials toxic to plant growth. Leaf compost shall not be accepted.

Compost shall have the following properties:

Parameters	Range
pH	6.5 – 7.5
Moisture content	35% - 55%
Soluble Salts	< 4.0 mmhos (dS)
C:N ratio	15 - 30:1
Particle Size	< 1/2”
Organic Matter Content	> 40%
Bulk Density	< 1000 lbs./cubic yard
Foreign Matter	< 1% (dry weight)
Total Ash	15% or less

Compost generator shall also provide minimum available nitrogen and other macro and micro nutrients to determine fertilizer requirements. Generator shall supply documentation showing state approval for intended use.

C. Fertilizer - Renovate Plus, 3-3-3. Refer to Appendix A.

2.04 ROOT ZONE MIX

A. Mixing Materials: Mixing of the sand, peat and soil mixture for the root zone mix must be blended by an experienced blending operator.

B. Physical performance Evaluation of the root zone mix will be evaluated using the guidelines set forth in ASTM standard F 2396-04 with the following exceptions:

Cu (Coefficient of Uniformity) = 6.0 – 8.0
Infiltration Rate (In/Hr) = 3.0 – 4.5
%Silt .002 - .05 mm = 5-7
#140 Very Fine 0.10 – 0.18 mm = 11-13
<5% #140 + #270 = 14.0-15.0
Silt to Clay Ratio = 3:1

PART III EXECUTION

3.01 ROOT ZONE MIX RATIOS

C. A. Upon approval of the processed loam, sand and compost components, the owners testing agents shall blend the components to determine the correct ratio of sand and compost to create the root zone mix. This ratio of sand and compost will be based on laboratory testing and performance guidelines established by these specifications. All costs shall be borne by the Contractor.

Based on previous testing and for bidding purposes, the field root zone mix ratio will contain approximately 80% sand, 20% Native Screened Loam.

B. The root zone mix developed by the owners testing agent will establish the required mix ratio and specifications for approval or rejections of all quality control submittals during construction.

Performance Testing: ASTM testing procedures for sand based athletic fields shall be used for performance testing.

3.02 PLACEMENT

Root zone Mix Established by the Blecavation method:

A. After re-spreading the screened loam from stockpile, the Contractor shall furnish and spread the required depth ASTM spec sand distributed by a top-dresser for uniformity.

B. All sport turf areas are to be tilled to a depth of 8” with a blecavator, conventional tilling is unacceptable. This depth includes the ASTM spec sand as indicated above.

C. Fine grading shall be accomplished with a fully automated dual plain LGP laser grader.

D. Under no circumstances will loaded rubber tired vehicles in excess of 1 ton be allowed on the gravel base or root zone mix prior to, during or after the spreading

of the root zone mix.

E. Finish grades shall be verified by the Contractor using laser operation survey instruments with a tolerance of +/- ¼ inch.

New or Blended Root zone Mix:

F. The Contractor shall furnish and spread Root Zone Mix to the depths shown on the contract drawings, which depth shall be the minimum required depth after settlement. No compaction shall be required beyond that extent necessary to place sod or for the establishment of seed.

G. Root Zone Mix shall be spread in such a manner as to establish a loose, friable seedbed.

H. Under no circumstances will loaded rubber tired vehicles in excess of 1 ton be allowed on the gravel base prior to or during the spreading of the root zone mix.

I. Finish grades shall be verified by the Contractor using laser operation survey instruments with a tolerance of +/- ¼ inch.

3.03 SUBGRADE

A. After the areas to receive loam borrow have been brought to subgrade, and immediately prior to placing and spreading such material, the subgrade shall be loosened by discing to a depth of at least three inches to permit bonding of the finished material to the subgrade material. Upon completion of loosening/discing the subgrade the contractor shall remove and dispose of all stones/boulders encountered greater than 2 ½" in size from the subgrade prior to spreading the loam borrow. Then place and spread the loam borrow to the depths required by the Drawings to establish finish grades. Refer to Loam Borrow Specifications.

B. All backfill to subgrade, shall be compacted to not less than eighty-five percent (85%) and not more than ninety percent (90%) of the maximum dry density of the material as determined by the Standard AASHTO Test Designation T-180-86, Modified Proctor Test.

C. Low Ground Pressure (LGP) Equipment must be used for final grading of subgrade in order to minimize the compaction on the backfill and subgrade.

D. Confirm that the subgrade is at the proper elevation and that no further earthwork is required to bring the subgrade to proper elevations. Subgrade elevations shall slope parallel to the finished grade and or toward any subsurface drain lines as shown on the Contract Documents. Provide an As-Built survey to the Owner that the subgrade has been placed to the required elevations. The As-Built survey shall consist of a minimum 300 spot elevations evenly spaces across the entire

baseball field area. Perform no work of placing and spreading loam borrow until elevations have been confirmed and the As-Built survey has been accepted by the Owner/Engineer.

3.04 ADDITIVES

A. The Contractor shall apply all necessary fertilizer and lime to the soil in accordance with the manufacturer's and laboratory's recommendations and as required by the sodding, seeding specifications referenced elsewhere.

END OF SECTION

Appendix A - Sand and Soil Amendments

Turf & Soil Diagnostics

ACCREDITED TESTING Cert #0797.02

MATERIALS TEST REPORT FOR
Town of Arlington, MA

REPORT TO: Tom Irwin Advisors
Ian Lacy
13 A Street
Burlington, MA 01803

DATE RECEIVED: Feb-28-2017
REPORT DATE: Mar-06-2017
CONDITION OF SAMPLE: Normal

PARTICLE SIZE (ASTM F1632)

		Gravel %			Soil Separate* %			Sieve Size / Sand Fraction Sand Particle Diameter % Retained				
Lab ID#	**Sample Name**	**1/4" 6.3 mm**	**No. 5 4.0 mm**	**No. 10 2.0 mm**	**Sand**	**Silt**	**Clay**	**No. 18 V. Coarse 1.0 mm**	**No. 35 Coarse 0.50 mm**	**No. 60 Medium 0.25 mm**	**No. 140 Fine 0.10 mm**	**No. 270 V. Fine 0.05 mm**
42385-1	Robbins Farm Park Baseball Outfield	2.6	1.0	3.1	43.7	48.0	8.3	3.8	7.6	9.2	12.2	10.6

INFILTRATION RATE (Ksat) / pH / ORGANIC MATTER / TEXTURAL CLASS

Lab ID#	**Sample Name**		**Ksat in/hr**	**Density g/cc**		**EC dS/m**	**pH[1] 1:1**	**Organic Matter[2] %**	**Textural Class**
42385-1	Robbins Farm Park Baseball Outfield		0.2	1.22			6.2	Pending	Loam

*ASTM F1632 Method B Data reported using USDA definitions of soil classification [1]ASTM D4972, method A, $CaCl_2$, 25 g sample used [2] ASTM F1647 Method A

* Saturated Hydraulic Conductivity (K-SAT) with compaction energy modified to 5.75 ft lb/sq inch.
Samples were tested as received and comments pertain only to the samples shown.

Samples were received with a transmittal letter.

Reviewed by Sophia Linn

35 King Street, Trumansburg NY 14886 ■ Phone: 855-769-4231
E-mail: lab@turfdiag.com ■ Website: http://www.turfdiag.com

Turf & Soil Diagnostics

March 6, 2017

Tom Irwin Advisors
Town of Arlington
TSD File #42385

Comments:

The Robbins Farm Park Baseball Outfield sample was tested as received.

The results of the particle size analysis show that the sample is classified as loam, per the U.S. Department of Agriculture Soil classification system. The gravel content of the sample is high.

Performance testing indicated that the Baseball Outfield sample has low saturated hydraulic conductivity (infiltration rate). Therefore, significant internal drainage should not be expected.

Loamy soils typically provide good nutrient and water retention. However, they can be prone to compaction under heavy use and do not provide significant internal drainage. Proper slopes and surface drainage should be incorporated to facilitate removal of excess water.

If the soil is used as is, care should be taken during any renovation or construction work to prevent excessive compaction. Never handle the soil when wet. Only equipment with low ground pressure should be used to spread and grade the soil. You may want to specify a maximum compaction level.

If you have any questions or are in need of further assistance, please contact us. Samples are generally kept on the premises for 45 days after report date. Thank you for using Turf & Soil Diagnostics, Inc.

Sincerely,

Sophia Finn

Sophia Finn

Turf & Soil Diagnostics
35 King St. Trumansburg, NY 14886 USA
Phone: 1-855-769-4231 Web: www.turfdiag.com

Renovate/*Plus*

Recovery Amendment

EARTHWORKS NATURAL ORGANIC PRODUCTS, INC.

A 50:50 BLEND OF RENOVATE AND ECO-LITE

Renovate/*Plus* is an Ideal Amendment for:

GOLF COURSE GREENS AERIFICATION	RECOVERY OF "DEAD SPOTS"
SODDING AND SEEDING PROJECTS	NEW CONSTRUCTION
SPORTS TURF RECOVERY	BIOLOGICAL REPLENISHMENT
LANDSCAPE PLANTINGS	DIVOT MIX

Renovate/*Plus* is the combination of EarthWorks **Renovate** and **Eco-Lite** and is a powerful amendment that will open tight soils, speed turf recovery, and stimulate soil biology without a big nitrogen push. This combination allows for oxygen movement through the soil and promotes an active microbial generated nitrogen cycle. This product is ideal for numerous projects on the golf course or sports field and can "save" those hard to grow areas. **Renovate/*Plus*** is the combination of all the raw materials found in The EarthWorks "Construction Program" which has been a huge success since the early 1990's, and has been the amendment program of choice for hundreds of golf courses as well as professional sports stadiums and other athletic fields. **Renovate/*Plus*** encourages quick recovery of "dead spots," is the ideal product to put under any sod job, and can replace multiple aerification products to simplify those projects and significantly increase their success rate. **Renovate** is a blend of organic and mineral amendments including kelp meal, compost and humic acids which make up a sustainable microbial food source of short, medium and long chained carbons. The diversity of ingredients allows for a quick jump-start of soil activity, but one that will also be sustainable. The mineral fraction of **Renovate** includes greensand, sul-po-mag, hard and soft rock phosphate, and calcium. This combination prevents de-mineralization of the soil and allows for roots to take up nutrients as needed, and is a great way to provide a biological foundation to any soil by promoting soil flocculation and turf recovery. **Eco-Lite** is the premier zeolite rock mineral mined from an exceptionally clean zeolite mine and provides an array of physical benefits including the highest CEC of all physical amendments. Zeolites are very hard rock minerals that possess a crystalline structure and have the capability to absorb water when the surrounding soil is wet, creating better air movement in the soil and allowing for the controlled release of this water when moisture levels in the soil fall. Perhaps the greatest difference between **Eco-Lite** and other physical amendments is its affinity to hold both ammonium nitrogen and potassium, allowing for both nutrients to be more available to the plant over a longer period of time.

EarthWorks™
Natural Organic Products

1500 Uhler Rd.
Easton, PA 18040
800-732-8873
Fax: 610-250-7840
soilfirst.com

Available in 50 lb bags and 2000 # super sacks

RENOVATE *Plus* ECO-LITE

Ecolite - zeolite

Kelp Meal

Greensand

Compost

Hard Rock Phosphate

Soft Rock Phosphate

Humic/Fulvic Acids

Sul-Po-Mag

Renovate/*Plus*

Recovery Amendment

Renovate/*Plus* has a multitude of applications on golf courses, sports turf and landscaping situations. A combination of EarthWorks **Renovate** and the physical amendment **Eco-Lite,** this product can assure the success of sod jobs, improve aerification projects, help recover worn out dead spots and is an ideal divot mix and planting amendment. **Renovate/*Plus*** is formulated from the following amendments in order of volume:

Eco-Lite™: A Zeolite rock mineral mined from the cleanest known mine in New Mexico. Eco-Lite provides numerous benefits to the soil profile. First and perhaps most significantly, this mineral has the highest CEC value of any popular physical amendment ~ as much as three times higher than calcined clays and diatomaceous earth. Eco-Lite also has a very high water holding capacity which allows excess water to be pulled into its crystalline structure to dry up wet soils but allowing for its release osmotically as water pressure drops outside the mineral structure. This phenomena also explains how this mineral can create more air pore space. The most unique benefit from Eco-Lite is its strong affinity to hold ammonium and potassium while not having the same affinity for sodium. Eco-Lite becomes a sustainable mineral form of potassium preventing the leaching of more soluble forms.

Dry Kelp Meal: A very digestible food source for micro-organisms. Rich in over 60 minerals, 21 Amino Acids and 12 Vitamins, ascophyllum nodosum is also a rich source of plant gibberellins and cytokinins which act as plant growth regulators. Kelp extract also provides polysaccarides, which are complex sugars, which along with its vitamins, minerals and amino acids greatly assists in the feeding of soil beneficial micro flora.

Greensand: A potassium silica rock mineral rich in sustainable and available potassium, iron and many other trace nutrients. This is a mica like rock mineral that holds it own weight in water and is an excellent soil conditioner.

Compost: Rich compost, produced on Amish farms in Pennsylvania, provides a stable form of carbon and minerals. Produced from stabilized manures, this product has gone through two digestions, producing an extremely biologically active material and a readily available food source for beneficial micro-organisms.

Hard Rock Phosphate: This is the mineral that is acidified to create the commonly used soluble phosphorous fertilizers. There are studies that show this sustainable rock mineral to be as available as its soluble counterparts when chemical tie-up is taken into account. It is used as a very sustainable form of phosphorus; one that organic acids produced by plant root systems can digest when phosphorus is needed.

Soft Rock Phosphate: A colloidal form of phosphorus. This mineral is available over a wider range of soil pH and provides a certain solubility not found in its hard rock counterpart.

Humic acid and Fulvic acids: An alkaline extract of geologically concentrated humus, rich in organic acids that stimulate beneficial soil fungi, act as chelating agents for micro-nutrients and perform as sequestering agents to help fracture bonds between phosphorus and iron/calcium/aluminum.

Sul-Po-Mag: A mineral that provides the soil with needed sulfur, potassium and magnesium as well as a host of other trace nutrients. Magnesium is a very important nutrient in the photosynthesis process. This mineral is a very good soil conditioner and is fairly soluble.

APPLICATION RATES:

Apply 25-50 lbs./1000 sq. ft. preferably in combination with aeration or worked into the top few inches of soil. Lighter top dressings can also be very beneficial. Continued use is important especially on heavily compacted and biologically weak soils or sand based soils.

EarthWorks™
Natural Organic Products

Myco-Replenish

3-3-3 Organic Fertilizer with Mycorrhizae

Myco-Replenish combines the high quality of EarthWorks Replenish natural organic fertilizers with root stimulating endo and ecto mycorrhizae fungi. **Myco-Replenish** is ideal for any landscape planting situation, establishment of grass seed or sod and will enhance all soil aerification practices. An extensive amount of Mycorrhizae fungi in combination with the known value of the Replenish compost fertilizer will help to promote extensive root growth, reduce heat and drought stress, improves water and nutrient uptake and can eliminate transplant shock.

The word "mycorrhizae" literally means "fungus-roots" and defines the close mutually beneficial relationship between specialized soil fungi (mycorrhizal fungi) and plant roots. About 95% of the world's land plants form the mycorrhizal relationship in their native habitats. It is estimated that mycorrhizal fungi filaments explore hundreds to thousands more soil volume compare to roots alone.

Mycorrhizal fungi increase the surface absorbing area of roots 10 to 1,000 times, thereby greatly improving the ability of the plant to use the soils resources. Several miles of fungal filaments can be present in the thimbleful of soil. But mycorrhizal fungi increase nutrient uptake not only by increasing the surface absorbing area of the roots, but also release powerful enzymes into the soil that dissolve hard-to-capture nutrients, such as phosphorous, magnesium and other "tightly bound" soil nutrients. This extraction process is particularly important in plant nutrient and explains why non-mycorrhizal plants require high levels of fertility to maintain their health.

When combined with the carbon rich food source of Replenish fertilizers the **Myco Replenish 3-3-3** has the energy to take off and perform.

Dry Organics

Myco-Replenish

Dry Organics:

- *Replenish Compost*
- *Endo Mycorrhizae*
- *Ecto Mycorrhizae*
- *Humic Acids*

EarthWorks™
NATURAL ORGANIC PRODUCTS
1500 Uhler Rd. Easton, PA 18040
800-732-8873 Fax: 610-250-7840

Myco-Replenish

3-3-3 Organic Fertilizer with Mycorrhizae

EarthWorks Dry Organics the key to success when building a healthy environment.

Myco-Replenish 3-3-3 Guaranteed Analysis

Total Nitrogen (N)	3%
Water Insoluble Nitrogen	2.1%
Water Soluble Nitrogen	0.9%
Available Phosphorous (P_2O_5)	3%
Soluble Potash (K_2O)	3%
Calcium (Ca)	6%
Iron	0.2%

Plant Nutrients Derived From: Composted Poultry Manure

Contains Endo Mycorrhizae

Endomycorrhizal fungi: 750 propagules per pound:
Glomus intraradices, Glomus etunicatum
Glomus mosseae, Glomus aggregatum

Contains Ecto Mycorrhizae

Ectomycorrhizal fungi: 2,750,000 propagules per pound:
Pisolithus tinctorius, Scleroderma cepa
Scleroderma citrinnum, Rhizopogon villosullus
Rhizopogon luteolus, Rhizopogon amylopogon
Rhizopogon fulvigleba

Application Rates & Programs

TURF:
Aerification: Apply 10 -15 pounds per 1,000 sq. ft.

Sod: Apply 10 pounds per 1,000 sq. ft. as a soil prep.

Seed: Apply 15 pounds per 1,000 sq. ft. of seeded area worked well into the soil.

PLANTINGS:
Mix with the soil being used to fill the planting hole at the rates shown:

Trees: ½ pound (1 cup) for every 1" diameter of trunk.

Shrubs: For one gallon containers use ¼ pound (1/2 cup) mixed thoroughly. For five gallon containers use 1 pound (2 cups) of product mixed with soil.

EarthWorks™
NATURAL ORGANIC PRODUCTS
1500 Uhler Rd. Easton, PA 18040 • 800-732-8873 Fax: 610-250-7840
soilfirst.com

Directions for use

Turf (all grasses)

Apply 10 pounds of **5-4-5** per 1000 square feet of turf area (½ lb of nitrogen per 1000 sq ft), 4 to 6 times a year as needed. For best results, adequate irrigation should be practiced after application and throughout the growing season.

Shrubs

Apply 1 pound of **5-4-5** around the base of the plant and lightly work into the soil, being careful not to disturb surface roots. Larger shrubs or stressed plants will benefit from larger feedings.

Trees

For young or small trees (1 to 3 inch diameter) apply 2 to 3 pounds of **5-4-5** per inch of trunk diameter evenly under the canopy drip line. Increase the application rate to 3 to 4 pounds for larger trees. Apply in Spring and Fall, thoroughly watering after each application.

Manufactured for:

EarthWorks
1500 Uhler Road
Easton, PA 18040
www.earthworksfirst.com

Net Weight:

50 pounds
22.68 kilograms

Guaranteed Analysis

Total Nitrogen (N) 5.00%
1.30% Ammoniacal Nitrogen
2.70% Water Insoluble Nitrogen*
1.00% Other Water Soluble Nitrogen**
Available Phosphate (P_2O_5). .4.00%
Soluble Potash (K_2O) 5.00%
Calcium (Ca) 7.25%
Sulfur (S) 3.10%
3.10% Combined Sulfur (S)

Derived from: Composted poultry manure, rock phosphate, sulfate of potash, ammonium sulfate and methylene urea.

* 1.45% water insoluble nitrogen from composted poultry manure
1.25% water insoluble nitrogen from methylene urea.

** .70% water soluble nitrogen from composted poultry manure
.30% water soluble nitrogen from methylene urea.

Suggested Spreader Settings
5-4-5 Standard Grade

Spreader	Spread Width	Nitrogen in lb/1000 sq ft	
		0.5	1.0
Spyker	12'	6.8	8.4
Scott's R8-A (cone 8)	10'	N	R ½
AccuPro 2000 (cone 8)	10'	O	T ½
Vicon	28'	50	71
Lely	25'	8.25	10

These settings were calibrated and field tested. Age, condition of spreader, speed of operator and evenness of terrain may require adjustment of setting for desired coverage.

Vicon spreader settings are based on 540 rpm and a ground speed of 4.7 mph.

Lely spreader settings are based on 425 rpm and a ground speed of 4.7 mph.

EarthWorks® 5-4-5
Replenish
Standard Grade

Pull narrow tape to open

EarthWorks®

5-4-5

Replenish

Standard Grade

Covers 5,000 square feet
at 1/2 lb Nitrogen per 1000 sq ft

Prilled

Net Weight:

50 pounds
22.68 kilograms

EarthWorks® 5-4-5
Replenish
Standard Grade

Cascade Plus Fertilizer

Synchronized Wetting Agent & Fertilizer Technology

0-0-20

PRECISION LABORATORIES

DESCRIPTION
Cascade Plus Fertilizer combines the proven water infiltration chemistry of Cascade Plus with a unique fertilizer blend. It is designed for golf courses, athletic fields, sports turf, landscapes and park and recreation applications.

BENEFITS
- Delivers long lasting wetting agent and fertilizer in one application.
- Enhances water management, water efficiency and turf quality.
- Prevents localized dry spot.
- Accelerates wilt recovery from drought.
- Reduces the need for repeat spray applications.
- Reduces labor costs and turf maintenance.
- Corrects hydrophobic soil conditions.

GUARANTEED ANALYSIS
Soluble Potash (K_2O) 20.0%
Sulfur (S) 9.0%
Calcium (Ca) 3.0%
Derived from: Potassium sulfate and calcium sulfate.

NONPLANT FOOD INGREDIENTS, ACTIVE INGREDIENTS:
Cascade Plus 10.6%
10% Proprietary Blend of Surfactants,
90% Polyethylene and Propylene Glycols

APPLICATION PRECAUTIONS
- Apply to dry turf or foliage. Irrigation is recommended as soon as possible after application.
- Iron and other plant nutrients can cause staining of sidewalks. Sweep walkways prior to irrigation.
- Keep away from pools, ponds, etc. Do not contaminate potable water.

APPLICATION RATES: TURFGRASS

Lbs of Product per 1,000 Sq. Ft.	Lbs. of Product per Acre	Square Feet per Bag	Oz. Cascade Plus per 1000 Sq. Ft.	Lbs. of Nutrient per 1000 Sq. Ft.		
				N	P	K
5	217.8	10000	8	0	0	1.0
6	261.4	8333	9.6	0	0	1.2
7	304.9	7143	11.2	0	0	1.4
8	348.5	6250	12.8	0	0	1.6
9	392.0	5556	14.4	0	0	1.8
10	435.6	5000	16	0	0	2.0

APPLICATION RECOMMENDATION
Use at 5 lbs. per 1000 ft² to obtain 8 ounces of Cascade Plus per 1000 ft².

SPREADER SETTINGS
Big Foot..... G–H
Spyker..... 4½
Lesco (029600) .....E–E½
Scotts (R8A)..... I½–J
Earthway 11–12
Note: Spreader settings are guidelines only. Spreaders should be checked for accuracy and calibrated by the user. For the most current settings check www.precisionlab.com.

SGN: 120
Bulk Density: 63 lbs./ft3
Note: SGN & Bulk Density are lot specific. Actual numbers may vary slightly.

KEEP OUT OF REACH OF CHILDREN
CAUTION

PRECAUTIONARY STATEMENTS
For outdoor use only.

PERSONAL PROTECTIVE EQUIPMENT (PPE)
If possibility for eye contact exists, wear protective eyewear. Cover open sores.

STATEMENT OF PRACTICAL TREATMENT
If In Eyes: Flush eyes with plenty of water for 15 minutes. Seek medical attention if irritation persists.
If On Skin: Wash with soap and water. Seek medical attention if irritation persists.
If Inhaled: Move individual to fresh air. If breathing is difficult, give oxygen. If not breathing, give artificial respiration. Seek immediate medical attention.
If Swallowed: Drink plenty of water.

STORAGE AND DISPOSAL
Store in a dry location in temperatures above 30°F. Dispose of in accordance with federal, state and local requirements. May be placed in household waste. Do not reuse packaging. Dispose of packaging when empty.

CONDITIONS OF SALE
Note: Read the information contained herein before buying or using this product. If the stated terms are not acceptable, return the product at once, unopened. It is critical that this product be used and mixed only as specified on this label. Neither the manufacturer nor the seller makes any representation or warranty, expressed or implied, with respect to the results from the use of this material. Buyer and user assume all risks of use and/or handling. Precision Laboratories, LLC warrants that this material is reasonably fit for use as specified on this label. No agent or representative is authorized to make any other representations concerning this material. Unforeseen factors beyond Precision's control prevent elimination of risks in connection with the use of its chemicals. Such risks include, but are not limited to, damage to plants and/or crops to which the material is applied, or lack of complete control and damage caused by drift to other plants or crops. Such risks may occur even though the product is reasonably fit for use as stated herein and even though label directions are followed. Follow directions carefully. Timing, mixture, method of application, weather and other conditions are influencing factors in the use of this product and are beyond the control of the seller. Except to the extent prohibited by applicable law, the exclusive remedy of the user or buyer and the limit of liability of the company or any other seller for any and all losses, personal injuries or damages resulting from the use of this product, shall be the purchase price paid by the user or buyer for the quantity of product involved.

S P E C I M E N L A B E L

For 24-hour technical assistance when using this product in the USA and Canada, call: 1-800-323-8351
For 24-hour emergency service when using this product in the USA and Canada, call CHEMTREC: 1-800-424-9300
7/2012 F1467

Precision Laboratories, LLC
1429 S. Shields Dr., Waukegan, IL 60085
Phone: (847) 596-3001 Fax: (847) 596-3017
Customer Service: (800) 323-6280
E-Mail: info@precisonlab.com
Web Site: www.precisionlab.com

LEBANON®

Country Club®

FERTILIZER

FAIRWAY GRADE FORMULA

HOMOGENEOUS GRANULES FOR PROFESSIONAL TURF

COVERS 12,500 SQ. FT.

13-25-12

SIZE GUIDE NUMBER SGN 195

GUARANTEED ANALYSIS

Total Nitrogen (N)	**13%**
13.0% Ammoniacal Nitrogen	
Available Phosphate (P_2O_5)	**25%**
Soluble Potash (K_2O)	**12%**
Sulfur (S)	5.7%
5.7% Combined Sulfur (S)	
Iron (Fe)	0.5%
0.05% Water Soluble Iron (Fe)	

Derived From: Ammonium Phosphate, Ammonium Sulfate, Muriate of Potash.
Chlorine (Cl) not more than 8.0%

0 88685 35573 8

F699 **21-35573**

NOTICE: This product contains the secondary nutrient iron. Iron may stain concrete surfaces and should not be applied on dry or water dampened concrete and should be removed from these areas promptly by sweeping or blowing. Do not wash off with water.

Information regarding the contents and levels of metals in this product is available on the Internet at: http://www.regulatory-info-lebsea.com

FOR FLORIDA: We recommend that you follow the Golf Course BMP's at:
http://www.dep.state.fl.us/water/nonpoint/docs/nonpoint/glfbmp07.pdf

DIRECTIONS FOR USE
Apply during the turf growing season or work into the soil prior to seeding.

To feed at the rate of 11/2 lb. Available Phosphate per 1,000 sq. ft., apply this product at 6 lbs. per 1,000 sq. ft. or 261 lbs. per acre. Supplemental applications of lawn fertilizer are needed to achieve a minimum 1 pound nitrogen per 1,000 sq. ft.

SUGGESTED SPREADER SETTINGS

Spreader	Speed		Width of	Settings		Spreader	Speed		Width of	Settings	
	Ground MPH	PTO RPM	Coverage	1 # P_2O_5	½ # P_2O_5		Ground MPH	PTO RPM	Coverage	1 # P_2O_5	½ # P_2O_5
LebanonTurf	3		8 ft.	5	4	Lesco® (Letter Dial)	3		8 ft.	K	H
Andersens AccuPro®	3		8 ft.	O	H	PennMulch® HVO	3		8 ft.	O	J
Earthway® Rotary	3		8 ft.	18	15	ProScape® SS	3		8 ft.	O	J
Gandy®	3			35	30	Spyker	3		8 ft.	5	4
Lely (HR, W 1250, 1500, 2010)	5		39 ft.	7II	5II	Vicon (all models)	5	540	35 ft.	30	25

These settings were calibrated and field tested. However, age and condition of spreader, speed of operation, and evenness of terrain may require slightly different settings for desired coverage.

Fertilizer may cause irritation of eyes, nose, throat and skin.
In case of contact with skin or eyes, flush with plenty of water; for eyes, get medical attention.

KEEP OUT OF REACH OF CHILDREN.
CAUTION

LebanonTurf

For technical assistance or more information about our products visit www.LebanonTurf.com

Manufactured by:
Lebanon Seaboard Corporation
1600 E. Cumberland St. • Lebanon, PA 17042

Made in the U.S.A.
www.LebanonTurf.com

50 Lbs. (22.7 kg) Net Weight

FAIRWAY GRADE FORMULA

HOMOGENEOUS GRANULES FOR PROFESSIONAL TURF

COVERS 12,500 SQ. FT.

13-25-12

SIZE GUIDE NUMBER SGN 195

GUARANTEED ANALYSIS

Total Nitrogen (N)	**13%**
13.0% Ammoniacal Nitrogen	
Available Phosphate (P_2O_5)	**25%**
Soluble Potash (K_2O)	**12%**
Sulfur (S)	5.7%
5.7% Combined Sulfur (S)	
Iron (Fe)	0.5%
0.05% Water Soluble Iron (Fe)	

Derived From: Ammonium Phosphate, Ammonium Sulfate, Muriate of Potash.
Chlorine (Cl) not more than..... 8.0%

0 88685 35573 8

F699 **21-35573**

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FOR FLORIDA: We recommend that you follow the Golf Course BMP's at: http://www.dep.state.fl.us/water/nonpoint/docs/nonpoint/glfbmp07.pdf

DIRECTIONS FOR USE

Apply during the turf growing season or work into the soil prior to seeding.

To feed at the rate of 11/2 lb. Available Phosphate per 1,000 sq. ft., apply this product at 6 lbs. per 1,000 sq. ft. or 261 lbs. per acre. Supplemental applications of lawn fertilizer are needed to achieve a minimum 1 pound nitrogen per 1,000 sq. ft.

SUGGESTED SPREADER SETTINGS

Spreader	Speed		Width of	Settings		Spreader	Speed		Width of	Settings	
	Ground MPH	PTO RPM	Coverage	1 # P_2O_5	½ # P_2O_5		Ground MPH	PTO RPM	Coverage	1 # P_2O_5	½ # P_2O_5
LebanonTurf	3		8 ft.	5	4	Lesco® (Letter Dial)	3		8 ft.	K	H
Andersens AccuPro®	3		8 ft.	O	H	PennMulch® HVO	3		8 ft.	O	J
Earthway® Rotary	3		8 ft.	18	15	ProScape® SS	3		8 ft.	O	J
Gandy®	3			35	30	Spyker	3		8 ft.	5	4
Lely (HR, W 1250, 1500, 2010)	5		39 ft.	7II	5II	Vicon (all models)	5	540	35 ft.	30	25

These settings were calibrated and field tested. However, age and condition of spreader, speed of operation, and evenness of terrain may require slightly different settings for desired coverage.

Fertilizer may cause irritation of eyes, nose, throat and skin.
In case of contact with skin or eyes, flush with plenty of water;
for eyes, get medical attention.

KEEP OUT OF REACH OF CHILDREN.
CAUTION

LebanonTurf

For technical assistance or more information about our products visit www.LebanonTurf.com

Manufactured by:

Lebanon Seaboard Corporation

1600 E. Cumberland St. • Lebanon, PA 17042

Made in the U.S.A.

www.LebanonTurf.com

50 Lbs. (22.7 kg) Net Weight

SILI-CAL SS

Granulated Premium Greens Fertilizer
plus Soil Conditioner

GUARANTEED ANALYSIS:

Calcium (Ca)	**21.00**
Total Magnesium as (Mg)	**2.50**

2.00 % Water Soluble Magnesium (Mg)
Derived From: Calcium Silicate and Magnesium Sulfate

SOIL CONDITIONER

Guaranteed Analysis Silicone Dioxide (Si02) . . .	**29.00**
Total Other Ingredients:	**71.00**

Derived From: Calcium Silicate

DIRECTIONS FOR USE

Soil testing prior to application recommended. An initial application rate of 20lbs/1000 sq. ft. is suggested, based on soil analysis. After adequate silicon levels in the soil are achieved, it is suggested that SILI-CAL *SS* be applied once per month at a rate of 10 lbs pounds per 1,000 sq. ft.; not to exceed 50 lbs per 1000 sq. ft. annually.

Calcium Silicate Corporation

Columbia, Tennessee; Lake Harbor, Florida
Mark C. Elizer, President, Ph: (863) 902-0217, Fax: (863) 902-0107

Designation: F2396 – 11

Am American National Standard

Standard Guide for Construction of High Performance Sand-Based Rootzones for Athletic Fields[1]

This standard is issued under the fixed designation F2396; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This guide covers techniques that are appropriate for the construction of high performance sand-based rootzones for sports fields. This guide provides guidance for the selection of materials, including soil, sand, gravel, peat, and so forth, for use in designing and constructing sand-based sports turf rootzones.

1.2 Decisions in selecting construction and maintenance techniques are influenced by existing soil types, climatic factors, level of play, intensity and frequency of use, equipment available, budget and training, and the ability of management personnel.

1.3 This guide offers an organized collection of information or a series of options and does not recommend a specific course of action. This document cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of this guide may be applicable in all circumstances. This guide is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged, nor should this document be applied without consideration of a project's many unique aspects. The word "standard" in the title of this document means only that the document has been approved through the ASTM consensus process.

1.4 The values stated in SI units are to be regarded as the standard. The values in parentheses are for information only.

1.5 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory requirements prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C88 Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate

C131 Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine

C1444 Test Method for Measuring the Angle of Repose of Free-Flowing Mold Powders (Withdrawn 2005)[3]

D422 Test Method for Particle-Size Analysis of Soils

D698 Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft^3 (600 kN-m/m^3))

D1883 Test Method for CBR (California Bearing Ratio) of Laboratory-Compacted Soils

D1997 Test Method for Laboratory Determination of the Fiber Content of Peat Samples by Dry Mass

D2944 Test Method of Sampling Processed Peat Materials

D2974 Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils

D2976 Test Method for pH of Peat Materials

D2980 Test Method for Volume Mass, Moisture-Holding Capacity, and Porocity of Saturated Peat Materials

D3080 Test Method for Direct Shear Test of Soils Under Consolidated Drained Conditions

D4427 Classification of Peat Samples by Laboratory Testing

D4972 Test Method for pH of Soils

F1632 Test Method for Particle Size Analysis and Sand Shape Grading of Golf Course Putting Green and Sports Field Rootzone Mixes

F1647 Test Methods for Organic Matter Content of Athletic Field Rootzone Mixes

F1815 Test Methods for Saturated Hydraulic Conductivity, Water Retention, Porosity, and Bulk Density of Athletic Field Rootzones

[1] This guide is under the jurisdiction of ASTM Committee F08 on Sports Equipment, Playing Surfaces, and Facilities and is the direct responsibility of Subcommittee F08.64 on Natural Playing Surfaces.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] The last approved version of this historical standard is referenced on www.astm.org.

F2060 Guide for Maintaining Cool Season Turfgrasses on Athletic Fields
F2107 Guide for Construction and Maintenance of Skinned Areas on Baseball and Softball Fields
F2269 Guide for Maintaining Warm Season Turfgrasses on Athletic Fields
F2651 Terminology Relating to Soil and Turfgrass Characteristics of Natural Playing Surfaces

3. Terminology

3.1 *Definitions:*

3.1.1 Except as noted, soil-related definitions are in accordance with Terminology F2651.

NOTE 1—Particle size ranges for sand, silt, and clay used in this standard vary somewhat from ranges given in Test Method D422.

4. Significance and Use

4.1 A dense, uniform, smooth, and vigorously growing natural turfgrass sports field provides the ideal and preferred playing surface for most outdoor field sports. Such a surface is pleasing to the spectators and athletes. A thick, consistent, and smooth grass cover also increases playing quality and safety by providing stable footing for the athletes, cushioning their impact from falls, slides, or tackles, and cools the playing surface during hot weather. Sand is commonly used to construct high performance sports turf rootzone systems. Sand is chosen as the primary construction material for two basic properties, compaction resistance and improved drainage/aeration state. Sands are more resistant to compaction than finer soil materials when played upon within a wide range of soil moisture conditions. A loamy soil that may provide a more stable surface and enhanced growing media compared to sand under optimal or normal conditions will quickly compact and deteriorate in condition if used in periods of excessive soil moisture, such as during or following a rainy season. A properly constructed sand-based rootzone, on the other hand, will resist compaction even during wet periods. Once compacted, sands are easier to decompact with the use of mechanical aeration equipment. Even when compacted, sands will retain an enhanced drainage and aeration state compared to native soil rootzones under the same level of traffic. As such, sand-based rootzones are more conducive to providing an all-weather type of playing surface. Properties of both the soil and grass plants must be considered in planning, constructing, and maintaining a high quality sports turf installation. Turfgrass utilized must be adapted to the local growing conditions and be capable of forming a thick, dense, turf cover at the desired mowing height. Unvegetated sand in and of itself is not inherently stable; therefore, it is imperative that grasses with superior wear tolerance and superior recuperative potential are utilized to withstand heavy foot traffic and intense shear forces. Sand does, however, have incredible load bearing capacity and if a dense, uniform turf cover is maintained, the sand-based system can provide a very stable, firm, smooth, and uniform playing surface. A successful sand-based rootzone system is dependent upon the proper selection of materials to use in the project. The proper selection of sand, organic amendment, soil and gravel is of vital concern to the performance of the system and this guide addresses these issues.

4.1.1 During construction, consideration should be given to factors such as the physical and chemical properties of materials used in the area, freedom from stones and other debris, and surface and internal drainage.

4.1.2 Maintenance practices that influence the playability of the surface include mowing, irrigation, fertilization, and mechanical aeration and are factors addressed in other standards (see Guides F2060 and F2269).

4.2 Those responsible for the design, construction, or maintenance, or a combination thereof, of natural turf athletic fields for high-performance, all-weather purposes will benefit from this guide.

4.3 A successful project development depends upon proper planning and upon the selection of and cooperation among design and construction team members. A high-performance, sand-based rootzone project design team should include a project designer, an agronomist or soil scientist, or both, and an owner's representative. Additions to the team during the construction phase should include an owner's project manager (often an expansion of role for the owner's representative), an owner's quality control agent (often the personnel that is employed in advance with the intent of becoming the finished project's sports field manager), an owner's testing agent (often an expansion of roles for the project's agronomist/soil scientist), and the contractor.

4.3.1 Planning for projects must be conducted well in advance of the intended construction date. This often requires numerous meetings to create a calendar of events, schedule, approvals, assessments, performance criteria, material sourcing, geotechnical reports, and construction budgets.

NOTE 2—Other specifications on soils for athletic field construction have been published and have been considered during the development of this guide.

5. Construction

5.1 The steps to be used in construction of a new athletic field include:

5.1.1 Survey and stake the site to establish subgrade and finish grade elevations.

5.1.2 Construct and prepare subgrade, and provide a correct and certified subgrade.

5.1.3 Install subsurface drainage system, frame out warning tracks, skinned areas, and so forth, as appropriate.

5.1.4 Install irrigation system (irrigation system may be installed prior to rootzone installation).

5.1.5 Prepare for rootzone installation.

5.1.5.1 Secure suitable sand, properly tested and approved.

5.1.5.2 Blend any amendments with sand to project specifications, approve using QC program.

5.1.5.3 Install approved gravel (if included in design).

5.1.6 Install rootzone blend.

5.1.7 Bring field to final grade and contour in accordance with specifications, compact to specifications.

5.1.7.1 A pre-plant fertilizer application may be applied at this point as specified.

5.1.8 Establish turf by appropriate methods (seed, sprigs, plugs or sod).

5.1.9 Fertilize the installation as appropriate based upon soil testing.

5.1.10 Turf is to be established based upon grow-in recommendations from a competent agronomist or soil testing laboratory, as appropriate for the turf species utilized and the climate of the site.

5.2 *Survey and Stake*—This procedure should be done to conform to the project designer's specifications as appropriate for the sport. In the case of the construction of a replacement field, this step may be deleted or modified as appropriate. Care should be taken to protect staking during the construction process.

5.3 *Construct and Prepare Subgrade*—Contour the subgrade in accordance with specifications at a suggested tolerance of ±12.5 mm (½ in.) within 3 m (10 ft) of linear direction as specified in 5.5.6. The subgrade should be installed at a depth such to accommodate the final profile depth of rootzone and any gravel layer (if included). The subgrade should be compacted sufficiently (suggested 85 % minimum to 90 % maximum proctor density) to prevent future settling. Subgrade should be designed to conform to surface contour of finished playing surface.

5.4 *Subsurface Drainage System*—Many types of designs exist for subsurface drainage most commonly including a grid or herringbone pattern. The project specifications should include a subsurface drainage design to facilitate drainage for a 25 year storm event. Most commonly used drainage systems for sand-based athletic fields include utilizing perforated drainlines 10 cm (4 in.) in a 4.5 m (15 ft) to 6 m (20 ft) spacing between drainline laterals.

5.4.1 *Drainline Trenches*—Trenches constructed for drainlines should be excavated into a properly prepared, graded, and compacted subgrade. Drainage trenches should be of a depth such to conform to the drainage contours. All drainage trenches and drainline installations should maintain a minimum positive slope gradient of ≥0.5 % toward drainage outlets with trench bottoms compacted to subgrade specifications. Drainage excavations should be made such that a minimum of 5 cm (2 in.) of bedding material can be contained around the installed drainline (below, to each side, and above). For example, a 10 cm (4 in.) diameter drainline installation will require a minimum dimension of 20 cm (8 in.) wide by 20 cm (8 in.) depth (for example, 10 cm drainline + (5 cm/side × 2 sides) = 20 cm; 10 cm drainline + 5 cm top + 5 cm bottom = 20 cm). Once drainage trenches are excavated, all excavated material should be removed from the subgrade surface and disposed off site. The subgrade should have no elevations of subgrade soil material such to hinder the flow of water along the subgrade interface into the drainage trench. Once drainage trenches have been excavated, the trench bottoms should be sufficiently compacted to the subgrade compaction specifications prior to installation of drainage system. Subgrade shall be re-surveyed and certified prior to gravel or rootzone import.

5.4.2 *Surface Drainage*—To maintain adequate surface drainage, all field installations should include a minimum of 0.5 % slope gradient (simple slope or crown) to remove water off of the playing field in case of a storm event with severe rainfall intensity and to facilitate the use of tarps. It is recommended that an adequate number of small size surface drainage inlets be installed in the perimeter of the installation (in out-of-play areas) and tied into the drainage collection system for removal of surface runoff with the subsurface drainage water.

NOTE 3—In planning and designing projects, consideration shall be given to the permeability of the rootzone when determining the slope of the finished surface and the need for adjacent surface drainage systems. Further consideration shall be given in cold climates where frost penetration may impact the permeability of the rootzone when determining the slope of the finish surface and the need for adjacent surface drainage systems. Generally, the need for improved surface drainage increases as the permeability of the rootzone decreases.

5.4.3 *Sub-Surface Drainage Material*—Three recommended options exist for the use of drainage material. Option 1 could utilize sand rootzone material to backfill around drainlines within the drainage trenches. Option 2 could utilize gravel material to backfill around drainlines in the drainage trenches. Option 3 could include the use of gravel to backfill around drainlines in drainage trenches and to form a drainage layer overlying the subgrade before placement of rootzone sand blend. All backfill treatments shall be compacted to specifications prior to further installation procedures. It is recommended that backfill for trench bottoms is installed and compacted prior to installing drain pipe into the trenches. It is recommended that the trench bottom remain unobstructed as installed and no soil pilings, wood blocks, concrete or metal blocks are used to adjust and maintain slope of drainlines. Any blocks used for this purpose must be removed from under the drainlines and any cavities backfilled before proceeding. It is recommended that drainage trenches (bottom and sides *only*) should be lined with a woven geosynthetic filter fabric to prevent contamination (lateral movement of subgrade materials into trench fill). Geosynthetic filter fabric should *not* be used to cover the drainage trench. It is recommended that all drainlines are installed straight (without 'snaking') within the trenches. It is recommended that sleeves (of oversize PVC piping) should be installed across the drainage trenches at appropriate points as indicated by the irrigation design to facilitate irrigation pipe installation at points where the irrigation line crosses over the drainage trenches.

5.4.3.1 *Option 1*—Rootzone sand (with or without other rootzone amendments) may be utilized to backfill around drainlines. If sand is utilized for this purpose, the drainage pipe used in these installations must be of a type that utilizes slitted perforations with slit openings meeting a specification of D_{85} sand/slot width >1.5, to reduce the potential for particle migration into the drainage system (7).

5.4.3.2 *Option 2*—Gravel may be used for backfill of drainage trenches. If gravel is used for backfill, it should conform to the specifications in Table 1. Soft gravel minerals (such as limestone, sandstone, or shale) are not acceptable for use and all questionable gravel material should be tested for weathering stability using the sulfate soundness test (see Test Method C88). A loss of material greater than a 12 % by weight is unacceptable. Likewise, any gravel material that is suspect in its mechanical stability should be tested utilizing the LA

TABLE 1 Gravel Filter/Drainage Layer Specifications (7, 8)

Performance Factor	Criteria	Acceptable Value
Filtering Factors	D_{15} of gravel/D_{85} of rootzone mix	<5
	D_{50} of gravel/D_{50} of rootzone mix	<25
Permeability Factor	D_{15} of gravel/D_{15} of rootzone mix	≥5
Uniformity Factors	D_{90} of gravel/D_{15} of gravel	≤2.5
	>12 mm fraction	0 %
	<2 mm fraction	≤10 %
	<1 mm fraction	≤5 %

Abrasion test (see Test Method C131). An LA Abrasion test value greater than 40 is unacceptable.

5.4.3.3 *Option 3*—Gravel may be used to backfill drainage trenches and to form a drainage layer beneath the sand rootzone. If gravel is used for this purpose, the same gravel should be used for backfill and the drainage layer, and should conform to the specifications given in Table 1. Soft gravel minerals are not acceptable for use and all questionable gravel material should be tested for weathering stability using the sulfate soundness test (see Test Method C88). A loss of material greater than 12 % by weight is unacceptable. Likewise, any gravel material that is suspect in its mechanical stability should be tested utilizing the LA Abrasion test (see Test Method C131). An LA Abrasion test value greater than 40 is unacceptable. A gravel drainage layer should be a minimum of 7.5 cm (3 in.), with 10 cm to 15 cm (4 to 6 in.) preferred. During installation, the gravel is typically dumped from the delivery trucks onto the perimeter, and then distributed over the construction site by a small, tracked, crawler tractor (or similar), being careful to avoid driving over and crushing the drain lines. Contour and compact the gravel in accordance with specifications at a suggested tolerance of ±12.5 mm (½ in.) within 3 m (10 ft) of linear direction and as specified in 5.5.6.

5.4.3.4 *Discussion*—If gravel is utilized as a drainage layer, it will improve the drainage of the system under conditions of saturated flow only. Saturated flow conditions typically only occur during intense or prolonged rainfall events. Under unsaturated conditions, the use of a gravel layer will impede drainage and will serve to retain additional moisture within the rootzone profile. This condition is commonly referred to as a 'perched' or 'suspended' water table. The water perched in the rootzone at the interface with the gravel will be retained in a condition nearing saturation. While such conditions may be beneficial in terms of water conservation, care must be exercised in the design of the rootzone system, such that excessive moisture is not retained that could lead to anaerobic rootzone conditions. Such conditions are common on poorly designed gravel, underdrained, sand-based rootzone systems. If a gravel underdrain system is used, the design parameters should be adjusted to assure a minimum of 15 cm (6 in.) of well aerated rootzone. If the capillary rise of salts or other contaminants from the subgrade are of concern on a particular project, the use of a gravel layer is recommended to prevent this occurrence.

5.4.3.5 *Determination of Well-Aerated Rootzone Conditions*—A well-aerated rootzone is normally that portion of the rootzone that retains ≥20 % air-filled porosity (AFP) after gravitational drainage ceases (as determined at 40 cm tension). To determine the depth of sand required to obtain the desired well-aerated profile depth, a soil moisture retention curve of the rootzone material must be determined. Considering that the perched water above a gravel layer will be retained at a tension of approximately 10 cm tension, the moisture retention status of the rootzone material should be considered at tensions greater than 10 cm until the proportion of air-filled pores within the rootzone material reaches 20 % or greater. For example, let's hypothesize that a soil moisture retention curve shows that a material reaches 20 % AFP at 21 cm tension. To provide a 15 cm well-aerated rootzone, our profile depth would be 21 cm (AFP threshold tension) – 10 cm (tension of perched water) + 15 cm of well-aerated rootzone, for a total rootzone depth of 26 cm. Moisture retention points should be determined utilizing methodologies in Test Method F1815.

5.5 *Sand-Based Rootzone*—Materials used to provide the sand for the rootzone shall meet the performance criteria established in this guide. Additions of peat or soil, or both, may be included in small proportions as part of the rootzone blend, if the inclusion of these materials will not bring the resulting blend out of specifications and if they are uniformly blended together to form a homogeneous blend.

5.5.1 *Sand Type*—Quartz sands are recommended; if sand contains more than 5 % calcium carbonate equivalent, the sand has the potential for particle cementation due to dissolution and reprecipitation of carbonates. Other sands are not recommended due to their propensity to weather (by either mechanical or chemical means, or both) over a relative short period of time (1 to 5 years) that may influence the performance of the construction. For example, granitic material often contains appreciable amounts of feldspar or mica which is much more readily subject to weathering. Caution should be given to sands that contain appreciable proportions of mica minerals. Mica grains have a flat or plate-like morphology and redistribution of these grains with a rootzone profile may create layers that impede drainage and aeration.

5.5.2 *Particle Size Distribution*—Particle size analyses (Test Methods D422 or F1632) are based on oven-dried mass of a weighed sample; shaker is the preferred method of dispersion to prevent fracturing of sand particles that may falsely influence the sand size distribution. There are many published specifications within the turf industry for sand size distribution for sand-based rootzone constructions. Many of these specifications are primarily intended for golf green construction. As such, the amount of coarse material allowed is limited in order to produce a very smooth surface under extremely short mowing conditions to facilitate smooth roll of the small golf ball. Such conditions are not required for athletic field construction and the use of higher proportion of coarser sand material can be utilized. Table 2 includes a recommended sand particle size distribution (before amendments), but is not inclusive of all size distributions of sands that could be used to produce a high performance sand-based field. Additionally:

5.5.2.1 No more than 30 % in the combined very coarse sand, fine gravel, and gravel fractions.

5.5.2.2 At least 60 % of the total sand should be in the combined medium sand and coarse sand fractions.

TABLE 2 Recommended Particle Size Distribution of Rootzone Sand[A]

Size Fraction	Particle Diameter Range	Specified Range (%)
Gravel	>4.75 mm	0 %
Gravel	3.4 to 4.75 mm	<5 %
Fine gravel	2.0 to 3.4 mm	<20 %
Very coarse sand	1.0 to 2.0 mm	<20 %
Coarse sand	0.5 to 1.0 mm	25 to 50 %
Medium sand	0.25 to 0.5 mm	>25 %
Fine sand	0.15 to 0.25 mm	<10 %
Very fine sand	0.05 to 0.15 mm	<5 %
Silt	0.002 to 0.05 mm	<5 %
Clay	<0.002 mm	<3 %

[A] See 5.5.2.1-5.5.2.4 for additional recommendations.

5.5.2.3 No more than 15 % in the combined fraction less than 0.25 mm (fine sand, very fine sand, silt and clay fractions).

5.5.2.4 A Coefficient of Uniformity ($CU = D_{60}/D_{10}$) value of 2.5 to 4.5.

5.5.3 *Sand Shape*—Although acceptable sand-based rootzones can be constructed with sands of all shapes, this factor is worth consideration in athletic field construction. Sand shape is generally classed as to angularity and sphericity. Angularity includes well-rounded, rounded, subrounded, subangular, angular, and very angular. Sphericity includes high sphericity, medium sphericity, and low sphericity. Sand shape should be classified according to Figure 1 of Test Method F1632. While no sand will have sand grains of uniform shape, there is normally a predominant shape of grains from a single sand source. The shape and dimension of sand grains affect its stability. For example, rounded grains are the least stable because of the lack of edges to interlock the grains. As such the sand grains tend to act like small ball bearings. Angular sands to have greater stability because the sharper edges have a greater grain-grain interlock and resistance to shear. Sands that have a predominance of grains that show extremes in angularity (extremely angular or extremely round) that fit outside the classification in Test Method F1632 should be avoided. Likewise, extremely high or low sphericity particles should be avoided, including plate-like particles. Many dune sand sources may contain sand grains that have internal fracture planes. During the saltation process, dune sands can become rounded as they roll and skip along the surface as a function of the wind. However, during strong wind events, the grains can be moved at a high velocity, whereby the grains impacting upon each other develop 'cracks' or fracture planes within the grain. When rootzones are constructed with these sands, traffic and other weathering factors may cause the grains to fracture along these planes, resulting in the formation of silt-size quartz grains which may then be prone to particle migration and subsequent accumulation in layers. Sand grains should be examined under 20 to 50× magnification for sand size, shape, and potential fracture planes.

5.5.4 *Rootzone Amendments*—Two types of amendments are commonly included in a blend with sand that together make up the rootzone material. This would most commonly include a blend with soil or peat, or both.

5.5.4.1 *Soil*—Soil is commonly used as a component of a sand-based rootzone construction in order to provide some enhanced capacity for moisture and nutrient retention and sometimes to improve the mechanical stability of the rootzone. Proportions of soil in a high performance rootzone mix typically range from 5 to 15 % by volume. The amount of soil to include in a blend depends upon the make-up of the soil component, and the effects of the soil additions to the physical performance characteristics of the resulting blend. Ideally, the soil component would be one that is composed purely of clay. Clay minerals generally have good moisture and nutrient retention capacities, and if present in high enough proportions may significantly improve rootzone stability by enhanced cohesive properties. When clay is included in a blend with sand in the appropriate proportion, the clay will coat the sand and form bridges between sand grains without clogging up the large pores (interstitial pores or packing voids) of the sand matrix. If a pure clay source is used, many sands will accommodate 10 to 15 % clay additions without clogging. However, care must be used in the blending and preparation process because a small increase in clay content can cause a drastic detrimental change in the performance of the rootzone. This is a primary reason for a well-designed calibration and quality control program. Other soils may be used as a component of a sand-based rootzone blend, but should be restricted to those soil textures that are low in silt content. Silt is normally a fine-grained, non-plastic soil material and is subject to migration and layering. Soils that exhibit a silt to clay ratio greater than 2 should not be used. Likewise, those soils with a fines (silt + very fine sand + fine sand) to clay ratio greater than 3 should be avoided. Generally, soils containing more than 6 % organic matter should not be used, nor any mucky-type soils. Peat may be used to increase the organic matter content in a three-way blend of sand-soil-peat.

5.5.4.2 *Peat*—Peat is commonly used as an amending source in a sand-based rootzone. Proportions of peat included in a blend (usually 15 to 20 % by volume) should give an organic matter content of 0.3 to 2.0 % by mass. As with soils, peat adds water and nutrient retention capacity, but will add little in terms of increased soil strength (cohesion). Peats can also slow water movement through excessively drained sands. Finer peats, whether by decomposition or by finer grinding, generally have a greater effect on slowing water movement. Three sources of peat have been used successfully to modify sands. They are moss peats (sphagnum and hypnum), reed-sedge peats (derived from reeds, sedges, marsh grasses, and other plants of the wetland), and peat humus, which is decomposed peat (usually derived from moss or reed-sedge sources). Peats to avoid in modifying sands are woody peat (derived from trees and shrubs) and sedimentary peat (derived from plants that grow in water and found on pond and lake bottoms). Peats can be classified according to fiber content (see Classification D4427). In general, moss peats fall into the fibric classification, which indicates the greatest fiber content; reed-sedge peats into the hemic classification (a mid-range of fiber content); and peat humus into the sapric classification (lowest fiber content). The acceptable sources of peat range in their physical and chemical properties and information in Table 3 can be utilized during the selection of a peat. Fibric peats are characterized by low ash contents, and low volume weights

TABLE 3 Suitability Ratings of Properties of Organic Amendments for Utilization in High Performance Sand-based Athletic Field Rootzones

Rating\Property	C/N Ratio	Ash Content	pH
Preferred	20:1 to 30:1	<12 %	4.5 to 7.0
Acceptable	30:1 to 50:1	12 to 17 %	3.5 to 4.5
Marginal	50:1 to 80:1	17 to 30 %	3.0 to 3.5
Unacceptable, or use only with caution	<20:1 or >80:1	>30	<3.0 or >7.0

(bulk densities). Because of a lower volume weight, a greater amount on a volume basis than with the other sources will be needed to achieve a desired organic matter content in the blend, which is reported on a mass basis. The low volume weight peats do not mix as readily as heavier peats when being mixed on-site by tillage, but this problem is largely negated by off-site mixing with various blending equipment. Off-site mixing is preferred for high performance sand-based rootzones. The fibric peats decompose more rapidly than hemic and sapric peats; however, their longevity is such that they provide benefits until organic additions from the turfgrass stand contribute significantly to the soil organic matter pool. With sphagnum moss peat, low pH may create the need for lime additions to the mix, and relatively low nitrogen (N) content and wide C/N ratio could lead to N tie-up by microorganisms and the need for additional N fertilization. Potential problems encountered with fibric peats are reduced with hemic peats, which are denser, somewhat lower in acidity, higher in N content, and more readily mixed. Also sapric, or decomposed peats, have fewer problems with pH, N content, and volume weight; however, they contain more ash and some low quality sapric peats may contain mineral soils that result in unacceptably high ash contents. The organic matter in sapric peats, already being in a somewhat decomposed state, is more stable than organic matter in the more fibrous peats. Peats considered for inclusion in high performance sand-based rootzones can be classified according to Classification D4427, and further tested by methods listed in 5.5.5.3. Suggested recommendations for peat/organic amendments for high performance sand-based rootzones are given in Table 3.

5.5.4.3 *Discussion*—Often the use of composts are proposed as substitutes for peat products. While in some instances, composts may produce satisfactory products for inclusion in a rootzone construction, the variability of compost products tends to be much higher than those of natural peat deposits. This variability is especially true over time and from season to season. Composts also typically contain higher ash content, may contain contaminants of soil or other earthy materials, may contain wood, and may not be completely stable in terms of chemical and physical properties. Composts may also contain high elevations of trace metals or salts, or both (although testing can be used to determine the level of these constituents). The use of composts in a high performance sand-based rootzone should be approached with a high degree of caution and employed with thorough quality control in the sourcing and construction phases. Under strict control and testing, composts have and may be used for high performance sand-based rootzone constructions. It is recommended that only compost products be used that have been used successfully in high performance sand-based field mixes in the past, and only in amounts sufficient to meet the performance parameters outlined in this guide. Mix design and testing should be performed by laboratories experienced in evaluating composts and compost amended mixes.

5.5.4.4 *Quality Control (QC) Program*—Every high performance sand-based rootzone should be constructed using a well designed and administered calibration and QC program. Such program should set the parameters to be included in the QC testing, the procedures for sampling, sampling intervals, handling the samples (chain of custody), the limits/tolerances or confidence intervals for accept/reject status within a sample, and the allowable variability of test parameters between samples.

5.5.5 *Rootzone Blending*—Rootzone blending is perhaps the most critical aspect of the construction process. Once amendment ratios are known, the components of the blend should be prepared.

5.5.5.1 *Sand*—The sand should have been previously processed, stockpiled, tested, approved, and quality control tested.

5.5.5.2 *Soil*—Any soil amendments should have been tested and approved and then prepared for blending by first shredding, screening, and the removal of any objectionable stones or other items. Once the soil has been prepared in this manner, the soil should be transported to the blending site for stockpiling. Once the material arrives on site, it should be protected from weather, particularly rain. During the processing and transportation of the soil component, it may be beneficial to mix or homogenize the soil material as much as is feasibly possible. Once homogenized and transported to the blending site, an additional sample should be taken and tested for conformance with the original tested material so that any adjustments in the blending proportions needed to compensate for variance in the soil stockpile may be made. It should be noted that soil components (particularly topsoils) are a potential source of weeds by seeds or plant parts. Consideration for eradication or fumigation of these materials may be warranted.

5.5.5.3 *Peat*—The peat product used for amending the sand should have been tested and approved prior to shipment of material to the blending site. Once the material arrives on site, it should be protected from weather, particularly rain. As peat is unloaded or unpackaged, it should be visually inspected for apparent uniformity within the shipment. If the project owner, project designer, or agronomist is sufficiently familiar with the peat material from past projects, the only QC testing that may be required for the peat is the calibration and QC for organic matter content of the resulting sand-peat mix. If the peat product/source is new or unfamiliar to the project personnel, additional QC tests should be performed at set testing intervals prior to blending. Peat QC test parameters may include ash content, organic matter, pH, fiber content, moisture content and volume weight (see Test Methods D1997, D2944, D2974, D2976, D2980, and Classification D4427) and C/N ratio. The above advice also applies to composts used as organic amendments.

5.5.5.4 *Blending*—The blending operation should only proceed once all of the materials have been tested and approved

and transported to the blending site. It is recommended that blending operations proceed off-site as to the installation. Possible blending sites include: *(1)* the location for sand materials supply or stockpile; and *(2)* in an area adjacent to field site (such as a paved parking lot). The materials to be blended should be blended in a slightly moist to moist condition. Excessively wet material will not blend together properly and uniformly. Blending should be performed using commercial soil blending equipment designed for this purpose. The project designer should calculate production to include a minimum of 5 % (10 % preferred) additional rootzone material to account for shrinkage. Any leftover rootzone material could be stockpiled by the owner for use in future maintenance (topdressing) operations and for other repairs. The blending should be initiated with the preparation of a 'batch' for calibration purposes. A calibration batch stockpile is normally composed of a 100 ton minimum. The calibration batch should be sampled and tested to assure the blending equipment is properly calibrated before proceeding further. Each test for calibration may delay the blending operation 24 to 48 h, awaiting test results and recommendations from the testing laboratory. Another option would be to employ a commercial testing agent with the capacity to perform on-site testing with mobile laboratory equipment. The mobile laboratory may be utilized throughout the calibration and blending process to facilitate the logistics of the operation. It is recommended that 1 of 10 tests conducted by the mobile laboratory are duplicated at the regular laboratory facility to assure accuracy of the on-site testing data.

5.5.5.5 *Stockpile Storage and Transportation*—During the blending operation, and once the rootzone material has been blended and all QC approvals have been met, the stockpiled material should be protected against the effects of weather. If heavy rain is expected, the stockpiles should be covered, if possible. To protect against wind erosion of soil or organic components, the stockpiles should be kept moist on the surface of the stockpile. Once stockpiled rootzone material is to be transported to the construction site, care should be taken to ensure that the loading equipment and haul vehicles/containers are properly sanitized such to contain no foreign soil, aggregate, asphalt, and so forth that might contaminate the blended rootzone material. When the stockpile material is being picked up for loading, care should be exercised to assure that the bucket of the loading equipment is not picking up underlying soil or asphalt and that cleated tires or tracks are not 'tilling' other material into the rootzone mix.

5.5.6 *Grading Requirements*—All grades should conform to those grades and elevations as specified in the construction documents. The suggested method for grade evaluation and grade tolerances are:

5.5.6.1 For general conformance, perform an as-built survey based upon an 8 m (25 ft) grid to be within:

(1) Subgrade, ±12.5 mm (½ in.).

(2) Gravel Drainage Layer (if used), ±12.5 mm (½ in.).

(3) Surface/Finish, ±6 mm (¼ in.).

5.5.6.2 For specific conformance and acceptability of grades between grid points (spot check), it is recommended that any observed (or suspected) high and low points be checked using a 3-m (10-ft) straight edge with tolerances based upon:

(1) Subgrade, ±12.5 mm (½ in.) in any linear direction.

(2) Gravel Drainage Layer (if used), ±12.5 mm (½ in.) in any linear direction.

(3) Surface/Finish, ±6 mm (¼ in.) in any linear direction.

5.5.6.3 Grades shall be correct, certified, and approved (at each phase: subgrade, gravel layer (if used), and finish grade) by the owner or project designer, or both, prior to proceeding to the next phase of construction. Correct and certified grade shall be given by the production of an as-built drawing/diagram depicting elevation and location data that has been prepared and stamped by a licensed surveyor. The certified as-built drawing/diagram shall be submitted for approval to the owner or project designer, or both, as specified in the construction documents prior to proceeding to the next phase of the field construction.

5.6 *Installation*—Installation procedures include the installation of the drainage trench backfill material, installation of any gravel drainage layers, delivery, and installation of the rootzone material, installation of the irrigation, finish grading of the site, and then turf establishment. Rootzone installation depth shall conform to project designer's specifications. Typical rootzone placement depths range from 15 cm (6 in.) to 30 cm (12 in.) for installations without a gravel drainage layer. If a gravel drainage layer is used, the rootzone placement depth must be correlated with the desired depth of well-aerated rootzone. Typically, the profile depth of a sand-based field installed over a gravel drainage layer ranges from 23 cm (9 in.) to 40 cm (16 in.).

5.6.1 *Installation of Drainage Materials*—Drainage trench installation should be completed to the point of backfill and compaction (see 5.4.3) prior to installation of the irrigation system. If a gravel drainage layer is a component of the system design, the installation of the gravel layer should be completed following the rough installation and pressure testing of the irrigation system.

5.6.2 *Installation of the Irrigation System*—Irrigation system shall be designed and installed to provide head to head coverage with uniform distribution (**9**). Suggested irrigation design uniformity values (CUIRR or Christiansen's coefficient of uniformity) are: *(1)* football, soccer, or other rectangular field designs: ≥90 %; and *(2)* baseball/softball, cricket, or other non-rectangular field designs: ≥84 %. Irrigation pipe should be installed to a depth sufficient to be protected from mechanical aeration maintenance practices. Normally, this would be at a depth of 36 cm (14 in.) or more from finished grade. In the case of shallow profile designs of less than 20 cm (8 in.), the irrigation lateral and mainlines may be installed within the subgrade below the depth of the entire drainage system. The installation of the irrigation lines below the drainage system serves to isolate the irrigation lines from potential damage from aeration or other maintenance practices. Irrigation mainlines

and lateral lines (with sleeving, if included) should be installed prior to placement of the gravel drainage layer (if used) or rootzone materials, or both. Irrigation lines crossing drainage trenches may be 'sleeved' across the drainage trench to facilitate subsequent irrigation system installation without disturbing the drainage trench system. Irrigation lines *should not* be installed within the same trenches as the drainage system in order to minimize the disturbance of one system to the other as they are being installed or repaired. The irrigation system mainlines should be pressure checked (24 h static pressure) before backfilling and prior to proceeding with the next construction phase.

5.6.2.1 *Complete Installation of Gravel Drainage Layer*—If a gravel drainage layer is used as a component of the rootzone design, this gravel layer may be installed once the irrigation system rough installation and a pressure check are completed.

5.6.3 *Delivery and Installation of the Rootzone*—The rootzone material should be transported to the site and dumped around the perimeter of the site. A small crawler tractor is ideally suited to spread the rootzone material working from the perimeter inward toward the center of the field. Wheeled tractors or larger tractors may cause excessive pressure that could lead to crushing of the drainage pipes, rutting of the subgrade, or over compaction of the rootzone material. As subsequent rootzone material is moved to the site for dumping, a plywood course should be constructed over the installed rootzone to facilitate the movement of trucks onto the field for dumping of the load. The plywood course not only protects the rootzone from rutting and excessive compaction, but also allows the trucks to deliver their load without becoming stuck in the sand. Under no circumstances should trucks or other equipment be allowed to travel over the uncovered subgrade. Once the delivery of the rootzone material is completed, the field may be shaped, rough-graded, and compacted as specified.

5.6.4 *Final Field Preparations*—Final field preparations include bringing the field to final grade and contour and may include pre-plant fertilization and pre-plant irrigation.

5.6.4.1 *Finished Grade*—Once the rootzone material has been installed and rough graded, the field should be graded to final (finish) grade and contour. It is strongly recommended that laser guided leveling equipment is specified and utilized for this critical aspect of the construction process. A smooth and uniform grade is a very important aspect of proper conditions for enhanced playability and safety of an athletic field. The specified grade and contour should conform to a ±6 mm (±¼ in.) within 3 m (10 ft) in any lateral distance for general conformance and specific conformance as outlined in 5.5.6. Such tolerances are only achievable with laser-guided equipment. During the finish grade operation, compaction should be achieved by irrigating and rolling the surface utilizing a lightweight roller (less than 2 ton) with at least two passes in perpendicular directions. Finished grade should be within specified tolerances, correct and certified as specified (see 5.5.6) before turf installation.

NOTE 4—In general, as the soil component in a sand-based rootzone increases, rolling should be performed with lighter equipment also giving a higher level of attention to the moisture content of soil component. In any case, it is recommended that when using soil components with an increased potential to compact in a blend with sand, rolling shall be done with caution.

5.6.4.2 *Pre-Plant Operations*—Pre-plant operations may include the use of a pre-plant fertilizer or other soil fertility amendment. Applications can be made as a granular product that is spread across the field or as a liquid application that is sprayed across the field or injected into the irrigation system. Once the pre-plant materials are applied, it may be desirable to lightly irrigate or 'water-in' the applied materials. Any pre-plant operations must be performed with care to avoid rutting or disruption of the final grade in any manner. Only lightweight or walk-behind equipment is advisable.

5.6.5 *Turf Installation*—The turf to be used in the athletic field project should be thoughtfully considered and specified by the project's project designer, owner, or project agronomist. It should be of a species and cultivar adapted to the local climate, capable of withstanding the stresses imposed on an athletic turf, while providing good playability and aesthetic characteristics. Depending upon turf species and cultivar selected, turf installation methods may include seeding, sprigging, plugging, or sodding. Any turf installation methods used must be carried out in a manner that protects the integrity of the finished grade. No heavy machinery such as tractors, hydrospray tanks, or trucks should be allowed on the surface, unless equipped with turf-type tires.

5.6.5.1 *Seeding and Sprigging*—Seeding and sprigging offer the most flexibility of the methods because they do not pose the risk of contamination of the rootzone with attached soil, they can be spread or planted mechanically or by the use of hydroseeding/hydrosprigging. If the project construction timeframe allows, seeding or sprigging are the preferred methods of establishment. Any mechanical sprigging equipment or seeders should be outfitted such to avoid disruption of finished grade. The use of heavy or large hydrosprig/hydroseed equipment intended for use in the hydroseeding or hydrosprigging of roadside and highway landscapes should be avoided, except where the equipment can be kept off the field and the hydroseed/hydrosprig material applied by use of a hose. Seeds or sprigs should be Certified turfgrass seed/sprigs (if available). Seeds or sprigs shall be free of, or below acceptable threshold levels for, objectionable or noxious weeds, foreign turfgrass cultivars, off-types of the same species, insects, nematodes, diseases, or any other objectionable material.

5.6.5.2 *Plugging*—Establishment of rapidly growing warm season turf cultivars that propagate by spreading through rhizomes or stolons (for example, seashore paspalum and bermudagrass), may be established by plugging. Plugging has some distinct advantages as an establishment method. Installed plugs have an established root system, and therefore are not as subject to stresses of drought should an interruption in water supply occur, or if limited water quantities are available for irrigation. If the growing medium of the plugs was a 'soil-less' mix, then minimum contamination of the rootzone can be expected. Plugs can be planted on a wide variety of spacings, depending upon the desired rate of grow-in desired and the turf cultivar utilized. Typical plug planting spacing ranges from 20 cm (8 in.) to 40 cm (16 in.) on center. Plugs should be free of weeds, contaminants, off-type turf, or any other objectionable

TABLE 4 Sod-soil to Rootzone Sand Compatibility Recommendations

Criteria	Preferred	Acceptable	Marginal	Unacceptable
$D_{50}R/D_{50}S$	<2.5	2.5 to 5.0	5 to 10	>10
Silt and clay (%)	<5	5 to 10	10 to 15	>15
Silt to clay ratio	<2	2 to 5	5 to 7	>7
Gravel (>2 mm) (%)	0	0 to 2	2 to 5	>5

R = Rootzone S = Sod-soil

TABLE 5 Recommended Physical Properties of the Rootzone Mix (Test Method F1815)

Physical Property	Specified Range
Total porosity	35 to 45 %
Bulk density ($kg \cdot m^{-3}$)	1.5 to 1.7
Air-filled porosity	15 to 25 %
Capillary porosity	15 to 25 %
Saturated hydraulic conductivity (cm/h)	≥25
(Saturated hydraulic conductivity [in./h])	(≥10)

material. Plugs for athletic fields are best planted by hand. Another method of plug establishment is sometimes utilized whereby a mechanical planter processes sod into irregular pieces and then plants them as 'plugs.' This method of plugging irregular sod pieces may also be used for satisfactory establishment of turf and can be done mechanically with due caution to avoid disruption or rutting of the finished grade.

5.6.5.3 *Discussion*—Plugging as used in this guide defines the use of discreet media-rooted turf plugs (as often coming in a plastic media tray). This method of plugging should not be confused with the practice of planting irregular sod pieces, which is also referred to as plugging in some areas. Plugging by the use of irregular sod pieces is a practice more closely resembling a sprigging operation and the establishment of turf by this practice should conform to the specifications as given for mechanical sprigging.

5.6.5.4 *Sodding*—Sodding offers the quickest establishment of any turf installation method. Sod can come in rolls or slabs of various dimension and thickness. If sod is to be used, it is preferable to wash the soil from the sod before installation to avoid contamination of the rootzone. If washed sod is not available, then only sod grown in sand or loamy sand soil should be considered. Any sod-soil considered for installation in the project should meet the criteria as outline in Table 4. Big-roll sod is the preferred sod type in order to reduce the seams in the finished installation. Sod delivery and installation procedures should be such to avoid compaction and disruption of the finished grade. (Sod may also be planted mechanically as irregular sized pieces in a process called 'plugging,' see 5.6.5.2.) Sod deliveries should be made off the field and the sod moved in on a pallet-by-pallet or roll-by-roll basis as appropriate. Specialized sod handling and installation equipment only should be used during this process to protect the finished grade. For example, with big-roll sod installations, rubber-tracked handling and installation equipment is commercially available.

5.6.5.5 *Recommended Sod Specifications*—If sod is the chosen turf establishment method, the following criteria is a recommended specification for the sod to be used:

(1) Certified Turfgrass Sod—Superior sod grown from Certified (if available), high quality seed (stolons) of known origin, or from plantings of Certified grass seedlings or stolons. It shall be inspected by a sports turf consultant and owners' representative at the sod farm at which it is grown to ensure satisfactory genetic identity and purity, overall high quality, and freedom from noxious weeds, as well as excessive quantities of other crop and weedy plants at time of harvest. All seed or original plant material in mixture should be Certified. Turfgrass sod shall meet the published state or government standards for Certification of the species and cultivar as specified.

(2) Sod may be washed (soil-less) or a special "sand base" material meeting compatibility specifications for sand-based athletic fields as given in Table 4. Sod-soil containing greater than 15 % silt and clay are unacceptable. In most cases, sod thickness should not contain a soil layer greater than 12.5 mm (½ in.). Thick cut (>12.5 mm or >½ in.) sod may be used in cases where insufficient time exists for establishment of sod before play is initiated. In any case, sod-soil should meet appropriate compatibility criteria as given in Table 4.

(3) Strip Size—Sod shall be big roll turf cut to the supplier's standard width and length. Maximum allowable deviation from standard widths and lengths shall be plus or minus 12.5 mm (½ in.) on width and plus or minus 5 % on length. Broken strips and torn or uneven ends will not be accepted.

(4) Time Limitations—Sod shall be harvested, delivered, and transplanted within a 12 h period unless a suitable preservation method is approved by the project designer or project agronomist prior to delivery. Sod not transplanted within this period shall be inspected and approved by the project agronomist and project designer prior to its installation.

(5) Thatch—Sod shall be relatively free of thatch. A maximum of 12.5 mm (½ in.) (uncompressed) thatch will be permitted.

(6) Diseases, Nematodes, and Insects—Sod supplier should be required to supply (and warrant) sod that shall be relatively free (below established acceptable threshold levels) of diseases, parasitic nematodes, and soil-borne insects.

(7) Weeds—Sod shall be free of objectionable grassy and broad leaf weeds.

(8) Sod supplier to identify specific fields for harvest, inspection, and submit a fertility and management program schedule for 6 months prior to harvest.

6. Recommended Rootzone Performance Criteria

6.1 Several criteria should be considered for proper design of high performance sand-based rootzone construction. These include physical performance criteria, chemical performance criteria, and mechanical performance criteria. The rootzone performance criteria should be considered on the entire rootzone mix rather than on any component separately.

6.2 *Recommended Physical Performance Specifications*—Physical performance criteria (as determined at 40 cm tension for water retention and air-filled porosity) include permeability or saturated hydraulic conductivity, water retention, air-filled

TABLE 6 Recommended Chemical Properties of the Rootzone Mix

Chemical Property	Specified Range
pH (Test Method D4972)	5.0 to 7.5
Calcium carbonate equivalent, preferred	<5 %
Calcium carbonate equivalent, marginal	5 to 15 %
Organic matter (Test Methods F1647)	0.5 to 2.5 %
Nutrient content	Adjust for local conditions
Heavy metals or other phytotoxic ions	Adjust for local conditions, do not exceed regulated thresholds

TABLE 7 Recommended Mechanical Properties of the Rootzone Mix

Mechanical Property	Specified Range
Friction angle (degrees) (Test Method D3080) or, alternatively	38 to 50
Angle of repose (degrees) (Test Method C1444)	35 to 45
CBR (%) (Test Method D1883)	12 to 25
Coefficient of Uniformity (CU) of sand component	2.5 to 4.5

porosity, and bulk density. The recommended physical performance criteria are given in Table 5. The physical performance criteria should be given priority over the sand size distribution specifications.

6.3 *Recommended Chemical Performance Specifications*—Chemical performance criteria include pH, calcium carbonate equivalent, organic matter content, nutrient content and the presence of any heavy metals or phytotoxic ions/substances. The recommended chemical performance criteria are given in Table 6.

6.4 *Recommended Mechanical Performance Specifications*—Mechanical performance criteria (for sands) includes shear resistance (specified as friction angle determined by direct, simple, or triaxial shear methodolgies (see Test Method D3080) when compacted to an initial standard proctor density of 85 % and at 40 cm soil tension (see Test Methods D698)), California Bearing Ratio (confined CBR) at 40 cm soil tension and 85 % standard proctor density (see Test Method D1883) and coefficient of uniformity (CU = D_{60}/D_{10}) of the sand component.

7. Keywords

7.1 athletic field; baseball; clay; cricket; football; natural turf; sand; soccer; softball; soil; sports field; sports turf; turfgrass

APPENDIX

(Nonmandatory Information)

X1. RESOURCE MATERIALS

X1.1 For additional information related to sports fields, consult the following sources of information:

X1.1.1 Sports Turf Managers Association (STMA). STMA, 805 New Hampshire, Suite E, Lawrence, KS 66044, http://www.sportsturfmanager.com.

X1.2 For additional information related to soil modification for athletic field construction, you may desire to consult the following publications:

X1.2.1 Adams, W. A., and Gibbs, R. J., *Natural Turf for Sport and Amenity: Science and Management*, (Oxford Press, 1994).

X1.2.2 Davis, W. B., Paul, J. L., and Bowman, D., "The Sand Putting Green Construction and Management," *University of California Bulletin, Publication # 21448*, University of California, ANR Communication Services, 1990.

X1.2.3 Davis, W. B., Farnham, D. S., and Gowans, K. D., "The Sand Football Field," *California Turfgrass Culture*, Vol. 24(3), 1974, pp. 17–20.

X1.2.4 Goss, R. L., and Cook, T., "Construction and Maintenance of Natural Grass Athletic Fields," *PNW Publication 0240*, Washington State University Cooperative Extension, 1983.

X1.2.5 Harper, J. C., "Athletic Fields—Specification, Outline, Construction, and Maintenance," Penn State University, 1983.

X1.2.6 Keith J. Karnok, ed., *Turfgrass Management Information Directory*, Third Edition, (Hoboken, New Jersey: John Wiley & Sons, Inc.).

X1.2.7 Landschoot, P. J., "Using Composts to Improve Turf Performance," *Cooperative Extension Circular 5M49ps5733*, Penn State University, 1996.

X1.2.8 Peacock, C. H., "Athletic Fields: Design, Construction, and Maintenance," *Bulletin 202*, University of Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, 1999.

X1.2.9 Taylor, D. H., Blake, G. R., and White, D. B., "Construction and Maintenance of Athletic Fields," *University of Minnesota Extension Bulletin 3105*, 1987.

REFERENCES

(1) Soil Science Society of America, *Glossary of Soil Science Terms*, Soil Science Society of America, Madison, WI, 1997.

(2) USDA, Soil Conservation Service, Soil Survey Staff, "Soil Taxonomy: A Basic System of Soil Classification for Making and Interpreting Soil Surveys," *USDA Handbook 436*, U.S. Government Print Office, 1975 .

(3) USDA, Soil Conservation Service, Soil Survey Staff, "Soil Survey Manual," *USDA Handbook 18*, U.S. Government Print Office, 1993.

(4) USDA, Soil Conservation Service, Soil Survey Staff, "Keys to Soil Taxonomy," 7th ed., Pocahontas Press, Blacksburg, VA, 1997.

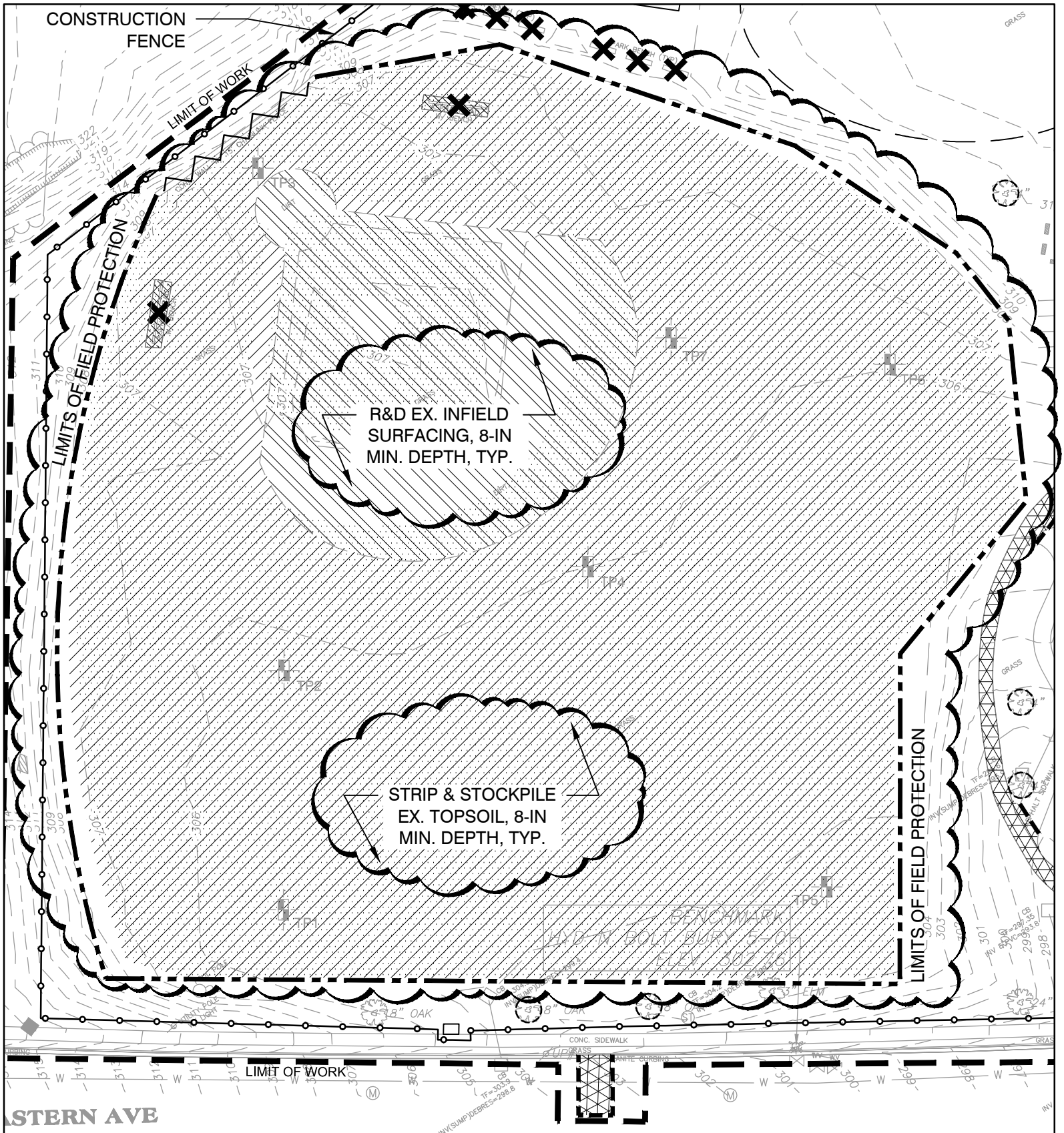
(5) Dixon, J. B., and Weed, S. B., *Minerals in Soil Environments*, 2nd ed., Soil Science Society of America, Madison, WI, 1989.

(6) Brownell, W. E., *Structural Clay Products*, (Applied mineralogy; v. 9), Springer-Verlag, Wien-New York, 1976.

(7) U.S. Department of Defense, USACE, "Drainage and Erosion Control—Mobilization Construction, Chapter 5, Backfill for Subsurface Drains," *Engineering Manual EM 1110-3-136*, U.S. Government Print Office, Washington, DC, 1984, http://www.usace.army.mil/inet/usace-docs/eng-manuals/em1110-3-136/c-5.pdf.

(8) USGA, Green Section, *USGA Recommendations For A Method Of Putting Green Construction*, USGA, Golf House, Far Hills, NJ, 1993,http://www.usga.org/green/coned/greens/recommendations.html#gravel.

(9) Christiansen, J. E., "Irrigation by Sprinkling," *California Agricultural Experimental Station Bulletin 670*, University of California: Berkeley, CA, 1942.



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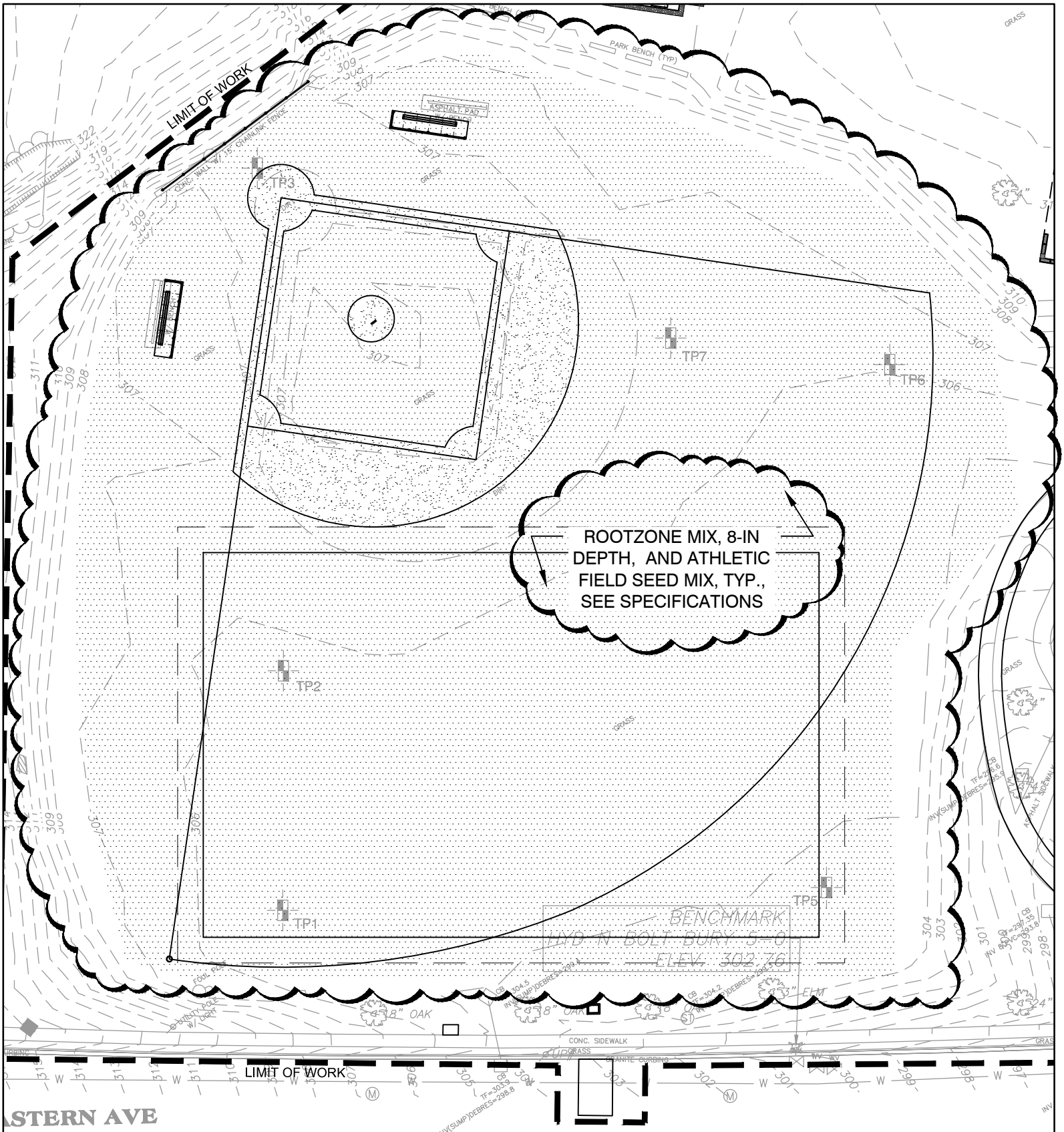

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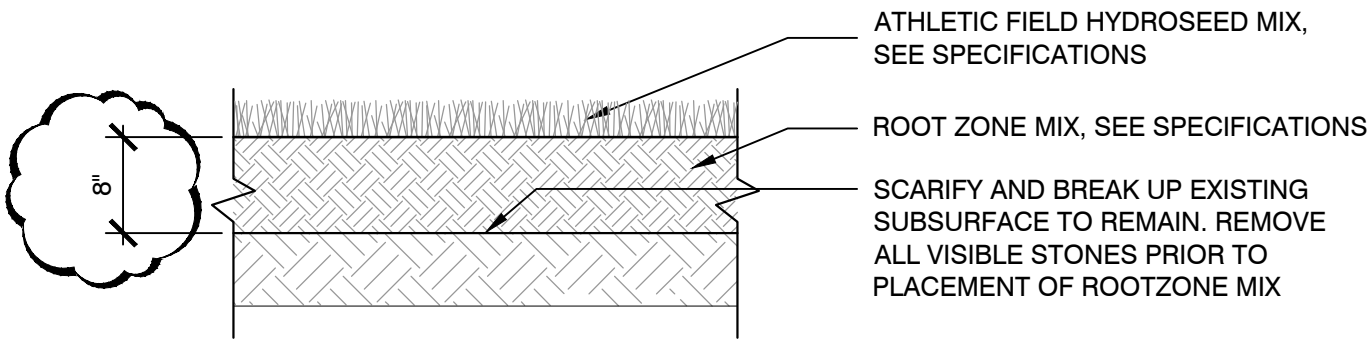

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