DIVISION II
CONSTRUCTION AND MATERIAL SPECIFICATIONS
SECTION 2200 PAVING

APPROVED AND ADOPTED THIS 15th DAY OF FEBRUARY, 2017

KANSAS CITY METROPOLITAN CHAPTER
OF THE AMERICAN PUBLIC WORKS ASSOCIATION

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SECTION 2201 SUBGRADE PREPARATION

2201.1 Scope

This section governs the furnishing of all labor, materials and equipment for the preparation of subgrade as shown on the Plans and in accordance with the Standard Drawings, the specifications and the Special Provisions. This section includes subgrade preparation at locations which have been previously graded in accordance with the requirements of Section 2100 "Grading and Site Preparation".

2201.2 Referenced Standards

The following standards are referenced directly in this section. The latest version of these standards shall be used. If conflicting standards are referenced, the more stringent standard shall apply.

ASTM

D 698 Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3))

2201.3 Definitions

A. Subgrade: Subgrade is defined as a well graded and compacted layer on which base and subsequent courses are placed.

B. Subgrade Preparation: Subgrade preparation is the repeated operation of fine-grading and compacting the subgrade until the specified lines, grades, and cross-section, as indicated on the Plans are obtained and the materials are compacted to the specified depth and density.

2201.4 Construction

A. General: The subgrade surface shall be brought to the specified lines, grades and cross-section by adding or removing material and compacting to the specified density. Tolerance allowed on all lines, grades and cross-sections shall be no more than 1/4 inch.

B. Compacting the Subgrade: Unless otherwise specified, the top 6 inches of subgrade for pavements shall be compacted to 95% of the standard proctor maximum density for the material used as determined by ASTM D 698 and within a tolerance of plus 3% and minus 3% of the optimum moisture content. The tolerance applies only to the top 6 inches.

C. Protection and Maintenance of Subgrade: The subgrade shall be protected from action of the elements or others. Any action (e.g. settlement or erosion) that damages the subgrade or any subgrade that has become unacceptable prior to placing the pavement thereon, shall be repaired and the specific lines, grades, cross-section, tolerance, density, and moisture content range reestablished.

D. Cleanup: Subgrade cleanup shall follow the work progressively. The Contractor shall remove from the project site all rubbish, surplus or discarded material, unsuitable material, and any equipment, tools and temporary construction items used for the preparation of the subgrade.

E. Roll Testing: Once the subgrade has been brought to the final plan elevation, but prior to approval of the

subgrade for paving, all lanes shall be roll tested in their entire length. The subgrade will not be acceptable if rutting, pumping, or deformation of the subgrade results from the roll test. This testing will be done by the contractor, and will be in addition to the applicable moisture and density testing.

Equipment for roll testing shall be a tandem dump truck (one front and two rear axles) carrying a minimum load of twenty (20) tons.

The truck shall proceed slowly along each traffic lane, allowing the Engineer to walk alongside and observe the results. Areas failing the roll test will be reworked and retested prior to approval of the subgrade for paving.

2201.5 Method of Measurement

Subgrade Preparation will generally not be listed in the Contract Documents as a separate item.

2201.6 Basis of Payment

Subgrade Preparation will generally be included in payment for other items in the Contract Documents.

SECTION 2202 SUBGRADE STABILIZATION

2202.1 Scope

This section governs the furnishing of all labor, materials and equipment for the stabilization of subgrade as shown on the Plans and in accordance with the Standard Drawings, the specifications and the Special Provisions. This work shall consist of the addition of self-cementing fly ash or lime to soil, mixing and compacting the material to the required density to develop a stabilized subgrade section. This 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.

2202.2 Referenced Standards

The following standards are referenced directly in this section. The latest version of these standards shall be used. If conflicting standards are referenced, the more stringent standard shall apply.

ASTM
C 25 Standard Test Methods for Chemical Analysis of Limestone, Quicklime, and Hydrated Lime
C 618 Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
D 698 Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3))
D 1556 Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method
D 5239 Standard Practice for Characterizing Fly Ash for Use in Soil Stabilization
D 6938 Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

AASHTO
T 99 Standard Method of Test for Moisture-Density Relations of Soils Using a 5.5 lb. Rammer and a 12 inch Drop
M 216 Standard Specification for Lime for Soil Stabilization

2202.3 Materials

A. Fly Ash: Fly Ash shall comply with the physical requirements of ASTM D 5239, paragraph 6.4 maintaining a minimum compressive strength of 500 psi at 7 days and the chemical requirements of ASTM C 618, Table 1 for Class C fly ash, unless otherwise shown on the Plans. The source of the ash shall be selected by the Contractor and approved by the Engineer in advance of stabilization operations in order that the required laboratory tests can be completed prior to construction without delaying the work. Certification shall be provided by the supplier that the fly ash used on the project meets the above criteria. Fly ash shall be stored and handled in closed weatherproof containers until distribution. Fly ash exposed to moisture prior to mixing with soils shall be discarded.

B. Lime: Lime shall be hydrated or quicklime conforming to the requirements of AASHTO M 216. Contractor shall provide certification that the product complies. Hydrated lime shall contain not less than ninety (90) percent calcium hydroxide Ca(OH)2, and quicklime shall have a minimum available lime percentage (CaO) of 90%, as determined by ASTM C 25. Lime shall be introduced to the subgrade in a slurry form. When quicklime is used, slake it at the jobsite to manufacture hydrated lime slurry. The Contractor shall submit calculations to the Engineer that determines the amount of water needed to make a slurry with a percent solids between 20 and 40 percent. The Contractor will then determine the concentration strength of the lime slurry and the rate of application to obtain the lime percentage specified in the Contract Documents.

C. Water: Water used for mixing shall be clean and potable. For lime stabilization, it shall be added during mixing, remixing and compaction operations, and during the curing period to keep the cured material moist until covered. If water is not included in the Contract Documents as a pay item, it is subsidiary to other Contract items.

D. Soil: The subgrade soil to be stabilized shall be uniform in quality and gradation and free from rubble, rubbish, vegetation, and stones larger than 1” diameter.

2202.4 Composition

Fly ash shall be applied at a rate determined by laboratory testing using the materials from the site and the specific fly ash to be supplied unless otherwise designated by the Contract Documents. Testing shall be the responsibility of the Contractor and is subsidiary to other items. The minimum application rate shall be 15% unless testing indicates otherwise.

Lime shall be applied at a rate determined by laboratory testing using the materials from the site and the specific lime to be supplied unless otherwise designated by the Contract Documents. Testing shall be the responsibility of the Contractor and is subsidiary to other items. The minimum application rate shall be 5% (by weight) unless testing indicates otherwise.

2202.5 Thickness

The thickness of the completed, compacted soil mixture shall be 6 inches or as called out in the Plans or Special Provisions. The thickness shall not be less than the specified minimum. Check thickness and when found to be ½ inch or more out of tolerance, the contractor shall correct the area represented by the checked location at no additional cost.

2202.6 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. Utilize spreading equipment capable of producing a consistent

application rate. Blending of the soil mixture shall be accomplished by equipment with a recycling or mixing drum, positive depth control, and automatic water proportioning system that provides consistent results. Compaction shall be achieved using pneumatic or vibratory sheepsfoot or padfoot rollers capable of meeting the compaction requirements. Final surface compaction may be completed with a steel wheel or rubber-tired roller.

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

2202.7 Construction

A. General: It is the primary purpose of this specification to secure a completed section of treated material which contains a uniform mixture with no loose or segregated areas, has a uniform density and moisture content and 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 fly ash or lime, to achieve final compaction within the specified time, to maintain the work, and to rework the lifts as necessary to meet the above requirements.

B. Weather Limitations: The soil mixture shall not be mixed while the soil is frozen, the temperature is below 40°F or when conditions indicate that the atmospheric temperatures may fall below 40°F within 24 hours.

C. Preparation of Subgrade: Before other construction operations are begun, the area to be stabilized shall be cut and shaped in conformance with the lines and grades shown on the plans. 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 by the Contractor using a method approved by the Engineer.

D. Moisture Control: Moisture control shall be achieved through use of a controllable water additive system capable of being regulated to the degree necessary to maintain moisture contents within the recommended range.

1. For fly ash, the required moisture content will be established by laboratory tests with the site soils and specific fly ash to be used, determined in accordance with ASTM D 698 or AASHTO T 99. Laboratory testing shall be the responsibility of the Contractor and is subsidiary to other items. Final moisture content of the mix, immediately prior to compaction shall be +/- 3 percentage points of the optimum moisture content as determined by laboratory testing unless otherwise specified in the Contract Documents. If moisture contents exceed the specified limits, additional fly ash may be incorporated to lower moisture contents to the required limits. Lowering moisture contents by aeration following addition of fly ash will not be allowed.

2. For lime, the required final moisture content of the lime-soil mix will be established by laboratory tests with the site soils and specific lime to be used, determined in accordance with ASTM D 698 or AASHTO T 99. Laboratory testing shall be the responsibility of the Contractor and is subsidiary to other items. During mixing and compaction operations, the moisture content of the mix shall be a minimum of 3 percentage points above the optimum moisture content as determined by laboratory testing, unless otherwise specified in the Contract Documents. After completion of the preliminary mixing operation and during the aging period, the surface shall be kept moist by spraying with water. Following the final mixing operation and compaction, the surface shall be kept moist by spraying with water until covered by a subsequent layer of material or sealed with a bituminous prime coat applied at a minimum rate of 0.15 gallons per square yard. Other curing methods may be submitted by the Contractor for consideration by the Engineer.

E. Application of Material

1. Fly Ash: Immediately prior to application of fly ash, the areas shall be scarified to allow for uniform distribution. The use of scarification equipment with positive depth control is required and should be performed to a depth between four inches (4") and one inch (1") less than the specified depth of treatment. The fly ash shall be spread only on that area where the placement, mixing and compaction operations can be completed within 2 hours.

   The fly ash shall be spread uniformly over the top of the subgrade – the use of a controlled application system approved by the Engineer is preferred but the Contractor may submit an alternate method of spreading for approval that provides uniform distribution at the specified rate of application. The amount of fly ash spread shall be the amount required for mixing to the specified depth which will result in the percentage determined by laboratory testing as described in section 2202.4 Composition.

   The fly ash shall be distributed in a manner that reduces the scattering of fly ash by wind to a minimum. Fly ash 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.

   The mixing operation shall be completed within 30 minutes of the addition of water to the subgrade.

2. Lime: Immediately prior to the application of the lime, the areas shall be scarified to allow for uniform distribution. The use of scarification equipment with positive depth control is required and should be performed to a depth between four inches (4") and one inch (1") less than the specified depth of treatment.

   Lime slurry is to be applied with equipment that can regulate the amount passing through the nozzles and the speed of travel to place the specified amount on the soil with a uniform lime distribution. The concentration of the lime slurry should allow for the application of the correct quantity of lime without adding an undue amount of excess moisture. The Contractor is responsible for testing the concentration of the lime suspension a minimum of once per day or once per batch, whichever is greater.

   Application of the lime slurry should occur on the same day the slurry is produced. Continuously agitate the lime slurry once it is produced.

F. Mixing

1. Fly Ash: The full depth of the treated subgrade shall be mixed with a rotary pulvamixer which utilizes a direct hydraulic drive. Fly ash shall not be left exposed for more than 30 minutes after distribution. Water shall be added through a spray bar in the mixing drum capable of uniformly applying sufficient quantities of water to achieve the required moisture content of the soil-fly ash mixture. The system shall be capable of being regulated to maintain moisture contents within the recommended range.

   Mixing shall continue until a homogeneous, friable mixture with zero clods greater than 1-1/2" in size remain and no more than 50% of the mixture is retained on a ½" sieve.

2. Lime: The mixing process for lime includes preliminary mixing, aging, and final mixing. The preliminary mixing should occur immediately following the introduction of the lime slurry to the subgrade. The equipment used for mixing shall have positive depth control with a visual depth indicator and be capable of mixing the full specified depth of treatment to within ½" tolerance. The mixing equipment should also have a travel speed indicator and controllable water additive system. Preliminary mixing shall continue until the material is uniformly mixed, at a minimum moisture content of 3% above

optimum and with zero clods greater than 2" in size remaining. Perform a minimum of two passes over all treated areas with the mixer. Upon completion of the preliminary mixing, seal the mixture to prevent moisture loss by lightly rolling with a pneumatic or steel drum flat roller.

Aging should occur for a minimum of 24 hours and a maximum of 72 hours unless approved otherwise by the Engineer.

Following the aging period, the final mixing is performed by re-mixing the entire treated area until the mixture contains zero clods greater than 1.5" and has 95% of the mixture passing the 1" sieve and 60% of the mixture passing the No. 4 sieve. The mixture should be brought to a moisture content of a minimum of 3% above optimum for compaction.

G. Compaction

1. Fly ash: Compaction of the soil-fly ash mixture shall begin immediately after mixing of the fly ash and be completed within two hours following incorporation of fly ash. Compaction of the mixture shall continue until the entire depth of mixture is uniformly compacted to the specified density using vibratory sheepsfoot or pad foot rollers. A pneumatic rubber tire or smooth wheel steel drum roller may be used to complete the compaction of the surface. A test for both density and moisture content of the soil-fly ash mixture shall be taken for each 750 square yards of material placed with a minimum of one test per day of production. The field density of the compacted mixture shall be at least 95 percent of the maximum density established by laboratory tests using the site soils and specific fly ash to be used, determined in accordance with ASTM D 698. Laboratory testing shall be the responsibility of the Contractor and is subsidiary to other items.

   The in-place field density shall be determined in accordance with ASTM D 1556 or ASTM D 6938. When ASTM D 6938 is utilized for testing purposes, the nuclear gauge shall be calibrated within the last year. Calibration and operation of the gauge shall be in accordance with the requirements of the manufacturer. The operator of the nuclear gauge must show evidence of training and experience in the use of the instrument. The gauge shall be standardized daily in accordance with ASTM D 6938, paragraph 8.

   Final acceptance of the compaction is dependent upon passing visual roll testing. This will be observed and approved by the Engineer. 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 fly ash 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.

   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, recompacted and refinished at the sole expense of the Contractor. Reprocessing shall follow the same pattern as the initial stabilization including the addition of fly ash.

2. Lime: Compaction of the soil-lime mixture shall begin immediately after final mixing. Compaction of the mixture shall continue until the entire depth of mixture is uniformly compacted to the specified density using vibratory sheepsfoot or pad foot rollers. A pneumatic rubber tire or smooth wheel steel drum roller may be used to complete the compaction of the surface. A test for both density and moisture content of the soil-lime mixture shall be taken for each 750 square yards of material placed with a minimum of one test per day of production. The field density of the compacted mixture shall be at least 95 percent of the maximum density established by laboratory tests using the site soils and

specific lime to be used, determined in accordance with ASTM D 698. Laboratory testing shall be the responsibility of the Contractor and is subsidiary to other items.

The in-place field density shall be determined in accordance with ASTM D 1556 or ASTM D 6938. When ASTM D 6938 is utilized for testing purposes, the nuclear gauge shall be calibrated within the last year. Calibration and operation of the gauge shall be in accordance with the requirements of the manufacturer. The operator of the nuclear gauge must show evidence of training and experience in the use of the instrument. The gauge shall be standardized daily in accordance with ASTM D 6938, paragraph 8.

Final acceptance of the compaction is dependent upon passing visual roll testing. This will be observed and approved by the Engineer. 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.

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.

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, recompacted and refinished at the sole expense of the Contractor.

H. Finishing (Trimming) & Curing

1. Fly ash: After each layer or course of the fly ash treated subgrade has been compacted, it shall be brought to the required lines and grades in accordance with the typical sections. The finished surface of the final layer shall not vary more than 3/8 inch when tested with a 10-foot straightedge applied parallel with and at right angles to the pavement centerline. Any variations in excess of this tolerance shall be corrected by the Contractor, at his/her own expense, in a manner satisfactory to the Engineer.

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

   a. Maintain in a thorough and continuously moist condition by sprinkling with water.
   b. Apply an asphalt prime coat emulsion curing seal approved by the Engineer at a rate of 0.15 gallons per square yard.
   c. Other options for maintaining moisture may be submitted in writing for approval by the Engineer.

   Restrict construction traffic from operating on the treated subgrade until it can withstand the loads without damage or deformation.

   Protect the treated subgrade from freezing throughout the protection period.

2. Lime: After each layer or course of the lime treated subgrade has been compacted, it shall be brought to the required lines and grades in accordance with the typical sections. The finished surface of the final layer shall not vary more than 3/8 inch when tested with a 10-foot straightedge applied parallel with and at right angles to the pavement centerline. Any variations in excess of this tolerance shall be corrected by the Contractor, at his/her own expense, in a manner satisfactory to the Engineer. After the lime treated course has been finished as specified herein, the surface shall be cured by one of the

following methods for a period of not less than three days and maintained until placement of the subsequent course (base or pavement) or up to seven days, whichever occurs first:

a. Maintain in a thorough and continuously moist condition by sprinkling with water.
b. Apply an asphalt prime coat emulsion curing seal approved by the Engineer at a rate of 0.15 gallons per square yard.
c. Other options for a curing seal may be submitted in writing for approval by the Engineer.

Restrict all construction traffic (except watering equipment) from operating on the treated subgrade during the curing period. Restriction may be lifted after three days if treated subgrade has gained sufficient strength to withstand the loads without damage or deformation.

Protect the subgrade from freezing throughout the curing period.

I. Maintenance: 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.

2202.8 Method of Measurement

The amount of completed and accepted work will be measured or determined as follows:

A. Lime: Per ton or tenth part thereof for the specified depth.

1. For bag lime, use the net weight on the bag.

2. For certified truck or rail car quantity, use the net weight of lime.

3. For hydrated lime slaked at the jobsite, use the quantity calculated in Section 2202.4, correcting for purity and inert material.

B. Fly Ash: Per ton or tenth part thereof for the specified depth.

C. Manipulation (Lime Treated Subgrade or Fly Ash Treated Subgrade): Per square yard or tenth part thereof.

D. Water: Per M Gallon (1,000 Gallons) using calibrated tanks or water meters.

1. For lime treated subgrade, measure water used for mixing, moisture control and curing but do not measure water used for slaking the lime, dust control, or excess water used due to Contractor negligence.

2. For Fly Ash treated subgrade, measure water used for mixing, moisture control and protection but do not measure water used for dust control or excess water used due to Contractor negligence.

E. Alternate curing (lime) and protection (fly ash) of subgrade: No measurement will be made if the Contractor elects to use asphalt prime coat emulsion or other alternative method for curing or protection of subgrade. These are subsidiary to other Contract Documents.

2202.9 Basis of Payment

Payment for the completed and accepted work will be made as follows when included in the Contract Documents:

A. Lime will be paid for by one of the following:

1. Contract unit bid price.

2. Contract lump sum bid price.

B. Fly Ash will be paid for by one of the following:

1. Contract unit bid price.

2. Contract lump sum bid price.

C. Manipulation (Lime Treated Subgrade or Fly Ash Treated Subgrade) will be paid for by one of the following:

1. Contract unit bid price.

2. Contract lump sum bid price.

D. Water will be paid for by one of the following:

1. Contract unit bid price.

2. Contract lump sum bid price.

SECTION 2203 AGGREGATE BASE COURSE

2203.1 Scope

This section governs the furnishing of all labor, materials and equipment for the placement of aggregate base course and underdrains, including pipe, geotextiles and granular filter material as shown on the Plans and in accordance with the Standard Drawings, the specifications and the Special Provisions.

2203.2 Referenced Standards

The following standards are referenced directly in this section. The latest version of these standards shall be used. If conflicting standards are referenced, the more stringent standard shall apply.

ASTM

C 31 Standard Practice for Making and Curing Concrete Test Specimens in the Field
C 33 Standard Specification for Concrete Aggregates
C 39 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
C 88 Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
C 117 Test Method for Materials Finer than 75 µm (No. 200) Sieve in Mineral Aggregates by Washing
C 131 Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
C 136 Test Method for Sieve Analysis of Fine and Coarse Aggregates
C 142 Test Method for Clay Lumps and Friable Particles in Aggregates
C 150 Standard Specification for Portland Cement
D 75 Practice for Sampling Aggregates

D 695 Test Method for Compressive Properties of Rigid Plastics
D 1621 Test Method for Compressive Properties Of Rigid Cellular Plastics
D 2419 Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate
D 3034 Specification for Type PSM Polyvinyl Chloride (PVC) Sewer Pipe and Fittings
D 3666 Specification for Minimum Requirements for Agencies Testing and Inspecting Bituminous Paving Materials
D 4318 Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
D 4716 Test Method for Determining the (In-plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head
D 4791 Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
D 5821 Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate
F 758 Standard Specification for Smooth-Wall Polyvinyl Chloride (PVC) Plastic Underdrain Systems for Highway, Airport, and Similar Drainage

AASHTO
M 252 Corrugated Polyethylene Drainage Tubing
T 99 The Moisture-Density Relations of Soils Using a 5.5-lb. (2.5 kg) Rammer and a 12-in. (305 mm) Drop

2203.3 Materials

A. Untreated Compacted Aggregate: This base course material shall consist of crushed stone aggregate with not more than 1.0% clay lumps and friable particles in accordance with ASTM C 142, and free from vegetable or other deleterious substances. The abrasion loss shall be no more than 35% when tested in accordance with ASTM C 131. That fraction passing the 1 inch sieve and retained on the No. 4 sieve shall have a loss not greater than 18% by weighted average for magnesium sulfate method (12% maximum loss if tested using sodium sulfate method) of ASTM C 88 Soundness Test at 5 cycles. That fraction of the material passing the 1-inch sieve and retained on the No. 4 sieve shall contain less than 20% by weight of flat and elongated particles when tested in accordance with ASTM D 4791 (flat being a ratio of 1 to 3 between thickness and least width and a ratio of 1 to 3 between the least width and length). The material shall consist of angular particles with no less than 90% of particle count having two or more fractured surfaces. The gradation in percentages by weight passing square mesh sieves shall be in accordance with ASTM C 136 and as follows:

Sieve Designation (Square Opening)	Percentage by Weight Passing Sieve
1-1/4 in (31.5 mm)	100
1 in (25.0 mm)	72 – 100
3/4 in (19.0 mm)	60 – 90
3/8 in (9.5 mm)	43 – 74
No. 4 (4.75 mm)	28 – 60
No. 10 (2.00 mm)	16 – 40
No. 40 (425 um)	3 – 22
No. 200 (75 um)	0 – 15

In addition to the above limits, the difference between the "Percent Passing Square Mesh Sieve" of successive sieve sizes shall not exceed 25 percent.

That fraction of the material passing the No. 40 sieve shall have a plasticity index not to exceed 8 when tested in accordance with ASTM D 4318.

B. Drainable Base: All drainable base materials shall have a minimum coefficient of permeability of 1000 ft/day as

determined by the test method described in 2203.4.E Permeability Test Procedure.

1. Portland Cement Concrete Drainable Base: This item shall consist of an open-graded drainable base composed of mineral aggregate, Portland cement and water mixed in a central mixing plant and placed on a prepared course in accordance with these specifications and shall conform to the lines, grades, thicknesses and typical cross sections shown on the Plans.

    a. Coarse Aggregate
        i. General: Coarse aggregate shall be 3/4 inch maximum size consisting of crushed gravel or crushed stone and shall meet the requirements of ASTM C 33 and quality requirements of 2203.3.A.
        ii. Gradation shall be ASTM C 33, Size 67.
    b. Fine Aggregate: Fine aggregate shall consist of natural sand or manufactured sand meeting the requirements of ASTM C 33.
    c. Cement: Portland cement shall conform to the requirements of ASTM C 150, Type I or Type II. Substitution of fly ash or other pozzolan for Portland cement shall be in conformance with Section 2208.
    d. Water: Water used in mixing or curing shall be clean and free of oil, salt, acid, alkali, sugar, vegetable or other substances injurious to the finished product as possible. Water known to be of potable quality may be used without testing.
    e. Admixtures: The use of any material to be added to the mixture shall be approved by the Engineer.
    f. The Contractor shall furnish vendor's certified test reports for the materials used in the project. The report shall be delivered to the Engineer as part of the mix design before permission to use the materials is granted.
    g. Proportions: The Contractor shall submit a mix design containing the quantity of each material to the Engineer including certifications of materials used. The Contractor will be responsible for preparing the drainable base mix design at no cost to the Owner. The testing laboratory preparing the mix design shall comply with Section 2203.3.B.2.e. The mix design shall include the following:

        Cement Content
        Water-Cement Ratio - Approximately 0.36
        Coarse Aggregate
        Fine Aggregate
        All Admixtures
        Coefficient of Permeability - Tested per Section 2203.4.E

    h. Compressive Strength: Proportions will be such to produce a compressive strength of 800 psi in 28 days as determined by test cylinders made in accordance with ASTM C 31 and tested in accordance with ASTM C 39. A strength of 500 psi will be required prior to any traffic being allowed on the surface.

2. Plant Mix Bituminous Drainable Base: This item shall consist of an asphalt stabilized drainable base course composed of mineral aggregate and bituminous material mixed in a central mixing plant and placed on a prepared course in accordance with the specifications and shall conform to the lines, grades, thicknesses, and typical cross sections shown on the Plans. Each course shall be constructed to the depth, typical section, or elevation required by the Plans and shall be rolled, finished, and approved before the placement of the next course. A prime coat will be used on the subbase prior to placement of the first course, and no tack coat will be used between courses.

a. Aggregate: Aggregate shall consist of crushed stone or crushed gravel and be free of organic materials.
   i. Coarse Aggregate: Coarse aggregate shall comply with Section 2303.3.A except wear may not exceed 50 % in accordance with ASTM C 131.
   ii. Aggregate shall contain at least 70% by weight of individual pieces having two fractured faces and 85% by weight having at least one fractured face as determined by ASTM D 5821.
   iii. The aggregate shall not contain more than 8%, by weight, of flat and elongated pieces, when tested in accordance with ASTM D 4791 (ratio = 5:1).
   iv. Sampling: ASTM D 75 shall be used in sampling the coarse aggregate.

b. Bituminous Material: The asphalt cement shall be in conformance with Section 2205.3.A. The type and grade of asphalt used shall be specified in the mix design but shall not be lower than a PG 64-22.

c. Preliminary Material Acceptance: Prior to delivery of materials to the job site, the Contractor shall submit certified test reports to the Engineer for the following materials:

   Coarse Aggregate - Percent of wear, soundness.

   Bituminous Material - The certification(s) shall show the appropriate ASTM test(s) for each material, the test results, and a statement that the material meets the specification requirements.

d. Job Mix Formula. (JMF): No bituminous mixture for payment shall be produced until the Engineer has approved a JMF in writing. The method of determining the proper asphalt content is to store the mix trial batches in the laboratory overnight (15-18 hrs) at 140°F. The proper asphalt content will then be selected visually.

   The asphalt content mix is selected from the batch from which a small amount of asphalt drains to the bottom of the pan and the mix still appears glossy. A heat resistant, clear glass dish may be used for better visibility of the drained asphalt. The asphalt content may be varied as necessary during construction to meet this requirement.

   The aggregate shall be of such size that the percentage composition by weight will conform to the gradation of gradations specified in Table 2, when tested in accordance with ASTM C 117 and C 136. The gradation shall be on the coarse side of the Master Band.

TABLE 2. PLANT MIX BITUMINOUS DRAINABLE BASE
MASTER GRADATION

Sieve Designation (Square Opening)	Percent by Weight Passing Sieve
1-1/2 in (37.5 mm)	100
1 in (25.4 mm)	90 – 100
3/4 in (19.0 mm)	75 – 100
1/2 in (12.5 mm)	70 – 90
3/8 in (9.5 mm)	50 – 70
No. 4 (4.75 mm)	20 – 40
No. 8 (2.36 mm)	15 – 25
No. 30 (637 um)	5 – 15
No. 200 (75 um)	0 – 3

Recommended Asphalt Cement Content 2.0% – 3.5%

The gradations in Table 2 represent the limits that shall determine the suitability of aggregate for use from the supply source.

The job mix tolerance shown in Table 3 shall be applied to the JMF to establish a job control-grading band. The resulting job control grading band must comply with the Master Gradation criteria.

TABLE 3. JOB MIX FORMULA TOLERANCES (Based on Single Test)	
Material	Tolerance Plus or Minus
Aggregate passing No. 4 (4.75 mm) sieve or larger	5.00%
Bitumen*	0.40%
Temperature*	20 degrees F

*Unless otherwise approved by the Engineer.

The aggregate gradation may be adjusted within the limits of Table 2 as directed, without adjustments in the Contract unit prices.

Should a change in sources of materials be made, a new JMF shall be established before the new material is used.

Dry aggregate gradations will be made at least twice daily. The aggregate gradation shall be tested by the Contractor in accordance with ASTM C 117 and C 136 and the results submitted to the Engineer within 24 hours.

The JMF shall be submitted in writing by the Contractor and approved by the Engineer prior to the start of paving operations. The job mix shall have been prepared no more than 12 months prior to submittal and shall include as a minimum:

Percent passing each sieve
Percent of asphalt cement
Asphalt designation and certifications
Mixing temperature
Compaction temperature
Temperature of mix when discharged from the mixer
Percent fractured faces
Percent elongated particles

The Contractor shall submit samples to the Engineer, upon request, for job mix formula verification testing.

e. Testing Laboratory: The laboratory used to develop the JMF formula shall meet the requirements of ASTM D 3666.

C. Underdrains: Underdrains shall consist of the following materials unless otherwise specified in the Plans, Standard Drawings, or Contract Documents.

1. Aggregate: Blanket underdrain aggregate and pipe underdrain aggregate shall be clean or washed

aggregate and conform to requirements of Section 2203.3.A with the following gradations:

TABLE 4. BLANKET UNDERDRAIN AGGREGATE	
Sieve Designation (Square Opening)	Percent by Weight Passing Sieve
1-1/2 in (37.5 mm)	100
1 in (25.4 mm)	90 – 100
3/4 in (19.0 mm)	60 – 90
3/8 in (9.5 mm)	-----
No. 4 (4.75 mm)	20 – 40
No. 8 (2.36 mm)	-----
No. 16 (1.2 mm)	0 – 10
No. 30 (0.6 mm)	-----
No. 50 (0.3 mm)	0 – 7
No. 100 (150 um)	0 – 2

TABLE 5. PIPE UNDERDRAIN AGGREGATE	
Sieve Designation (Square Opening)	Percent by Weight Passing Sieve
1-1/2 in (37.5 mm)	-----
1 in (25.4 mm)	-----
3/4 in (19.0 mm)	100
3/8 in (9.5 mm)	85 – 100
No. 4 (4.75 mm)	-----
No. 8 (2.36 mm)	40 – 60
No. 16 (1.2 mm)	-----
No. 30 (0.6 mm)	5 – 30
No. 50 (0.3 mm)	-----
No. 100 (150 um)	1 – 2

2. Underdrain Pipe

   a. Polyvinyl chloride pipe shall meet the requirements of ASTM F 758/D 3034.
   b. Corrugated Polyethylene Tubing may be used only outside of traffic areas and driving surfaces. The tubing shall be the heavy duty type and shall meet the requirements of AASHTO M 252. In addition, the tubing shall have a minimum pipe stiffness of 30 psi at 10% deflection.
   c. All underdrain pipes shall have a nominal minimum inside diameter of six inches unless shown otherwise on the Plans.
   d. Perforations shall be approximately circular and cleanly cut; shall have nominal diameters not less than 3/16-inch nor more than 3/8-inch; and shall be arranged in at least two rows parallel to the axis of the pipe.
   e. Fittings shall be of the same composition and have the same physical properties as the pipe and shall not restrict flow.

3. Geocomposite Edge Drain

   a. Edge drain shall consist of a plastic core completely surrounded by geotextile. The core shall provide a minimum of 10 percent open area to facilitate water entry or cross flow and shall be composed of plastic which is physically and chemically stable under a normal range of

conditions.

b. The edge drain shall have nominal dimensions of 1 to 1-1/2 inches in thickness and 12 inches in height.

c. The edge drain shall have a minimum flow capacity of 15 gallons per minute per foot of width as determined by ASTM D 4716 when tested under a confining stress of 10 psi or more at a gradient of 0.1 or less.

d. The edge drain shall have a minimum compressive strength of either 7,000 psf at a maximum deformation of 10 percent of the original thickness when tested in accordance with ASTM D 1621, or 8,000 psf at a maximum deformation of 20 percent when tested in accordance with ASTM D 695.

e. Geotextile shall have an apparent opening size (AOS) corresponding to a U.S. sieve number greater than 50 but not exceeding 100.

4. Geotextile: Geotextile for use with pipe and edge underdrains shall be a nonwoven geotextile and shall meet the requirements of Section 2605.2.C.

2203.4 Construction

A. Untreated Compacted Aggregate

1. Subgrade: Prior to placement of base course material the previously prepared subgrade surface shall be cleared of all foreign substances and restored in shape, tolerance and density as specified in Section 2201 entitled "Subgrade Preparation".

2. Material Placement: The material shall be uniformly spread in successive layers to such depth that when compacted, the base will meet the minimum thickness specified. The Contractor may construct the base in any number of layers that he chooses except that in no case shall any individual layer have a compacted thickness of more than 6 inches. Each layer shall be compacted as hereinafter specified before any succeeding layer is placed.

3. After spreading a layer of material, water in an amount sufficient to insure the desired compaction shall be added and uniformly mixed with the aggregate in a manner to prevent segregation. Excess moisture resulting in runoff shall be avoided. If for any reason, the material and subgrade become too wet to permit satisfactory work, they shall be allowed to dry to a moisture content that will permit satisfactory work.

4. The material shall meet the required specifications immediately before compaction operations are commenced. If, for any reason, segregation occurs in excess of 10% variation from the gradation required by this specification or the materials become contaminated, such segregated or contaminated materials shall be removed and replaced with suitable materials at the expense of the Contractor. The limited segregation of 10% variation will be ascertained by a sieve analysis of a minimum 100 pound sample taken from the in-place base course.

5. However, for untreated compacted aggregate base, segregated surface areas may be corrected by adding limestone screenings of such gradation and quantity as required to fill the surface voids and firmly bind the loose material in place. Screenings so used in correcting segregated surface areas will be subsidiary.

6. Shaping and compacting shall be carried on continuously until a true, even and uniform surface of proper grade and cross-section is obtained, and until the density of the complete base is at least 95%

of maximum density as determined by AASHTO T 99. The proper moisture content shall be maintained by wetting the surface as required during shaping and compacting operations. Final rolling shall be accomplished by use of a self-propelled smooth-wheeled roller.

B. Portland Cement Concrete Drainable Base

1. Spreading: The base material shall be spread to the lines and grades shown on the Plans. Any material which becomes mixed with soil or other contaminants shall be removed and replaced with fresh mixture.

2. Compaction: After spreading and/or trimming, the base material shall be uniformly compacted by making a minimum of 2 coverages with a steel wheeled roller meeting the requirements of Section 2205.8.B. The compaction process may be adjusted on the project by the Contractor with approval of the Engineer to assure uniform compaction of the drainable base material. In areas not accessible by the roller, the base material shall be compacted by mechanical hand methods. Compaction must be completed within 2 hours of the time water is introduced to the mixture.

3. If after spreading and compacting the base is not to the required lines and grade, the Contractor shall trim the base by means of an electronically controlled machine utilizing string line controls for grade. The Engineer reserves the right to direct the Contractor to suspend all operations if the Contractor produces excessive fines in the trimming process which are viewed by the Engineer to be detrimental to the permeability of the base. Appropriate corrections to the trimming process shall be made by the Contractor prior to beginning again.

4. After compaction of the drainable base, the Contractor shall protect the surface from damage and/or contamination. If the integrity of the drainable base is disturbed at any time prior to placement of the succeeding pavement course the area shall be removed and replaced with new material and compacted to conform to the original lines and grades at the Contractor's expense. Any removed material shall not be reincorporated into the drainable base or other drainage features.

5. Curing Of The Drainable Base Material: The Contractor will be required to provide a curing plan to the Engineer.

6. Temperature Limitations: The air temperature must be between 50°F and 90°F for drainable base construction. The Engineer may order operations to cease in hot windy conditions if it appears the mixture is drying out prior to achieving initial set.

7. Construction Joints: The formation of all joints shall be made in such a manner as to ensure a continuous bond between old and new sections of the course. All joints shall present the same texture and smoothness as other sections of the course.

8. All contact surfaces of previously constructed courses shall be cleaned of all dirt or other objectionable materials, and thoroughly moistened with water prior to placing the new material.

9. Thickness: The thickness of the base course may be measured by cores taken at intervals determined by the Engineer.

C. Plant Mix Bituminous Drainable Base

1. Test Section: Prior to full production, the Contractor shall prepare and place a section of drainable base according to the JMF. The amount of mixture should be 80 tons and may be placed as part of the

project. The underlying grade or pavement structure upon which the test section is to be constructed shall be the same as the remainder of the course represented by the test section. The equipment used in construction of the test section shall be the same type and weight to be used on the remainder of the course represented by the test section.

2. Two random samples of mixture may be taken at the plant and tested for aggregate gradation and asphalt content. The test section shall be considered acceptable if the gradation and asphalt content are within the limits specified in Tables 2 and 3.

3. If the initial test section should prove to be unsatisfactory to the Engineer, the necessary adjustments to the JMF, plant operation, placing procedures, and/or rolling procedures shall be made. A second test section shall then be placed. If the second test section also does not meet specification requirements, both sections shall be removed at the Contractor's expense. Additional test sections, as required, shall be constructed and evaluated for conformance to the specifications. Any additional sections that do not conform to specification requirements shall be removed at the Contractor's expense. Full production shall not begin until a satisfactory section has been constructed and accepted by the Engineer. The test sections that meet the specification requirements shall be paid for in accordance with project quantities.

4. The Contractor shall perform job mix control testing at the start of plant production and in conjunction with the calibration of the plant for the JMF. It should be recognized that the aggregates produced by the plant may not satisfy the gradation requirements or produce a mix that exactly meets the JMF. In those instances, it will be necessary to reevaluate and redesign the mix using plant-produced aggregates. Specimens should be prepared and the optimum bitumen content determined in the same manner as for the original design tests.

5. Weather Limitations: The bituminous mixture shall not be placed upon a wet surface or when the surface temperature of the underlying course is less than 40 degrees F or the wind chill factor is less than 35 degrees F. The temperature requirements may be waived by the Engineer; however, all other requirements including compaction shall be met.

6. These materials will be placed, handled, hauled and accepted based on requirements of Section 2205.

D. Underdrains

1. General: Underdrains shall be constructed as shown on the Plans or Standard Drawings. The exact location and layout of underdrains and/or edge drains as shown on the Plans shall be subject to revision by the Engineer during construction.

2. Excavation

   a. Trenches for all lateral and longitudinal underdrains shall be excavated to the dimensions, depths and elevations shown on the Plans or Standard Drawings or as ordered by the Engineer. In case of a conflict, where the actual elevation of the strata or stratum to be intercepted is found to vary from Plan elevation, the stratigraphy shall govern in the installation of underdrains.
   b. Trench bottoms for perforated pipe underdrain and edge drain shall be in firm material (no mucky or soupy condition existing) and constructed to permit the placing of three inches (3") of aggregate underneath the pipe. If unstable material is encountered in the bottom of the trench, the trench shall be over excavated to firm material.
   c. Minimum width of trench shall be as shown in the Plans or in the specifications or the

Standard Drawings.

3. Laying Pipe

   a. All underdrain pipe shall be laid carefully to Plan line and grade.
   b. All pipe shall be laid on a minimum grade of one percent unless otherwise shown on the Plans.
   c. All dead ends of pipe underdrains shall be completely closed with a cap of the same material as the pipe.
   d. All junctions and turns shall be made with wyes, tees, and bends as supplied by the manufacturer of the pipe.
   e. Perforations shall be laid down unless otherwise indicated on the Plans.

4. Installing Edge Drain

   a. Installation shall be in accordance with manufacturer's instructions.
   b. Each length of drain shall be joined to the adjacent length prior to installation. Splices shall keep adjoining lengths in proper alignment, shall not separate during installation, shall have the same or greater compressive strength than the geocomposite drain, and shall be sealed against infiltration of backfill material.
   c. Drain shall be placed in the center of the trench and held in place with a temporary support while blanket underdrain aggregate backfill is placed.
   d. The placement of the edge drain and the first lift of backfill shall be accomplished in a single continuous operation.

5. Backfilling

   a. Backfilling the trenches of lateral and longitudinal underdrains shall not be started until approved by the Engineer.
   b. The trenches shall be backfilled to the specified elevations and in accordance with the Plans, specifications or Standard Drawings.
   c. The backfill material shall be placed in such a manner as to prevent formation of large cavities in the backfill and walls of the trench.
   d. Overbreakage due to blasting of rock in trench excavation and widening due to caving of trench walls or overbreakage at construction outcrops shall be backfilled with aggregate approved by the Engineer.

E. Permeability Test Procedure for Drainable Base

This test method is used to determine the permeability of unbound and bound aggregate base material. Bound base material will use Portland cement or asphaltic cement as a cementing agent.

1. Unbound Base and Base Bound with Portland Cement

   a. Apparatus
      i. Mold: A cylindrical metal mold with an approximate inside diameter of 6" and a minimum height of 6". The mold shall be equipped with a removable collar at least 2" in height and a removable base plate. The base plate may be used as part of the permeability test equipment. If so, the base plate must exceed the permeability of the material being tested. A #40 screen shall be placed on top of the base plate to prevent test material from being lost through the base plate during compaction and

permeability testing.

ii. Standpipe: A standpipe with the same diameter as the removable collar for the mold with a minimum height of 8.5". The standpipe shall be equipped with an overflow outlet.

iii. Rammer: A mechanically operated metal rammer equipped to control the height of drop to 12" plus or minus 1/16" above the elevation of the sample. The rammer shall be equipped to distribute the blow uniformly over the sample surface. The rammer shall have a rigid flat faced "pie shaped" foot and a nominal weight of 5.50 lbs. The "pie shaped" foot shall be a sector of 6" diameter circle and shall have an area equal to that of a 2" circular foot.

iv. Straight edge: A rigid steel straight edge with one edge beveled, at least 8" in length.

b. Sample preparation

i. Obtain a 50 lb. to 60 lb. sample, dry if necessary.

ii. Mix a sufficient amount of aggregate and cementing agent, if required, to fill the mold 1 and 1/2 times.

iii. Add the appropriate amount of water and thoroughly mix.

iv. Place the assembled mold on the rigid base and fill approximately 1/2 full of the loose moist material. Compact the layer with 25 blows of the rammer with the blows being distributed uniformly over the surface of the layer. Place three additional approximately equal layers of material in the mold and compact each layer in a similar manner (four layers total).

v. After the fourth layer has been compacted, remove the collar and trim excess material level with top of the mold.

vi. Cure Portland cement treated specimens by covering with plastic, to prevent drying for 3 days at room temperature.

vii. Unbound specimens do not need to be cured before testing.

2. Asphalt Bound Aggregates

a. Apparatus

i. Mold: A cylindrical mold with an inside diameter of approximately 6" and a minimum length of 4.5". The mold is open at each end and is equipped with a removable collar and a base plate about 0.5" thick.

ii. Specimen Mold Holder: The specimen mold holder has a semi-circular base and a flanged top to hold the specimen mold in place during the compaction process. Any equivalent hold down device that performs the same function is satisfactory.

iii. Compaction Hammer: The compaction hammer consists of a hammer having a flat circular tamping face 5.88" in diameter and appropriate extension rod with handle which acts as guide for a free falling weight. The weight shall weigh 22.5 lbs. and have a free fall of 18" plus or minus 0.1". The hammer may be operated manually or be driven with a motor.

iv. Compaction Pedestal: The compaction pedestal is a wood block approximately 12" x 12" x 18". A 12" x 12" x 1" steel plate is securely fastened to the top of the block. The pedestal is set on and securely fastened to a solid concrete slab with the vertical axis plumb and the top level.

v. Heating Equipment: Ovens or hot plates for heating aggregates, bituminous material, specimen molds, compaction hammers and other associated items required for mixing and molding. It is recommended that, when possible all heating units be thermostatically controlled to maintain the required temperature within ±5°F. Suitable shields, thick steel plates or pans of sand shall be used on the surfaces of hot plates to minimize locally overheating.

vi. Mixing Apparatus: Mechanical mixing is recommended. Any type of mechanical mixer may be used provided it will produce a well coated, homogeneous mixture of the required amount in the allowable time and further that the mixing paddle or whip does not fracture or pulverize aggregate fractions during the mixing process. The bowl employed with the mixer shall be such a nature that essentially all of the batch can be removed. More than one mixing bowl is recommended unless the mixer is equipped with a heating jacket to keep the bowl heated during the mixing process.

b. Determination of Mixing and Compacting Temperature

i. The temperature to which the asphalt cement must be heated to produce a viscosity of 85 ± 10 SFS shall be the mixing temperature.

ii. The temperature to which the asphalt cement must be heated to produce a viscosity of 130 ± 15 SFS shall be the compacting temperature.

c. Sample Preparation for Laboratory Prepared Mix

i. Combine the dry individual aggregates to produce desired combined aggregate with a batch weight of approximately 8.9 lbs. This should be sufficient to produce a compacted specimen 3.75 ± 0.125 inches thick. Adjust the weight of the batch as needed to produce a compacted specimen of 3.75 ± 0.125 inches thick.

ii. Prepare a minimum of two aggregate and asphalt specimens. The first specimen shall be mixed and thrown away. This sample is to "butter" the mixing bowl and paddle and thus reduce material loss when mixing the test specimen.

iii. Heat the aggregate and asphalt within the limits of mixing temperature determined in Section 2203.4.E.2.b. Charge the mixing bowl with the heated aggregate and form a crater in the top. Add the required amount asphalt and mix the aggregate and asphalt until coated at least 2 minutes. Care should be taken to keep all of the sample in the mixing bowl during this process.

d. Compaction of Specimen

i. Prior to the addition of the asphalt to the batches, thoroughly clean the specimen mold assembly and the face of the compaction hammer and heat the mold assembly and hammer to a temperature between 200°F and 350°F. Assemble the mold, base plate and collar and place a paper disc cut to size in the bottom of the mold.

ii. Place the hot batch of aggregate-asphalt mixture in the mold, spade vigorously with a heated spatula or trowel 15 times around the perimeter and 10 times over the interior of the mold. Smooth the surface of the mix to a slightly rounded shape. The temperature of the mix prior to compaction shall be within the limits in Section 2203.4.E.2.b. Place a paper disc on top of the mix.

iii. Place the mold assembly, including the collar, on the pedestal, fasten securely with the mold holder and apply 20 blows with the compaction hammer. Each blow must have the prescribed free fall of 18" with the axis of the compaction hammer held perpendicular to the base of the mold assembly during the compaction process. Remove the base plate and collar, and reverse and reassemble the mold. Apply the specified number of blows to the reversed specimen. After compaction remove the mold assembly from the pedestal, remove the collar and base plate and cool the specimen in the mold until the mold can be handled comfortably with bare hands. Asphalt treated samples do not need to be cured before testing, only cool to the touch.

3. Test Procedure

a. Assemble test equipment, base plate, mold with specimen, and standpipe.

b. Prior to conducting the test, allow a sufficient amount of water to pass through the specimen to cause all air to be expelled from the specimen. (Establish reservoir around the base with

water open to atmospheric pressure.)

c. Conduct Constant-Head Permeability test and report coefficient of permeability "k". Repeat a minimum of two additional times until two runs agree reasonably well.

d. Constant-Head Permeability:

$$k = \frac{QL}{Aht}$$

Q = quantity of water discharged (volume)
L = length of specimen
A = cross-sectional area of specimen
h = hydraulic head (height column of water above discharge)
t = elapsed time of test
k = coefficient of permeability (length/time)

Note: For very permeable material, maintain elevation of water above the sample for 3 minutes then measure Q (flow).

2203.5 Method of Measurement

A. Untreated Compacted Aggregate Base will be measured by one of the following:

1. Per square yard or tenth part thereof for the specified depth.

2. Per ton or tenth part thereof.

B. Portland Cement Concrete Drainable Base may be included in the Contract Documents as a single item or as separate items (Portland Cement and Base Aggregate) and measured by one of the following:

1. Per square yard or tenth part thereof for the specified depth.

2. Per ton or tenth part thereof.

C. Plant Mix Bituminous Drainable Base may be included in the Contract Documents as a single item or as separate items (Asphaltic Cement and Base Aggregate) and measured by one of the following:

1. Per square yard or tenth part thereof for the specified depth.

2. Per ton or tenth part thereof.

D. Pipe and Edge Underdrains will be measured per lineal foot or tenth part thereof. Pipe Underdrain and Edge Underdrain aggregate shall be subsidiary.

E. Blanket Underdrains will be measured by the actual quantities used as follows:

1. Per square yard or tenth part thereof for the specified depth.

2. Per ton or tenth part thereof.

2203.6 Basis of Payment

A. Untreated Compacted Aggregate Base will be paid for by one of the following:

1. Contract unit bid price.

2. Contract lump sum bid price.

B. Portland Cement Concrete Drainable Base will be paid for by one of the following:

1. Contract unit bid price.

2. Contract lump sum bid price.

C. Plant Mix Bituminous Drainable Base will be paid for by one of the following:

1. Contract unit bid price.

2. Contract lump sum bid price.

D. Pipe and Edge Underdrains will be paid for by one of the following:

1. Contract unit bid price.

2. Contract lump sum bid price.

E. Blanket Underdrains will be paid for by one of the following:

1. Contract unit bid price.

2. Contract lump sum bid price.

SECTION 2204 PRIME AND TACK COAT

2204.1 Scope

This section governs the furnishing of all labor, materials and equipment for the application of liquid asphalt to a prepared pavement (concrete, asphaltic concrete), or granular base as shown on the Plans and in accordance with the Standard Drawings, the specifications and the Special Provisions.

2204.2 Referenced Standards

The following standards are referenced directly in this section. The latest version of these standards shall be used. If conflicting standards are referenced, the more stringent standard shall apply.

ASTM
D 140 Practice for Sampling Bituminous Materials

2204.3 Materials

A. The type and grade of asphalt material to be used as prime or tack coat shall be designated by the Engineer in the Plans or in the Special Provisions. If not specified in the Plans or Special Provisions, the Contractor shall

submit proposed type and grade of asphalt material to the Engineer for approval. The liquid asphalt material to be used for surface preparation shall be as listed in the following table:

Material to be Treated	Application Usage	Type of Emulsion of Grade of Cutback	Application Rate (Gal/SY) (L/SM)	Application Temperature ^{0}F (^{0}C)	Cure Time at 70^{0}F (21^{0}C)
Existing Asphalt or Concrete Surface	Tack	RC-70	0.05-0.10 Gal/SY (0.23-0.46 L/SM)	150 – 225 (65 – 107)	1 – 6 hrs
	Tack	SS-1 SS-1h CSS-1 CSS-1h	0.05-0.15 Gal/SY (0.23-0.69 L/SM)	70 – 160 (22.5 – 42)	1 – 3 hrs
Treated Base (lime, flyash, cement)	Prime	MC-30 MC-70	0.1-0.3 Gal/SY (0.46-1.38 L/SM)	85 – 120 (29 – 49)	12 – 24 hrs
	Prime	SS-1 SS-1h CSS-1 CSS-1h	0.1-0.3 Gal/SY/in (0.46-1.38 L/SM/mm)	70 – 160 (20 – 70)	24 – 48 hrs
Untreated Aggregate Base w/ Fines	Prime	MC-30 MC-70	0.1-0.3 Gal/SY (0.46-1.38 L/SM)	85 – 120 (29 – 49)	12 – 24 hrs
Untreated Aggregate Base w/o Fines	Prime	MC-250	0.2-0.5 Gal/SY (0.92-2.30 L/SM)	85 – 120 (29 – 49)	12 – 24 hrs
Untreated Aggregate Base	Prime	SS-1 SS-1h CSS-1 CSS-1h	0.1-0.3 Gal/SY/in (0.46-1.38 L/SM/mm)	70 – 160 (20 – 70)	24 – 48 hrs
	Prime	EAP PAE, or PEP	0.1-0.3 Gal/SY (0.46-1.38 L/SM)	70 – 160 (20 – 70)	12 – 24 hrs

The asphalt material shall conform to the latest ASTM specifications for "Asphalt Cements and Liquid Asphalts." Sampling shall be in accordance with ASTM D 140.

B. Sand Cover, if used, shall be any clean granular mineral meeting the following grading requirements. When tested with laboratory sieves 100% shall pass the No. 4 (4.75 mm) sieve and not more than 2% shall pass the No. 200 (75 um) sieve. The moisture content of the sand shall not exceed 3% by weight.

C. Asphalt materials shall be approved by the Engineer prior to use in the work. The Engineer may accept a certified analysis by the material supplier laboratory when a copy of the certified analysis accompanies each shipment of asphalt to the project. The Engineer reserves the right to perform tests of the asphalt received on the job.

2204.4 Construction

A. Pressure Distributor: The distributor shall be so designed, equipped, maintained and operated that liquid

asphalt at even heat may be applied uniformly on variable widths of surface up to 15 feet at readily determined and controlled rates from 0.02 to 1.00 gallon per square yard, with uniform pressure, and with an allowable variation from any specified rate not to exceed 0.02 gallons per square yard. Distributor equipment shall include a tachometer, pressure gauges, a calibrated tank and a thermometer for measuring temperatures of tank contents. Distributors shall be equipped with a power unit for the pump, and full circulation spray bars adjustable laterally and vertically. The calibration of all distributors must be approved by the engineer, and the contractor shall furnish all equipment, material and assistance necessary if calibration is required.

B. Preparation of Existing Surface

1. For tack coats: The existing surface shall be free of dust, loose material, grease or other foreign material at the time the tack is applied. Preparation of the surface is to be performed by the contractor before the tack is applied and is subsidiary to other items in the Contract.

2. For prime coats: the surface to be primed shall be shaped to the required grade and cross section, shall be free from ruts, corrugations, segregated material or other irregularities, and shall be uniformly compacted by rolling. The surface shall be firm and slightly damp when primer is applied. Delays in priming may necessitate reprocessing or reshaping to provide a smooth compacted surface.

C. Application of Asphalt Material

1. For Tack Coats: Asphalt emulsion shall be applied uniformly with a pressure distributor at the rate specified in the Contract, or as revised by the Engineer to be within a minimum of 0.05 and a maximum of 0.15 gallons per square yard. Water may be added to the asphalt emulsion and mixed therewith in such proportion that the resulting mixture will contain no more than 50% of added water, the quantity of added water to be approved by the Engineer. The application of the resulting mixture shall be such that the original emulsion will be spread at the specified rate. The asphalt emulsion shall be heated at the time of application to a temperature in accordance with the limits provided in Sec 2204.3, or as specified in the Contract Documents. The tack shall be properly cured and the tacked surface shall be cleaned of dirt and other foreign material before the next course is placed.

   The tack coat shall be applied in such manner as to cause the least inconvenience to traffic and to permit one-way traffic without pickup or tracking of the asphalt emulsion.

2. For Prime Coats: Bituminous material shall be applied to the width of the section to be primed by means of a pressure distributor in a uniform, continuous spread. The subgrade shall be moistened before the prime is applied. The application rate shall be as specified in the Contract Documents or as approved by the Engineer between 0.1 and 0.5 gallons per square yard. The primer shall be heated at the time of application to a temperature in accordance with the limits provided in Sec 2204.3, or as specified in the Contract Documents.

   Care shall be taken that the application of bituminous material at overlap locations is not in excess of the specified quantity, per square yard. Building paper shall be placed over the end of the previous applications and the joining application shall start on the building paper. Building paper used shall be removed and satisfactorily disposed of. Pools of primer material remaining on the surface after the application shall be removed.

   When traffic is maintained, not more than one half of the width of the section shall be treated in one application and one-way traffic will be permitted on the untreated portion of the roadbed. As soon as the bituminous material has been absorbed by the surface and will not pick up, traffic shall be routed to the treated portion and the remaining width of the section will be primed.

The primer shall be properly cured, and the primed surface shall be cleaned of dirt and surplus sand before the next course is placed.

D. Application of Sand Cover: If the asphalt material is not completely cured within the maximum specified curing time, sufficient sand shall be spread over the surface with a mechanical spreader to blot up the excess asphalt. The rate of application shall be specified or approved by the Engineer. Prior to placing an asphalt paving course, all loose sand shall be swept from the primed surface.

2204.5 Method of Measurement

Asphalt Prime and Tack Coat will be measured per gallon.

2204.6 Basis of Payment

Asphalt Prime and Tack Coat will be paid for at the Contract unit bid price.

SECTION 2205 ASPHALTIC CONCRETE SURFACE AND BASE

2205.1 Scope

This section governs the furnishing of all labor, materials and equipment for the construction of asphalt concrete base and/or asphalt concrete surface as shown on the Plans and in accordance with the Standard Drawings, the specifications and the Special Provisions.

2205.2 Referenced Standards

The following standards are referenced directly in this section. The latest version of these standards shall be used. If conflicting standards are referenced, the more stringent standard shall apply.

ASTM

C 88 Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
C 117 Test Method for Materials Finer than 75- um (No. 200) Sieve in Mineral Aggregates by Washing
C 127 Test Method for Specific Gravity and Absorption of Coarse Aggregate
C 128 Test Method for Specific Gravity and Absorption of Fine Aggregate
C 131 Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
C 136 Test Method for Sieve Analysis of Fine and Coarse Aggregates
C 142 Test Method for Clay Lumps and Friable Particles in Aggregates
D 75 Practice for Sampling Aggregates
D 140 Practice for Sampling Bituminous Materials
D 979 Practice for Sampling Bituminous Paving Mixtures
D 1188 Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens
D 2041 Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures (comparable to AASHTO T209)
D 2172 Test Methods for Quantitative Extraction of Bitumen From Bituminous Paving Mixtures
D 2726 Test Method for Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures
D 2950 Test Method for Density of Bituminous Concrete in Place by Nuclear Methods

D 3666 Specification for Minimum Requirements for Agencies Testing and Inspecting Bituminous Paving Materials
D 4552 Practice for Classifying Hot-Mix Recycling Agents
D 4791 Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
D 5444 Test Method for Mechanical Size Analysis of Extracted Aggregate
D 6307 Test Method for Asphalt Content of Hot-Mix Asphalt by Ignition Method
D 6373 Specification for Performance Graded Asphalt Binder

AASHTO
T 166 Standard Method of Test for Bulk Specific Gravity (Gmb) of Compacted Hot Mix Asphalt (HMA) Using Saturated Surface-Dry Specimens
T 245 Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus
T 269 Standard Method of Test for Percent Air Voids in Compacted Dense and Open Asphalt Mixtures (ASTM Designation: D 3203/D 3203M-11)
T 283 Resistance of Compacted Bituminous Mixture to Moisture Induced Damage
T 312 Standard Method of Test for Preparing and Determining the Density of Asphalt Mixture Specimens by Means of the Superpave Gyratory Compactor

Asphalt Institute
"Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types", MS-2, latest edition

Kansas Department of Transportation
Standard Specifications for State Road and Bridge Construction, 2015 Edition

Missouri Highways and Transportation Commission
Missouri Standard Specifications for Highway Construction, 2011 Edition

National Institute of Standards and Technology
Handbook #44, "Specifications, Tolerance and other Technical Requirements for Commercial Weighing and Measuring Devices"

2205.3 Materials

No material shall be used until it has been approved by the Engineer. All costs associated with material testing, certification and the preparation of trial mixes to determine the job mix formula shall be the responsibility of the Contractor. Representative samples of all materials proposed for use under these specifications shall be submitted by the Contractor to a properly certified testing laboratory approved by the Owner, at the Contractor's expense, for testing and the preparation of trial mixes to determine the job-mix formula. Tests required by this specification for field verification of the mix shall be the responsibility of the Contractor at the Contractor's expense, unless specified otherwise. The Engineer reserves the right to perform additional testing to verify conformance with the requirements specified herein. These tests will be performed under the supervision of the Engineer without cost to the Contractor, unless specified otherwise in the Contract Documents.

A. Asphalt: Asphalt cement used in the manufacture of asphalt paving mixtures shall conform to the Performance Graded system. The PG graded material used shall conform to the provincial grade used by the local DOT or as designated by the Engineer. In the Kansas City Metropolitan area, the provincial grade is a PG64-28 but PG 64-22 is commonly used so either is deemed acceptable.

B. These general usage guidelines may not address all project conditions. APWA strongly recommends that the Engineer apply sound pavement design principles when designating mix type and selecting asphalt cement

grade based upon individual project conditions. The Federal Highway Administration makes available LTPPBIND software that will assist with asphalt grade selection for specific projects.

The asphalt cement shall conform to ASTM D 6373. Sampling shall be in accordance with ASTM D 140.

The Contractor or asphalt supplier shall submit a temperature-viscosity chart showing the recommended mix and compaction temperatures for non-modified asphalts, and shall provide the specific gravity of the asphalt.

C. Aggregate: The quality of aggregates used in Asphaltic Concrete shall conform to the following:

Coarse Aggregate (Retained on the No. 4 Sieve)
LA Abrasion (ASTM C 131) ..... 40% loss (maximum)
Soundness using Mag. Sulfate (ASTM C 88, 5 cycles) ..... 18% loss (maximum)
Soundness using Sodium Sulfate (ASTM C 88, 5 cycles)…… ..... 12% loss (maximum)
Total shale, clay, coal and lignite content (ASTM C 142) ..... 1.0% by weight (max)

Fine Aggregate (Passing the No. 4 Sieve)
Organic content ..... 1% maximum
The parent material of manufactured sand must also meet the requirements for coarse aggregate shown above.

Sampling shall be in accordance with ASTM D 75. Gradation analysis shall be in accordance with Standard Method of Test for Material Finer than No. 200 (75 um) Sieve in Mineral Aggregates by Washing, ASTM C 117 and Standard Method Test for Sieve Analysis of Fine and Coarse Aggregate, ASTM C 136. All aggregate quality tests must have been run within 12 months of the submission date of a mix design.

D. Commercial Mix: Providing a commercial mix will only be permitted when specified in the Contract Documents or approved in writing by the Engineer. Contractor shall adhere to the most current State Department of Transportation standard specifications governing commercial mix asphalt for the state the work is being performed in. Example: for Kansas, Standard Specifications for State Road and Bridge Construction, 2015 Edition, Section 611, or for Missouri, Missouri Standard Specifications For Highway Construction, 2011 Edition, Division 400.

2205.4 Mixing and Proportioning

A. Composition of the Mix: Asphaltic concrete mixtures shall consist of Mineral Aggregates and Asphalt Cement within the following limits for the type specified.

	ASPHALTIC CONCRETE-TYPE					
	1-01	2-01	3-01	4-01	5-01	6-01
Percent by Weight of Total Mixture						
Asphalt Cement	4-6	4-7	4-7	5-7.5		
Aggregate - U.S. Standard						
Square Sieve Size Total Percent Passing by Weight						
1 ½" (37.5 mm)	100	--	--	--	--	--
1" (25.0 mm)	75-100	100	--	--	100	--
¾" (19.0 mm)	60-85	80-100	100	--	95-100	100
½" (12.5 mm)	--	--	85-100	100	--	86-100
3/8" (9.0 mm)	40-65	60-80	70-90	85-100	--	75-100
No. 4 (4.75 mm)	30-50	48-65	50-70	55-75	--	--
No. 8 (2.4 mm)	19-36	35-47	37-47	39-50	28 min	28 min
No. 16 (1.2 mm)	13-26	25-36	26-36	27-38	--	--
No. 30 (0.6 mm)	--	18-30	18-30	19-30	--	--
No. 50 (0.3 mm)	--	12-22	12-22	11-23	--	--
No. 100 (150 µm	4-12	6-14	6-15	6-16	--	--
No. 200 (75 µm)	2-10	3-10	4-10	4-10	2-6	2-6

In addition to the above limits, the difference between the "Percent Passing Square Mesh Sieve" of successive sieve sizes shall not exceed 25 for types 1-01, 2-01, 3-01, and 4-01.

That fraction of material retained on the No. 4 (4.75-mm) Sieve-shall be composed of particles with not less than 75% having two or more fractured faces for asphalt types 1-01, 2-01, 3-01, and 4-01, and not more than 20% by weight of that fraction shall be composed of flat or elongated particles based on a ratio of 5:1 when tested in accordance with ASTM D 4791. For Asphalt Types 5-01 and 6-01 only, the total aggregate (coarse aggregate, fine aggregate, and the material passing the No. 200 sieve (75um) shall contain not less than 85% crushed material for intermediate course and surface course.

It shall be noted that when the gradation varies appreciably from the single point gradation used in the mix design, the test properties of the mix will be out of specification. This condition can occur even though the gradation meets the tolerances below.

The job-mix formula shall be within the limits specified above. The maximum permissible variation from the job-mix formula, within the specification limits, shall be as follows:

Permissible Gradation Variation from Mix Design Percent by Wt. of Total Mix:

U.S. Standard Sieve Size	Type 1-01, 5-01, 6-01	Type 2-01, 3-01, 4-01
No. 4 and larger	5.0	4.0
No. 8, 16, 30, 50	4.0	3.0
No. 200	2.0	1.0

Permissible Oil Content Variation from Mix Design:

Type 1-01, 5-01, 6-01 – 0.5%
Type 2-01, 3-01, 4-01 – 0.3%

B. Asphalt Mix General Usage:

	Surface	Base
Arterial	5-01, 6-01	5-01
Collector	5-01, 6-01	5-01
Local/Access	5-01	5-01
Paved Trail	2-01, 3-01, 4-01, 5-01	1-01.2-01.5-01
Recreational Surface	4-01	1-01, 2-01, 5-01
Parking Lot	2-01, 3-01, 5-01	1-01, 2-01, 5-01

Generally, mix types 1-01, 2-01, 3-01 and 4-01 are composed of local materials and are appropriate for general use other than roadways. Unless specified otherwise in the Contract, Plans or Special Provisions, only mixes 5-01 and 6-01 should be used for roadways. The Contractor may submit a written request to use mix 1-01 for pavement base or mix 3-01 for pavement surface.

Mix type 2-01 is acceptable for surfacing, but is generally more open-graded than the other surface mixes, and may not provide a tightly sealed surface.

Mix type 4-01 is very susceptible to rutting and is only recommended for non-vehicular use.

C. Asphalt Hot-Mix Recycling

1. General: Except as modified herein, Recycled Asphaltic Concrete (RAC) shall be equal to that produced as new material. Reclaimed Asphalt Pavement (RAP), Fractionated Reclaimed Asphalt Pavement (FRAP) and/or Reclaimed Aggregate Materials (RAM) shall represent no more than 30% of the composition for all surface mixtures and no more than 40% of the composition for all base mixtures. However, for base mixtures using FRAP, the composition may be no more than 50%.

   Recycled Asphaltic Concrete may contain combinations of FRAP, RAP, RAM, coarse aggregate, fine aggregate, mineral filler, asphalt cement, recycling agent, anti-stripping agent and approved additives to produce an acceptable mixture. Recycled Asphalt Shingles (RAS) are not allowed. Recycled Asphaltic Concretes shall be designated by prefacing the type with “RC,” such as “RC Type 1-01”.

2. FRAP is defined as having two or more stockpiles, where RAP is processed into coarse and fine fractions. The fine FRAP stockpile will contain only material passing the ¼ inch screen. The coarse FRAP stockpile will contain milled material retained on the ¼ inch screen and passing the ¾ inch screen. FRAP may be comprised of coarse or fine FRAP or a combination thereof. Utilize a separate cold feed bin for each stockpile of FRAP used. Do not blend coarse and fine FRAP either in the stockpile or in a cold feed bin. Add FRAP to the mix through the RAP collar. Sources and types FRAP must be recorded and submitted to the Engineer upon request. The FRAP used in production shall be similar in composition (extracted gradation and asphalt content) to the source used for design.

3. Materials Evaluation: All recycled materials shall have the following tests performed in addition to those required in Section 2205.4.D:

   a. A sieve analysis shall be performed on FRAP, RAP and/or RAM in accordance with ASTM C 117, "Standard Test Method for Material Finer than No. 200 Sieve (75 um) in Mineral Aggregates by Washing" and ASTM C 136, "Standard Method for Sieve Analysis of Fine and Coarse Aggregates" after extraction of asphalt.
   b. Asphalt content analysis shall be performed for FRAP or RAP in accordance with Method "A" of ASTM D 2172, "Standard Test Methods for Quantitative Extraction of Bitumen from Bituminous Paving Mixtures" where the FRAP or RAP content exceeds 30%. For mixtures

with FRAP or RAP contents less than 30%, asphalt content may be determined using ASTM D 6307.

c. The asphalt cement used shall be determined as follows:
   i. For FRAP or RAP contents of up to 20%, the asphalt grade shall be as specified in the mix design.
   ii. For FRAP or RAP contents from 20% up to 30%, the asphalt grade shall be decreased one temperature range. For example, a design PG 64-22 would be decreased to a PG 58-28.
   iii. For FRAP or RAP contents from 30% to 50%, the asphalt grade of the new asphalt shall be determined using the procedures outlined in MS-2, latest edition, Appendix A. This would likely result in a PG 52-34.
d. All sources of material for use in RAC must be approved by the Engineer prior to use.

4. Material Requirements

   a. New asphalt cements added to the aged asphalt shall meet the requirements of Section 2205.3.
   b. Recycling Agents, if used, shall meet the requirements of ASTM D 4552, "Standard Practice for Classifying Hot Mix Recycling Agents".
   c. The FRAP, RAP and/or RAM stockpiled at the plant site shall be maintained in stockpiles separated into surface and base. The RAP and/or RAM shall be processed such that 100% will pass the 1-1/2 inch (38 mm) sieve and 90% will pass the 1-inch (25.4 mm) sieve.
   d. The final product shall be free of foreign matter (e.g., old planer teeth, ice, wood, soil, broken sewer castings, loop detector wire, protective membranes, rubberized joint filler materials and foil turn lane markers, trash, debris, etc.).

5. Mix Design Requirements: The necessary steps for a final mix design for recycled mixtures shall be done in accordance with the Asphalt Institute's Manual MS-2 latest edition in the appendix entitled "Mix Design Using RAP". If there is a change in the RAP and/or RAM percentage from the original amount of RAP and/or RAM in the mix design, a new mix design must be submitted.

6. Asphalt Plant Requirements: All delivery tickets shall designate the type of recycled mix, (RC-Type 1-01, RC-Type 2-01, RC-Type 3-01, etc.).

D. Mix Design Criteria: Laboratory Test Specimen(s) of mixes 1-01, 2-01, 3-01 and 4-01, combined in proportions of the job-mix formula, shall be prepared and tested in accordance with AASHTO T 245 and the volumetric properties of the compacted paving mixtures as calculated by ASTM procedures using Chapter 4 of the Mix Design Methods for Asphalt Concrete and other Hot-Mix Types (MS-2), latest edition, Asphalt Institute referred hereafter as “MS-2”. The Marshall procedure shall be as specified in Chapter 5 of the MS-2.

For mixes 5-01 and 6-01, the procedures outlined in Asphalt Institute’s “Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types (MS-2)”, latest edition, must be used to prepare the asphalt samples for design and quality control testing. The gyratory values for the SuperGyratory Compactor (SGC) to be used for this purpose are $N_{initial}$ = 6, N_{design} = 50, and N_{max} = 75. At $N_{initial}$, the specific gravity of the specimen must be 90.5% or less of G_{mm}, at N_{max} the specific gravity of the specimen must be 98.0% or less of G_{mm}. The Voids in the Mineral Aggregate (VMA) shall be as specified in Chapter 5 of the MS-2.

The material for the theoretical specific gravity (G_{mm} per ASTM D 2041) and the material for the Marshall specimens and Super Gyratory Compactor specimens (pucks) shall be cured at 285+/-5ºF for four hours in a closed oven after the mix is produced in the laboratory. Also, the plant produced mixture shall be tested when the mix is four hours old when preparing a mix design but may be tested when at least two hours old for

production testing. The mixture shall be transported to the laboratory in an insulated container and then stored in a laboratory oven at 285 +/-5°F for the remainder of the curing period. This procedure shall be used when the water-absorption as determined by ASTM C 127 and ASTM C 128 of any aggregate in the mixture exceeds 1.25%. The mixture shall be compacted at 285 +/-5°F. If total mix aggregate absorption exceeds 2.0%, the laboratory may use the G_{mm} dryback option within the test method.

Test requirements and criteria for the paving mixes under these specifications shall be as follows:

Marshall Stability: 1500 lbs. (6672 N) minimum (Types 1-01, 2-01, 3-01, and 4-01)

No. of compaction blows: 50 (Types 1-01, 2-01, 3-01, and 4-01)

Flow: 0.08-0.16 inches maximum (Types 1-01, 2-01, 3-01, and 4-01)

Air Voids:	Percent
Base & Surface (Types 5-01 & 6-01)	3-5
Base & Surface (Types 1-01, 2-01, 3-01, and 4-01)	2-5

Voids filled with asphalt (VFA)	Percent
Types 5-01 & 6-01	65-75

Voids in Mineral Aggregate (VMA) for Types 5-01 & 6-01

(Nominal Max Size as defined in MS-2)	Percent (min.)
3/4" (19 mm)	13
1/2" (12.5 mm)	14
3/8" (9.5 mm)	15

The VMA for Mix Types 5-01 & 6-01 shall be the minimum value allowed. For these mixes, the asphalt content should be just to the left side of the low point on the VMA vs. Asphalt Percent curve, not to the "wet" or right (increasing) side of the curve. Nominal maximum sized as defined in MS-2 means the sieve size where the next smaller sieve size (from Table in Section 2205.4.A) retains at least 10% of the sample.

The VMA requirements shown represent values that may be higher than those obtained in the KC Metropolitan area using locally available materials. The minimum values are values recommended by the Asphalt Institute in MS-2, latest edition, for high quality asphaltic concretes, but may require the use of non-local aggregates. VMA values shown are for 4% air voids and should be used for the design of conventional roadway pavements.

During production, the air voids can be expected to vary plus or minus 1% of the design value of 4%. For Mix Types 1-01, 2-01, 3-01, and 4-01, 3% - 4% air voids may be used for design and production may be allowed to vary plus or minus 1% of the design value.

The ratio of minus 200 (75 um) material to % Effective asphalt cement (P_{eff}) based on the weight of the aggregate shall be between 0.6-1.4 for Mix Types 5-01 and 6-01.

The blend of FRAP, RAP and/or RAM and virgin aggregates or non-recycled asphalts shall be checked for resistance to stripping using AASHTO T 283 to determine if an anti-stripping agent is needed. The index of retained strength shall exceed 75% for Mix Types 1-01, 2-01, 3-01, and 4-01, and 80% for Mix Types 5-01 and 6-01.

E. Sampling and Testing of the Mixture: All Mix Types shall be sampled in accordance with ASTM D 979 and tested in accordance with AASHTO T 245, ASTM C 136, ASTM C 117, AASHTO T 312, AASHTO T 269,

AASHTO T 166, AASHTO T 283, ASTM D 2041, ASTM D 2726, ASTM D 1188, ASTM D 2950, ASTM C 127 and ASTM C 128, as specified herein. The mixtures will be tested for binder content in accordance with ASTM D 2172 or D 6307. The recovered aggregate will be sieved in accordance with ASTM D 5444.

F. Mixture Temperature Requirements: The temperature of the completed mix at the plant and at the paver shall be set by the Contractor/Producer who shall consider hauling and placing conditions, asphalt specifications as set forth in Section 2205.3, and weather limitations set forth in Section 2205.9.B. The temperature of Mix Types 5-01 and 6-01 shall not exceed 315° F at the point of discharge from the asphalt plant.

When the mix is produced in a batch-type plant, the aggregate shall be weighed accurately in the designated proportions to provide the specified batch weight. The temperature of the aggregate at the time of introduction into the mixer shall be determined by the Contractor/Producer, with a tolerance of + or - 25º F. In no case, however, shall the temperature of the mixture exceed the maximum temperature recommended by the manufacturer or supplier of the asphaltic cement (generally 350º F).

G. Control of Mixing Time: The Contractor/Producer shall control mixing time to produce asphaltic concrete that is uniformly and thoroughly coated with asphaltic cement.

H. Preparation of Asphalt Cement: The asphalt shall be heated so that it can be distributed uniformly throughout the mix. For mixing applications, the specified temperature generally will be such that the asphalt viscosity is within the range of 150-190 centistokes and shall not exceed 350º F. The material shall be sufficiently fluid to produce a complete coating on every particle of aggregate within the specified mixing time.

The Contractor/Producer shall maintain calibrated temperature monitoring equipment at the point of discharge from the asphalt plant and at the asphalt tank, and shall supply temperature records upon request.

I. Preparation and Handling of Aggregate: Coarse and fine aggregate shall be stored at the plant in such a manner that the separate sizes will not become intermixed. Cold aggregates shall be carefully fed to the plant in such proportions that surpluses and shortages in the bins will not cause breaks in the continuous operation. When loading aggregate into stockpiles, and into cars, barges, and trucks, the material shall be placed in such a manner as to prevent segregation of aggregate sizes. Stockpiles shall be built in uniform layers not exceeding 5 feet in depth.

1. Samples of coarse and fine aggregate shall be submitted to the Engineer for testing upon request. The Contractor/Producer shall be responsible for the preparation and handling of aggregates to insure that the cold-feed gradations fall within the mix design limits. Cold-feed gradation tests shall be taken as requested by the Engineer.

2. Drying: The aggregate shall be thoroughly dried and heated to provide a paving mix temperature within a tolerance of + or – 25º F of that specified by the approved mix design. The moisture content of the heated and dried aggregate shall not exceed 0.5%. The quantity of material fed through the dryer shall in all cases be held to an amount which can be thoroughly dried and heated.

J. Inspection and Control of Asphalt Mixing Plant

1. Tests: During production the plant shall have the specified tests performed by an approved laboratory. These may include: asphalt (binder) content, aggregate gradation after removal of asphalt, density, stability, % voids, VMA, VFA, theoretical specific gravity, bulk specific gravity, maximum theoretical density, maximum theoretical specific gravity, tensile strength ratio, etc. Properties of the plant produced mix shall be determined using uncompacted mix sampled behind the paver. Laboratories shall be approved if they are:

a. Accredited in accordance with ASTM D3666; and/or
b. Approved for Superpave asphalt testing by the State Highway Department in the state where the plant is located.
    i. The individual performing the test must carry a state certification for Superpave testing.
    ii. The laboratory must have an annual certification by an independent testing agency of all testing equipment used for Superpave mix designs, and must also have the Marshall hammer weight and height of drop certified by that same agency.

2. Availability of test reports: The results of the latest current test report shall be furnished to the Engineer upon request. All test reports shall be kept at the plant, and shall be made available upon request. If the mix is found to be outside of tolerance, or outside the specification limits as specified in Section 2205.4, correction shall be made. Test reports shall be furnished on the appropriate attached "Asphalt Concrete Test" form or a similar form containing equivalent information.

3. Frequency of testing for mixes 1-01 through 4-01: the tests listed in paragraph 1 shall be performed a minimum of once for every 3000 tons of asphalt production (minimum of once per day when the plant has produced at least 200 tons and at discretion of Engineer if less than 200 tons produced) except during initial startup, or whenever the production asphalt fails one of the following conditions at which time they will be tested every 1000 tons until 4 consecutive tests show compliance with the specifications:

    a. Production void content measured at the plant discharge is less than 2% or more than 5%.
    b. Extracted gradation of the production asphalt exceeds the permissible gradation variation for the mix type being produced.
    c. Asphalt cement exceeds the content variation for the mix type being produced.

4. Frequency of testing for mixes 5-01 and 6-01: the tests listed in paragraph 1 shall be performed once per day of production, or every 1000 tons, whichever is less frequent except during initial startup (if less than 200 tons produced testing is at discretion of Engineer); or whenever the production fails one of the following conditions at which time they will be tested every 500 tons, or twice per day of production, whichever is less frequent until 4 consecutive tests show compliance with the specifications:

    a. Production void content measured at the plant discharge is less than 3% or more than 5%.
    b. Extracted gradation of the production asphalt exceeds the permissible gradation variation for the mix type being produced.
    c. Production VMA measured at the plant discharge is below the design minimum VMA.
    d. Production VFA measured at the plant discharge is outside the allowable range.
    e. Production dust to binder ratio is outside the allowable range.

5. Redesign of Asphalt mixes: If four consecutive tests performed as described in paragraph 3 or 4 above show noncompliance with the specifications as enumerated in the subparagraphs of paragraph 3 or 4 above, production of that type of asphalt will immediately cease, and may not be resumed until a new mix design is submitted and approved, or the plant can demonstrate to the Engineer an ability to meet specifications. Resumption of asphalt production after a mix redesign or failure of four consecutive tests to meet specifications will be treated as an initial startup for testing purposes.

MARSHALL ASPHALTIC CONCRETE TEST (Verified Mix Design)
(Types 1-01, 2-01, 3-01, 4-01)

Description:				
APWA Type:				
LAB ID:		LOT		
Sample Date:		Belt		Tons
Sample ID:		Hot Mix		Tons
Supplier:				

Sieve Size	Belt Sample	Hot-Mix Sample*	Single Point Job-Mix Formula	Job-Mix Formula Tolerances
1" (25 mm)				
3/4" (19 mm)				
1/2" (12.5 mm)				
3/8" (9.5 mm)				
No. 4 (4.75 mm)				
No. 8 (2.36 mm)				
No. 16 (1.18 mm)				
No. 30 (600 um)				
No. 50 (300 um)				
No. 100 (150 um)				
No. 200 (75 um)				

ASTM C 136, C 117, D 5444

*Uncompacted Behind Paver
**total mix basis
***total aggregate

EXTRACTION DATA - ASTM D6307 or D 2172	FRAP	Sample	Plant Setting	Recycled AC%
%AC**				
%AC**				

Aggregate Type	%***	Aggregate Type	%***

MARSHALL CHARACTERISTICS (ACCEPTANCE CRITERIA)			
Compaction Blows (average of 3 specimens) = 50			
	Sample*	Specifications*	
Stability, lbs (kg)		Min	AASHTO T 245
Flow, 1/100 in (mm)		Max	AASHTO T 245
% Voids		3-5	
% VFA			
Density, pcf (kg/cu.m)		-----	ASTM D 2950, D 2726, or D 1188
Max Theoretical Specific Gravity G_{mm}		-----	ASTM D 2041
Bulk Spec. Gr. of total Agg. Gsb		-----	ASTM C 127 & C 128
COMMENTS:			

LOT DENSITY SHALL BE TIED TO THE LOT AND DATE (Laboratories shall conform to ASTM D 3666)

SUPERPAVE ASPHALTIC CONCRETE TEST (Verified Mix Design)
(Types 5-01, 6-01)

Description:				
APWA Type:				
LAB ID:		TIME		TONS
Sample Date:		Belt		
Sample ID:		Hot Mix		
Supplier:				

Sieve Size	Belt Sample	FRAP/RAP Sample*	Hot-Mix Sample*	Master Grade Limits	Cal. Single Point
1" (25 mm)					
3/4" (19 mm)					
1/2" (12.5 mm)					
3/8" (9.5 mm)					
No. 4 (4.75 mm)					
No. 8 (2.36 mm)					
No. 16 (1.18 mm)					
No. 30 (600 um)					
No. 50 (300 um)					
No. 100 (150 um)					
No. 200 (75 um)					

ASTM C 136, C 117, D 5444

*Uncompacted Behind Paver
**total mix basis
***total aggregate

EXTRACTION DATA - ASTM D6307 or D 2172	FRAP	Sample	Plant Setting	Recycled AC%
%AC**				
%AC**				

Aggregate Type	%***	Aggregate Type	%***

VOLUMETRIC DATA 6" NOMINAL SIZE Gyratory Specimens			
Gyrations (avg. of 2 specimens) @ 280-290 deg F – AASHTO T312 N_{des} = 50 N_{ini} = 6 N_{max} = 75	Sample*	Specifications*	
Mix bulk specific gravity @ N_{des}, G_{mb}		---	
% Voids @ N_{des}		3.0-5.0	AASHTO T 269
% VMA @N_{des}, G_{sb} basis			
% VFA @ Ndes		9.0–11.0	=%VMA-%Voids
% G_{mm} @ Nini		85-91	AASHTO T 166
Ratio (-) 75 um (No. 200) to % Eff. Binder		0.6-1.4	
Tensile Strength Ratio, %		80 minimum	AASHTO T 283
Max Theoretical Specific Gravity G_{mm}		-----	ASTM D 2041
Max Theoretical Density, pcf		-----	
Effective Specific Gravity Agg., G_{se}		-----	
Bulk Specific Gravity of Total Agg., G_{sb}		-----	ASTM C 127 & C 128
Specific Gravity of Asphalt, G_b		-----	
COMMENTS:			

2205.5 Asphalt Mixing Plant

Plants used by the Contractor for preparation of the asphalt paving mix shall conform to the following requirements:

A. Field Testing Laboratory: The Contractor shall provide a laboratory building or room at the plant site, for the exclusive use of the Engineer for performing tests, keeping records, and making reports at such times as the Engineer is performing those actions.

   The Contractor shall also furnish necessary laboratory sieves and a powered shaker device for sieve analysis, scales, ignition oven and supplementary equipment to make aggregate sieve analysis, asphaltic concrete paving mixture analysis, and paving mixture density tests. This equipment shall be in good working condition and properly calibrated.

B. The asphalt producer shall establish a quality control plan and shall maintain records. The quality control plan required by the state highway agency is a suggested standard. Upon request by the Engineer, the quality control plan shall be submitted for review and approval.

2205.6 Transportation of Mix

The mix shall be transported to the job site in vehicles with tight metal bottoms, clean of all foreign material which may affect the mix. If a release agent is used, it must comply with State and Federal environmental regulations.

The dispatching of the vehicles shall be so scheduled that all materials delivered may be placed in daylight unless the Engineer approves artificial light. Delivery of the material to the paver shall be at a uniform rate and in an amount within the capacity of the paving and compacting equipment.

Haul trucks shall be provided with covers of sufficient size and weight to completely cover the truck bed to protect the load and to prevent cooling of the upper surface. Failure to have the load completely covered shall be sufficient cause for rejection of the entire load. The load shall remain covered until the truck is next in line to be unloaded. In no case shall a load remain uncovered for more than 10 minutes before starting to use the load. If for any reason there is a delay in completely using a load, the remaining part of the load shall be recovered until it can be used. It shall be the responsibility of the Contractor to inform all truck drivers of these provisions before starting work.

2205.7 Scales and Weighing of Vehicles

The vehicle's tare and gross weight shall be established by weighing the vehicle on a certified scale. The tare weight will be established at least twice each day. The vehicle, when establishing tare, shall be clean, bed empty, fuel tanks filled and shall have all side and back boards in place.

A. Measurement by weight: Measurement will be made by weighing each truck load on scales conforming to the requirements of Section 2205.7.B “Vehicle Scales”.

B. Vehicle Scales: Vehicle scales shall be approved by the Engineer and shall conform to the requirements specified herein. The specifications, tolerances, and other technical requirements for weighing and measuring devices as recommended by the National Conference on Weights and Measures and published in the National Institute of Standards and Technology Handbook 44, Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices, and supplements thereto or revisions thereof, shall apply to all vehicles scales used.

C. Scale acceptance shall be based on one of the following:

1. A valid certification or seal of approval by the Division of Weights and Measures from the state.

2. A certification of calibration from a commercial scale service company showing that the scale meets the requirements of these specifications. The Contractor shall furnish the certification of calibration to the Engineer.

D. Scale Calibration: Scales shall have been calibrated within the nine month period prior to any material being delivered, or at any time the Engineer has cause to question the accuracy of the scale. Scales shall meet the requirements of Accuracy Class III L as defined in Handbook 44 (above).

Verification of a vehicle scale may be required by weighing a hauling unit on another recently calibrated and certified scale.

If equipment to be weighed is of such length that all axles cannot be weighed simultaneously, a level paved surface shall be provided permitting those axles not on the scale platform to be supported by the paved surface. The approach shall be at least as wide as the platform and of sufficient length to insure the level positioning of vehicles during weight determinations. The weighing shall be performed with all brakes released. If equipment to be weighed is equipped with an air bag suspension unit on any axle, the equipment including semi-trailers or pup trailers shall be weighed on vehicle scales of sufficient size to weigh all axles of the combination simultaneously.

All costs incurred in obtaining a certification of calibration or verification shall be borne by the Contractor.

2205.8 Asphalt Paving Equipment

All asphalt paving equipment used by the Contractor shall meet the requirements of this section and shall be maintained in acceptable mechanical condition. Equipment shall be serviced and lubricated away from the paving site. Units that drip fuel, oil, grease or other fluids shall be removed from the project until such leakage is corrected.

A. Pavers and Laydown Machines: Mechanical self-powered pavers shall be capable of spreading the mix within the specified tolerances, true to the line, grade and crown indicated on the Plans.

Pavers shall be in good working condition, equipped with quick and efficient steering devices and shall be capable of traveling both forward and in reverse. They shall be equipped with hoppers and distributing screws that place the mix evenly in front of the adjustable screeds. They shall be equipped with either a vibrating screed or a tamping bar immediately preceding a static screed. There shall be sufficient auxiliary attachments for the paving machine so that it may be operated to lay the necessary width as determined in the field by the Engineer. Vibrating screed or tamp bars shall be provided for the full width of all paving operations.

The screed shall include a strike-off device which is effective on mixes at workable temperatures without tearing, shoving or gouging them, and which produces a finished surface of an even and uniform texture. The screed shall be adjustable as to the height and crown and shall be equipped with a controlled heating device for use when required. However, for irregular width paving, hydraulic extensions without tamping bars or a vibrating screed may be used only along the curb or outer edge of pavement.

1. Automatic Screed Controls: The paver shall be equipped with and use an approved system capable of automatically controlling the elevation and transverse slope of the paver screed unless otherwise directed by the Engineer. An erected stringline, traveling stringline or other approved device operating on the roadbed being paved or the surface of the previously placed lane shall be used to establish the grade reference. The grade reference device shall operate on either or both sides of the paver as

required and shall be capable of maintaining the desired transverse slope regardless of changes in the screed elevation.

2. The traveling stringline shall be constructed in such a manner that it does not vibrate or cause the sensor to make erroneous readings during the laydown operation. The length of the beam to be used shall be approved by the Engineer and shall be between 20 feet and 40 feet.

3. The use of the automatic screed control devices on asphalt pavers will not be required for paving small irregular areas, entrances, approaches, or side street connections.

4. Automatic screed control devices will be required for matching the joint with all previously laid strips, except for those areas noted above.

B. Rollers: Compaction equipment shall consist of vibratory steel wheel, static steel wheel and pneumatic-tired rollers unless otherwise directed by the Engineer. They shall be self-propelled and equipped with such controls that starting, stopping and reversing direction can be accomplished without displacing the hot asphaltic concrete pavement.

Rollers shall be equipped with adjustable scrapers to keep the wheel surfaces clean and with efficient means of keeping them wet to prevent mixes from sticking. The roller surfaces shall have no flat areas, openings or projections that will mar the surface of the pavement.

1. Steel-Wheeled Rollers: Steel-Wheeled Rollers shall be self-propelled, vibratory two-axle tandem rollers. These rollers shall develop contact pressure of 250 to 350 pounds per inch of width (vibratory mode) or 150 to 180 pounds per inch of width (static). Rollers shall be in good working condition.

2. Pneumatic-Tired Rollers: Heavy pneumatic-tired rollers shall be self-propelled and shall consist of two axles on which are mounted an odd number of pneumatic-tired wheels. The roller shall have at least nine pneumatic-tired wheels mounted in such a manner that the rear group of wheels will not follow in the tracks of the forward group, but shall be spaced to give essentially uniform coverage with each pass. Axles shall be mounted in a rigid frame provided with a loading platform or body suitable for ballast loading. Tires shall be smooth, inflated to 90 psi. Construction of the roller shall be such that each wheel is loaded to a minimum of 2,300 pounds.

3. In lieu of the above requirements, consideration will be given to use other types of equipment that are capable of producing equivalent results consistent with the requirements of the specifications. Any roller not meeting the requirements of paragraphs 1 and 2 above must be approved by the Engineer prior to use.

C. Pressure Distributor: The pressure distributor shall meet the requirements of Section 2204.4.A entitled "Pressure Distributor".

D. Hand Tools: The Contractor shall provide sufficient lutes, rakes, shovels, and other equipment as required to produce results consistent with the specifications.

2205.9 Construction

A. Preparation of the Area to be Paved: The area to be paved shall be true to line and grade, and shall have a properly prepared surface prior to the start of the paving operations. It shall be free from all loose or foreign material.

Where a base is rough or uneven, a leveling course shall be placed and properly compacted before the placing of subsequent courses.

When leveling course is not required, depressions and other irregularities shall be patched or corrected, and the work approved by the Engineer before the paving operation begins.

The area to be paved shall be primed or tacked uniformly in accordance with the provisions of Section 2204 entitled "Prime and Tack Coat".

The surfaces of curbs, gutters, vertical faces of existing pavements and all structures in actual contact with asphalt mixes shall be painted with a thin, complete coating of tack to provide a closely bonded joint.

B. Weather Limitations: When the moisture of the aggregate in the stockpile or from the dryer interferes with the quality of mix production, or with normal plant operations, the mixing and placing of hot-mix asphalt will not be permitted without the permission of the Engineer. No mixture shall be placed on wet or frozen surface.

Hot Mix asphalt paving shall not be mixed or placed when the ambient air or base temperature is below the temperatures shown in the following table, or when there is frost in the subgrade or any other time when weather conditions are unsuitable for the type of material being placed without expressed approval of the Engineer.

Paving Course	Thickness (inches)	Air Temperature (Degrees F)	Road Surface Temperature (Degrees F)
Surface	All	50	55
Base	Less than 3	40	45
Base	3 or more	30	35

All bituminous mixtures shall be delivered to the paver at a temperature sufficient to allow the material to be placed and compacted to the specified density and surface tolerance. Minimum allowable temperature for the asphalt mix to be placed into the paver is 235º F. Regardless of the temperature, final acceptance of the asphalt mat shall be based on density determined in accordance with Section 2205.9.E.

C. Spreading and Finishing: The spreading and finishing of each course shall be to the thickness, cross slope, and width indicated on the Plans or Special Provisions. The thickness of individual layers shall not exceed the following for the respective type of mixture. The suggested minimum lift thickness shall be three times the nominal maximum size of the mix. Nominal maximum is defined as the first sieve size larger than the sieve which retains at least 10% of the aggregate by weight.

Asphalt Type	Max. Compacted Lift Thickness
Type 1-01	4"
Type 2-01	4"
Type 3-01	3"
Type 4-01	2"
Type 5-01	4”
Type 6-01	3”

Spreading and finishing shall be conducted in the following manner:

1. Mechanical Pavers: The base and surface courses shall be spread and struck-off with a mechanical paving machine meeting the requirements of Section 2205.8.A entitled "Pavers and Laydown

Machines". The paving machine shall be operated so that the material does not accumulate and remain along the sides of the receiving hopper. The wings of the spreader hopper shall not be emptied (flipped) between truck loads.

a. Equipment which leaves tracks or indented areas which cannot be corrected in normal operation, or which produces other permanent blemishes or fails to produce a satisfactory surface, shall not be used.
b. The screed auger shall be operated approximately 3/4 full and the hopper conveyor shall not be allowed to run out of material during the paving operation. Sufficient trucks shall be used to continuously supply asphalt to the paver. Delays in the paving operation shall be kept to a minimum.
c. When using pavers in echelon, the second paver shall follow the edge of the material placed by the first paver. The length of each laydown pass shall be limited, depending on weather conditions, to assure a hot joint and obtain proper compaction.

2. Longitudinal joints and edges shall be constructed to true lines. Lines for the paver to follow in placing individual lanes will be established parallel to the centerline of the proposed roadway. The paver shall be positioned; and operated to follow closely the established line. Offset the longitudinal joint in successive courses by 6 to 12 inches. Longitudinal joints in the final surface layer shall be at the lane lines of the traveled way, but shall be offset to prevent lane separation pavement markings from falling on the joint. Any irregularities in alignment left by the paver shall be corrected directly behind the paver, prior to compaction. Distortion of the pavement during this operation shall be avoided. Edges against which additional pavement is to be placed shall be placed on a 30º (2:1) bevel, or as specified by the Engineer.

3. Transverse joints in succeeding courses shall be offset at least 2 feet.

4. The Contractor shall make every effort to minimize the number of passes heavy equipment makes over uncompleted roadway sections. The Contractor shall schedule and route his hauling operation to minimize hauling over a final course as much as feasible.

5. As soon as the first load of material has been spread, the texture of the unrolled surface shall be checked to determine its uniformity. Segregation of materials shall not be permitted. If segregation occurs, the spreading operation shall be immediately suspended until the cause is determined and corrected by the Contractor.

6. Any irregularities in the surface of the pavement course shall be corrected directly behind the paver. Excess material forming high spots shall be removed by a shovel or lute. Indented areas shall be filled with hot mix and smoothed. Broadcasting of material shall not be permitted.

7. Hand Spreading: In small areas where the use of mechanical finishing equipment is not practical, the mix may be spread and finished by hand. The material shall be distributed uniformly to avoid segregation of the coarse and fine aggregate. Broadcasting of material shall not be permitted. During the spreading operation, all material shall be thoroughly and uniformly distributed by lutes or rakes. Material that has formed into lumps and does not break down readily shall be removed. Following placing and before rolling, the surface shall be checked with templates and straightedges and all irregularities corrected.

D. Compaction

1. General: The Contractor is responsible for development of a compaction procedure that will obtain the

required density. A minimum of three rollers shall be used for compacting mixes on roadways (2 steel drum and 1 pneumatic tire) unless otherwise approved by the Engineer. For uses other than roadways, a minimum of two rollers shall be used unless otherwise approved by the Engineer. Rollers shall meet the requirements of Section 2205.8.B entitled "Rollers".

Immediately after spreading, each course of the pavement mixture shall be uniformly compacted by rolling. The initial or "breakdown" rolling shall be accomplished with a steel-wheeled vibratory roller and shall take place as closely behind the laydown machine as the temperature and condition of the mat will allow. The pneumatic-tired roller shall be used to knead and compact the pavement mixture following the initial rolling and preceding the final rolling. Care shall be exercised in the use of the pneumatic-tired roller to ensure that the pavement mixture is sufficiently cooled to avoid "picking up" of the mixture on the tires of the roller, and also to ensure that the pneumatic-tired rolling is completed before the mixture becomes too cool to allow satisfactory finish rolling. Final, or finish rolling, shall be done with a steel-wheeled roller in static mode. The sequence of rolling operations may be changed with the approval of the Engineer. Rolling shall be longitudinal, starting near the low or unconfined edge of the pavement, then to the other edge and finally progressing towards the center. Alternate trips of the roller shall be of slightly different lengths.

The motion of the roller shall be slow enough at all times to avoid displacement of the hot mixture (generally 3mph). Any displacement occurring as a result of reversing the direction of the roller, or from any other cause, shall be corrected immediately by the use of rakes and fresh mixture when required. To prevent adhesion of the mixture to the roller, the wheels shall be kept properly moistened, but excess water will not be permitted.

The surface of the mixture after compaction shall be smooth and true to established section and grade. Any surface which is segregated, or is in any way defective, shall be removed and replaced with fresh hot mixture at the Contractor's expense, and shall be immediately compacted to conform to the surrounding area.

2. Rolling Procedure: The Contractor is responsible for determining an acceptable rolling procedure that will provide a product that is uniformly compacted to the required density and true to line and grade. There are many possible variations that may accomplish this but the general order for rolling is:

   a. Transverse joint
   b. Longitudinal joint (if in echelon)
   c. Unconfined or low side edge
   d. Other edge
   e. Middle
   f. Intermediate rolling; same procedure as breakdown rolling but pneumatic roller should stay the thickness of the lift from the free edge
   g. Finish rolling

   When paving in echelon, 2-3 inches of the first mat shall be left unrolled, and rolled when the joint between the lanes is rolled, after the 2nd mat is placed. Edges shall not be exposed more than fifteen minutes without being rolled. Particular attention shall be given to the construction of transverse and longitudinal joints in all courses.

   In laying a surface mix adjacent to any finished area, it shall be placed sufficiently high so that, when compacted, the finished surface will be true and uniform. Where the grade is slight a level will be used to insure drainage to the desired outlet.

3. Transverse joints: The Contractor shall use a method of making a transverse construction joint that provides a thorough and continuous bond with acceptable surface texture and meeting the density requirements. The surface elevation should not vary more than 3/16" in 10' when tested across the joint. If the joint has been distorted, it shall be trimmed to a line. The joint face shall be tacked before the fresh material is placed against it.

4. Longitudinal joints: When paving against existing asphalt pavement, the edge to be joined shall be tack coated. The paver screed shall be set to overlap the first mat by 1-2 inches. The elevation of the screed above the surface of the first mat should be equal to the amount of roll-down expected during compaction of the new mat. For large aggregate mixes, the coarse aggregate in the material overlapping the cold joint should be carefully removed and wasted, leaving only the finer portion of the mixture. The overlapping material should be pushed with a lute or rake onto the side of the joint where the new pavement is located prior to compaction.

   When paving against existing concrete pavement, curb and gutter or other structure, the edge to be joined shall be tack coated. The elevation of the screed above the surface of the first mat should be equal to the amount of roll-down expected during compaction of the new mat. Where drainage of stormwater will flow from the new mat onto abutting curb and gutter, add an additional ⅛" - ¼" of thickness to the new mat.

5. Breakdown Rolling: Steel wheel rollers as specified in Section 2205.8.B entitled "Rollers" shall be used for breakdown rolling. Breakdown rolling shall be performed as close behind the paver as necessary to obtain adequate density without causing undue displacement. The breakdown roller shall be operated with the drive wheel nearest the laydown machine. Exceptions may be made by the Engineer when working on steep slopes or super-elevated curves. Breakdown rolling sequencing is to be determined by the Contractor and approved by the Engineer.

6. Intermediate Rolling: Pneumatic-tired rollers as specified in Section 2205.8.B entitled "Rollers" shall be used for intermediate rolling unless otherwise approved by the Engineer. The intermediate rolling shall follow the breakdown rolling as closely as possible and while the paving mix is still of a temperature that will result in maximum density from this operation. Pneumatic-tired rolling shall be continuous after the initial rolling until all of the mix placed has been compacted to the required density. Turning of pneumatic-tired rollers on the hot paving mix which causes displacement shall not be permitted.

7. Finish Rolling: The finish rolling shall be accomplished before the material falls below a temperature of 175º F to allow for the removal of roller marks. All roller marks shall be removed by the finish rolling operation. All rolling operations shall be conducted in close sequence.

8. In places inaccessible for the operation of standard rollers as specified, compaction shall be performed by others means meeting the requirements of Section 2205.8.B entitled "Rollers." The Contractor shall ensure that the material is thoroughly compacted to the satisfaction of the Engineer. If approved by the Engineer, hand tamping, manual or mechanical, may be used in such areas, if the required density is met.

E. Density and Surface Requirements: The completed asphalt concrete paving shall have a density equal to or greater than 95% for Types 1-01 and 5-01 Asphalt Concrete Base and 96% for Types 2-01, 3-01, 4-01, 5-01, and 6-01 Asphalt Concrete Surface. Density is based on the density of laboratory specimens from plant produced mix prepared as specified in Section 2205.4.D entitled "Mix Design Criteria" and made from a sample representing the material being tested. Density testing shall conform to ASTM D 2950, ASTM D 2726, or ASTM D 1188.

If cores are used to determine density, one or more tests (one test equals three cores) will be taken for each tonnage lot and averaged to determine acceptance. The cores will be taken from random locations within the lane being paved, a minimum of 1' from any joint or edge. The Engineer will mark the locations of all cores.

All unsatisfactory work shall be repaired, replaced or corrected. The surface of the final course shall be of a uniform texture and conform to line and grade shown on the Plans. Allowable tolerance for the final surface of roadway pavement shall conform to the requirements of Section 2211 entitled "Smoothness". Tests for Plan grade conformance and surface smoothness shall be performed by the Contractor in the presence of the Engineer. Tests shall be performed at intervals as directed by the Engineer.

2205.10 Method of Measurement

Asphaltic concrete base, asphaltic concrete surface, or asphaltic concrete base and surface may be included in the Contract Documents as separate items, or as a single item, and may be measured by one of the following:

A. Per square yard or tenth part thereof for the specified depth.

B. Per ton or tenth part thereof.

C. If pavement smoothness is required in the Contract, payment shall be in accordance with Section 2211.

2205.11 Basis of Payment

Asphaltic Concrete Surface, Asphaltic Concrete Base, or Asphaltic Concrete Base and Surface whether used for paving, patching, or leveling courses will be paid for by one of the following:

A. Contract unit bid price.

B. Contract lump sum bid price.

C. Testing described in Section 2205 is subsidiary to the price bid for asphalt unless otherwise provided for in the Contract.

SECTION 2206 ASPHALT CRACK SEALING, ASPHALT CRACK FILLING, CHIP SEALING, SLURRY SEALING, AND MICRO-SURFACING

2206.1 Scope

This section governs the furnishing of all labor, materials and equipment for the performance of asphalt crack sealing, asphalt crack filling, chip sealing, slurry sealing and micro-surfacing as shown on the Plans and in accordance with the Standard Drawings, the specifications and the Special Provisions.

2206.2 Referenced Standards

The following standards are referenced directly in this section. The latest version of these standards shall be used. If conflicting standards are referenced, the more stringent standard shall apply.

ASTM

C 88 Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
C 117 Test Method for Materials Finer than 75- um (No. 200) Sieve in Mineral Aggregates by Washing
C 131 Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
C 136 Test Method for Sieve Analysis of Fine and Coarse Aggregates
C 142 Test Method for Clay Lumps and Friable Particles in AggregatesD 36 Standard Test Method for Softening Point of Bitumen (Ring-and-Ball Apparatus)
D 140 Practice for Sampling Bituminous Materials
D 242 Standard Specification for Mineral Filler For Bituminous Paving Mixtures
D 244 Standard Test Methods for Emulsified Asphalts
D 946 Standard Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction
D 977 Standard Specification for Emulsified Asphalt
D 1073 Standard Specification for Fine Aggregate for Bituminous Paving Mixtures
D 2027 Standard Specification for Cutback Asphalt (Medium-Curing Type)
D 2028 Standard Specification for Cutback Asphalt (Rapid-Curing Type)
D 2397 Standard Specification for Cationic Emulsified Asphalt
D 2419 Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate
D 3381 Standard Specification for Viscosity-Graded Asphalt Cement for Use in Pavement Construction
D 3910 Standard Practices for Design, Testing, and Construction of Slurry Seal
D 5078 Standard Specification for Crack Filler, Hot-Applied, for Asphalt Concrete and Portland Cement Concrete Pavements
D 6372 Standard Practice for Design, Testing, and Construction of Micro-Surfacing
D 6690 Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements

AASHTO

T 53 Softening Point of Bitumen (Ring-and-Ball Apparatus)
T 59 Testing Emulsified Asphalts
M 208 Standard Specification for Cationic Emulsified Asphalt

ISSA Bulletin #139 “Test Method to Classify Emulsified Asphalt/Aggregate Mixture Systems by Modified Cohesion Tester Measurement of Set and Cure Characteristics”

Manual of Uniform Traffic Control Devices, latest Edition (MUTCD)

2206.3 Crack Sealing/Filling

A. Crack Sealant Application: Material used for crack sealing shall be a modified asphalt product selected to be compatible with the environment of application and found to meet the criteria of ASTM D 6690 with a modified resilience value between 30 and 60 percent, or material meeting the requirements of ASTM D 5078. Crack Sealing shall be understood to be the process of placing an asphaltic material into and/or above working cracks to prevent the intrusion of surface water and/or incompressibles into the crack. A working crack shall be understood to correspond to cracks that sustain more than 0.1 inch of movement during the course of the year.

B. Crack Filling Application: Material used for crack filling shall be a viscosity graded AC-20 asphalt product meeting the criteria of ASTM D 3381 Table 1, a penetration-graded asphalt product having a penetration number in the range of 85-100 measured in accordance with ASTM D 946, or material meeting the criteria of ASTM D 5078. Crack filling material may contain polyester or polypropylene fibers.

C. Material satisfying the criteria of a crack sealant may also be used as a crack filling material. Crack filling shall

be understood to be the process of placing an asphaltic material into non-working cracks to substantially reduce water infiltration and reinforce adjacent cracks. Crack filling materials shall not be used for sealing pavements in preparation for an overlay.

D. Equipment

1. Router: This machine shall be an impact cutter head with a minimum of 6 tungsten-carbide cutters. The router blades shall be driven with a minimum 25-hp gasoline engine.

2. Compressor: The compressor shall be a two-stage compressor rated as a minimum 40 CFM unit capable of delivering compressed air to the nozzle at a minimum pressure of 100 psi. The compressor shall be equipped with a filter trap to eliminate oil and moisture from the air line.

3. Hot-Air Lance (HCA): The hot air lance shall be capable of delivering super-heated air at an exit temperature in excess of 1500 degrees F and at a velocity in excess of 1000 ft/sec against the side walls of the crack. The hose shall be wrapped with reflective tape to keep hoses together and to protect workers in low light situations.

4. Melter/Applicator

   a. The melting pot shall consist of double-boiler type jacket and shall be equipped with a full sweep agitator that promotes proper mixing and maintains uniform heat distribution throughout the melting pot. The melting pot shall have sufficient capacity of the heat transfer oil reservoir that heat transfer oil is able to come in contact with 100 percent of the outside area of the jacket. The melting pot shall be equipped with a drain plug to permit 100% of the heat transfer oil to drain from the boiler. The heat transfer oil shall consist of ISO grade 68.
   b. The heat transfer oil shall be heated with a properly sized vapor fuel LP or diesel fuel burner. The heat shall be applied directly to the bottom of the heat transfer tank. The burner shall be lit by an electric spark igniter controlled by a sensor, which detects a lack of burn or ignition and subsequently shuts down the fuel supply. The unit must be capable of starting at ambient temperature and bringing the sealant up to the required applications temperature within the period of approximately one hour while continuously agitating and recirculating the sealant. The unit shall have the capability of independently monitoring both the transfer oil and melting pot temperatures. The unit shall be capable of heating a variety of application materials within a range of temperatures between 200 º F and 425 º F. The sealant should not be heated to a temperature in excess of that specified by the manufacturer.
   c. The agitator and material pump shall be actuated by hydraulic motors driven by a single, pressure-compensated hydraulic pump. Hydraulic fluid should only be pumped to the agitator or material pump motor on demand.
   d. The sealant shall be applied to the pavement through an application system consisting of a pressure feed hose and wand. The hose shall be specially manufactured to handle liquid asphalt products up to 450 º F at 350 psi working pressure. The hose shall not be less than 15 feet in length. The hand wand shall be constructed of steel of sufficient strength to withstand normal day-to-day operations. Material flow through the wand shall be controlled with a toggle switch. A squeegee shall be used to distribute the asphalt evenly and uniformly in the recommended configuration.
   e. All equipment shall be in good working order, as determined by the Engineer, on a day-to-day basis. The Engineer shall not be responsible for payment of labor or rental charges on days when the equipment is not in good working order.

E. Preparation

1. Crack sealing shall be limited to working, transverse and longitudinal cracks that are more than 1/8-inch in width. Cracks 1/8- to 5/8-inches in width requiring sealing shall be routed to 5/8-inches in width. Cracks 5/8- to 1-inch in width requiring sealing do not require routing but shall be thoroughly cleaned and sealed. Cracks shall be sealed using either the Standard Reservoir and Flush or Standard Recessed Band-Aid configurations. Cracks greater than 1-inch in width shall be filled with either an emulsion slurry and sand, widened and backfilled with Hot-Mix Asphalt (HMA) in compliance with Section 2205, or repaired in a manner approved by the Engineer. Cracks requiring filling do not require any routing but simply thorough cleaning. Cracks shall be filled using either the Simple Band-Aid, Simple Flush Fill, or Capped configurations.

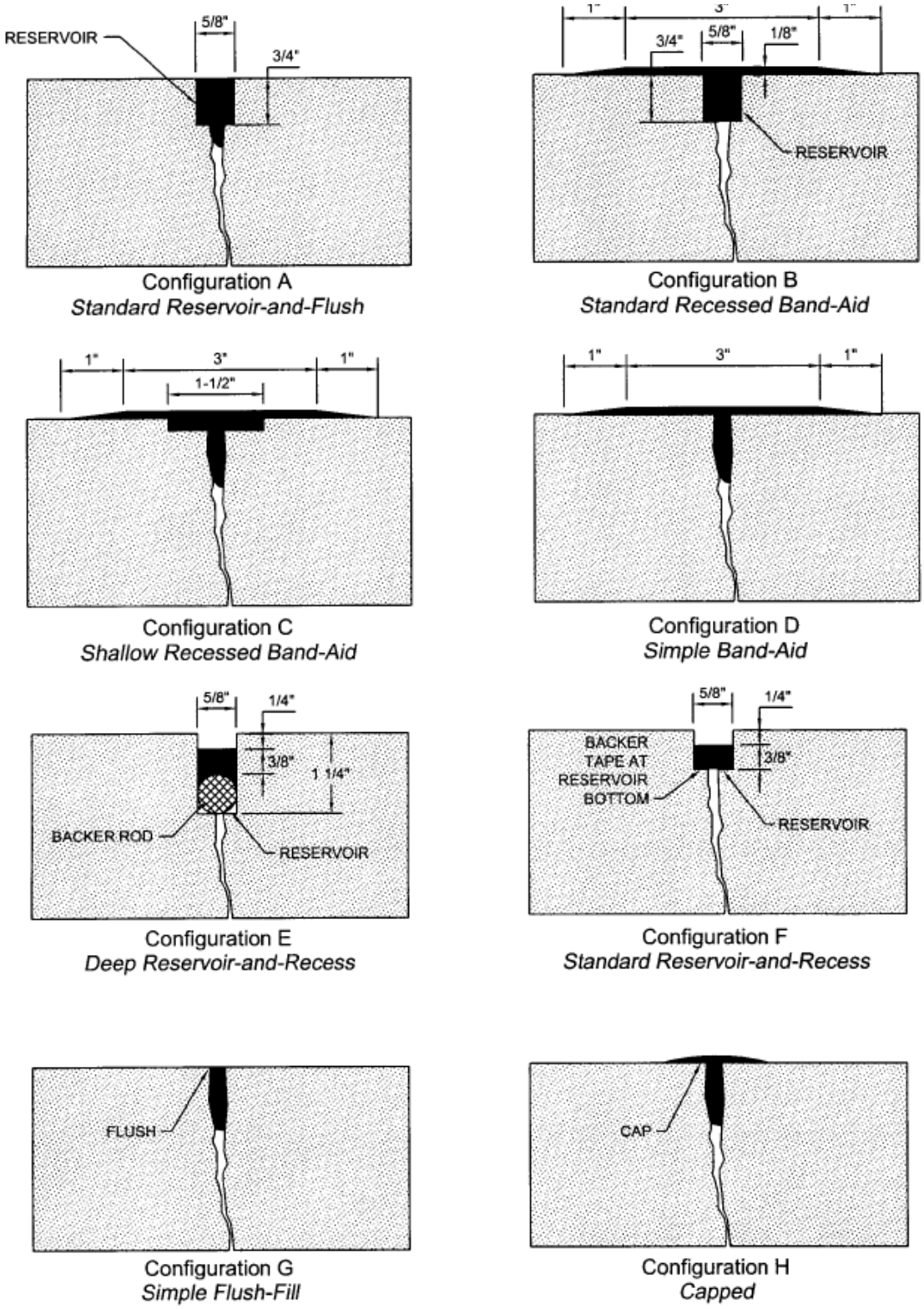
2. Cracks shall be clean and free of all deleterious materials, including any old sealant, incompressibles, and organic material. The crack shall be free of any standing water and any moisture along the sidewalls of the crack as evidenced by a darker color than the adjacent pavement. This shall be accomplished in one of three manners: wire-brushing – where the crack channels are cleaned with a mechanical wire brush followed by high-pressure compressed air; hot air blasting – where the crack channels are cleaned, heated, dried with hot compressed air (HCA) lance connected to a high pressure air compressor; or high-pressure air blasting – where the crack channels are cleaned with high-pressure compressed air. Pavement cracks to be sealed or filled shall be cleaned and dried using one of the methods described previously within 10 minutes of the application of the sealer/filler. Equipment for the two operations should be kept in a compact configuration such that not more than 50 feet separates equipment required by the two operations. Additionally, not more than 10 minutes time shall passed between the cleaning of a crack and the filling of the crack with the appropriate sealing/filling material.

F. Installation

1. Sealer/filler materials should not be applied when the pavement surface is wet or when the pavement temperature is less than 40 º F without the use of hot air blasting or the approval of the Engineer.

2. Sealant/Crack filler should be applied to fill the crack from the bottom to the top in order to prevent air bubbles from forming and creating a point of weakness in the sealant. Upon application, hot sealant/filler material should not make a hissing or popping noise indicative of moisture in the crack. Noises of this kind should indicate that additional drying of the crack is necessary in order to facilitate proper bonding of the material to the sidewalls of the crack. Application of the sealant/filler material shall be made in such a way as to completely fill the crack and provide enough excess to facilitate completion of the seal/fill consistent with the configuration selected. The use of a squeegee or applicator disk to shape the application material to conform to one of the material placement configurations shown on Figure 1 is required. Care shall be taken not to place any sealant/filler material on top of any pavement markings, manholes, or drainage castings. The Contractor shall be responsible to prevent tracking of the sealant/filler material onto the adjacent pavement surfaces to the satisfaction of the Engineer.

3. The manufacturer's technical representative shall be notified by the Contractor and shall be present during the initial installation. Prior to beginning the work, the Contractor will be required to demonstrate to the satisfaction of the Engineer and the manufacturer's representative his ability to apply the material in accordance with the manufacture's specifications. Operations and procedures which are considered by the Engineer as detrimental to the effectiveness of the material will not be permitted.



Material placement configurations for crack treatments

Figure 1

2206.4 Improved Street Chip Seal

A. Description: This work shall consist of the application of a thin, uniform layer of emulsified asphalt to the existing pavement surface in order to universally seal cracks from the intrusion of surface water. Cover aggregate shall then be uniformly distributed upon the asphalt layer and seated in place with the use of a rubber-tired roller. Any excess aggregate material shall be removed, leaving a durable wearing surface.

B. Material Requirements

1. Emulsified Asphalt

a. The asphaltic sealant material applied to the roadway surface shall consists of a rapid-setting emulsified asphalt either an anionic RS-2 meeting the criteria of ASTM D 977 or a cationic CRS-2 meeting the criteria of ASTM D 2397. These materials may be modified with rubber products in the form of liquid latex, styrene-butidane-rubber, or styrene-butidane-styrene to enhance performance of the material as approved by the Engineer. If a polymer-modified material is used, the emulsified asphalt shall meet the additional specification criteria required by the Engineer.

b. A sample of the emulsified asphalt may be taken from any of the distributors or delivery tankers on the job site. Failure of the emulsified asphalt to meet the material specification criteria at the time of application shall require the Contractor, at his own expense, to correct all unsatisfactory areas. No additional areas shall be sealed until correction has been made to the satisfaction or the Engineer.

2. Cover Aggregate – Pre-coated Chips

a. Materials: Aggregate materials shall consist of an approximately cubic and uniformly-graded, hard, durable 100 percent crushed and washed limestone, sandstone, lightweight aggregate, basalt/porphyry, granitic material, steel slag, gravel, or chat. Chat is a by-product from the production of lead and zinc from the area located in southwestern Missouri, northeastern Oklahoma, and southeastern Kansas. Lightweight aggregate shall consist of expanded shale. The application rates reported in these specifications is for the Bethany Falls Limestone in the Kansas City area. The specific gravity of this material is approximately 2.58.

b. Physical properties required of the aggregate materials:

Los Angeles Abrasion (ASTM C131)	35% loss (maximum)
Soundness using Mag. Sulfate (ASTM C 88, 5 cycles)	18% loss (maximum)
Soundness using Sodium Sulfate (ASTM C 88, 5 cycles)	12% loss (maximum)
Total Shale, clay, coal, and lignite content (ASTM C 142)	0.5% by weight (max)
Absorption	4.0% (max)

c. Gradation: Gradation of cover aggregates shall conform to the following percentages:

Sieve Size	Percent Passing
3/4” (19mm)	100
1/2” (12.5mm)	90-95
3/8” (9.5mm)	30-50
No. 4 (4.75mm)	0-5
No. 8 (2.36mm)	0

d. Pre-coating of Chips: Aggregate chips shall be uniformly heated in a dryer until surface dry. All material shall be free of moisture, dust, and lumps and shall be approved by the Engineer prior to use. The aggregate chips shall then be pre-coated with 0.9%+ 0.025% a liquid asphalt cement having a viscosity of 2000 poise, +20%. The asphaltic material and hot aggregate shall be measured separately and accurately immediately before introduction into the mixer. Mixing shall be accomplished at a temperature between 275 º F and 325 º F, sufficient to produce a thoroughly and uniformly coated aggregate. The pre-coated chips shall be stockpiled at least 3 days prior to use.

3. Weighing: Weighing of cover aggregate shall be accomplished by the Contractor on scales that he furnishes for the purpose of weighing the cover aggregate as required in Section 2205.7 entitled "Scales and Weighing of Vehicles." All loads of cover aggregate will be weighed and evidenced by approved delivery tickets showing the net weight in pounds for each load. Two copies of each ticket shall accompany the load to the work site. Upon the load being incorporated in the work, the Engineer will sign both copies and one of these copies will be returned to the Contractor.

C. Spot Patching: Areas where base failure of the roadway has occurred, or where the surface is broken out shall be repaired prior to the sealing operation. The failed sections will be marked by the Engineer, and shall be removed by sawing a neat rectangular hole into the pavement. The failed material shall be removed without damage to the adjacent pavement. Where base failures have occurred, the pavement shall be removed to the subgrade which shall be corrected to the satisfaction of the Engineer prior to patching. Unstable material shall be overexcavated and replaced with base materials meeting the requirements of Section 2203. All surfaces shall be properly primed and tacked in accordance with Section 2204.

The prepared hole shall be patched with hot-mix asphaltic patching material by placing in layers not to exceed 2 inches; each layer being thoroughly compacted before the next layer is placed. After the patching material is placed and raked to a uniform surface, it shall be thoroughly compacted by rolling with a roller meeting the requirements of Section 2205.8. The edges shall be well bonded with the old surface. The completed patch shall be in the same plane as the existing pavement.

The asphaltic concrete used for patching at the different locations shall be as directed by the Engineer and shall conform to one of the mixes as set out in Section 2205.4.

D. Sealing

1. Cleaning: After all holes and cracks have been repaired to the satisfaction of the Engineer, and immediately before sealing the Contractor shall thoroughly clean the area to be sealed with a mechanical pickup type sweeper to insure proper adhesion of the new seal coat to the existing pavement. The street shall be dry before applying the seal coat.

2. Sealing: After the street has been prepared as set forth above the Contractor shall apply the emulsified asphalt by means of an approved distributor meeting the requirements of Section 2204.4. Provisions shall be made by the Contractor to properly protect the curbs and gutters from the asphaltic spray. Emulsified asphalt shall be applied at a rate between 0.28 and 0.35 gallons per square yard. The specific rate for each job will be determined by the Engineer in the field.

Immediately after the application of the asphalt, the Contractor shall, by means of a self-propelled mechanical spreader, apply a uniform layer of cover aggregate. This material shall be spread at the rate specified by the Engineer. This rate shall be between 18 and 25 pounds per square yard of pre-coated limestone chips. The application rate shall be set to prevent bleeding of the asphaltic material

through the cover aggregate. If material is spread on any area in excess of the amount specified by the Engineer, the surplus shall be immediately removed and placed elsewhere as directed. No payment will be made to the Contractor for the picking up and redistribution of such excess. Hand spreading will be permitted only in those areas not accessible to the mechanical spreader.

Immediately after spreading the cover aggregate, the entire surface shall be rolled with multiple-wheel, pneumatic-type rollers meeting the requirements of Section 2205.8. Rolling shall be continued until a thoroughly compacted surface with a uniform aggregate coverage has been obtained, a minimum of 6 passes. The Engineer may require additional rollers if one roller cannot keep up with the operations. The first pass of the rollers over the cover aggregate shall not exceed 3 miles per hour. The rollers shall not exceed 5 miles per hour during any rolling operation.

Forty-eight hours after spreading the cover aggregate, the entire surface shall be swept with a mechanical pickup type sweeper to remove any loose or excess cover aggregate.

During the sealing operation as described above, the Contractor shall cooperate with the Engineer in arranging a program and schedule of work so traffic may be handled or routed around or through the section being sealed. Whenever possible, the street will be closed; but when this is not possible, the sealing will be done in strips while traffic is diverted to the balance of the street. No traffic will be permitted on the sealed portion of the roadway until rolling is completed. All traffic control signage shall conform to the MUTCD handbook for traffic control in work zones.

When bleeding occurs or more material is required, additional cover aggregate shall be spread as directed. As soon as the cover material has adhered to the surface, and the emulsion is thoroughly cured all excess cover aggregate shall be removed with a mechanical pickup type sweeper. This curing period is generally 48 hours, but may be adjusted by the Engineer.

2206.5 Unimproved Street Chip Seal

A. Description: This work shall consist of the application of a thin, uniform layer of liquified asphalt to the surface of the existing roadway which may either consist of an existing surface of asphaltic concrete pavement or a gravel-surfaced road. Cover aggregate shall then be distributed uniformly upon the liquified asphalt and seated in place with the use of a rubber-tired roller leaving a durable wearing surface.

B. Requirements for Liquified Asphalt Materials

Asphaltic materials used for the sealing of unimproved streets shall be liquified either by the introduction of a diluent (cutback) or by emulsification. The particular grade of cutback material for use on a particular roadway shall be determined by the Engineer. Cutback asphaltic materials shall comply with the requirements of either ASTM D 2027 or ASTM D 2028. The particular grade of emulsified asphalt material for use on a particular roadway shall be determined by the Engineer. Anionic emulsified asphaltic materials shall comply with the requirements for either a rapid or medium-setting emulsion as described in ASTM D 977 while cationic emulsified asphaltic materials shall comply with the requirements for either a medium or rapid-setting emulsion as described in ASTM D 2397.

C. Requirements for Cover Aggregate Materials

1. Aggregate materials shall consist of an approximately cubical and uniformly-sized, hard, durable 100 percent crushed and washed limestone, sandstone, lightweight aggregate, basalt/porphyry, granitic material, steel slag, gravel, or chat. Chat is a by-product from the production of lead and zinc from the area located in southwestern Missouri, northeastern Oklahoma, and southeastern Kansas. Lightweight

aggregate shall consist of expanded shale. Due to the variation in specific gravities between these materials, the application rate will need to be adjusted to reflect the change in specific gravity. The application rates reported in these specifications is for the Bethany Falls Limestone in the Kansas City area. The specific gravity of this material is approximately 2.58.

2. Physical properties required of the aggregate materials:

Los Angeles Abrasion (ASTM C 131)	35% loss (maximum)
Soundness using Mag. Sulfate (ASTM C88, 5 cycles)	18% loss (maximum)
Soundness using Sodium Sulfate (ASTM C 88, 5 cycles)	12% loss (maximum)
Total Shale, clay, coal, and lignite content (ASTM C 142)	0.5% by weight (max)
Absorption	4.0% (max)

Aggregate chips applied to cutback asphalt shall be shown to have a moisture content less than 1 percent immediately prior to application. Aggregate chips applied to emulsified asphalt shall be shown to have a moisture content of 3 percent or less immediately prior to application.

Gradation for aggregate chips used for Single sealing:

Square Sieve Size	Percent Passing
1/2" (12.5mm)	100
3/8" (9.5mm)	80-100
No. 4 (4.75 mm)	0-26
No. 10 (2.00mm)	0-2

Gradation for aggregate chips used for the first application of a Double sealing:

Square Sieve Size	Percent Passing
3/4" (19mm)	100
1/2" (12.5mm)	90 to 100
3/8" (9.5mm)	40 to 70
No. 4 (4.75mm)	0 to 15
No. 10 (2.0mm)	0-2

Gradation for aggregate chips used for the second application of a Double sealing shall conform to the gradation for a Single sealing above.

The Contractor shall furnish scales for weighing cover aggregate as required in Section 2201.7 entitled "Scales and Weighing of Vehicles". All loads of cover aggregate will be weighed as required, and evidenced by approved delivery tickets showing the net weight in pounds for each load. Two copies of each ticket shall accompany the load to the work site. In order for the load to be received and incorporated into the work, both copies will be signed by the Engineer (or inspector) and one of these copies returned to the Contractor.

D. Sealing

Sealing shall be accomplished in the same manner as described in Section 2206.3.D except as modified herein. Where a seal coat is applied to a gravel-surface roadway the surface shall be prepared in accordance with Section 2204.4. The surface shall then be primed in accordance with Section 2204.4 prior to the application of the seal coat.

The application rate of cutback asphalt shall be in the range 0.25 to 0.45 gallons per square yard as directed by the Engineer or demonstrated to result in a satisfactory seal in a test strip provided by the Contractor. Anti-Strip agent may be added to Cutback Asphalt at a rate not to exceed 1 percent of the residual asphalt volume as directed by the Engineer in order to improve adhesion of the asphalt to the moist aggregates. The cutback agent shall be thoroughly mixed and blended with the cutback asphalt. The application rate of emulsified asphalt shall be in the range of 0.28 to 0.40 gallons per square yard as approved or directed by the Engineer. The distributor used shall meet the requirements of Section 2204.4.

Limestone materials shall be spread at the rate specified by the Engineer with the range of 16 to 24 pounds per square yard.

Where double sealing is indicated on the Plans or required by the Engineer, the area shall be treated with two seal coats. The application rate of the asphaltic material for the first application shall be approximately one-half of that used for a single seal with the remainder applied during the second seal application. The application rate of the first application of cover aggregate shall be within the range specified for a single seal. The application rate of the second application shall be approximately one-half the application rate of the first layer.

2206.6 Improved Street Slurry Seal

A. Description: This work shall consist of the application of Slurry Seal Material to an existing surface. The Slurry Seal shall consist of a mixture of emulsified asphalt, mineral aggregate and potable water, properly proportioned, mixed and spread on the surface in accordance with this specification and as directed by the Engineer.

B. Material

1. Emulsified Asphalt: The emulsified asphalt shall conform to Grade SS-1h of ASTM D 977, for emulsified asphalt, or Grade CSS-1h of ASTM D 2397, for cationic emulsified asphalt. Quick-set emulsified asphalts QS-1h and CQS-1h may also be used. They shall conform to ASTM D 977 and ASTM D 2397 respectively, except that the test requirements for cement mixing and storage stability shall not apply. Refer to the International Slurry Surfacing Association (ISSA) Bulletin No. 139. The emulsified asphalt shall have not less than 60% residue after distillation when tested using ASTM D 244 and shall have a penetration of between 40 and 90 when tested using ASTM D 2397 at 77° F. Each load of emulsified asphalt delivered shall have a certificate of analysis/compliance matching the material used in the mix design.

2. Aggregate for Slurry Seal: The mineral aggregate used for this work shall be natural or manufactured crushed granite, slag, or chat which is a byproduct of the milling of lead and zinc ores and shall conform to one of the following grading requirements when tested in accordance with ASTM C 136 and ASTM C 117. All aggregate shall conform to the quality requirements of ASTM D 1073.

GRADING REQUIREMENTS FOR AGGREGATE			
Sieve Size	Amount Passing Sieves, Weight %		
	Type I	Type II	Tolerance
3/8 inch (9.5 mm)	100	100	
No. 4 (4.75 mm)	100	90 – 100	+/- 5%
No. 8 (2.36 mm)	90 – 100	65 – 90	+/- 5%
No. 16 (1.18 mm)	65 – 90	45 – 70	+/- 5%
No. 30 (600 um)	40 – 65	30 – 50	+/- 5%
No. 50 (300 um)	25 – 42	18 – 30	+/- 4%
No. 100 (150 um)	15 – 30	10 – 21	+/- 3%
No. 200 (75 um)	10 - 20	5 – 15	+/- 2%

The percent passing the No. 200 (75 um) sieve shall be determined by ASTM C 117.

3. Mineral Filler: Mineral Fillers are of two types, chemically active and chemically inactive. Both shall conform to ASTM D 242. Chemically active mineral fillers such as Portland cement, hydrated lime, and ammonium sulfate are used to improve workability, regulate the setting time, and, in some cases, to alter the aggregate gradation. Chemically inactive mineral fillers such as limestone dust, fly ash, and rock dust are used mainly to alter aggregate gradation.

4. Water: All water used shall be potable and shall be free of harmful salts or contaminates.

5. Mix Design: The Engineer shall approve all slurry seal materials and methods prior to mixing and application. The Contractor shall submit a completed and tested slurry seal mix design for the Engineer's approval. The approved test method for emulsified asphalt slurry seal shall be found in ASTM D 3910. The mix design shall be made with the same materials the Contractor will be using on the project. The percentage of each material must be shown on the mix design. Proportions of the mixture shall be as follows unless variations are approved by the Engineer:

	TYPE I	TYPE II
Aggregate for Slurry Seal	8.0 to 12.0 lbs per sq yd 3.63 to 5.44 kg/m^2 (dry basis)	13.5 to 16.5 lbs per sq yd 7.32 to 8.95 kg/m^2 (dry basis)
Emulsified Asphalt (Residual Asphalt Content)	10.0 to 16.0% by weight of dry aggregate	7.5 to 13.5% by weight of dry aggregate
Mineral Filler	1.5 to 3.0% by weight of dry aggregate	1.5 to 3.0% by weight of dry aggregate
Water	Minimum amount necessary to obtain a fluid and homogenous mixture	Minimum amount necessary to obtain a fluid and homogenous mixture

Once the proper consistency is obtained, changes in proportioning of the various components of the mixture shall be held to a minimum.

6. Application Rates: The slurry seal mixture shall be of proper consistency at all times so as to provide the application rate required by the surface condition and shall be in accordance with the following:

Type I: 8.0 to 12.0 lbs per sq yd
Type II: 13.5 to 20 lbs per sq yd

Application rates are affected by the unit weight of the aggregate, the gradation of the aggregate and

the demand of the surface to which the slurry seal is being applied.

7. Equipment: The slurry mixing machine shall be a continuous flow mixing unit and shall be capable of delivering accurately a predetermined proportion of aggregate, water and asphalt emulsion to the mixing chamber and to discharge the thoroughly mixed product on a continuous basis. The equipment shall be capable of pre-wetting the aggregate immediately prior to mixing with the emulsion. The mixing unit of the mixing chamber shall be capable of thoroughly blending all of the components together without violent mixing. The mixing machine shall be equipped with an approved fines feeder that includes an accurate metering device or method to introduce a predetermined proportion of mineral filler into the mixer. The mineral filler shall be fed at the same time and location as the aggregate. The fines feeder shall be required whenever added mineral filler is a part of the aggregate blend. The mixing machine shall be equipped with a water pressure system and fog-type spray bar, adequate for complete fogging of the surface receiving slurry treatment. Attached to the mixer machine shall be a mechanical type squeegee distributor, equipped with flexible material in contact with the surface of the pavement to prevent loss of slurry from the distributor. It shall be maintained so as to prevent loss of slurry on varying grades and crown by adjustments to insure uniform spread. There shall be a steering device and a flexible strike-off. The spreader box shall have an adjustable width. The box shall be kept clean and build-up of asphalt and aggregate on the box or in the corners shall not be permitted. Use of burlap drags or other drags shall be approved by the Engineer. Hand squeegees, shovels, and other equipment shall be provided if necessary to supplement the slurry mixing machine. Power brooms, power blowers, air compressors, and hand brooms suitable for cleaning the surface and cracks of the existing surface shall be implemented to provide a clean surface.

8. Construction Requirements

   a. Surface Preparation: Immediately prior to applying the slurry, clean the surface of all loose material, mud spots, vegetation, and other objectionable material. Any standard cleaning method used to clean pavements will be acceptable except water flushing. A pickup sweeper must be used unless otherwise approved by the Engineer. Manholes, valve boxes, drop inlets, and other service entrances shall be protected from the slurry seal by a method approved by the Engineer.
   b. Application: The surface shall be pre-wetted by fogging ahead of the slurry box unless waived by the Engineer. Water used in pre-wetting the surface shall be applied at such a rate that the entire surface is damp with no apparent flowing water in front of the slurry box. The slurry mixture shall be of the desired consistency upon deposit on the surface and no additional elements shall be added. Total time of mixing shall not exceed four (4) minutes. A sufficient amount of slurry shall be carried in all parts of the spreader at all times so that a complete coverage is obtained. Overloading of the spreader shall be avoided. No lumping, balling, or unmixed aggregate shall be permitted. No segregation of the emulsion and aggregate fines from the coarse aggregate shall be permitted. If the coarse aggregate settles to the bottom of the mix, the slurry shall be removed from the pavement. No excessive breaking of emulsion shall be allowed in the spreader box. No streaks, such as those caused by oversized aggregate will be left in the finished pavement.
   c. Hand Work: Approved squeegees shall be used to spread slurry in areas not accessible to the slurry mixer. Care should be exercised in leaving no unsightly appearance from the hand work.
   d. Curing: Treated areas shall be allowed to cure for four hours, or until such time as the Engineer permits their opening to traffic.
   e. Weather Limitation: The slurry seal shall not be applied if either the pavement or air temperature is below 60° F and falling. The mixture shall not be applied if the relative

humidity exceeds 80%.

f. Traffic Control: Suitable methods shall be used to protect the slurry from all types of traffic until sufficiently cured to accept traffic. The length of time before traffic is permitted to use the surface depends on the type of emulsified asphalt, mixture characteristics, and weather conditions.

g. Lines: Care shall be taken to insure straight lines along curb and shoulders. No runoff on these areas will be permitted. Lines at intersections will be kept straight to provide good appearance.

h. Property Owners Notification: The Contractor shall supply and place door tags on the doors of all involved property owners. The door tag language shall be approved by the Engineer.

i. Provisions for Public Convenience During Sealing Operation: The Contractor shall provide and maintain sufficient signs, barricades, warning lights, flag persons and watch persons to protect the work and public in a manner satisfactory to the Engineer. Any areas damaged prior to acceptance by the Engineer shall be repaired at the Contractor's expense. "No Parking" signs will be furnished by the Contractor. These signs shall comply with the standards established by the MUTCD with regard to size, color, working height and placement. When "No Parking" signs are posted on the streets with parking meters, the Contractor shall cover the parking meter heads with cloth or paper bags. The Contractor shall take all necessary precautions to protect the public (pedestrian and vehicular) from flying debris. The Contractor shall use warning signs and devices to warn motorists and pedestrians of work ahead.

2206.7 Improved Street Micro-Surfacing

A. Description: This work shall consist of the application of a polymer modified asphalt emulsion, mineral aggregate, mineral filler, potable water, and other additives, properly proportioned, mixed and spread on a paved surface in accordance with this specification and as directed by the Engineer.

B. Materials

1. Emulsified Asphalt: The emulsified asphalt shall be a quick wet polymer modified asphalt emulsion conforming to the requirements specified in ASTM D 2397 or AASHTO M 208 for Grade CSS-1h. The cement mixing test shall be waived for this emulsion. The polymer material shall be milled or blended into the asphalt or emulsifier solution prior to the emulsification process. The emulsified asphalt shall have not less than 62% residue after distillation when tested using ASTM D 244. The temperature for this test shall be held below 280° F. Higher temperatures may cause the polymers to break down. In addition, the emulsified asphalt shall have a penetration of between 40 and 90 when tested using ASTM D 2397 at 77° F (25° C) and shall have a minimum softening point of 135° F when tested using ASTM D 36. Each load of emulsified asphalt delivered shall have a certificate of analysis/compliance matching the material used in the mix design.

2. Aggregate for Micro-Surfacing: The aggregate shall be a manufactured crushed stone such as granite, or chat which is a by-product of the milling of lead and zinc ores. The aggregate shall be totally crushed with 100% of the parent aggregate being larger than the largest stone in the gradation to be used. The mineral aggregate used shall conform to one of the following grading requirements when tested in accordance with ASTM C 136 and ASTM C 117. All aggregate shall conform to the quality requirements of ASTM D 1073.

GRADING REQUIREMENT FOR AGGREGATE			
Sieve Size	Amount Passing Sieves, Weight %		
	Type I	Type II	Tolerance
3/8 inch (9.5 mm)	100	100	
No. 4 (4.75 mm)	90 – 100	70 – 90	+/- 5%
No. 8 (2.36 mm)	65 – 90	45 – 70	+/- 5%
No. 16 (1.18 mm)	45 – 70	28 – 50	+/- 5%
No. 30 (600 um)	30 – 50	19 – 34	+/- 5%
No. 50 (300 um)	18 – 30	12 – 25	+/- 4%
No. 100 (150 um)	10 – 21	7 – 18	+/- 3%
No. 200 (75 um)	5 - 15	5 – 15	+/- 2%

The combined aggregate prior to the addition of any chemically active mineral filler shall have a sand equivalent of not less than 65 when tested by ASTM D 2419. The aggregate shall have a weighed average loss not greater than 25% using magnesium sulfate when tested by ASTM C 88. Testing of abrasion resistance shall not exceed 30% when tested by ASTM C 131.

3. Mineral Filler: Mineral filler shall be any recognized brand of non-air entrained Portland cement or hydrated lime. The mineral filler shall be free of lumps and accepted upon visual inspections. The type and amount of mineral filler needed shall be determined by a laboratory mix design and will be considered as part of the aggregate gradation.

4. Water: All water used shall be potable and shall be free of harmful salts or contaminates.

5. Additives: Additives may be added to the emulsion mix or any of the component materials to provide the control of the quick-traffic properties. They must be included as part of the mix design and be compatible with the other components of the mix.

6. Mix Design: The Engineer shall approve all micro-surfacing materials and methods prior to mixing and application. The Contractor shall submit a completed and tested micro-surfacing mix design for the Engineer's approval. The approved test method for micro-surfacing shall be found in ASTM D 6372. The mix design shall be made with the same materials the Contractor will be using on the project. The percentage of each material must be shown on the mix design. Proportions of the mixture shall be as follows unless variations are approved by the Engineer.

	TYPE I	TYPE II
Aggregate for Micro-surfacing	10.0 to 20.0 lbs per sq yd 4.53 to 9.07 kg/m^2 (dry basis)	13.5 to 16.5 lbs per sq yd 7.32 to 8.95 kg/m^2 (dry basis)
Emulsified Asphalt (Residual Asphalt Content)	7.5 to 13.5% by weight of dry aggregate	7.5 to 13.5% by weight of dry aggregate
Polymer Based Modifier	Minimum of 3% solids based on asphalt weight content	Minimum of 3% solids based on asphalt weight content
Additive	As needed	As needed
Mineral Filler	0.0 to 3.0% by weight of dry aggregate	0.0 to 3.0% by weight of dry aggregate
Water	Minimum amount necessary to obtain a fluid and homogenous mixture	Minimum amount necessary to obtain a fluid and homogenous mixture

Once the proper consistency is obtained, changes in proportioning of the various components of the mixture shall be held to a minimum.

7. Application Rates: The Micro-Surfacing mixture shall be of proper consistency at all times so as to provide the application rate required by the surface condition and shall be in accordance with the following:

   Type II: 10.0 to 20.0 lbs per sq yd
   Type III: 15.0 to 30.0 lbs per sq yd

   Application rates are affected by the unit weight of the aggregate, the gradation of the aggregate, and the demand of the surface to which the micro-surfacing is being applied.

8. Equipment

   a. Micro-Surfacing Mixing Equipment: The micro-surfacing mixing machine shall be specifically designed and manufactured to lay micro-surfacing. The machine shall be self-propelled, continuous flow mixing unit able to accurately deliver and proportion the aggregate, emulsified asphalt, mineral filler, control setting additive, and water to a revolving multi-blade double-shafted mixer and discharge the mixed product on a continuous flow basis. The machine shall have sufficient storage capacity for aggregate, emulsified asphalt, mineral filler, control additive, and water to maintain an adequate supply to the proportioning controls. On major highway work, the machine may be required to be a self-loading machine capable of loading materials while continuing to lay micro-surfacing. The self-loading machine shall be equipped to allow the operator to have full control of the forward and reverse speed during application of the micro-surfacing material and be equipped with opposite side drivers stationed to assist in alignment. The self-loading device, opposite side drivers stations, and forward and reverse speed controls shall be original equipment manufacturer designed.
   b. Proportioning Devices: Individual volume or weight controls for proportioning each material, and used in material calibration, shall be provided and properly marked.
   c. Calibration: Each mixing unit to be used in the performance of the work shall be calibrated prior to construction. Calibration documentation shall include an individual calibration of each material at various settings, which can be related to the machine metering devices. No machine will be allowed to work on the project until a calibration has been completed. Final calibration sheets shall be provided to the Engineer for acceptance.
   d. Micro-Surfacing Spreading Equipment: The machine shall include a surfacing box with twin-

shafted paddles or spiral augers fixed in a spreader box. A flexible front seal shall be provided to insure no loss of mixture at the road surface contact point. The rear flexible seal shall act as a final strike-off and shall be adjustable in width. The spreader box and rear strike-off shall be so designed and operated that a uniform consistency is achieved to produce a free flow of material to the rear strike-off box. The box shall have suitable means provided to side-shift the box to compensate for variations of pavement geometry. A secondary strike-off shall be provided to improve the surface texture. It shall have the same leveling adjustments as the spreader box.

e. Auxiliary Equipment: Hand squeegees, shovels, traffic control equipment, and other support and safety equipment shall be provided as necessary to perform the work.

f. Cleaning Equipment: Power brooms, pickup sweepers, power blowers, air compressors, and hand brooms suitable for cleaning shall be utilized to provide a clean surface.

9. Construction Requirements

a. Surface Preparation: Immediately prior to applying the micro-surfacing, the surface shall be cleaned of all loose material, silt spots, vegetation, and objectionable material as determined by the Engineer. Any standard cleaning method used to clean pavements will be acceptable except water flushing. Manholes, valve boxes, drop inlets, and other service entrances shall be protected from the micro-surfacing by a method approved by the Engineer.

b. Application: If the pavement area to be covered is extremely oxidized and raveled or is concrete or brick, a tack coat may be required at the discretion of the Engineer. The tack coat shall conform to Section 2204 and shall be a SS or CSS grade. The tack coat shall be allowed to break sufficiently before the application of micro-surfacing. The surface shall be pre-wetted by fogging ahead of the spreader box unless waived by the Engineer. Water used in pre-wetting the surface shall be applied at such a rate that the entire surface is damp with no apparent flowing water in front of the spreader box. The micro-surfacing mixture shall be of the desired consistency upon deposit on the surface and no additional elements shall be added. A sufficient amount of material shall be carried in all parts of the spreader box at all times so that a complete coverage is obtained. Overloading of the spreader box shall be avoided. No lumping, balling, or unmixed aggregate shall be permitted. No streaks, such as those caused by oversized aggregate shall be left in the finished surface.

c. Hand Work: Areas which cannot be reached with the mixing machine shall be surfaced using approved hand squeegees to provide a complete and uniform coverage. If necessary, the area to be hand-worked shall be lightly dampened prior to mix placement. The same type of finish as applied by the spreader box shall be required.

d. Curing: Micro-surfacing shall be allowed to cure for one hour, or until the Engineer permits opening the street to traffic.

e. Weather Limitation: Micro-surfacing shall not be applied if either the pavement or air temperature is below 60° F and falling. The mixture shall not be applied if the relative humidity exceeds 80%.

f. Traffic Control: Suitable methods shall be used to protect the micro-surfacing from all types of traffic until sufficiently cured to accept traffic. The length of time before traffic is permitted to use the surface shall be determined by the Engineer.

g. Lines: Care shall be taken to insure straight lines along curb and shoulders. No runoff on these areas will be permitted. Lines at intersections will be kept straight to provide good appearance.

h. Property Owners Notification: The Contractor shall supply and place door tags on the doors of all involved property owners. The door tag language shall be approved by the Engineer.

i. Provisions for Public Convenience During Surfacing Operation: The Contractor shall provide and maintain sufficient signs, barricades, warning lights, flag persons and watch persons to

protect the work and public in a manner satisfactory to the Engineer. Any areas damaged prior to acceptance by the Engineer shall be repaired at the Contractor's expense. "No Parking" signs will be furnished by the Contractor. These signs shall comply with the standards established by the MUTCD with regard to size, color, working height and placement. When "No Parking" signs are posted on the streets with parking meters, the Contractor shall cover the parking meter heads with cloth or paper bags. The Contractor shall take all necessary precautions to protect the public (pedestrian and vehicular) from flying debris. The Contractor shall use warning signs and devices to warn motorists and pedestrians of work ahead.

2206.8 Method of Measurement

A. Asphaltic Crack Seal will be measured per pound.

B. Chip seal will be measured by one of the following:

1. Per square yard or tenth part thereof.

2. Actual quantities used:

a. Asphaltic concrete patch, per ton or tenth part thereof.
b. Bitumen (asphaltic cement or liquid asphalt) per gallon.
c. Coated cover aggregate, per ton or tenth part thereof.

C. Slurry seal will be measured per square yard or tenth part thereof.

D. Micro-surfacing will be measured per square yard or tenth part thereof.

2206.9 Basis of Payment

A. Asphaltic Crack Seal will be paid for by one of the following:

1. Contract unit bid price.

2. Contract lump sum bid price.

B. Chip Seal will be paid for by one of the following:

1. Contract unit bid price.

2. Contract lump sum bid price.

C. Slurry Seal will be paid for by one of the following:

1. Contract unit bid price.

2. Contract lump sum bid price.

D. Micro-surfacing will be paid for by one of the following:

1. Contract unit bid price.

2. Contract lump sum bid price.

SECTION 2207 COLD MILLING

2207.1 Scope

This section governs the furnishing of all labor, materials and equipment for the performance of cold milling pavement surfaces as shown on the Plans and in accordance with the Standard Drawings, the specifications and the Special Provisions. This work will consist of the removal of the existing surface, loading, hauling, and stockpiling, if required, of the milled material and the cleaning of the milled surface.

2207.2 Equipment

Milling the surface of pavements shall be completed by the use of a milling machine conforming to the following:

A. Machine: The cold milling machine shall be self-propelled and able to automatically control grade and slope of the milled surface. Operate the automatic grade and slope control from a travelling stringline a minimum of 30 feet long, attached the milling machine and operating parallel to the direction of travel. Other methods of positive grade control may be used if approved by the Engineer. The machine shall have the means of milling without damaging the remaining pavement (torn, gouged, shoved, broken, etc.). The machine shall be capable of blading the cuttings into a single windrow or depositing them directly into a truck.

B. Air Pollution: The machine shall be equipped with a dust suppression system including water storage tanks and high pressure spray bars.

C. Operating Width: It is desirable that the cutting width be greater than 6 feet. In the event the cutting width is less than 6 feet, a system of electronic grade control for consecutive passes will be required.

D. Cutting Drum: The cutting drum shall be totally enclosed to prevent discharge of any loosened material on adjacent work areas.

2207.3 Construction

A. Methods of Operations for Milling

1. Utilities: Street surfaces adjacent to manholes, water valves and other utility extensions shall be completely removed to the full depth of cut specified for the street unless otherwise specified by the Engineer.

2. Material Disposal: All material from the milling operation shall be removed immediately from the surface of the pavement and properly disposed of by the Contractor at an approved disposal area.

3. Surface Conditions: The drum lacing patterns shall produce a smooth surface finish after milling, with groove depths not to exceed 1/4 inch and groove spacing not to exceed 1 inch unless otherwise approved by the Engineer.

B. Types of Cuts to be made by Milling

1. Leveling: Sufficient passes shall be made such that all irregularities or high spots are eliminated, and that 100% of the surface is milled.

2. Average Depth: Sufficient passes, or cuts, shall be made in order to remove a specified depth over the entire street section. These depths will be designated in the Plans or Special Provisions.

3. Curb Cut: Sufficient passes or cuts shall be made to remove the specified depth at the curb for a specified width. These dimensions will be designated in the Plans or Special Provisions.

4. Bridge Deck Milling: Sufficient passes, or cuts, shall be made in order to remove the material as specified on the Plans or in the Special Provisions.

C. Cleanup: All loose asphalt and debris shall be removed from the street surface and curb and gutter. Any material and debris that adheres to the curb and gutter shall be removed.

D. Opening to Traffic: If the milled area will be opened to traffic prior to surfacing, provide a smooth riding surface by either milling or placing a wedge of hot mix asphalt or other approved material of a thickness and design that will remain in place under traffic. The transition between the milled area and transverse joints shall be a minimum of 1 vertical to 24 horizontal. The transition between the milled surface and manholes, utility fixtures or other appurtenances shall be a minimum of 1 vertical to 12 horizontal. Transitions shall be removed prior to surfacing.

2207.4 Method of Measurement

Cold milling will be measured per square yard or tenth part thereof for the specified depth.

2207.5 Basis of Payment

Cold milling will be paid for by one of the following:

A. Contract unit bid price.

B. Contract lump sum bid price.

SECTION 2208 PORTLAND CEMENT CONCRETE PAVEMENT

2208.1 Scope

This section governs the furnishing of all labor, materials and equipment for the placement of Portland Cement Concrete Pavement as shown on the Plans and in accordance with the Standard Drawings, the specifications, and the Special Provisions.

2208.2 Referenced Standards

The following standards are referenced directly in this section. The latest version of these standards shall be used. If conflicting standards are referenced, the more stringent standard shall apply.

ASTM
A 615 Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
A 775 Standard Specification for Epoxy-Coated Steel Reinforcing Bars

A 1064 Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
C 31 Standard Practice for Making and Curing Concrete Test Specimens in the Field
C 39 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
C 143 Standard Test Method for Slump of Hydraulic-Cement Concrete
C 172 Standard Practice for Sampling Freshly Mixed Concrete
C 231 Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
C 309 Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
C 1064 Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete

D 1751 Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
D 1752 Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
D 2628 Standard Specification for Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements
D 2835 Standard Specification for Lubricant for Installation of Preformed Compression Seals in Concrete Pavements
D 6690 Standard Specification for Joint and Crack Sealants, Hot-Applied, for Concrete and Asphalt Pavements
D 7174 Standard Specification for Preformed Closed-Cell Polyolefin Expansion Joint Fillers for Concrete Paving and Structural Construction
E 965 Test Method for Measuring Surface Macrotexture Depth Using a Sand Volumetric Technique

AASHTO
M 148 Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
M 213 Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
M 324 Joint Sealants, Hot-Poured, for Concrete and Asphalt Pavements

MCIB Mid-West Concrete Industry Board Concrete Specifications - Concrete Pavement
The current editions of the "Bulletins" and Approved Sections of the "Standard Concrete Specifications" issued by the Mid-West Concrete Industry Board, Inc. (MCIB) are made a part hereof by reference. However, when the provisions of this Specification differ from the provisions of such "Bulletins" and "Sections" the provisions of this Specification shall govern.

KCMMB Kansas City Metro Materials Board Specifications

Kansas Department of Transportation
Standard Specifications for State Road and Bridge Construction, 2015 Edition

Missouri Highways and Transportation Commission
Missouri Standard Specifications for Highway Construction, 2011 Edition

National Concrete Pavement Technology Center Guide Specifications for Concrete Overlays, September 2015, including latest revisions

2208.3 Materials

A. Concrete: Concrete shall conform to referenced specifications as called out in the Contract Documents. If no direct reference to concrete specifications is included in the Contract Documents, concrete shall meet KCMMB

specifications.

1. If KCMMB concrete is specified, an approved KCMMB concrete mix shall be required.

2. If MCIB concrete is specified, concrete shall comply with MCIB Section entitled “Concrete Pavement”.

3. If KDOT specifications are referenced for concrete, provide material in compliance with the latest version of KDOT specifications. Approval of component materials will be based on submittal of certifications from supplier. Aggregates shall meet the quality requirements specified by KDOT. Engineer reserves the right to perform testing of components to verify compliance.

4. If MoDOT specifications are referenced, provide material in compliance with the latest version of MoDOT specifications. Approval of component materials will be based on submittal of certifications from supplier. Aggregates shall meet the quality requirements specified by MoDOT. Engineer reserves the right to perform testing of components to verify compliance.

5. Proposed concrete mix designs for use on the project shall be submitted to Engineer for approval at least two (2) weeks in advance of anticipated use. Mix design shall be approved prior to use of that mix.

6. Field testing of concrete shall be performed by the Engineer at the frequency required by the referenced specification. Unless otherwise specified, the following tests shall be performed once for every 50 cuyd of concrete placed:

    a. Sampling of fresh concrete per ASTM C 172
    b. Slump per ASTM C 143
    c. Air Content per ASTM C 231
    d. Temperature per ASTM C 1064
    e. Cylinders cast per ASTM C 31 and tested per ASTM C 39. Four cylinders shall be cast with one tested at 7 days, 2 tested at 28 days and one held in reserve.

7. For concrete overlays, material and construction specifications shall be governed by the National Concrete Pavement Technology Center Guide Specifications for Concrete Overlays, September 2015, including latest revisions.

B. Reinforcement

1. Bars: Non-epoxy coated bars shall conform to ASTM A 615. Epoxy coated bars shall conform to ASTM A 775.

2. Welded Steel Wire: Welded steel wire fabric shall conform to ASTM A 1064.

3. Supporting Elements: Representative samples of supporting elements shall be submitted and approved by the Engineer prior to their use in the project.

4. Fibers: When specified in the Contract Documents, fibers shall be incorporated into the concrete at the rate recommended by the manufacturer but no less than a minimum of 3 pounds per cubic yard of concrete for macro fibers and 1 pound per cubic yard of concrete for micro fibers. Fibers shall meet the requirements of KDOT Standard Specifications for State Road and Bridge Construction, 2015 Edition, Section 1722.2. Micro fibers are used to control plastic shrinkage cracks in concrete while macro fibers control cracking in hardened concrete and are often used as a substitute for traditional crack

control steel reinforcing bars or mesh. In addition, macro fibers add toughness, and impact and fatigue resistance to hardened concrete.

C. Isolation Joint Fillers: Isolation joint fillers shall conform to ASTM D 1751, D 1752, or ASTM D 7174.

D. Joint Sealing Compounds: Joint sealing compounds shall conform to the standards for the type of sealant specified as listed in the following table:

Joint Seals and Sealants	AASHTO	ASTM
Hot-poured, Polymeric Asphalt Based	M 324	D 6690
Preformed Polychloroprene Elastomeric		D 2628
Lubricant for Installation of Preformed Seal	-----	D 2835
Preformed Expansion Joint Filler	M 213	D 1751, D 1752 or D 7174

E. Curing Membrane: All material to be used or employed in curing Portland Cement Concrete must be approved by the Engineer prior to its use. It shall be of the liquid membrane type and shall conform to ASTM C 309, Type II, Class B or AASHTO M 148, Type 2, white pigmented.

2208.4 Construction

Portland Cement Concrete Pavement shall be constructed to the configuration, and to the lines and grades shown on the Plans.

A. Grading, Subgrade Preparation and Base Course: All excavation, embankment, subgrade stabilization or aggregate base course required shall be as defined in Sections 2100 “Grading and Site Preparation”, 2201 "Subgrade Preparation", 2202 “Subgrade Stabilization”, and 2203 “Aggregate Base Course”. If areas of the subgrade are below the lines, grades and cross-sections shown on the Plans, they shall be brought to the proper line, grade and cross-section by one of the following:

1. Additional fill material placed in accordance with applicable sections.

2. Areas may be filled with additional thickness of Portland Cement Concrete Pavement.

B. Surface Preparation for Concrete Overlay: Prepare surface for concrete overlay as specified in the National Concrete Pavement Technology Center Guide Specifications for Concrete Overlays, September 2015.

C. Forms: All forms shall be in good condition, clean, and free from imperfections. Each form shall not vary more than 1/4 inch in horizontal and vertical alignment for each 10 feet of length.

1. Material & Size: Forms shall be made of metal and shall have a height equal to or greater than the prescribed edge thickness of the pavement slab. Wood forms may be substituted when approved by Engineer and if they are free from warp with sufficient strength for the intended application.

2. Strength: Forms shall be of such cross-section and strength, and so secured as to resist the pressure of the concrete when struck off, vibrated, and finished, and the impact and vibration of any equipment which they may support.

3. Installation: Forms shall be set true to line and grade, supported through their length and, joined neatly in such a manner that the joints are free from movement in any direction.

4. Preparation: Forms shall be cleaned and lubricated prior to each use and shall be so designed to permit their removal without damage to the new concrete.

D. Joints: Generally joints shall be formed at right angles to the true alignment of the pavement and to the depths and configuration specified by the appropriate standard or as modified by the Plans and specifications. For additional guidance on jointing, see American Concrete Paving Association jointing guides. All joints shall be sealed with sealant meeting the requirements of Section 2208.3.D. Unless specified otherwise on the Plans, specifications, Standard Drawings or Special Provisions, use hot-poured joint sealant.

1. Isolation Joints: Isolation joints shall be placed at all locations where shown on the Plans and Standard Drawings or as directed by the Engineer.

    a. Isolation joints shall extend the entire width of the pavement and from the subgrade to the surface of the pavement. The material will have a suitable tear strip or removable cap provided to allow for the application of the joint sealer to the required depth.
    b. Under no circumstances shall any concrete be left across the isolation joint at any point.
    c. Material: Isolation joints shall be formed by a one-piece, one inch thick preformed joint filler cut to the configuration of the correct pavement section.
    d. Stability: Isolation joints shall be secured in such a manner that they will not be disturbed during the placement, consolidation and finishing of the concrete.
    e. Dowels: If isolation joints are to be equipped with dowels they shall be of the size and type specified, and shall be firmly supported in place, by means of a dowel basket or other support method approved by the Engineer, which shall remain in place. Each dowel shall be lightly painted or greased with a product approved by the Engineer.

2. Contraction Joints: Contraction joints shall be placed where indicated and to the depth indicated by the Plans, specifications and Standard Drawings.

    a. Method: Contraction joints shall be sawed.
    b. When sawing joints, the Contractor shall begin as soon as the concrete hardens sufficiently to prevent excessive raveling along the saw cut and shall finish before conditions induce uncontrolled cracks, regardless of the time or weather. All sawed joints shall begin with a relief cut that shall be approximately 1/8 inch wide, and a minimum of 1/3 the thickness of the slab unless shown otherwise on the Plans. If the Plans indicate a joint width greater than 1/8" but with no backer rod, the Contractor may saw the initial relief cut to the full width. If a reservoir cut is specified that uses a backer rod, a second stage saw cut which widens the joints to allow the insertion of joint sealing material shall be performed. The second stage saw cut shall not be performed until the concrete is at least 48 hours old and shall be delayed longer when the sawing causes raveling of the concrete. If second stage sawing is performed prior to the completion of the curing period, the Contractor shall maintain the cure by use of materials approved by the Engineer.
    c. The Contractor shall be responsible for using suitable methods to cut joints straight and in the correct location. The Contractor shall protect joints from damage until completion of the project and shall repair damaged joints to the satisfaction of the Engineer.
    d. Where not indicated on the Plans or Standard Drawings, joint spacing for concrete overlays shall not exceed 12 times the thickness of the overlay, and shall be constructed such that the larger dimension of any panel does not exceed 125% of the smaller dimension. Joints of adjacent panels shall be aligned. Joints shall intersect pavement free edges at 90 degrees, and shall extend a minimum of 1 foot from the pavement edge. Saw joints shall be one-third the thickness of the slab, or two inches, whichever is greater.

e. For bonded concrete overlays, joints shall be located above existing joints, shall be sawed full depth plus one-half inch for overlays up to 4 inches in two stages. The first stage provides a relief cut approximately 1/8 inch wide.

f. Dowels: If contraction joints are to be equipped with dowels they shall be of the size and type specified and shall be firmly supported in place and accurately aligned parallel to the pavement line and grade with an allowable tolerance of 1/8 inch.

3. Longitudinal and Construction Joints: Longitudinal joints and construction joints shall be placed as shown on the Plans or where the Contractor's construction procedure may require them to be placed with approval of the Engineer. Longitudinal construction joints (joints between construction lanes) shall be keyed or tied joints of the dimensions shown on the Plans or Standard Drawings. Transverse construction joints of the type shown on the Plans or Standard Drawings shall be placed wherever concrete placement is suspended for more than 30 minutes. Unless shown otherwise on the Plans, do not place a construction joint within 5 feet of another transverse expansion, contraction or construction joint.

4. Center Joints: Longitudinal center joints shall be constructed using the methods specified in Section 2208.4.D.2 "Contraction Joints".

5. Tie Bars: Tie bars shall be deformed steel of the dimensions specified by the Plans or Standard Drawings. Tie bars shall be installed at the specified spacing and firmly secured so as not to be disturbed by the construction procedure. Tie bars shall not be placed mechanically or by hand into the plastic concrete during the paving operation unless approved by the Engineer. Tie bars shall not be located within one foot of an intersecting joint.

E. Placing, Finishing, Curing, and Protection: Concrete shall be furnished in quantities required for immediate use and shall be placed in accordance with the requirements of the applicable specification as stipulated in Section 2208.3.A. Prior to commencing construction, the Contractor shall furnish a concrete delivery plan which includes at a minimum the number of trucks which will be dedicated to the project, the location of the concrete plant, the route and distance from the plant to the job site, and the anticipated rate of concrete usage. It is essential that concrete be delivered in sufficient quantities to prevent stoppage of the paving operation.

1. Concrete Placement: The concrete shall be deposited on the subgrade to the required depth and width of the construction lane in successive batches and in a continuous operation without the use of intermediate forms or bulkheads. The subgrade shall be moistened prior to the placement of concrete. The concrete shall be placed as uniformly as possible in order to minimize the amount of additional spreading necessary. The concrete shall not be permitted to drop freely a distance of greater than 3 feet. While being placed, the concrete shall be vibrated and compacted with suitable tools so that the formation of voids or honeycomb pockets is prevented.

   The concrete shall be well vibrated and tamped against the forms and along all joints. Care shall be taken in the distribution of the concrete to deposit a sufficient volume along the outside form lines so that the curb section can be consolidated and finished simultaneously with the slab.

   No concrete shall be placed around manholes or other structures until they have been brought to the required grade, alignment, and cross slope.

   Concrete shall not be allowed to extrude below the forms.

   Limitations for time of placement and other items not specifically covered by this specification shall be in accordance with the most recent Standard Specifications of the State Department of Transportation

for the state the work is being performed in. The Engineer may extend placement time limitations based on field conditions and concrete consistency and workability.

2. Concrete Finishing Methods: The pavement shall be struck off and consolidated with a mechanical finishing machine. Hand finishing methods may be used for small or irregular areas. Furnish paving and finishing equipment applicable to the type of construction as follows:

    a. Slip-form Machines: Furnish slip-form machines capable of spreading, consolidating, screeding, and float finishing the freshly placed concrete in one pass to provide a dense and homogeneous pavement with minimal hand finishing.
    b. Self-Propelled Form-Riding Machines: Furnish mechanical, self-propelled spreading and finishing machines capable of consolidation and finishing the concrete with minimal hand finishing. Do not use machines that displace the fixed side forms.
    c. Manual Fixed-Form Paving Machines: Furnish spreading and finishing machines capable of consolidating and finishing the concrete with minimal hand finishing.
    d. Hand Methods: When finishing by hand methods, concrete shall be consolidated by use of vibrating units operating in the concrete. Unless the vibrating apparatus is such that the full width of concrete is consolidated in a single passage, a definite system or pattern shall be used in the operation of the vibrator so the full width of concrete in each linear foot of lane will receive adequate and uniform consolidation. The system and methods of vibrating shall be subject to approval of the Engineer. Vibrating equipment shall, under no circumstances, be used as a tool for moving concrete laterally on the grade.

3. Concrete Finishing

    a. Do not apply moisture (water, finishing aids, etc.) to the surface of the concrete pavement. The concrete should be provided with proper consistency and workability to place, strike off, consolidate, finish and texture without the addition of moisture. Only in the event of exceptional and unusual circumstances may the Engineer consider allowing a fine, fog mist to be added.
    b. Floating: All surfaces shall be consolidated and floated after strike-off and prior to final surface finish.
    c. Straightedging: Following the floating and while the concrete is still plastic, the surface shall be tested for trueness with a 10-foot straightedge placed parallel to the centerline and operated across the entire width of the pavement. The straightedge shall be advanced in successive stages not to exceed half its length and the operation repeated. Surface deviations greater than 1/8 inch shall be corrected and the straightedging repeated. Straightedging may be eliminated if the pavement smoothness is verified using a profilograph as specified in Section 2211.
    d. Edging: Before final finishing is completed and before the concrete has taken its initial set, the edges of the slab and curb shall be finished to 1/8" radius, or that shown on the Plans or Standard Drawings by the paving equipment, or with hand edging tools.
    e. Final Surface Finish
        i. Dragged Surface Treatment: For roadways with a design speed of 45 mph or less to be posted at 45 mph or less, astroturf or burlap shall be dragged longitudinally over the finished surface to produce a tight, uniform, textured surface, and the edges shall be rounded in a workmanlike manner.

            For roadways to be posted at 50 mph or more, astroturf or burlap shall be dragged longitudinally over the finished surface to produce a tight, uniform, textured surface, and the edges shall be rounded in a workmanlike manner. The texture achieved by

the astroturf or burlap drag shall be tested by the Contractor in accordance with ASTM E 965, "Test Method for Measuring Surface Macrotexture Depth Using a Sand Volumetric Technique", to ensure the texture is adequate for skid resistance. Test locations will be determined by the Engineer. The results of ASTM E 965 shall show an average texture depth of any lot, as defined below, and shall have a minimum value of 0.032 inch. Any lot showing an average of less than 0.032 inch but equal to or greater than 0.024 inch will be accepted as substantial compliance but the Contractor shall amend their operation to achieve the required 0.032 inch minimum depth. (It is not the intention of this tolerance to allow the Contractor to continuously pave with an average texture depth of less than 0.032 inch). Any lot showing an average texture depth of less than 0.024 inch shall require diamond grinding of the pavement represented by this lot to attain the necessary texture. Any *individual test* showing a texture depth of less than 0.020 inch shall require diamond grinding of the pavement represented by this lot to attain the necessary texture. Limits of any failing individual test shall be determined by running additional tests at 100 foot intervals before and after the failing test location. All testing of the surface texture shall be completed no later than the day following pavement placement.

ii. Groove Treatment: For roadways to be posted at 50 mph or more, the surface of the traveled lanes shall be grooved in a transverse direction unless specified otherwise in the Plans, Special Provisions, or Specifications. If approved by the Engineer, a suitable longitudinal grooving or a dragged surface treatment as described in Section 2208.4.E.3.e.i may be used in lieu of the transvers grooving. Surface grooving shall be done with a mechanical device such as a wire broom or comb or by hand. The broom or comb shall have a single row of spring steel tines, rectangular in cross section, 1/8 inch to 3/16 inch wide; spaced on 3/4 inch centers of sufficient length, thickness, and resilience to form grooves to a depth of a minimum of 1/8 inch and a maximum of approximately 3/16 inch in the plastic concrete. If grooves are to be installed by hand, the proposed equipment and process to be used shall be approved by the Engineer. This operation shall be done at such time and in such manner that the desired surface texture will be achieved while minimizing displacement of the larger aggregate particles and before the surface permanently sets. Where abutting pavement is to be placed, the grooving should extend as close to the edge as possible without damaging the edge. If abutting pavement is not to be placed, the 6 inch area nearest the edge or 1 foot from the face of the curb is not required to be grooved. For small or irregular areas or during equipment breakdown, grooving may be done by hand methods.

4. Curing: As soon as practical after the concrete is finished it shall be cured with an approved curing method. If a liquid curing membrane is used, it shall be white pigmented and applied in accordance to the manufacturer's directions.

   a. Method of Applying Curing Membrane: A nozzle producing a uniform fan pattern will be used on all spray equipment when applying the liquid curing membrane. The curing compound should be applied immediately after final finishing, and before the loss of all free water on the surface of the concrete. Normally one smooth, even coat shall be applied at a rate of 150 to 200 square feet per gallon, but two coats may be necessary to ensure complete coverage and effective protection. Second coats should be applied at right angles to the first.
   b. Curing Formed Surfaces: If the forms are removed from finished concrete pavement within a period of 72 hours or if a slip-form paving machine has been used, all exposed surfaces shall be cured. Curing membrane damaged by joint sawing operations shall be repaired by the Contractor as directed by the Engineer.

5. Protection: The Contractor shall, at his own expense, protect the concrete work against damage or defacement of any kind until it has been accepted by the Engineer. All vehicular traffic shall be prohibited from using the new concrete pavement until the following criteria have been met:

    a. Construction traffic: New concrete pavement may be opened to light construction traffic after a minimum of four (4) days of cure time has elapsed and the joints have been protected from the intrusion of foreign material by an approved method. The Contractor may reduce this length of time by one of these options, performed at the expense of the Contractor:
        i. Achieve a minimum compressive strength of 70% of the 28 day design strength as determined in accordance with ASTM C 39.
        ii. Achieve a minimum flexural strength of 350 psi using a third point loading method.
    b. All traffic: New concrete pavement may be opened to all traffic after a minimum of seven (7) days of cure time has elapsed and the joints have been sealed in accordance with Section 2208.4.D. The Contractor may reduce this length of time by one of these options, performed at the expense of the Contractor:
        i. Achieve a minimum compressive strength of 100% of the 28 day design strength as determined in accordance with ASTM C 39.
        ii. Achieve a minimum flexural strength of 450 psi using a third point loading method.

    Concrete pavement that is not acceptable to the Engineer because of damage or defacement shall be removed and replaced, or repaired, to the satisfaction of the Engineer, at the expense of the Contractor.

6. Pavement Smoothness: If required by the Contract Documents, pavement smoothness shall adhere to Section 2211. If not required by the Contract Documents, the Engineer shall determine areas to be checked for surface tolerance by the Contractor. The areas identified by the Engineer shall be checked with a 10 foot straightedge placed parallel to the center line at any location within a driving lane. Areas showing high spots of more than 1/4 of an inch in 10 feet shall be marked and ground down with approved grinding equipment to an elevation where the area or spot will not show surface deviations in excess of 1/8 inch when tested with a 10 foot straight edge. Grinding will be performed on the full width of the lane failing to meet the above criteria. The cost of correcting the smoothness and any other associated costs such as traffic control shall be at Contractor's expense.

7. Diamond Grinding: If required by the Contract Documents or if pavement smoothness criteria from Section 2208.4.E or Section 2211 are not achieved, the Contractor shall grind the riding surface to reduce or eliminate the irregularities.

    a. Use a self-propelled grinding machine with diamond blades mounted on a multi-blade arbor. Avoid using equipment that causes excessive ravels, aggregate fractures, or spalls. Provide uniform texture the full width of the lane.
    b. Transverse grooving will not be required.
    c. Use vacuum equipment or other continuous methods to remove grinding slurry and residue. Prevent the grinding slurry from flowing across lanes being used by traffic or into streams, lakes, ponds or other bodies of water, inlets, storm sewer or other drainage system.
    d. After corrections have been made to the riding surface, test the pavement for smoothness using the same technique used to determine smoothness originally. Furnish and operate the smoothness measurement equipment, and evaluate the results as specified in Section 2211.
    e. Perform additional grinding as required to attain the required smoothness. Correct all deviations (in excess of 1/2 inch in a length of 25 feet or ¼ inch in a length of 10 feet) within each section regardless of the profile index value.

8. Temperature Limitation: Concrete work shall be in accordance with the requirements of the state DOT specifications for the state where the work is being performed.

9. Backfill: A minimum of 24 hours shall elapse before forms are removed and 5 days shall elapse or the concrete must have attained 75% of its 28 day compressive strength before pavement is backfilled unless otherwise approved by the Engineer.

10. Backfill shall be accomplished in accordance with Sections 2100 and 2201 entitled "Grading and Site Preparation" and "Subgrade Preparation".

11. The Contractor shall be responsible for the repair of any existing street pavement damaged by the construction to the satisfaction of the Engineer.

12. Joint Sealing and Cleanup: All joints shall be sealed with an approved joint sealer meeting the requirements of Section 2208.3 applied in accordance with this section and the manufacturer's directions within 7 days of the placement of the concrete and prior to the opening of the pavement to traffic. If pavement design does not specifically require the use of joint sealant, prepare the joint as described on the Plans or in the specifications.

    The Contractor shall be responsible for the removal of excess dirt, rock, broken concrete, concrete splatters and overspray from the area of the construction.

2208.5 Integral Curb

If required by the Plans, Standard Drawings or Special Provisions, integral curbs shall be placed along the edges of all street pavement, except at such locations as the Engineer may direct.

The integral curb shall be constructed during or immediately following the finishing operation unless otherwise shown on the Plans. Special care shall be taken so that the curb construction does not lag behind the pavement construction and form a "cold joint".

Steel curb forms or integral slip-forming shall be required to form the backs of all curbs except where impractical because of small radii street returns or other special sections.

Concrete shall be consolidated with an approved vibrator.

Curbs shall be finished to the cross-section as shown on the Plans with a mule; or templates supported on the side forms and with a float not less than four feet in length, unless another method is approved by the Engineer.

The finished surface of the curb and gutter shall be checked for no more than 1/4 inch deviation by the use of a 10 foot straightedge and corrected if necessary.

Where grades are flat and while the concrete is still plastic, the flowline of the gutter should be checked by the Contractor to verify positive drainage.

Finishing, edging, curing, protection, jointing, temperature limitations and backfill shall all comply with Section 2208.4. The curb shall have a brush or broom finish.

2208.6 Repairing Defects

Any defect occurring prior to final acceptance of the project or the end of a Contract warranty period shall be repaired by removing and replacing the affected area to the nearest joint, or as directed by the Engineer. After project final acceptance or expiration of the warranty period, repair defects in conformance with the following. Do not begin corrective work until after submitting a plan and receiving the Engineer's approval for repair methods.

Defect Type	Defect Direction	Defect Location	Description	Repair Procedure	Alternate Procedure
Plastic Shrinkage Crack	Any	Anywhere	Only partially penetrates depth	Do nothing	Fill with HMWM2
Uncontrolled Crack	Transverse	Mid-slab	Full-depth	Saw and seal crack	LTR3
Uncontrolled Crack	Transverse	Crosses or ends at transverse joint	Full-depth	Saw and seal the crack; Epoxy uncracked joint	
Uncontrolled Crack	Transverse	Relatively parallel and within 5 ft of joint	Full-depth	Saw and seal the crack; Seal joint	FDR4 to replace crack and joint
Saw cut or Uncontrolled Crack	Transverse	Anywhere	Spalled	Repair spall by PDRS if crack not removed	
Uncontrolled Crack	Longitudinal	Relatively parallel and within 1 ft of joint; May cross or end at longitudinal joint	Full-depth	Saw and seal crack; Epoxy uncracked joint	Cross stitch crack
Uncontrolled Crack	Longitudinal	Relatively parallel and in wheel path 1-4.5 ft (from joint)	Full-depth, hairline or spalled	Remove and replace slab	Cross stitch crack
Uncontrolled Crack	Longitudinal	Relatively parallel and further than 4.5 ft from a long joint or edge	Full-depth	Cross-stitch crack; Seal longitudinal joint	
Saw cut or Uncontrolled Crack	Longitudinal	Anywhere	Spalled	Repair spall by PDRS if crack not removed	
Uncontrolled Crack	Diagonal	Anywhere	Full-depth	FDR4	
Uncontrolled Crack	Multiple per Slab	Anywhere	Two cracks dividing slab into 3 or more pieces	Remove and replace slab	

HMWM = High molecular weight methacrylate poured over surface and sprinkled with sand for skid resistance.
LTR = Load-transfer restoration; 3 dowel bars per wheel path grouted into slots sawed across the crack; Slots must be parallel to each other and the longitudinal joint.
FDR = full-depth repair; 10 ft long by one lane wide. Extend to nearest transverse contraction joint if 10 ft repair would leave a segment of pavement less than 10 ft long.
PDR = partial-depth repair; Saw around spall leaving 2 in between spall and 2 in deep perimeter saw. Chip concrete free, then clean and apply bonding agent to patch area. Place a separating medium along any abutting joint or crack. Fill area with patching mixture.
Cross-stitching: for longitudinal cracks only, drill ¾" holes at 35° angle, alternating from each side of joint on 30-36 inch spacing. Epoxy #5 epoxy coated deformed steel tie-bars into hole.

2208.7 Method of Measurement

Portland Cement Concrete Pavement will be measured per square yard or tenth part thereof for the specified depth.

2208.8 Basis of Payment

Portland Cement Concrete Pavement will be paid for by one of the following:

A. Contract unit bid price.

B. Contract lump sum bid price.

SECTION 2209 CURBING

2209.1 Scope

This section governs the furnishing of all labor, materials and equipment for the construction or reconstruction of curbing as shown on the Plans and in accordance with the Standard Drawings, the specifications, and the Special Provisions.

2209.2 Referenced Standards

The following standards are referenced directly in this section. The latest version of these standards shall be used. If conflicting standards are referenced, the more stringent standard shall apply.

ASTM
D 698 Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3))

2209.3 Materials

All Materials shall conform to Section 2208.3. Materials submittals and testing shall conform to Section 2208.

2209.4 Construction

The curbing shall be constructed or reconstructed to the configuration and to the lines and grades shown on the Plans.

A. Removal of Existing Curbing for Reconstruction: Existing curbing shall be totally removed to the nearest contraction or expansion (isolation) joint or with the approval of the Engineer it may be sawed provided no free section is left that is less than 5 lineal feet in length, and provided the entire curbing section is sawed a minimum of 2 inches below any exposed surface, or sufficiently to prevent disturbance or damage to all adjacent structures or slabs, whichever is greater.

B. Grading and Subgrade Preparation: All excavation or embankment shall conform to Sections 2100 and 2201 entitled "Grading and Site Preparation" and "Subgrade Preparation".

   Compaction shall conform to Section 2201.4.B.

C. Forms: All forms shall be in good condition, clean, and free from imperfections. Each form shall not vary more than 1/4 inch in horizontal and vertical alignment for each 10 feet in length. Face forms will be used when feasible. Forms shall have a height equal to or greater than the height of the curb face being formed. The forms shall be set true to line and grade and shall be supported to stay in position while depositing and

consolidating the concrete. The forms shall be designed to permit their removal without damage to the concrete. The forms shall be lubricated.

D. Slip-Form Curb Machine: A slip-form curb machine may be used in lieu of forms. The machine must be equipped with mechanical internal vibrators and be capable of placing curb to the correct cross section, line and grade within the allowable tolerances.

E. Joints: The joints shall be formed at right angles to the alignment of the curbing and to the depths specified by the appropriate Standard Drawing or as shown on the Plans. Joints should be aligned with concrete pavement joints where feasible.

1. Isolation Joints: Isolation joints shall be placed at all radius points, driveways, curb inlets, or where directed by the Plans or Engineer.

    a. Material: Isolation joints shall be formed by a one piece, one inch thick preformed joint filler cut to the configuration of the correct curb section, and conforming to Section 2208.3.D.
    b. Stability: Isolation joints shall be secured in a manner so they will not be disturbed by depositing and consolidating of concrete.
    c. Edging: The edges of the joints shall be rounded with an edging tool of 1/4 inch radius.

2. Contraction Joints: Curbing shall have contraction joints at intervals of not less than 10 feet or more than 15 feet. They shall extend through the entire curb section from the top of the curb to a depth 2 inches below pavement surface.

    a. Method: Contraction joints shall be formed or sawed.
        i. When sawing joints, the contractor shall begin as soon as the concrete hardens sufficiently to prevent excessive raveling along the saw cut and shall finish before conditions induce uncontrolled cracks, regardless of the time or weather. When joint sealing backup material is specified with sawed joints, the first stage, which provides a relief cut shall be approximately 1/8 inch wide, and shall be to Plan depth. The second stage which widens the joints to allow the insertion of joint sealing backup material to Plan depth shall not be performed until the concrete is at least 48 hours old, and shall be delayed longer when the sawing causes raveling of the concrete. If second stage sawing is performed prior to the completion of the curing period, the Contractor shall maintain the cure by use of curing tapes, plastic devices, or other materials approved by the Engineer.
        ii. When forming joints, templates shall be 1/8" metal cut to the configuration of the curbing section. The templates shall be secured at the proper locations so that they will not be disturbed by the depositing of concrete. The templates shall be removed as soon as the concrete has attained its initial set and finished with a ¼ inch radius on all exposed edges.
    b. Joint Sealer: When specified, joint sealants shall conform to Section 2208.3.

F. Concrete Work: Concrete for curbing shall be placed in accordance with the requirements of Section 2208.4. Isolation and contraction joints shall be constructed as shown on the Plans, Standard Drawings, or where directed by the Engineer.

1. Concrete Placement: Concrete shall be mechanically vibrated and shall not be allowed to extrude below the forms to cause an irregular alignment of the abutting street pavement.

2. Finishing: After placing and initial strike-off the curb shall be tooled to the required radii. If the surface

of the concrete is sufficiently wet that a ridge is formed at the inside of the radius tool, finishing will cease until the excessive moisture has evaporated.

After initial set, the face forms shall be removed and the surface finished to the required dimensions. No water, dryer, or additional mortar shall be applied to the free surface of the concrete.

The finished surface of the concrete shall be broomed perpendicular to the curb with a clean broom to provide an antiskid surface.

In all cases the finished curb shall have a true surface, free from sags, twists, or warps, and shall have a uniform color and appearance.

3. Curing: As soon as practical after the concrete is finished it shall be cured with a liquid curing membrane meeting the requirements of Section 2208.4.E.4, applied according to the manufacturer's directions.

   If front and/or back forms are removed from finished curbing within a period of 72 hours of placement these surfaces shall also be cured.

   Wet burlap, cotton mat, waterproof paper, polyethylene sheeting or earth backfill is not an acceptable curing method for curbing.

4. Protection: The Contractor shall protect the concrete work against damage or defacement of any kind until it has been accepted by the Engineer. Concrete which is damaged or defaced, shall be removed and replaced, or repaired to the satisfaction of the Engineer, at the expense of the Contractor.

5. Temperature Limitations: Concrete work shall be performed in accordance with requirements of the state DOT specifications for the state where the work is being performed.

6. Backfill: Backfill shall conform to Section 2208.4.E.9. The Contractor shall be responsible for the repair of any pavement disturbed by the construction to the satisfaction of the Engineer.

7. Joint Sealing and Clean-Up: Unless otherwise specified or waived by the Engineer, an approved joint sealer shall be applied in accordance with the manufacturer's directions within 7 days of the placement of the concrete. The Contractor shall be responsible for the removal of excess dirt, rock, broken concrete, concrete splatters and overspray from the area of the construction.

8. Surface Tolerances: Curbing shall have a surface tolerance of 1/4 inch in 10 feet when checked with a ten foot straightedge.

9. Repairing Defects: Defects in the concrete shall be repaired in accordance with Section 2208.6.

2209.5 Method of Measurement

Curbing will be measured per lineal foot or tenth part thereof for the applicable type.

2209.6 Basis of Payment

Curbing will be paid for by one of the following:

A. Contract unit bid price.

B. Contract lump sum bid price.

SECTION 2210

This section has been intentionally left blank.

SECTION 2211 SMOOTHNESS

2211.1 Scope

This section governs the furnishing of all labor, materials and equipment for the determination of pavement surface smoothness, evaluation of results, and corrective actions as shown on the Plans and in accordance with the Contract Documents, Standard Drawings, the specifications and the Special Provisions.

2211.2 Referenced Standards

The following standards are referenced directly in this section. The latest version of these standards shall be used. If conflicting standards are referenced, the more stringent standard shall apply.

Kansas Department of Transportation
Standard Specifications for State Road and Bridge Construction, 2015 Edition
Kansas Test Method KT-46 from KDOT Construction Manual, latest revision

Missouri Highways and Transportation Commission
Missouri Standard Specifications for Highway Construction, 2011 Edition
MoDOT Engineering Policy Guide Section 106.3.2.59 TM-59, Determination of the International Roughness Index

2211.3 Equipment

Equipment for determination of pavement smoothness and performance of corrective actions shall be in compliance with the specifications of the Department of Transportation of the state where the work is performed; for MoDOT, Section 502.8 and for KDOT, Sections 503 and 603.

2211.4 Construction

If specified in the Contract Documents, profilographing shall be performed on roadways classified as arterials, major collectors, freeways, expressways and interstates.

A. Exceptions: Unless otherwise specified in the Contract Documents, profilographing will not be required for local roads or minor collectors. In addition, other exceptions shall be as specified in the state DOT specifications for the state the work is being performed in.

    1. Finished pavements on local roads, minor collectors and other areas exempted from profilographing shall be checked with a 10 foot straightedge placed parallel to the center line at any location within a driving lane. Areas showing high spots of more than 1/4 of an inch in 10 feet shall be marked and ground down with approved grinding equipment to an elevation where the area or spot will not show surface deviations in excess of 1/8 inch when tested with a 10 foot straight edge. Grinding will be

performed on the full width of the lane failing to meet the smoothness criteria. The cost of correcting the smoothness and associated traffic control shall be at Contractor's expense.

B. Profilographing: Profilograph testing and evaluation shall be performed in accordance with the State Department of Transportation specifications and test methods for the state where the work is being performed; for MoDOT, Section 502.8 and for KDOT, Sections 503 and 603. Within two days after the paving, furnish the Engineer with the profilogram and its evaluation.

C. Corrective Actions: Corrective actions shall be performed at the Contractor's expense and in accordance with the State Department of Transportation specifications for the state where the work is being performed; for MoDOT, Section 502.8 and for KDOT, Sections 503 and 603.

D. Final Report: The Contractor shall submit a final report to the Engineer with final profilograph results verifying compliance with the specified pavement smoothness requirements.

E. Pay Adjustments: No pay adjustments (incentive or disincentive) shall be made to the smoothness or pavement items based on the results of the profilograph testing.

2211.5 Method of Measurement

Smoothness will be measured as a lump sum unit.

2211.6 Basis of Payment

Smoothness will be paid for by Contract lump sum bid price.

END OF SECTION