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SECTION 2200 - PAVING

APPENDIX for CHEMICAL STABILIZATION OF SOIL

Using CEMENT or LIME KILN DUST

1.01 DESCRIPTION

1.01.1 This work shall consist of the addition of Portland Cement or Lime Kiln Dust, mixing the material, compacting to the required density, and weatherproofing to develop a stabilized subgrade section. This item applies to natural ground or fills and shall be constructed as specified herein and in conformity with the typical sections, lines and grades as shown on the plans or as established by the Engineer.

1.02 MATERIALS

1.02.1 **Cement:** Portland Cement, or Blended Hydraulic Cement, shall comply with the physical requirements of ASTM C-150, ASTM C-595, or ASTM C-1157

1.02.2 **By-Product Lime (non-hydrated) / Lime Kiln Dust (LKD):** LKD shall meet the following Criteria

Property		
Total Calcium and Magnesium Oxides		60% minimum
Available calcium hydroxide (rapid sugar test, ASTM C 25) plus total MgO content calculated to be equivalent Ca (OH) ₂		30% minimum
Free moisture (as-received basis)		4% Max.
As-received loss on ignition (carbon dioxide plus moisture, combined and free)		40% Max.
Sieve Size		Max. % Retained
#4 (4.75 mm)		5
#30 (600 μm)		10
#100 (150 μm)		25

1.03 WATER

1.03.1 The water use in the stabilized mixture shall be clean, clear, and free of sewage, vegetable matter, oil, acid and alkali. Water known to be potable may be used without testing. All other sources shall be tested in accordance with ASSHTO T26 and approved by the Engineer.

1.03.2 **SOIL.** The soil for this work shall consist of materials on the site or selected materials from other sources and shall be uniform in quality and gradation, and shall be approved

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by the Engineer. The soil shall be free of roots, sod, weeds, and stones larger than 2-1/2 inches. Asphaltic concrete or aggregate may be added to the soil during the mixing operation, provided the material can be pulverized and incorporated by the mixing equipment to meet such that 100% of the mixture passes a 1-inch sieve (No. 25) and at least 60% passes a No. 4 Sieve (4.75mm).

1.04 COMPOSITION

1.04.1 **Cement:** Application rate shall be based on percent of material added as a percentage of the dry unit weight of soil. The application rate shall be determined by a geotechnical engineer. The application rate shall be submitted to the City in the form of a written report prepared by a firm specializing in geotechnical engineering and sealed by a geotechnical engineer. The report shall be submitted at least 30 days prior to any subgrade stabilization work on site.

1.04.2 **By-Product Lime (non-hydrated) / Lime Kiln Dust (LKD):** Application rate shall be based on percent of material added as a percentage of the dry unit weight of soil. The application rate shall be determined by a geotechnical engineer. The application rate shall be submitted to the City in the form of a written report prepared by a firm specializing in geotechnical engineering and sealed by a geotechnical engineer. The report shall be submitted at least 30 days prior to any subgrade stabilization work on site.

1.04.2 **TOLERANCES.** At final compaction, the chemical and water content for each course of subgrade treatment shall conform to the following tolerances:

<u>Material</u>	<u>Tolerance</u>
Cement/LKD	At or above target application
Water	+2% to +4% over Optimum Moisture Content

If material application rate of cement or LKD exceeds the target application rate by 0.5% or more, then the Contractor shall provide new soil moisture-density tests to evaluate relative compaction and moisture content at the actual application rate in the field.

1.04.3 **THICKNESS.** The thickness of the completed, compacted chemical/soil mixture shall be no less than 9 inches, and meet or exceed the depths called out in the plans or specifications. If when checked for minimum thickness it is found to be less than the 1/2 inch tolerance the contractor shall correct the area represented by the checked location.

1.05 EQUIPMENT

1.05.1 **EQUIPMENT.** The machinery, tools, and equipment necessary for proper execution of the work shall be on the project and approved by the Engineer prior to beginning construction operations.

Blending of the soil-cement mixture shall be accomplished by self-propelled, high power

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rotary mixer capable of mixing to a depth of 16 inches. The cutting drum should be fitted with cutting teeth capable of trimming earth, aggregate, and bituminous mixtures. Mixing equipment shall be designed to accurately adjust vertical depth, hold vertical depth, and not develop center deflection of more than 1/8-inch across the width of the mixing drum.

Compaction shall be achieved using padfoot roller. Smoothing and shaping shall be accomplished using a motor grader. Finish rolling shall be done using a smooth steel wheel roller.

Spreaders and distributors shall be used to apply chemical shall be able to demonstrate consistent and accurate application rates, as well as dust control during application. Spreaders and distributors shall be equipped with screw-type augers that can evenly spread material over the width of the rotary mixing drum. Augers may typically feed into a rotary spreader, all spreading equipment shall be equipped with metering devices. Additional dust collection systems may be required at the direction of the Engineer.

All machinery, tools and equipment use shall be maintained in a satisfactory and workmanlike manner.

Cement and LKD shall be stored and handled in closed weatherproof containers until immediately before distribution. Materials exposed to moisture prior to mixing with soils shall be discarded.

1.06 CONSTRUCTION REQUIREMENTS

1.06.1 **GENERAL.** It is the primary purpose of this specification to secure a completed section of treated material which contains a uniform chemical/soil mixture with no loose or segregated areas; has a uniform density and moisture content: is well bound for its full depth. It shall be the responsibility of the Contractor to regulate the sequence of his/her work; to process a sufficient quantity of material to provide a completed section as shown on plans; to use the proper amounts of chemical; to achieve final compaction within the specified time; to maintain the work; and to rework the lifts as necessary to meet the above requirements.

1.06.2 **WEATHER LIMATATION.** The modified soil shall be constructed when the temperature of the soil, measured 6 inches below the surface, is above 50°F and the ambient air temperature is above 40°F. The compacted soil mixture shall be protected from freezing during the curing period.

The quantity of modified soil constructed shall be limited to that which can be covered by full thickness of PCC or AC pavement during the same construction season.

1.06.3 **PREPARATION OF SUBGRADE.** Before other construction operations are begun, the area where the chemical stabilization material will be placed shall be cut and shaped

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in conformance with the lines and grades shown on the plans. Grades shall accommodate potential volumetric expansion of stabilized material.

All areas shall be firm and able to support, without displacement, the construction equipment and the compaction hereinafter specified. Soft or yielding subgrade shall be corrected and made stable by scarifying, adding addition chemical, and compacting until it is of uniform stability.

- 1.06.4 **MOISTURE CONTROL.** Moisture control shall be achieved through use of a rotary mixer equipped with a spray bar in the mixing drum capable of applying sufficient quantities of water to achieve the required moisture content for the soil-chemical mixture. The system shall be capable of being regulated to the degree necessary as to maintain moisture contents within the recommended range.

Required moisture contents will be established by the Engineer based on laboratory tests with the site soils and chemical application rates to be used for the treatment. Final moisture content of the mix, immediately prior to compaction shall meet the specified range of moisture contents. If moisture content exceeds the specified limits, additional chemical may be incorporated to lower moisture contents to the required limits. Lowering moisture contents by aeration following addition of chemicals will not be allowed.

- 1.06.5 **APPLICATION OF PORTLAND CEMENT or LKD.** Immediately prior to application of Portland Cement or LKD, the areas shall be bladed to allow uniform distribution of material. The chemical shall be spread only on that area where the complete placement operation can be completed within 2 hours.

The chemical shall be spread uniformly over the top of the subgrade by an approved spreader truck. Dumping material on site and spreading with a blade shall not be allowed.

Material shall not be applied when wind conditions, in the opinion of the Engineer, are detrimental to a proper application or becomes objectionable to adjacent property owners or creates a hazard to traffic.

- 1.06.6 **MIXING.** The mixing procedure utilized shall be Dry Placing as hereinafter described.

The full depth of the treated subgrade shall be mixed with a rotary mixer to the full depth of stabilization as shown on the plans and specifications. Time from Portland Cement or LKD placement on the soil to the start of mixing shall not exceed 30 minutes.

In some cases, in situ moisture content is sufficient to meet specifications. If additional water is needed during mixing, water shall be injected directly into the mixing drum. The system shall be capable of being regulated to the degree as to maintain moisture contents within the recommended range.

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Mixing will continue until the material is uniformly mixed, moisture conditioned and form a homogeneous layer with particle sizes meeting the following requirements:

<u>Sieve Size</u>	<u>Minimum Percent Passing</u>
1" inch (25 mm)	100
No. 4 (4.75 mm)	60%

All chemicals and soils may require different mixing patterns, may require multiple passes, or may require different techniques to achieve optimal results.

1.06.7 **COMPACTION.** Compaction of the soil-chemical mixture shall begin immediately after mixing of the cement or LKD. Initial compaction shall be achieved using vibratory pad foot roller capable of compacting the entire depth of the mixture. Following the pad foot roller, the motor grader shall shape the area to consistent grade and cross slope in accordance with the project plans. Following the motor grader, a vibratory smooth drum roller compacts and seals the surface of the treated subgrade. Compaction shall be completed within one hour following incorporation of chemical.

A test for both density and moisture content of the soil-chemical mixture shall be taken for each 750 square yards of material placed. Stabilized soil shall be compacted to at least 95% of the soils maximum laboratory density (ASTM D698).

All irregularities, depressions, or weak spots which develop shall be corrected immediately by scarifying the areas affected, adding or removing material as required and remixing and re-compacting with additional cement or LKD if beyond the 2 hour limit. The surface of the course shall be maintained in a smooth condition, free from undulations and ruts, until other work is placed thereon or the work is accepted.

In addition to the requirements specified for density and moisture, the full depth of the material shown on the plans shall be compacted to the extent necessary to remain firm and stable under construction equipment. After each section is completed, tests will be made by the testing lab. If the material fails to meet the density requirements, it shall be reworked to meet these requirements. Throughout this entire operation, the shape of the course shall be maintained by blading, and the surface upon completion shall be smooth and shall conform with the typical section shown on the plans and to established lines and grades. Should the material, due to any reason or cause, lose the required stability, density and finish before the work is accepted, it shall be reprocessed, re-compacted and refinished at the sole expense of the Contractor. Reprocessing shall follow the same pattern as the initial stabilization including the addition of cement or LKD.

1.06.8 **FINISHING AND CURING.** After the final layer or course of the chemically treated subgrade has been compacted and cured, it shall be brought to the required lines and grades in accordance with the typical sections. The finished surface shall not vary more than 3/8 inch when tested with a 16-foot straightedge applied parallel with and at right angles to the pavement centerline. Any variations in excess of this tolerance shall be

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corrected by the Contractor, at his/her own expense, in a manner satisfactory to the Engineer.

After the chemically treated course has been finished as specified herein, the surface shall be protected against rapid drying by either of the following methods for a period of not less than three days or until the pavement section is placed.

- 1) Maintain in a thorough and continuously moist condition by sprinkling.
- 2) Spray a quick setting, trackless tack coat over the entire surface.
- 3) Placement of the aggregate base layer

1.07 MAINTENANCE.

- 1.07.1 The contractor shall maintain, at his/her own expense, the entire treated subgrade in good condition from the start of work until all the work has been completed, cured, and the pavement is placed. Heavy equipment shall not be allowed on the treated subgrade until capable of supporting the loads.

1.08 TESTING & OBSERVATION.

- 1.08.1 Tests shall be performed by an independent, accredited testing lab meeting A2LA, AMRL, AASHTO, AWWA, CCRL, or meeting other governing accreditation agencies recognized by the MoDOT, MDNR, or USACE. The testing lab shall also provide testing of the constructed stabilization and provide a certification to the city stating that all stabilization meets or exceeds the requirements of the project. The certification report shall include testing reports that include the moisture/density curves for the mixture, in place moisture and density test results, results of re-tests, field notes assuring the correct quantity of cement or LKD was incorporated, that mixing and compaction were completed specified the time limits in this specification, temperature and weather requirements were met, the stabilized lay was not subject to freezing during the curing process, and that the minimum thickness was placed.

END OF SECTION