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SECTION 329110 – STRUCTURAL SOIL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

1.2 SUMMARY

- A. This work shall consist of manufacturing and supplying a narrowly graded rock to support pavement without compression of the voids thus protecting roots growing within the voids. The voids are partially filled with soil to provide nutrients and to hold moisture for root growth.

- 1. Related Sections:

1.3 DEFINITIONS

- A. Rock: two inch narrowly graded rock
- B. Soil: Clay or clay loam fertile soil used to infill the gapes

1.4 SUBMITTALS

- A. General: Refer to and comply with Section 013300, SUBMITTAL PROCEDURES for procedures and other submittal criteria.
- B. Notices and Scheduling
 - 1. Submit a schedule itemizing time and volume of structural soil to be placed.

C. Product Data:

- a. At least 30 days prior to ordering materials, submit samples of proposed soil, proposed gravel/rock, certificates, manufacturers literature, and certified tests for materials specified.
 - 1. Samples shall be labeled to include location of source material, date of sample, and project name.
 - 2. Submit locations of all source fields for soils or source of soil.
 - 3. Submit a history of the site from which soil will be harvested.
 - 4. Testing shall be per the procedures outlined in sections c and d.
 - b. After the proposed soil and proposed rock have been accepted, blend the Structural/Gap Gaped soil. Submit one two-gallon representative sample of structural

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soil mixes for testing, analyses, and approval.

1. Samples shall be taken randomly throughout the field or stockpile.
 2. Deliver all samples to testing laboratory.
- c. Submit soils test analyses reports for each sample of Soils from an Owner approved soils testing laboratory. Test reports shall include the following:
1. Submit a bulk density and particle size analysis of sample, including the following gradient of mineral content (USDA Designation is size in mm):
 - a. Gravel – over 2 mm
 - b. Sand – 0.05 -2 mm
 - c. Silt – 0.002-0.05 mm
 - d. Clay – minus 0.002 mm
 2. Recommended testing laboratory for particle size and chemical analysis is Wallace Laboratories, 365 Coral Circle, El Segundo, CA 90245. Tel: (310) 615-0116.
 3. Submit a sieve analysis performed and compared with USDA Soil Classification System. Sieve analysis shall be by a combined hydrometer and wet sieving using sodium hexametaphosphate as a dispersant in accord with Particle-size Analysis, Chapter 15, Methods of Soil Analysis, Part 1, SSSA-ASA, Inc., 1986.
 4. Submit a chemical analysis performed in accord with current ASA and UC Standards, including the following:
 - a. pH.
 - b. Percent organic matter as determined by total organic carbon, and total nitrogen. Test samples shall be oven dried to a constant weight at a temperature of 105° C.
 - c. Analysis for nutrient levels and toxic elements by parts per million including nitrate nitrogen, and extractable phosphorus, potassium, magnesium, manganese, iron, zinc, copper, boron, sulfate, calcium, molybdenum, sodium, aluminum, arsenic, cadmium, chromium, cobalt, lead, lithium, mercury, nickel, selenium, silver, strontium, tin, and vanadium. Nutrient tests shall include testing laboratory recommendations for supplemental additions to soils as calculated by amount of material to be added per volume of soils for type of plants to be grown in the soil.
 - d. Soluble salt by electrical conductivity of a saturated paste extract measured in Millimho per cm, soluble calcium, magnesium, potassium, sodium, sulfate, chloride, nitrate, and boron
 5. Submit structural soils-gravel samples for acceptance.
 6. Approved structural soils samples shall be sampled and analyzed for each lot of 500 cubic yards of material.
 7. All costs for testing and analyses shall be paid by Contractor.
- d. Gravel/rock testing.
1. Provide a particle size analysis, including the following gradient of mineral content (USDA Designation Size in mm):
 - a. 3" - 76 mm
 - b. 2-1/2" – 3" - 63-76 mm

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- c. 2" – 2-1/2" - 50-63 mm
 - d. 1-1/2" – 2" - 37-50 mm
 - e. 1" - 25-37 mm
 - f. 3/4" - 1" - 19-25 mm
 - g. Fine gravel – 1/8" – 3/4" - 2-19 mm
 - h. Sand - 0.05 -2 mm
 - i. Silt - 0.002-0.05 mm
 - j. Clay - minus 0.002 mm
- 2. Provide manufacturers analysis of the following:
 - a. Loose and rodded unit weight.
 - b. Bulk specific gravity and absorbance.
 - c. Gravel dimension and surface texture description.
 - d. Aggregate soundness and L.A. abrasion.
 - 3. Provide a percent pore space analysis defined as follows:
 - a. $1 \text{ minus } [\text{rock specific gravity unit divided by the bulk specific gravity}] \text{ times } 100.$

1.5 QUALITY ASSURANCE

A. Reference standards:

- 1. ASA: American Society of America.
- 2. SSSA: Soil Science Society of America.
- 3. UC: University of California.
- 4. USDA: United States Department of Agriculture.

A. Qualifications:

- 1. Supply Company must have sufficient experience and training to provide suitable, uniform material. The installing company must have sufficient experience to properly install structural soil.

1.6 DELIVERY, STORAGE, AND HANDLING OF PRODUCTS AND PLANT MATERIAL

- A. Do not deliver or place soils in excessive wet, muddy or dry conditions.
- 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 excess water is introduced into the material after grading, allow material to drain to near optimum compaction moisture content before working.

1.7 PROJECT CONDITIONS

- A. All areas to receive structural soils shall be inspected by Owner before starting work, and all defects such as incorrect grading, compaction, and inadequate drainage and

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other unacceptable conditions shall be corrected prior to beginning work.

- 1 Do not commence work until unsatisfactory conditions have been corrected, and areas are ready to accept structural gap-graded soils.
- B. Verify full extent of work requirements involved, including but not limited to potential need for temporary storage and staging of soils, including moving soils stockpiles at site to accommodate scheduling of other work and the need to protect installed soils from compaction, erosion, and contamination.

PART 2 - PRODUCTS

2.01 ACCEPTABLE SUPPLIERS OF GAP-GRADED SOILS

- A. Aguinaga Fertilizer Company, Inc, 7992 Irvine Boulevard, Irvine, CA 92618. Tel: (949) 786-9558. Fax: (949) 786-9574.
- B. EarthWorks, 1725 Agua Mansa Road, Riverside, CA 92509, Tel. (951) 782-0260. Fax (951) 782-0268
- C. TMT Enterprises, 1996 Oakland Road, San Jose, CA 95131, Tel. (408) 432-9040. Fax (408) 432-9429
- D. Or known and approved equal

2.02 SOILS MATERIALS

- A. Soils shall be a "clay loam" or "clay" based on "USDA classification system" as determined by mechanical analysis and 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 larger than one inch in diameter or an excess of smaller pieces of same type materials as determined by Owner. 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. Soils shall contain not less than 3% or more than 7% organic matter as determined by organic carbon and total nitrogen on oven-dried samples. Topsoil in Division section for Soil Preparation
- B. Mechanical analysis for soils shall be as follows:
 1. Textural Class: based on material passing a 2 mm screen
 2. Gravel: Less than 5%.
 3. Sand: 20 - 50%.
 4. Silt 20 - 30%.
 5. Clay: 25 - 60%.
- C. Chemical analysis shall meet or be amended to meet the following criteria:
 - 1 pH: Between 6.5 to 7.9.
 2. Percent organic matter: 3 - 7% by dry weight.
 3. Nutrient levels as required by testing laboratory recommendations for type of plants to be grown in the soil.
 - a. Fertility: The range of the essential elemental concentration in soil shall be as follows. Soil might need to be fertilized for optimum fertility:

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Ammonium Bicarbonate/DTPA Extraction parts
per million (mg/kilogram dry weight basis)

phosphorus	10 – 40
potassium	100 - 220
iron	5 - 35
manganese	0.6 - 6
zinc	1 - 8
copper	0.3 - 5
boron	0.2 - 1
magnesium	50 - 150
sodium	0 - 100
sulfur	25 - 500
molybdenum	0.1 - 2

4. Toxic elements and compounds and excessive nutrients below UC guidelines and soil testing laboratory guidelines.
- a The maximum permissible elemental concentration in the soil shall not exceed the following concentrations:

Ammonium Bicarbonate/DTPA Extraction
parts per million (mg/kilogram) dry weight basis

arsenic	1
cadmium	1
chromium	10
cobalt	2
lead	30
mercury	1
nickel	5
selenium	3
silver	0.5
vanadium	3

5. Soluble salt: Less than 3.0 Millimho per cm in saturation extract.
6. Boron: Less than 1 part per million in saturation extract.
7. Sodium absorption ratio: Less than 4.
8. Carbon/Nitrogen ratio: Less than 15:1.
- D. Soils shall be the product of a commercial processing facility specializing in production of stripped natural topsoil or other approved source.

2.03 FERTILIZER

- A. Commercial fertilizer complying with California fertilizer laws. Deliver fertilizer in original unopened containers that bear manufacturers certificate of compliance covering analysis which shall be furnished to Owner.
- B. Fertilizer percentages of weight of ingredients and application rates shall be as recommended by soils testing results.

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2.04 GRAVEL/ROCK

- A. Gravel/rock shall be triangular without limestone or sandstone. Gravel shall pass a 3-inch screen and be retained on a 2-inch screen.
- B. Acceptable aggregate dimensions will not exceed 1.5:1.0 for any two dimensions chosen.

2.05 GYPSUM

- A. Agricultural mineral containing a minimum of 92% calcium sulfate dihydrate. Minimum gradation: 100% passing 10 mesh sieve; 98% passing 20 mesh sieve; 60% passing 60 mesh sieve, and 40% passing 100 mesh sieve.

2.06 POLYACRYLAMIDE (PAM)

- A PAM - a linear, water-soluble, propenoate-propenamide copolymer Soil Drain/PAM as manufactured by Complete Green Company. Tel: (310) 640-6815 or known equal.

2.07 STRUCTURAL SOILS

- A. A uniformly blended mixture of gravel/rock and PAM-treated soils mixed to following proportion: Soils shall be previously conditioned with PAM according to testing laboratory recommendations.
- B. Initial mix design for testing shall be determined by adjusting the ratio between gravel/rock and soils such that volume percent of soils in mix is not less than 20% nor more than 50% of voids in gravel as determined from stone rodded unit weight and bulk density of soils or by separation of the components.

PART 3.00 – EXECUTION

3.01 MIX DESIGN

- A. Prepare sample structural soils mixes to determine ratio of mix components. Submit to Owner for approval.
 1. Submit samples and test results of each mix component for approval. Based on samples and analyses of mix components, Owner and Contractor will jointly determine mix ratios to be tested for conformance with requirements of Specifications. For structural soils quantities greater than 100 cubic yards, perform test mix ratio for each soil or gravel where testing indicates a significant difference in physical analysis of soils or gravel as determined by Owner.
 2. Prepare samples of proposed mix ratio options and obtain soils test as specified herein. Submit samples of each mix with test results.
 3. Owner may request additional structural soils mix ratio samples to be tested in event that further refinement of mix is necessary.
 4. Submit to Owner proposed fertility amendment recommendations including amounts and types of fertilizers and pH adjustments for each mix ratio based on soils report and recommendations of Wallace Laboratory. Fertility adjustments shall be included as part of mixing process of soils prior to blending with gravel.

3.02 SOIL MIXING AND QUALITY CONTROL TESTING

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- A. Structural soils mixing shall be performed at supplier's yard using appropriate soils measuring, mixing, and shredding equipment of sufficient capacity and capability to assure proper quality control and consistent mix ratios. Mixing of structural soils at project site shall not be permitted.
 - 1. Maintain adequate soil moisture content during mixing process. Soils and mix components shall easily shred and break down without clumping. Soils clods shall easily break down into a medium crumbly texture material. Soils shall not be overly wet or dry. Measure and monitor amount of soils moisture at mixing site periodically during mixing process.

3.03 SITE PREPARATION

- A. Do not proceed with installation of structural soils materials until all walls, curbs, footings, and utility work in the area has been completed. For site elements dependent on structural soils for foundation support, postpone installation until immediately after installation of structural soil.
- B. Install subsurface drain lines as indicated on Drawings prior to installation of structural soils material.
- C. Excavate and compact proposed subgrade to depths, slopes, and widths as shown on Drawings. Maintain all required angles of repose of adjacent materials as indicated on Drawings. Do not over excavate compacted subgrades of adjacent pavement or structures.
- D. Confirm that subgrade is at proper elevation and compacted as required. Subgrade elevations shall slope parallel to finished grade and or toward subsurface drain lines as indicated on Drawings.
- E. Clear excavation of all construction debris, trash, rubble, and other foreign materials. In event that fuels, oils, concrete washout silts, or other materials harmful to plants have been spilled into subgrade materials, excavate the soils sufficiently to remove the harmful materials. Fill over-excavation with approved fill and compact to required subgrade compaction.

3.04 INSTALLATION OF STRUCTURAL SOILS MATERIAL

- A. Install structural soils in 6 inch lifts and compact each lift.
- B. Compact materials to not less than 95% of peak dry density from a standard compaction curve.
- C. Adjust structural soils to finished grades as indicated on Drawings. Immediately protect structural soils materials from contamination by toxic materials, trash, debris, water containing cement, clay, silt, or other foreign materials that will alter particle size distribution of mix with plastic or plywood as directed by Owner..
- D. Owner may periodically check materials being delivered and installed at site for color and texture consistency with approved sample provided by Contractor as part of submittal for structural soil. In event that installed materials vary significantly from approved sample, Owner may request that Contractor test installed structural soils. All soils which vary significantly from approved testing results, as determined by Owner, shall be removed and new structural soils installed that meet requirements specified herein.

END OF SECTION