PART 1 - GENERAL

1.1 GENERAL

A. The work of this section consists of all Structural Soil work and related items as indicated on the drawings or as specified herein and includes, but is not limited to, the following:

1. CU Soil™ is a proprietary material patented by Cornell University (US Patent # 5,849,069). Only licensed producers are allowed to supply this material, meeting the specifications described in this text. For a list of licensed CU-Soil™ producers, call AMEREQ, INC. at 1-800-832-8788.

B. The following documents form part of the Specifications to the extent stated. Where differences between exist between codes and standards, the one affording the greatest protection shall apply.

1.2 REFERENCES AND STANDARDS

A. The following references are used herein and shall mean
1. ASTM: American Society of Testing Materials
2. USDA: United States Department of Agriculture
3. AASHTO: American Association of State Highway and Transportation Officials
4. Standard Specifications: Regional or Municipal Standard Specifications Documentation for the location of proposed usage
5. AOAC: Association of Official Agricultural Chemists

1.3 SAMPLES AND SUBMITTALS

A. At least 30 days prior to ordering materials, the Contractor shall submit to the Engineers representative samples, certificates, manufacturer's literature and certified tests for materials specified below. No materials shall be ordered until the required samples, certificates, manufacturer's literature and test results have been reviewed and approved by the Engineer. Delivered materials shall closely match the approved samples. Approval shall not constitute final acceptance. The engineer reserves the right to reject, on or after delivery, any material that does not meet these specifications.

B. Submit two, one-half cubic foot representative samples of Clay Loam and one, one cubic foot representative samples Structural Soil mixes in this section for testing, analysis and approval. Submit one set of samples for every 500 CY of material to be delivered. In the event of multiple source fields for Clay Loam, submit a minimum of one set of samples per source field or stockpile. Samples shall be taken randomly throughout the field or stockpile at locations as directed by the Engineer and packaged in the presences of the Engineer. Samples shall be labeled to include the location of the source of the material, the date of the sample and the Contractor's name. One of the two samples is to be used by testing laboratory for testing purposes. The second sample of all Clay Loam and Structural Soil shall be submitted to the Engineer at the same time as test analysis as a record of the soil color and texture.
1. Submit the locations of all source fields for Clay Loam.
2. Submit a list of all chemicals and herbicides applied to the Clay Loam for the last five years and a list of all crops grown in the Clay Loam source fields for the last three years.

C. Submit soil test analysis reports for each sample of Clay Loam and Structural Soil from an approved soil-testing laboratory. The test results shall report the following:
1. The soil testing laboratory shall be approved by the Engineer. The testing laboratory for particle size and chemical analysis may be a public agricultural extension service agency or agricultural experiment station.

2. Submit a bulk density of the sample and particle size analysis including the following gradient of mineral content:

USDA Designation	Size in mm.
Gravel	+2 mm
Sand	0.05 – 2 mm
Silt	0.002-0.05 mm
Clay	minus 0.002 mm

Sieve analysis shall be performed and compared to USDA Soil Classification System. Sieve analysis shall be done by a combined hydrometer and wet sieving using sodium hexametaphosphate as a dispersant in compliance with ASTM D422 after destruction of organic matter by hydrogen peroxide.

3. Submit a chemical analysis, performed in accordance with current AOAC Standards, including the following:
   a. pH and Buffer pH.
   b. Percent organic matter as determined by the loss of ignition of oven dried samples. Test samples shall be oven dried to a constant weight at a temperature of 230 degrees F, plus or minus 9 degrees.
   c. Analysis for nutrient levels by parts per million including nitrate nitrogen, ammonium nitrogen, phosphorus, potassium, magnesium, manganese, iron, zinc, calcium and extractable aluminum. Nutrient test shall include the testing laboratory recommendations for supplemental additions to the soil as calculated by the amount of material to be added per volume of soil for the type of plants to be grown in the soil.
   d. Analysis for levels of toxic elements and compounds including arsenic, boron, cadmium, chromium, copper, lead, mercury, molybdenum, nickel, zinc and PCB. Test results shall be cited in milligrams per kilogram.
   e. Soluble salt by electrical conductivity of a 1:2 soil/water sample measured in Millimho per cm.
   f. Cation Exchange Capacity (CEC).
   g. Carbon/Nitrogen Ratio.
4. Submit 5-point minimum moisture density curve AASHTO T 99 test results for each Structural Soil sample without removing oversized aggregate.
5. Submit Bearing Ratio test results for each Structural Soil sample compacted to peak standard density. The soaked CBR shall equal or exceed a value of 50.
6. Submit measured dry-weight percentage of stone in the mixture.
7. The approved Structural Soil samples shall be the standard for each lot of 500 cubic yards of material.
8. All testing and analysis shall be at the expense of the Contractor.

D. Maintenance Instructions: Prior to the time of Final Acceptance of the Work, submit maintenance instructions for the use, removal and replacement of Structural Soil for the licensor's (Amereq Corp.) use. The instructions shall be reviewed by the Project Engineer as a pre-condition for Final Acceptance of the Work.

E. Submit to the Landscape Architect for review a proposed plan and vertical section layout of all Structural Soil.

F. Submit one cubic foot sample per each 500 cubic yards of required material, and for each sample, the following analysis for all Crushed Stone. The soil testing laboratory shall be approved by the Engineer.

1. Provide a particle size analysis including the following gradient of mineral content:

USDA Designation	Size in mm.
3@	+76 mm
2-1/2@	63-76 mm
2@	50-63 mm

1-1/2@	37-50 mm	
1@	25-37 mm	
¾@	19-25 mm	
Fine gravel		2-19 mm
Sand		0.05-2 mm
Silt		0.002-0.05 mm
Clay		minus 0.002 mm

2. Provide the manufacturers analysis of the following:
   a. Loose and rodded unit weight.
   b. Bulk specific gravity and absorbency.
   c. Stone dimension and surface texture description.
   d. Documentation of acceptance for use as DOT approved aggregate by the appropriate regional DOT.
3. Provide a percent pore space analysis defined as follows:
   a. Rodded Unit Weight divided by the Bulk Specific Gravity X 100

A. Submit one pound sample of each type of fertilizer and three certificates showing composition and analysis. Submit the purchasing receipt for each fertilizer showing the total quantity purchased for the project prior to installation.

B. Submit the Landscape or Pavement Material Contractor's qualifications outlining projects of similar quality, schedule requirements and construction detailing over the last five years. Qualifications shall include: the names of all similar projects, year completed, location, description of the scope of work including the types and quantities of planting mix/pavement material installed and the name, address and telephone number of the owner or the owner's representative.

1.4 DELIVERY, STORAGE AND HANDLING

A. Do not deliver or place soils in frozen, wet, or muddy conditions. Material shall be delivered at or near optimum compaction moisture content as determined by AASHTO T99 (ASTM D 698). Do not deliver or place materials in an excessively moist condition (Beyond two percent above optimum compaction moisture content as determined by AASHTO T 99 (ASTM D 698).

B. Protect soils and mixes from absorbing excess water and from erosion at all times. Do not store materials unprotected from large rainfall events. Do not allow excess water to enter site prior to compaction. If water is introduced into the material after grading, allow material to drain or aerate to optimum compaction moisture content.

1.5 EXAMINATIONS OF CONDITIONS

A. All areas to receive Structural Soil shall be inspected by the Contractor before starting work and all defects such as incorrect grading, compaction and inadequate drainage etc. shall be reported to the Engineer prior to beginning this work.

B. The Contractor shall be responsible for judging the full extent of work requirements involved, including but not limited to the potential need for temporary storage and staging of soils, including moving soil stock piles at the site to accommodate scheduling of other work and the need to protect installed soils from compaction, erosion and contamination.

1.6 QUALITY ASSURANCE

A. Qualifications of Landscape or Pavement material Contractor: The work of this section shall be performed by a Landscape Contracting firm which has a minimum of five years experience successfully installing planting mix of a similar quality, schedule requirement and construction detailing to this project. Proof of this experience shall be submitted as per paragraph, SAMPLES and SUBMITTALS, of this Section.

A. Contractor's Quality Control Responsibilities: Contractor is solely responsible for quality control of the Work.

B. Regulatory Requirements: Comply with applicable requirements of the laws, codes, ordinances and regulations of Federal, State and Municipal authorities having jurisdiction. Obtain necessary approvals from all such authorities.

PART 2 - MATERIALS

2.1 CLAY LOAM

A. Clay Loam shall be a “loam” based on the “USDA classification system” as determined by mechanical analysis (ASTM D-422) and it shall be of uniform composition, without admixture of subsoil. It shall be free of stones greater than one-half inch, lumps, plants and their roots, debris and other extraneous matter over one inch in diameter or excess of smaller pieces of the same materials as determined by the Engineer. It shall not contain toxic substances harmful to plant growth. It shall be obtained from naturally well-drained areas, which have never been stripped of topsoil before and have a history of satisfactory vegetative growth. Clay loam shall contain not less than 2% or more than 5% organic matter as determined by the loss on ignition of over-dried samples. Test samples shall be oven-dried to a constant weight at a temperature of 230 degrees F., plus or minus 9 degrees.

B. Mechanical analysis for a Loam/Clay Loam shall be as follows:

Textural Class	% of Total Weight
Gravel	less than 5%
Sand	20-45%
Silt	20-50%
Clay	20-40%

C. Chemical analysis: Meet or be amended to meet the following criteria:
1. pH between 5.5 to 6.5.
2. Percent organic matter 2-5% by dry weight.
3. Nutrient levels as required by the testing laboratory recommendations for the type of plants to be grown in the soil.
4. Toxic elements and compounds below the United States Environmental Protection Agency Standards for Exceptional Quality sludge or local standard; whichever is more stringent.
5. Soluble salt less than 1.0 Millimho per cm.
6. Cation Exchange Capacity (CEC) greater than 10.
7. Carbon/Nitrogen Ratio less than 33:1.

C. Loam/Clay Loam shall be the product of a commercial processing facility specializing in production of stripped natural topsoil. No topsoil shall come from USDA - classified prime farmland.

2.2 FERTILIZER

A. Commercial fertilizer complying with State and United States fertilizer laws. Deliver fertilizer in original unopened containers, which shall bear the manufacturer’s certificate of compliance covering analysis, which shall be furnished to the Engineer. Fertilizer shall be formulated for mixing into the soil and be certified by the manufacturer to provide controlled release of nitrogen continuously for a period of no less than nine months and no more than 12 months.

B. Fertilizer percentages of weight of ingredients and application rates shall be as recommended by the soil testing results.

2.3 SULFUR (if needed)

A. Sulfur shall be commercial granular, 96% pure sulfur, delivered in containers with the name of the manufacturer, material and analysis appearing on the container.

B. Sulfur used to lower soil pH above 6.5 shall be ferrous sulfate formulation.

2.4 LIME (if needed)

A. Agricultural limestone containing a minimum of 85% carbonates. Minimum gradation: 100% passing 10 mesh sieve; 98% passing 20 mesh sieve; 55% passing 60 mesh sieve and 40% passing 100 mesh sieve.

2.5 CRUSHED STONE

A. Crushed Stone shall be a DOT certified crushed stone. Granite and limestone have been successfully used in this application. The size of the crushed stone shall be 0.75 inches to 1.5 inches allowing for 5 – 10% to be greater than 1.5 inches, and 5 – 10% less than 0.75 inches.
B. Acceptable aggregate dimensions will not exceed 2.5:1.0 for any two dimensions chosen.
C. Minimum 90% with one fractured face, minimum 75% with two or more fractured faces.
D. Results of Aggregate Soundness Loss test shall not exceed 18%.
E. Losses from LA Abrasion tests shall not exceed 40%.

2.6 HYDROGEL

A. Hydrogel shall be a potassium propenoate-propenamide copolymer Hydrogel (Gelscape® Hydrogel Tackifier) as manufactured by Amereq Corp. (800) 832-8788

2.7 WATER

A. The Contractor shall be responsible to furnish his own supply of water to the site at no extra cost. All work inured or damaged due to the lack of water, or the use of too much water, shall be the Contractor's responsibility to correct. Water shall be free from impurities injurious to vegetation.

2.8 STRUCTURAL SOIL

A. A uniformly blended mixture of crushed Stone, Clay Loam and Hydrogel, mixed to the following proportion:

Material	Unit of Weight
Crushed Stone	100 units dry weight
Loam	as determined by the test of the mix (approx. 20 units)
Hydrogel	0.03 units dry weight
Total moisture	AASHTO T-99 optimum moisture

B. The initial mix design for testing shall be determined by adjusting the ratio between the Crushed Stone and the clay loam. Adjust final mix dry weight mixing proportion to decrease soil in mixture if CBR test results fail to meet acceptance (CBR #50).

PART 3 – CONSTRUCTION METHODS

3.1 MIX DESIGN

A. Prepare sample Structural Soil mixes to determine the ratio of mix components. Submit for approval.
   1. Submit samples and the test results of each mix component for approval. Based on samples and the analysis of the mix components, the Engineer and the Contractor will jointly determine a mix ratio to be tested for conformance with the requirements of the specifications. For Structural Soil quantities greater than 500 cubic yards, test the mix ratio for each Clay Loam or Crushed Stone where the testing indicates a significant difference in physical analysis of the Clay Loam or Crushed Stone as determined by the Engineer.
   2. The Contractor shall prepare the samples of the proposed mix ratio options and obtain soil test as described in paragraph 1.3 C. Submit the samples of each of the mixes with the test results.
   3. The Engineer may request additional Structural Soil mix ratio samples to be tested in the event that further refinement of the mix is necessary.
   4. Submit to the Engineer proposed fertility amendment recommendations including amounts and types of fertilizers and pH adjustments for each mix ratio. Fertility adjustments shall be included as part of the mixing process.

3.2 SOIL MIXING AND QUALITY CONTROL TESTING

A. All Structural Soil mixing shall be performed at the Producer's yard using appropriate soil measuring, mixing and shredding equipment of sufficient capacity and capability to assure proper quality control

and consistent mix ratios. No mixing of Structural Soil at the project site shall be permitted. Portable pugging may be used.

1. Maintain adequate moisture content during the mixing process. Soils and mix components shall easily shred and break down without clumping. Soil clods shall easily break down into a fine crumbly texture. Soils shall not be overly wet or dry. The contractor shall measure and monitor the amount of soil moisture at the mixing site periodically during the mixing process.
2. A mixing procedure for front-end loader shall be as follows:
   a. On a flat asphalt or concrete paved surface, spread an 8 inch to 12 inch layer of crushed stone.
   b. Spread evenly over the stone the specified amount of dry hydrogel.
   c. Spread over the dry hydrogel and crushed stone a proportional amount of clay loam according to the mix design.
   d. Blend the entire amount by turning, using a front-end loader or other suitable equipment until a consistent blend is produced.
   e. Add moisture gradually and evenly during the blending and turning operation as required to achieve the required moisture content. Delay applications of moisture for 10 minutes prior to successive applications. Once established, mixing should produce a material within 1% of the optimum moisture level for compaction.
3. A pugging operation mixing procedure may be as follows:
   a. Feed a know weight of crushed stone into the mixing trough.
   b. Add hydrogel as a slurry into trough and mix slurry and stone into a uniform blend.
   c. Meter in soil in proper proportion of Clay loam soil. While stone-slurry mixture is in motion.
   d. Add water to bring mixture to target moisture content after factoring in water from the slurry and the Clay-loam moistures.
   e. Auger out to stockpile or transport vehicle (or into pit if using portable pugging operation).
4. Add soil amendments to alter soil fertility including fertilizers and pH adjustment at the time of mixing at the rates recommended by the soil test.
   a. Soil pH shall be adjusted to fall within a value of 5.5 and 6.5 two months after mixing if the material is stored, unless mixing with a high pH stone. Once pavement is laid, no adjustment should be imposed.
   b. Soil component carbon/nitrogen ratio shall be adjusted to be less than 33:1 within two months after mixing.

B. The Producer shall mix sufficient material in advance of the time needed at the job site to allow adequate time for final quality control testing as required by the progress of the work. Structural Soil shall be stored in piles of approximately 500 cubic yards and each pile shall be numbered for identification and quality control purposes. Storage piles shall be protected from rain and erosion by covering with plastic sheeting.

C. During the mixing process, the Contractor obtains two, one cubic foot quality control samples per 500 cubic yards of production from the final Structural Soil. The samples shall be taken from random locations in the numbered stockpiles as required by paragraph 1.3.B of this specification. Each sample shall be tested for particle size analysis and chemical analysis as described in Paragraph 1.3.C.2 and 3 above. Submit the results directly to the Engineer for review and approval.

D. The quality control sample Clay Loam-Crushed Stone ratios shall be no greater or less than 2% of the approved test sample as determined by splitting a known weight of oven dried material on a #4 sieve. In the even that the quality control samples vary significantly from the approved Structural Soil sample, as determined by the Engineer, remix and retest any lot of soil that fails to meet the correct analysis making adjustments to the mixing ratios and procedures to achieve the approved consistency.

3.3 UNDERGROUND UTILITIES AND SUBSURFACE CONDITIONS

A. Notify the Engineer of any subsurface conditions which will affect the Contractor’s ability to complete the work.

B. Locate and confirm the location of all underground utility lines and structures prior to the start of any excavation.

C. Repair any underground utilities or foundations damaged by the Contractor during the progress of this work. The cost of all repairs shall be at the Contractor’s expense.

3.4 SITE PREPARATION

A. Do not proceed with the installation of the Structural Soil material until all walls, curb footings and utility work in the area have been installed. For site elements dependent on Structural Soil for foundation support, postpone installation until immediately after the installation of Structural Soil.
B. Install subsurface drain lines as shown on the Drawings prior to installation of Structural Soil material.
C. Excavate and compact the proposed subgrade to depths, slopes and widths as shown on the Drawings. Maintain all required angles of repose of the adjacent materials as shown on the drawings. Do not over excavate compacted subgrades of adjacent pavement or structures.
D. Confirm that the subgrade is at the proper elevation and compacted as required. Subgrade elevations shall slope parallel to the finished grade and or toward the subsurface drain lines as shown on the drawings.
E. Clear the excavation of all construction debris, trash, rubble and any foreign material. In the event that fuels, oils, concrete washout silts or other material harmful to plants have been spilled into the subgrade material, excavate the soil sufficiently to remove the harmful material. Fill any over excavation with approved fill and compact to the required subgrade compaction.
F. Do not proceed with the installation of Structural Soil until all utility work in the area has been installed. All subsurface drainage systems shall be operational prior to installation of Structural Soils.
G. Protect adjacent walls, walks and utilities from damage or staining by the soil. Use ½" plywood and or plastic sheeting as directed to cover existing concrete, metal and masonry work and other items as directed during the progress of the work.
   1. Clean up all trash and any soil or dirt spilled on any paved surface at the end of each working day.
   2. Any damage to the paving or architectural work caused by the soils installation Contractor shall be repaired by the general contractor at the soils installation contractor's expense.
H. Maintain all silt and sediment control devices required by applicable regulations. Provide adequate methods to assure that trucks and other equipment do no track soil from the site onto adjacent property and the public right of way.

3.5 INSTALLATION OF STRUCTURAL SOIL MATERIAL

A. Install Structural Soil in 6 inch lifts and compact each lift to a 2'6" overall depth..
B. Compact all materials to peak dry density from a standard AASHTO compaction curve (AASHTO T 99). No compaction shall occur when moisture content exceeds maximum as listed herein. Delay compaction 24 hours if moisture content exceeds maximum allowable and protect Structural Soil during delays in compaction with plastic or plywood as directed by the Engineer.
C. Bring Structural Soils to finished grades as shown on the Drawings. Immediately protect the Structural Soil material from contamination by toxic materials, trash, debris, water containing cement, clay, silt or materials that will alter the particle size distribution of the mix with plastic or plywood as directed by the Engineer.
D. The Engineer may periodically check the material being delivered and installed at the site for color and texture consistency with the approved sample provided by the Contractor as part of the submittal for Structural Soil. In the event that the installed material varies significantly from the approved sample, the Engineer may request that the Contactor test the installed Structural Soil. Any soil which varies significantly from the approved testing results, as determined by the Engineer, shall be removed and new Structural Soil installed that meets these specifications.

3.6 FINE GRADING

A. After the initial placement and rough grading of the Structural Soil but prior to the start of fine grading, the Contractor shall request review of the rough grading by the Engineer. The Contractor shall set sufficient grade stakes for checking the finished grades.
B. Adjust the finish grades to meet field conditions as directed.
   1. Provide smooth transitions between slopes of different gradients and direction.
   2. Fill all dips with CU-Soil™ and remove any bumps in the overall plane of the slope.
      a. The tolerance for dips and bumps in Structural Soil areas shall be a 3" deviation from the plane in 10'.
   3. All fine grading shall be inspected and approved by the Engineer prior to the installation of other items to be placed on the Structural Soil
C. The Engineer will inspect the work upon the request of the Contractor. Request for inspection shall be received by the Engineer at least 10 days before the anticipated date of inspection.

3.7 ACCEPTANCE STANDARDS

A. The Engineer will inspect the work upon the request of the Contractor. Request for inspection shall be received by the Engineer at least 10 days before the anticipated date of inspection.

3.8 CLEAN-UP

A. Upon completion of the Structural Soil installation operations, clean areas within the contract limits. Remove all excess fills, soils and mix stockpiles and legally dispose of all waste materials, trash and debris. Remove all tools and equipment and provide a clean, clear site. Sweep, do not wash, all paving and other exposed surfaces of dirt and mud until the paving has been installed over the Structural Soil material. Do no washing until finished materials covering Structural Soil material are in place.

END OF SECTION