FORWARD

This document modifies the 2012 edition of the “Manual of Standard Specifications” and its amendments. All other provisions in the manual and in its amendments remain in full force and effect.

1. Delete the following sections.
   Section 32 01.13.52 (in Amendment No. 2) entitled Mastic Seal.
   Section 32 01 13.61 entitled Slurry Seal.
   Section 32 01 13.64 entitled Chip Seal.
   Section 32 01 13.68 entitled High Density Mineral Bond Seal
   Section 32 01 13.69 entitled Micro-Surface Seal.

2. Add the following sections (attached hereto).
   Section 32 01.13.52 entitled Mastic Seal.
   Section 32 01 13.61 entitled Slurry Seal.
   Section 32 01 13.64 entitled Chip Seal.
   Section 32 01 13.68 entitled High Density Mineral Bond Seal
   Section 32 01 13.69 entitled Micro-Surface Seal.

The deletions and additions are approved.

AGC Representative: ____________________________ Date: 3/27/2015

APWA Representative: ___________________________ Date: 2/27/15
PART 1 GENERAL

1.1. SECTION INCLUDES

A. Application of an asphalt-aggregate mastic seal coat as a high density roadway surface preservation treatment.

1.2. REFERENCES

A. AASHTO Standards:
   T 85 Specific Gravity and Absorption of Coarse Aggregate.
   T 308 Determining the Asphalt Binder Content of Hot-Mix Asphalt (HMA) by the Ignition Method.
   T 327 Resistance of Coarse Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus.

B. ASTM Standards:
   C 117 Material Finer Than 0.075mm Sieve in Aggregate.
   C 131 Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
   C 136 Sieve Analysis of Fine and Coarse Aggregates.
   D 5 Penetration of Bituminous Materials.
   D 244 Emulsified Asphalts.
   D 3628 Selection and Use of Emulsified Asphalts.
   D 3666 Minimum Requirements for Agencies Testing and Inspecting Bituminous Paving Materials.
   D 6934 Residue by Evaporation of Emulsified Asphalt
   D 6937 Determining Density of Emulsified Asphalt.
   E 1911 Measuring Paved Surface Frictional Properties Using the Dynamic Friction Tester.

C. ISSA Standards:
   TB 100 Wet Track Abrasion of Slurry Surfaces, Modified.

1.3. SUBMITTALS

A. Mix Design: Submit the following. Allow ENGINEER 10 days to evaluate the submittal.
   1. Date of mix design. If older than 60 days from date of submission, recertify mix design.
   2. Proportions of aggregate, filler, water, polymer, and emulsion in the mix.
   3. Residual in-place bitumen content, in \textit{pounds per square yard}.
   4. Residual in-place aggregate or mineral solids content, in \textit{pounds per square yard}.
   5. Thickness target for each application coat, in \textit{gallons per square yard}.
6. Total minimum thickness, in **gallons per square yard**.
7. Results of a wear resistance or wet track abrasion test current within one (1) calendar year of the proposed mix design.

B. Before Placement: Submit 48 hours before delivery.
1. Traffic control plan, Section 01 55 26.
2. List of construction equipment to be used.
3. Certification from emulsion supplier stating emulsion meets requirements in this section.
4. Names, certification levels, and years of experience of testing agency's field technicians that are assigned to the Work. Verify laboratory complies with ASTM standards.
5. Warranty.

C. Reports: If requested by ENGINEER, submit the following.
1. List of five (5) projects that have successful product application on bituminous surfaces. Provide names of project contacts.
2. Source and field quality control testing reports performed by CONTRACTOR and Suppliers.

1.4 QUALITY ASSURANCE
A. Foreman of CONTRACTOR's crew or Supplier's representative has completed at least three (3) projects of similar scope. If crew foreman does not have such experience, Supplier must provide a full-time representative on site during application.

B. Use a laboratory that complies with ASTM D 3666 and follows Section 01 45 00 requirements.

C. Verify mixture delivered to site contains the same emulsion specified in the mix design.

D. Do not change source of the asphalt emulsion or aggregate without supporting changes in the mix design.

E. Reject product or work that does not meet requirements of this section.

1.5 WEATHER
A. Temperature:
   1. Apply surface treatment material if air and pavement surface temperatures in the shade is 55 deg F. and rising.
   2. Cease application if air or pavement surface temperatures are projected to fall below 40 deg F within 48 hours.

B. Moisture and Wind:
   1. Do not apply surface treatment material to a wet surface (no visible standing water or high sheen), during rain, 24 hours prior to forecast rain, or in unsuitable windy weather.
   2. Cease work if weather or other conditions prolong opening pavement surface to traffic.

1.6 NOTICE
A. Follow Laws and Regulations concerning when and to whom notices are to be given at least three (3) days before applying surface treatment material.
B. Indicate application time and when new surface can be used. If necessary, include a map showing closed-off areas.

C. Provide phone numbers of at least two (2) individuals who represent the CONTRACTOR who can be reached at any time during the work.

D. Warn of potential vehicle tow away and other construction issues affecting neighborhood.

E. Should work not occur on specified day, issue an updated notice.

1.7 ACCEPTANCE

A. General:
   1. Acceptance is by Lot.
   2. If non-complying material has been installed and no price for the material is specified, apply pay adjustment against cost of work requiring complying material as part of its installation, Section 01 29 00.
   3. Dispute resolution, Section 01 35 10.
   4. Opening surface treatment to vehicular traffic does not constitute acceptance.
   5. Observation of CONTRACTOR’s field quality control testing does not constitute acceptance. Such testing; however, may be used by ENGINEER for acceptance if requirements of Section 01 35 10 are met.

B. Asphalt Binder:
   1. Lot size is total contracted product placement. Sub-lot size is one (1) day's production.
   2. Of all sub-lot samples collected, randomly select one and test it for physical properties in this section. The lot is acceptable if this single test meets requirements. If the test does not meet requirements, continue testing other samples for compliance.
   3. At ENGINEER's discretion, a lot with deficient sub-lot properties may be accepted if pay for the lot is reduced using one of the following applicable pay factors, or lot may be accepted at 50 percent pay if lot is in Reject.

<table>
<thead>
<tr>
<th>Pay Factor</th>
<th>Number of Non-complying Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.00</td>
<td>0</td>
</tr>
<tr>
<td>0.90</td>
<td>1</td>
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<tr>
<td>0.80</td>
<td>2</td>
</tr>
<tr>
<td>0.70</td>
<td>3</td>
</tr>
<tr>
<td>Reject</td>
<td>4</td>
</tr>
</tbody>
</table>

C. Placement:
   1. Mat appearance.
      a. No runoff onto concrete curbs, gutter pans, and shoulders.
      b. No streaking, drilling, drag marks, or squeegee marks.
      c. No light spots.
      d. No de-bonding.
      e. Straight longitudinal edges with proper joints.
   2. Mat thickness, bitumen content and aggregate content.
a. Lot size is one (1) day's production. Sub-lot size is 0.5 lane mile.
b. Collect and test five (5) equally spaced samples from the initial sub-lot. Upon review of the initial sub-lot test results and at ENGINEER's discretion, acceptance of subsequent sub-lots may be based upon one or less samples from each subsequent sub-lot.

3. Pay Adjustment: Not applicable. Correct mat placement deficiencies at no additional cost to OWNER.

1.8 WARRANTY
A. Both the CONTRACTOR and Supplier shall provide a two (2) year minimum written warranty when the existing pavement is in an appropriate condition (CONTRACTOR and Supplier to determine condition). Warranty covers delaminating, peeling and premature surface wear.
   1. Before placement, notify ENGINEER if pavement condition or application condition voids the warranty.
   2. ENGINEER may allow or cancel product application at no cost to OWNER if warranty cannot be given.
B. Acceptable performance after two (2) year period is no delaminating, peeling, or inter-aggregate loss in surface wear. Mechanical disturbances by snow plow chatter, studded tires, etc. are excluded from warranty. Repair defective coverage at no additional cost to OWNER.

PART 2 PRODUCTS

2.1 ASPHALT BINDER
A. Crack Pouring Asphalt: Rubberized asphalt or asphalt rubber hot pour, Section 32 01 17.
B. Tack Coat: SS-1 or CSS-1, Section 32 12 13.13. Use a tack coat that is compatible with seal coat application.
C. Emulsified Asphalt: Grades SS-1, SS-1H, CSS-1, or CSS-1h, selected in accordance with ASTM D 3628 and the following.

<table>
<thead>
<tr>
<th>Table 1 – Physical Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Criterion</strong></td>
</tr>
<tr>
<td>Tests on Emulsion</td>
</tr>
<tr>
<td>Viscosity at 25 deg C, seconds</td>
</tr>
<tr>
<td>Particle Charge Test</td>
</tr>
<tr>
<td>Residue by distillation, percent</td>
</tr>
<tr>
<td>Tests on Residue from Evaporation</td>
</tr>
<tr>
<td>Penetration at 25 deg C, 100 g, 5 seconds</td>
</tr>
</tbody>
</table>

NOTES
(a) In case of inconclusive particle charge, material having a pH value of 6.0 will be acceptable as a CSS type.
2.2 AGGREGATE
A. Material:
   1. Clean and free from organic matter or other detrimental substances.
   2. Light weight with the following properties.

<table>
<thead>
<tr>
<th>Table 2 - Aggregate Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Criterion</strong></td>
</tr>
<tr>
<td>Water absorption, percent</td>
</tr>
<tr>
<td>Wear (hardness or toughness), percent</td>
</tr>
<tr>
<td>Micro-Deval, percent</td>
</tr>
</tbody>
</table>

NOTES
(a) Test results are on aggregate received before blending into sealer.
(b) Micro-Deval wear of aggregate retained on No. 60 sieve.

B. Gradation: Analyzed on a dry weight and percent passing basis.
   1. Material passing any sieve and retained on the next consecutive sieve is 45 percent maximum.
   2. Target Grading Curve must lie within the Master Grading Band.

<table>
<thead>
<tr>
<th>Table 3 - Master Grading Band and Target Tolerance Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sieve</strong></td>
</tr>
<tr>
<td>No. 8</td>
</tr>
<tr>
<td>No. 16</td>
</tr>
<tr>
<td>No. 30</td>
</tr>
<tr>
<td>No. 60</td>
</tr>
<tr>
<td>No. 100</td>
</tr>
<tr>
<td>No. 200</td>
</tr>
</tbody>
</table>

NOTES
(a) Test results are on aggregate received before blending into sealer.
(b) Target tolerance is the allowable variation from the Target Grading Curve.

2.3 ADDITIVES
A. Use water that is clean, non-detrimental, and free from salts and contaminant.
B. Polymers, clays, other additives as necessary to achieve mix design performance.

2.4 MIX DESIGN
A. Select type and grade of emulsified asphalt, ASTM D 3628.
B. Select set and cure time to meet opening to traffic requirements.
C. Provide a mix containing a minimum of 18 percent aggregate by weight of the wet mixture meeting the following requirements.

<table>
<thead>
<tr>
<th>Table 4 – Mix Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Test</strong></td>
</tr>
<tr>
<td><strong>Tests on Mix</strong></td>
</tr>
<tr>
<td>Weight per gallon, pounds (a)</td>
</tr>
<tr>
<td>Solids content by evaporation at 130 C, percent (b)</td>
</tr>
<tr>
<td><strong>Tests on Residue from Evaporation</strong></td>
</tr>
<tr>
<td>Asphalt binder content of cured mix, (130 deg C method), percent (d)</td>
</tr>
<tr>
<td>Mineral aggregate and fines content of cured mix (130 deg C method), percent (d)</td>
</tr>
<tr>
<td>Wet-track abrasion loss, (72 hour soak), g/m²</td>
</tr>
<tr>
<td>Asphalt content by ignition method, percent (a)</td>
</tr>
<tr>
<td>Dynamic friction test number, 20 km/h (e)</td>
</tr>
</tbody>
</table>

**NOTES**
(a) Use the modified method to account for a fine emulsion mixture. Required for calibration of application equipment and for field control and acceptance.
(b) A 500 to 1000 gram representative sample of the mix shall be dried in a suitable oven until weight loss ceases. Solids content shall then be defined as the net residual weight divided by net original weight expressed in percent. Retain this residual dried mix for AASHTO T 308 tests if required.
(c) Rotational viscosity acceptable range shall be provided by the Supplier. Test device, spindle type, size and rotational speed shall be included with the submitted certification test results.
(d) Due to the high binder content of the mix the sample size processed in the ignition oven may need to be adjusted to not exceed the binder content allowable for a particular model ignition oven.
(e) Establish base friction value using prepared laboratory compacted slab of any ENGINEER approved mix as surface to be tested. The Dynamic Friction Test (DFT) number ratio should indicate that after application of the mastic seal, the surface retains required minimum percentage DFT number of the original pavement surface. Based on a minimum of three (3) slabs with three (3) measurements per slab. Value for information only. Will not be used for project control.

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**PART 3 EXECUTION**

3.1 **CONSTRUCTION EQUIPMENT**
A. Paver: Use a continuous-flow mixing unit.
   1. Capable of applying at least 15,000 square yards of material per day.
   2. Equipped with full sweep agitation system to assure proper suspension of fine
aggregates.
3. Equipped with an operator control station that adjusts material spread rate in accordance with project calibration process.
4. Equipped with a filtering system to catch particles that plug nozzles.
5. Equipped with a retractable spray bar capable of applying mixture without drilling. The bar should be positioned to meet calibration requirements.

B. Storage Tanks:
1. When delivering mix from the central mixing plant to a job site storage tank, use only storage tanks with a capacity to contain the entire transport load.
2. Ensure that all site storage tanks have internal full sweep mixing mechanisms and mixing capability that can provide at any given point in the tank a homogenous mix.

3.2 PREPARATION

A. Paver Calibration: On a test strip at least 300 feet long, determine the correct pump settings, spray bar height, and ground speed for the application equipment. Apply material with pump settings at 80 percent of maximum output (plus or minus 5 percent) and a ground speed of 300 to 400 feet per minute.
   1. Do not begin or continue application without ENGINEER's knowledge of the calibration process and equipment settings.
   2. Do not deviate from calibration settings without ENGINEER's knowledge.

B. Surface Repair: Method of payment to be determined by ENGINEER if any of the following repairs are required.
   1. Raising low areas to grade, lowering high areas to grade, hole patching, inlays.
   2. Providing tack coat on highly absorbent, polished, oxidized, or raveled asphalt surfaces or on brick and concrete surfaces.
   3. Crack sealing and crack repairing, Section 32 01 17.
   4. Pushing or shoving pavement repairs.
      a. Mill damaged area at least three (3) inches below required surface elevation.

C. Masking: Mask-off Street Fixtures, end of streets, intersections.

D. Traffic Control:
   1. Implement traffic control plan requirements. Provide safe passage for pedestrians and vehicles. Do not proceed without flaggers if work requires maintaining two-way vehicular traffic.
   2. Grind off existing pavement markings and lane stripes. If existing markings and stripes are to be reestablished, use reflective tabs to mark existing locations before applying surface treatment material. Unless specified otherwise, cost is included in the work of this section.

E. Cleaning:
   1. Remove loose material, mud spots, sand, dust, oil, vegetation and other objectionable material.
   2. Do not flush water or apply pressurized water over cracked pavement unless ENGINEER allows its' use and a sufficient time is allowed for drying.

Mastic Seal
32 01 13.52 - 7
3.3 PROTECTION
   A. Trees, Plants, Ground Cover:
      1. Protect trees, plants and other ground cover from damage.
      2. Prune trees to allow equipment passage underneath, Section 32 01 93. Repair tree damage at no additional cost to OWNER.
   B. Protect structures, curb, gutter, sidewalks, guard rails, guide posts, etc. from physical damage.

3.4 APPLICATION
   A. General:
      1. Two separate application coats are required. The first application must be thoroughly set and free of any damp areas before the second application begins.
      2. Adjust application rates according to surface conditions, only after obtaining review by ENGINEER and the asphalt emulsion manufacturer.
   B. Spreading:
      1. Keep material delivery at a constant rate even if forward speed of lay-down machine varies.
      2. Do not reduce application rate along edges or around manhole covers.
      3. Apply both applications right to the edge of the pavement. Do not leave uncovered areas near curbs, Street Fixtures, or edges on either application.
      4. Make straight lines at all locations.
      5. Place product out to right-of-way line on side streets and intersections.
      6. Use hand squeegees to spread mix in areas that cannot be reached with distribution spray bar.
         a. Provide complete and uniform coverage.
         b. Avoid unsightly appearance from hand work.
   C. Joints:
      1. Make transverse joints straight-cut butt type, not over-lap type.
      2. Place longitudinal joints on lane lines. Limit overlap to three (3) inches maximum.
      3. Stop and correct paving operation if longitudinal or transverse joints have uncovered areas or unsightly appearance.
   D. Lines:
      1. Make straight lines along lip of gutters, shoulders, end of streets, and in street intersections. No runoff on these areas will be permitted.
      2. Vary edge lines no more than one (1) inch per 100 feet.
3.5 **TOLERANCES**
   A. Each coat thickness = **at least 40 percent of the total thickness.**
   B. Total thickness = **0.30 gallons per square yard minimum.**

3.6 **FIELD QUALITY CONTROL**
   A. Emulsion density testing, ASTM D 6937. If testing shows material non-compliance, remove installed product and halt operations until new material is delivered and is known to be in compliance.
   B. Measure the total amounts of material installed, and verify it meets the application rate.

3.7 **AFTER APPLICATION**
   A. Raise reflective tabs that were covered over by application.
   B. Clean Street Fixtures.
   C. Do not apply permanent pavement markings or striping material until layout and method of payment has been determined by ENGINEER and final application of surface treatment material has been in-place at least 10 days, or as permitted by ENGINEER. Layout must be verified by ENGINEER prior to application.

3.8 **REPAIR**
   A. Remove delaminated or non-compliant product found after installation and apply acceptable product.
   B. Remove spatter, mar and overcoat from curb, gutter, sidewalk, guard rails, guide posts, etc.
   C. Remove overcoat from Street Fixtures.
   D. Make edge and end lines straight. Provide a good appearance.
   E. Leave no streaks, holes, bare spots, or cracks through which liquids or foreign matter could penetrate to the underlying pavement.
   F. Repair collateral damage caused by construction.

3.9 **OPENING TO TRAFFIC**
   A. Cure time depends on type of asphalt, mixture characteristics and weather. Keep traffic off surface until material does not track out.

END OF SECTION
PART 1 GENERAL

1.1. SECTION INCLUDES
   A. Stone and an asphalt binder slurry evenly spread as a roadway surface treatment.

1.2 REFERENCES
   A. **AASHTO Standards:**
      R 9 Acceptance Sampling Plans for Highway Construction.
   
   B. **ASTM Standards:**
      C 88 Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
      C 117 Material Finer Than 0.075mm Sieve in Aggregate.
      C 131 Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
      C 136 Sieve Analysis of Fine and Coarse Aggregates.
      D 5 Penetration of Bituminous Materials.
      D 36 Softening point of Bitumen (Ring-and-Ball Apparatus).
      D 242 Mineral Filler for Bituminous Paving Mixtures.
      D 1664 Coating and Stripping of Bitumen-Aggregate Mixtures.
      D 2170 Kinematic Viscosity of Asphalts (Bitumens).
      D 2419 Sand Equivalent Value of Soils and Fine Aggregate.
      D 3319 Accelerated Polishing of Aggregates Using the British Wheel.
      D 3628 Selection and Use of Emulsified Asphalts.
      D 3740 Evaluation of Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.
      D 5821 Determining the Percentage of Fractured Particles in Coarse Aggregate.
      D 6937 Determining Density of Emulsified Asphalt.

1.3 SUBMITTALS
   A. Mix Design: Provide the following. Allow ENGINEER 10 days to evaluate the submittal.
      1. Date of mix design. If older than 180 days from date of submission, recertify mix design.
      2. Target Grading Curve for aggregate.
      3. Percentages of emulsion, aggregate, water and additives in the mix.
      4. Emulsion type and time target for opening up a thoroughfare to traffic.
      5. Slurry application rate.
      6. Aggregate physical properties (this section article 2.4). The information is for
suitability of source and not for project control. A new report may be required if aggregate source is changed. Test results shall not be older than 455 days from the date of submission.

B. Before Placement: Submit at least 48 hours before delivery.
   1. Traffic control plan, Section 01 55 26.
   2. List of construction equipment to be used.
   3. Certification from emulsion supplier stating emulsion meets requirements in this section.

C. Reports: If requested by ENGINEER, submit source and field quality control testing reports performed by CONTRACTOR and Suppliers.

1.4 QUALITY ASSURANCE
A. Foreman of paving crew has completed at least three (3) projects of similar scope.  
B. Use a laboratory that follows and complies with ASTM D 3740 and Section 01 45 00 requirements.
C. Verify mixture delivered to site contains the same emulsion specified in the mix design.
D. Do not change source of asphalt emulsion or aggregate without supporting changes in the mix design.
E. Reject product that does not meet requirements.

1.5 WEATHER
A. Temperature:
   1. Apply surface treatment material when air and pavement surface temperatures in the shade are 45 deg F. and rising.
   2. Do not apply surface treatment material if air or pavement surface temperatures are below 55 deg F and falling or if the finished product will freeze before 24 hours.
B. Moisture and Wind:  
   1. Do not apply surface treatment material during rain, if humidity prolongs curing, or in unsuitable windy weather.
   2. Cease work if weather or other conditions prolong opening pavement surface to traffic.

1.6 NOTICE
A. Follow Laws and Regulations concerning when and to whom notices are to be given at least three (3) days before applying surface treatment material.
B. Indicate application time and when new surface can be used. If necessary, include a map showing closed-off areas.
C. Provide phone numbers of at least two (2) individuals who represent the CONTRACTOR who can be reached at any time during the work.
D. Warn of potential vehicle tow away and other construction issues affecting neighborhood.
E. Should work not occur on specified day, issue an updated notice advising when work will be performed.
1.7 ACCEPTANCE

A. General:
   1. Acceptance is by Lot.
   2. If non-complying material has been installed and no price for the material is specified, apply pay adjustment against cost of work requiring complying material as part of its installation, Section 01 29 00.
   3. Dispute resolution, Section 01 35 10.
   4. Opening surface treatment to vehicular traffic does not constitute acceptance.
   5. Observation of CONTRACTOR’s field quality control testing does not constitute acceptance. Such testing; however, may be used by ENGINEER for acceptance if requirements of Section 01 35 10 are met.

B. Asphalt Binder:
   1. Lot size is total contracted product placement. Sub-lot size is one (1) day production.
   2. Of all sub-lot samples collected, randomly select one and test it for the physical properties in this section. The lot is acceptable if this single test meets requirements. If the test does not meet requirements, continue testing other samples for compliance.
   3. At ENGINEER's discretion, a Lot with deficient sub-lot properties may be accepted if pay for the lot is reduced using one of the following applicable pay factors, or lot may be accepted at 50 percent pay if lot is in Reject.

<table>
<thead>
<tr>
<th>Pay Factor</th>
<th>Number of Non-complying Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.00</td>
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<tr>
<td>0.90</td>
<td>1</td>
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<td>0.80</td>
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</tr>
<tr>
<td>0.70</td>
<td>3</td>
</tr>
<tr>
<td>Reject</td>
<td>4</td>
</tr>
</tbody>
</table>

C. Aggregate: Lot size is one (1) day's production with 300 tons sub-lots. Collect Samples randomly before mixing. Test gradation, ASTM C 136. Test thickness. Lot will be acceptable if:

   1. Average gradation of each sieve for the Lot is within the Target Grading Band for that sieve, and
   2. Number of Samples in the Lot with any sieve measurement outside of the Target Grading Band does not exceed two (2), and
   3. Material on 200 sieve does not exceed allowable.
   4. Price Adjustment: Aggregate gradation defects may be accepted if 2.5 percent price reduction is applied against lot for each condition not met. Maximum price reduction for a lot is five (5) percent.

D. Placement:
   1. Mat appearance.
      a. No runoff onto concrete curbs, gutter pans, and shoulders.
      b. No streaking, drilling, drag marks, or squeegee marks.
c. No light spots.
d. No de-bonding.
e. Straight longitudinal edges with proper joints.

2. Price Adjustment: Not applicable. Correct deficiencies at no additional cost to OWNER.

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**PART 2 PRODUCTS**

**2.1 ASPHALT BINDER**

A. Crack Pouring Asphalt: Rubberized asphalt or asphalt rubber hot pour, Section 32 01 17.

B. Tack Coat: SS-1 or CSS-1, Section 32 12 13.13. Use a tack coat that is compatible with seal coat application.

C. Emulsified Asphalt: Unless specified elsewhere provide CQS-1h quick traffic type, ASTM D 3628 with a two (2) hour return to traffic quickset and the following.

<table>
<thead>
<tr>
<th>Table 1 – Physical Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Criterion</strong></td>
</tr>
<tr>
<td>Tests on Emulsion</td>
</tr>
<tr>
<td>Viscosity at 25 deg C, second</td>
</tr>
<tr>
<td>Sieve test, percent</td>
</tr>
<tr>
<td>Settlement, 5 day, percent</td>
</tr>
<tr>
<td>Storage stability, 1 day, percent</td>
</tr>
<tr>
<td>Residue by distillation, percent</td>
</tr>
<tr>
<td>Tests on Residue from Evaporation</td>
</tr>
<tr>
<td>Penetration at 25 deg C, 0.1mm</td>
</tr>
<tr>
<td>Softening point, deg C</td>
</tr>
<tr>
<td>Kinematic viscosity, cSt/sec</td>
</tr>
<tr>
<td>Saybolt furol viscosity at 25 deg C, second</td>
</tr>
<tr>
<td>Polymer solids based on mass of residual asphalt, percent</td>
</tr>
</tbody>
</table>

NOTES
(a) Polymer is a solid synthetic rubber or latex material.
(b) Cement mixing test waived.
(c) Polymer solids are to be milled or blended into the asphalt or emulsifier solution before the emulsification process.

**2.2 AGGREGATE**

A. Material:

1. Clean and free from organic matter or other detrimental substances.
2. Stone, slag, or other high quality particle or combination with the following properties.
<table>
<thead>
<tr>
<th>Table 2 - Physical Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Criterion</strong></td>
</tr>
<tr>
<td>Angularity (fractured faces), percent</td>
</tr>
<tr>
<td>Wear (hardness or toughness), percent</td>
</tr>
<tr>
<td>Soundness (weight loss in 5 cycles), percent</td>
</tr>
<tr>
<td>Clay content (sand equivalent), SS Type I</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Polishing, BPN</td>
</tr>
<tr>
<td>Water absorption, percent</td>
</tr>
</tbody>
</table>

**NOTES**

(a) Angularity of aggregate retained on No. 4 sieve with at least one (1) mechanically fractured face or clean angular face. Provide 100 percent (maximum) for thoroughfares with a "heavy" traffic classification (Section 32 12 05).

(b) Wear of aggregate retained on No. 12 sieve after 500 revolutions.

(c) Soundness for combined coarse and fine aggregate measured using five (5) cycles Na₂SO₄.

(d) Clay content before additives.

B. Gradation: Analyzed on a dry weight and percent passing basis.

1. Material passing any sieve and retained on the next consecutive sieve is 45 percent maximum.

2. Target Grading Curve must lie within one (1) of the following Master Grading Bands. Field Samples shall not vary from the Target Grading Curve by more than the target tolerance.

<table>
<thead>
<tr>
<th>Table 3 - Master Grading Band and Target Tolerance Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sieve</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>3/8 inch</td>
</tr>
<tr>
<td>No. 4</td>
</tr>
<tr>
<td>No. 8</td>
</tr>
<tr>
<td>No. 16</td>
</tr>
<tr>
<td>No. 30</td>
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<tr>
<td>No. 50</td>
</tr>
<tr>
<td>No. 100</td>
</tr>
<tr>
<td>No. 200</td>
</tr>
</tbody>
</table>

**NOTES**

(a) Target tolerance is the allowable variation from the Target Grading Curve.

(b) Portion retained on the No. 4 sieve clean and free of clay coatings.

(c) Portion passing No. 200 sieve includes mineral filler.
2.3 ADDITIVES
   A. Use water that is clean, non-detrimental, and free from salts and contaminant.
   C. Portland cement, hydrated lime, limestone dust, fly ash, or aluminum sulfate to regulate setting time and improve workability.
   D. Limestone dust, fly ash, and rock dust to alter aggregate gradation

2.4 MIX DESIGN
   A. Asphalt Binder: Select type and grade of emulsified asphalt, ASTM D 3628.
   B. Proportioning: Use the consistency test of ASTM D 3910 to determine optimum ratio of aggregate, filler, water, and emulsion.
   C. Set and Cure Time: Select to meet opening to traffic requirements.
   D. Stripping: More than 90 percent of bituminous-coated particles retain asphalt coating, ASTM D 1664.

PART 3 EXECUTION

3.1 CONSTRUCTION EQUIPMENT
   A. Paver: Use a continuous-flow mixing unit.
      1. Capable of applying at least 15,000 square yards of material per day.
      2. Capable of accurately delivering a predetermined portion of aggregate, water, and asphalt emulsion to the mixing chamber.
      3. Prevent loss of slurry from the distributor by using a mechanical type squeegee distributor equipped with flexible material in contact with the pavement surface.
      4. Has a lateral control device and a flexible strike-off capable of being adjusted to lay the slurry at the mix design application rate.

3.2 PREPARATION
   A. Meter Calibration: On a test trip at least 500 feet long, determine the correct meter settings on the mixing equipment. The settings are to produce a product that complies with the following.
      1. Set time 30 minutes maximum. Initial set occurs when blotting of the slurry seal surface yields only water (no emulsion).
      2. No distress when exposed to traffic two (2) hours after placement.
   B. Surface Repair: Method of payment to be determined by ENGINEER if any of the following repairs are required.
      1. Raising low areas to grade, lowering high areas to grade, hole patching, inlays.
      2. Providing tack coat on highly absorbent, polished, oxidized, or raveled asphalt surfaces or on brick and concrete surfaces.
      3. Crack sealing and crack repairing, Section 32 01 17.
      4. Pushing or shoving pavement repair.
a. Mill damaged area at least three (3) inches below required surface elevation.

C. Masking: Mask-off Street Fixtures, end of streets, intersections.

D. Traffic Control:
   1. Implement traffic control plan requirements. Provide safe passage for pedestrians and vehicles. Do not proceed without flaggers if work requires maintaining two-way vehicular traffic.
   2. Grind off existing pavement markings and lane stripes. If existing markings and stripes are to be reestablished, use reflective tabs to mark existing locations before applying surface treatment material. Unless specified otherwise, cost is included in the work of this section.

E. Cleaning:
   1. Remove loose material, mud spots, sand, dust, oil, vegetation and other objectionable material.
   2. Remove loose material that may cause drag marks.
   3. Do not flush water or apply pressurized water over cracked pavement unless ENGINEER allows its' use and a sufficient time is allowed for drying.

3.3 PROTECTION
A. Trees, Plant, Ground Cover:
   1. Protect trees, plants, and other ground cover from damage.
   2. Prune trees to allow equipment passage underneath, Section 32 01 93. Repair tree damage at no additional cost to OWNER.

B. Protect structures, curb, gutter, sidewalks, guard rails, guide posts, etc. from physical damage.

3.4 APPLICATION
A. General:
   1. Machine meter settings must match mix design. Water and additives may be adjusted (per mix design) for better consistency or set time.
   2. Wait at least two(2) hours if an adjacent pass has broken and started to cure.
   3. The slurry seal material, when cured shall present a uniform, skid-resistant appearance with all cracks filled.
   4. Do not apply lane marking tape or paint for traffic control until layout and placement has been verified with ENGINEER.

B. In the Spreader Box:
   1. Do not exceed four (4) minutes total mixing time.
   2. No additional water.
   3. No lumping, balling or unmixed aggregate.
   4. No segregation of the emulsion and aggregate fines from the coarse aggregate.
   5. No breaking of emulsion.
   6. No overloading. Carry a sufficient amount of slurry in all parts of the spreader box for complete coverage.
C. Spreading:
   1. Dampen surface immediately before application of slurry seal (prevents premature breaking and improves bonding). All surfaces are to be uniformly damp with no free water standing on the surface or in cracks.
   2. Keep material delivery at a constant rate even if forward speed lay-down machine varies.
   3. Do not reduce application rate along edges or around manhole covers.
   4. Apply surface treatment material right to the edge of the pavement. Do not leave uncovered areas near curbs, Street Fixtures, or edges.
   5. Make straight lines at all locations.
   6. Place surface treatment material out to right-of-way line on side streets and intersections.
   7. Use hand squeegees to spread mix in areas that cannot be reached with distribution spray bar.
      a. Provide complete and uniform coverage.
      b. Avoid unsightly appearance from hand work.
   8. If coarse aggregate settles to bottom of mix, remove slurry from pavement.

D. Joints:
   1. Make transverse joints straight-cut butt type, not over-lap type.
   2. Place longitudinal joints on lane lines. Limit overlap to three (3) inches maximum.
   3. Tolerance for joint match is 1/4 inch difference in elevation when measured with a 10 feet long straight edge over the joint.
   4. Stop and correct paving operation if longitudinal or transverse joints have uncovered areas or unsightly appearance.

E. Lines:
   1. Make straight lines along lip of gutters, shoulders, end of streets, and in street intersections. No runoff on these areas will be permitted.
   2. Vary edge lines no more than one (1) inch per 100 feet.

3.5 TOLERANCES
   A. Thickness: Thickness measured in pounds per square yard. Standard application rate applies unless specified elsewhere.
      | Slurry   | Standard | Heavy  |
      | SS Type I | 8 to 12  | 10 to 13 |
      | SS Type II | 12 to 16 | 15 to 18 |
      | SS Type III | 15 to 18 | 22 to 25 |

3.6 FIELD QUALITY CONTROL
   A. Emulsion density testing, ASTM D 6937. If testing shows material non-compliance, remove installed product and halt operations until new material is delivered and is known to be in compliance.
   B. If sieve analysis shows aggregate gradation non-compliance, either remove the material or blend in other aggregates to bring it into compliance. This may require a new mix.
design. Screening may be required at the stockpile to remove any defective material.

C. Measure the total amounts of material installed, and verify it meets the application rate.

3.7 AFTER APPLICATION

A. Raise reflective tabs that were covered over by application.

B. Clean Street Fixtures.

C. Leave no streaks caused by oversized aggregate particles or buildup on squeegees.

D. Leave no holes, bare spots, or cracks. The slurry shall be uniform and skid-resistant when cured.

E. Do not apply permanent pavement markings or striping material until layout and method of payment has been determined by ENGINEER and final application of surface treatment material has been in-place at least 10 days, or as permitted by ENGINEER. Layout must be verified by ENGINEER prior to application.

3.8 REPAIR

A. Remove delaminated or non-compliant product found after installation and apply acceptable product.

B. Remove spatter, mar and overcoat from curb, gutter, sidewalk, guard rails, guide posts, etc.

C. Remove overcoat from Street Fixtures.

D. Make edge and end lines straight. Provide a good appearance.

E. Leave no streaks, holes, bare spots, or cracks through which liquids or foreign matter could penetrate to the underlying pavement.

F. Repair collateral damage caused by construction.

3.9 OPENING TO TRAFFIC

A. Cure time depends on type of asphalt, mixture characteristics and weather. Keep traffic off surface until material does not track-out.

END OF SECTION
SECTION 32 01 13.64
CHIP SEAL

PART 1     GENERAL

1.1 SECTION INCLUDES
   A. Asphalt binder and cover aggregate evenly spread as a uniform, skid-resistant roadway surface treatment.
   B. Application of a bituminous fog seal (if specified).
   C. Application of a cape seal (if specified).

1.2 REFERENCES
   A. ASTM Standards:
      C 88    Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
      C 117   Amount of Material Finer Than 0.075 mm Sieve in Aggregate.
      C 131   Resistance to Degradation of Small-Size coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
      C 136   Sieve Analysis of Fine and Coarse Aggregates.
      C 142   Clay Lumps and Friable Particles in Aggregates.
      D 5     Penetration of Bituminous Materials.
      D 36    Softening Point of Bitumen (Ring-and-Ball Apparatus).
      D 242   Mineral Filler for Bituminous Paving Mixtures.
      D 1664  Coating and Stripping of Bitumen-Aggregate Mixtures.
      D 2170  Kinematic Viscosity of Asphalts (Bitumens).
      D 2419  Sand Equivalent Value of Soils and Fine Aggregate.
      D 3319  Accelerated Polishing of Aggregates Using the British Wheel.
      D 3628  Selection and Use of Emulsified Asphalts.
      D 3740  Evaluation of Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.
      D 4791  Flat or Elongated Particles in Coarse Aggregate.
      D 5821  Determining the percentage of Fractured Particles in Coarse Aggregate.

1.3 SUBMITTALS
   A. Mix Design: Provide the following. Allow ENGINEER 10 days to evaluate the submittal.
      1. Date of mix design. If older than 60 days from date of submission, recertify mix design.
      2. Type and grade of asphalt binder to be used (if not specified).
      3. Target Grading Curve for aggregate.
      4. Asphalt and aggregate compatibility.
5. Asphalt additives.
6. Asphalt and aggregate application rates.
7. Fog seal application rate (if applicable).
8. Slurry seal application rate (if applicable).
9. Aggregate physical properties (this section article 2.3). The information is for suitability of source and not for project control. Test results shall not be older than 455 days from the date of submission.

B. Before Placement: Submit at least 48 hours before delivery:
   1. Traffic control plan, Section 01 55 26.
   2. List of construction equipment to be used.
   3. Certification from emulsion supplier stating emulsion meets requirements in this section.

C. After Installation: Submit the asphalt bill of lading. Identify weight of asphalt, weight of emulsified asphalt (after water has been added).

D. Reports: If requested by ENGINEER, submit source and field quality control testing reports performed by CONTRACTOR and Suppliers.

1.4 QUALITY ASSURANCE
A. Foreman of CONTRACTOR's crew has completed at least three (3) projects of similar scope.
B. Use a laboratory that follows and complies with ASTM D 3740 and Section 01 45 00 requirements.
C. Do not change source of asphalt emulsion or aggregate without supporting changes in the mix design.
D. Reject product that does not meet requirements.

1.5 WEATHER
A. Temperature:
   1. Apply surface treatment material when air and pavement temperatures in the shade are 70 deg F and rising.
   2. Allow four (4) weeks of warm weather cure time. This generally limits performance of work from May 15 to August 31.
   3. Do not apply chip seal if pavement surface is above 120 deg F
B. Moisture and Wind: Do not apply surface treatment material during rain, if humidity prolongs curing, or in unsuitable windy weather.

1.6 NOTICE
A. Follow Laws and Regulations concerning when and to whom notices are to be given at least three (3) days before applying surface treatment material
B. Indicate application time and when new surface can be used. If necessary, include a map showing closed-off areas.
C. Provide phone numbers of at least two (2) individuals who represent the CONTRACTOR who can be reached at any time during the work.
D. Warn of potential vehicle tow away and other construction issues affecting neighborhood.
E. Should work not occur on the specified day, issue an updated notice advising when work will be performed.

1.7 ACCEPTANCE

A. General:
1. Acceptance is by Lot.
2. If non-complying material has been installed and no price for the material is specified, apply pay adjustment against cost of work requiring chip seal material as part of its installation, Section 01 29 00.
3. Dispute resolution, Section 01 35 10.
4. Opening surface treatment to traffic does not constitute acceptance.
5. Observation of CONTRACTOR’s field quality control testing does not constitute acceptance. Such testing, however, may be used by ENGINEER for acceptance if requirements of Section 01 35 10 are met.

B. Asphalt Binder:
1. Lot size is total contracted product placement. Sub-lot size is one (1) day production.
2. Of all sub-lot samples collected, randomly select one and test it for the physical properties in this section. The lot is acceptable if this single test meets requirements. If the test does not meet requirements, continue testing other samples for compliance.
3. At ENGINEER’s discretion, a Lot with deficient sub-lot properties may be accepted if pay for lot is reduced using one of the following applicable pay factors, or lot may be accepted at 50 percent pay if lot is in Reject

<table>
<thead>
<tr>
<th>Pay Factor</th>
<th>Number of Non-complying Tests</th>
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<tbody>
<tr>
<td>1.00</td>
<td>0</td>
</tr>
<tr>
<td>0.90</td>
<td>1</td>
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<td>0.80</td>
<td>2</td>
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<tr>
<td>0.70</td>
<td>3</td>
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<tr>
<td>Reject</td>
<td>4</td>
</tr>
</tbody>
</table>

C. Aggregate: Verify suitability of aggregate source
1. Lot size is one (1) day production with 500 tons sub-lots. Collect samples randomly from the hauling equipment. Test gradation, ASTM C 136. Lot will be acceptable if:
   a. Average gradation of each sieve for lot is within the Target Grading Band for that sieve, and
   b. Number of samples in lot with any sieve measurement outside of the Target Grading Band does not exceed two (2), and
   c. Material on 200 sieve gradation does not exceed allowable.
2. Price Adjustment: Aggregate gradation defect may be accepted if 2.5 percent pay factor is applied against lot for each condition not met. If a lot has multiple defective sub-lots, maximum cumulative pay factor for a lot is five (5) percent.
D. Placement:
   1. Asphalt Binder:
      a. No runoff onto concrete curbs, gutter pans, and shoulders.
      b. No streaking, drilling or bare spots.
      c. No light spots.
      d. Uniform with no ridging.
   2. Aggregate:
      a. Asphalt See-through: Not more than 15 percent black (asphalt) can be seen through the newly laid and compacted rock chip after sweeping.
      b. Embedment: After rolling and evaporation, random sampling reveals large particles are embedded in the asphalt binder on their flat side to a depth of 50 percent to 70 percent.
   3. Pay Adjustment: Not applicable. Correct deficiencies at no additional cost to OWNER.

PART 2 PRODUCTS

2.1 ASPHALT BINDER
   A. Crack Pouring Asphalt: Rubberized asphalt or asphalt rubber hot pour, Section 32 01 17.
   B. Emulsified Asphalt: Cationic or anionic emulsion, Section 32 12 03. Use any of the following additives to match aggregate particle charge, weather conditions and mix design:
      1. Anti-strip: To change or neutralize particle charges.
      2. Enhancer: To promote greater film thickness on the aggregate.
      3. High Float Agent: To improve temperature susceptibility of the asphalt and impart a gel structure to the asphalt.
      4. Polymer: To reduce stripping, improve coating, decrease temperature susceptibility and increase stability of mix.
      5. Rejuvenator: To adjust penetration of base asphalt or soften reclaimed asphalt.

2.2 COVER AGGREGATE
   A. Material:
      1. Clean and free from organic matter or other detrimental substances.
      2. 100 percent crushed stone, slag or other high quality particle or combination.
### Table 1 – Physical Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>ASTM</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry-unit weight (rodded), lb/ft³</td>
<td>C 29</td>
<td>--</td>
<td>100</td>
</tr>
<tr>
<td>Wear (hardness or toughness), percent</td>
<td>C 131</td>
<td>--</td>
<td>30</td>
</tr>
<tr>
<td>Angularity (2 fractured or angular faces), percent</td>
<td>D 5821</td>
<td>60</td>
<td>--</td>
</tr>
<tr>
<td>Soundness (weight loss), percent</td>
<td>C 88</td>
<td>--</td>
<td>12</td>
</tr>
<tr>
<td>Polishing, BPN</td>
<td>D 3319</td>
<td>30</td>
<td>--</td>
</tr>
<tr>
<td>Flats or elongates (1:3 ratio), percent</td>
<td>D 4791</td>
<td>--</td>
<td>10</td>
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<tr>
<td>Friable particles, percent</td>
<td>C 142</td>
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<td>3</td>
</tr>
</tbody>
</table>

**NOTES**

(a) Wear of aggregate retained on No. 8 sieve.
(b) Soundness for combined coarse and fine aggregate measured using five (5) cycles Na₂SO₄.

### Table 2 – Master Grading Band

<table>
<thead>
<tr>
<th>Sieve</th>
<th>ASTM</th>
<th>Grade A</th>
<th>Grade B</th>
<th>Grade C</th>
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<tbody>
<tr>
<td>1/2 in.</td>
<td>C136</td>
<td>100</td>
<td>--</td>
<td>100</td>
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<tr>
<td>3/8 in.</td>
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<td>85 – 100</td>
<td>--</td>
<td>70 – 90</td>
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<tr>
<td>No. 4</td>
<td></td>
<td>0 – 20</td>
<td>--</td>
<td>0 – 5</td>
</tr>
<tr>
<td>No. 8</td>
<td></td>
<td>0 – 5</td>
<td>85 – 100</td>
<td>0 – 3</td>
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<td>No. 16</td>
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<td>--</td>
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<td>No. 50</td>
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</tr>
<tr>
<td>No. 200</td>
<td>C117</td>
<td>0 – 1</td>
<td>0 – 2</td>
<td>0 – 2</td>
</tr>
</tbody>
</table>

**NOTES**

(a) Portion retained on No. 4 sieve clean and free of clay coatings.
(b) Material passing any sieve and retained on the next consecutive sieve is 45 percent maximum.
(c) Portion passing No. 200 sieve includes mineral filler.

### 2.3 MIX DESIGN

A. Select type and grade of emulsified asphalt, ASTM D 3628.

B. Determine asphalt application rate based upon achieving an aggregate embedment of 50 to 70 percent.

Note: It is difficult to get adequate embedment of 3/8 inch aggregate with an asphalt application rate of 0.30 gallons per square yard.

### PART 3 EXECUTION

### 3.1 CONSTRUCTION EQUIPMENT

A. Distributor truck: Use triple overpass distributor bar setting. Apply asphalt binder
uniformly (no drilling).

B. Aggregate Spreader: Variable width up to 20 feet in a single pass. Distribution varies no more than one (1) pound per yard.

C. Rollers: Rubber tire pneumatic with a gross load adjustable to apply 200 to 250 pounds per inch of rolling width.

3.2 PREPARATION

A. Equipment Calibration:
   1. Do not begin or continue application without ENGINEER's knowledge of the calibration process and equipment settings.
   2. Do not deviate from calibrations settings without ENGINEER's knowledge.

B. Surface Repair: Method of payment to be determined by ENGINEER if any of the following repairs are required. Wait at least seven (7) days before placing chip seal on new bituminous surfaces.
   1. Raising low areas to grade, lowering high areas to grade, hole patching, inlays.
   2. Providing tack coat on highly absorbent, polished, oxidized, or raveled asphalt surfaces or on brick and concrete surfaces.
   3. Crack sealing and crack repairing, Section 32 01 17.
   4. Pushing or shoving pavement repair.
      a. Mill damaged area at least three (3) inches below required surface elevation.

C. Masking: Mask-off Street Fixtures, end of streets, intersections.

D. Traffic Control:
   1. Implement the notification and traffic control plan requirements. Provide safe passage for pedestrians and vehicles. Do not proceed without flaggers if work requires maintaining two-way vehicular traffic.
   2. Grind off existing pavement markings and lane stripes. If existing markings and stripes are to be re-established, use reflective tabs to mark existing locations before applying surface treatment material. Unless specified otherwise, cost is included in the work of this section.

E. Cleaning:
   1. Remove loose material, mud spots, sand, dust, oil, vegetation, and other objectionable material.
   2. Do not flush water or apply pressurized water over cracked pavement, unless ENGINEER allows its’ use and a sufficient time is allowed for drying.

3.3 PROTECTION

A. Trees, Plants, Ground Cover:
   1. Protect trees, plants and other ground cover from damage.
   2. Prune trees to allow equipment passage underneath, Section 32 01 93. Repair tree damage at no additional cost to OWNER.

B. Protect structures, curb, gutter, sidewalks, guard rails, guide posts, etc. from physical damage.
3.4 APPLICATION
A. Asphalt Emulsion: Keep viscosity between 50 and 100 centistokes, ASTM D 2170 during application.
   1. Make straight lines along lip of gutter and shoulders, end of streets, and in street intersections. No runoff on these areas will be permitted.
   2. Leave no holes, bare spots, or cracks.
   3. Vary edge lines no more than one (1) inch per 100 feet.
   4. Protect curb, gutter, and sidewalk from spatter, mar, or overcoat.
B. Chips: Apply aggregate within +1 to –2 pounds per square yard of mix design:
   1. For polymer and latex modified emulsions, apply chips immediately.
   2. For other emulsions, maintain a distance of not more than 100 feet between distributor and chip spreader.
   3. Use a damp chip but not saturated. (Note. If water can be seen running out of the haul truck, the chips are too wet).
   4. Spread larger aggregate first.
   5. Hand broom cover material if necessary to distribute the aggregate uniformly over Pavement surface.
C. Blotting: If bleeding occurs, apply a blend of 25 to 50 percent hydrated lime with sand (blotting material). Use sand to cool chips.

3.5 ROLLING
A. Use a rubber tire roller to seat aggregate. Apply at least two (2) complete rolling coverages.
B. Complete rolling before the bituminous material cools or hardens.
C. Keep traffic off at least four (4) hours or until moisture leaves remaining chips. Sweep surface before allowing uncontrolled traffic on chips.

3.6 FOG SEAL
A. If a fog seal is specified, apply the asphalt seal over the chips within 24 hours of placing chips.
B. Keep viscosity between 50 and 100 centistokes during application, ASTM D 2170.

3.7 CAPE SEAL
A. If a cape seal is specified, remove loose chips (by sweeping), fog the chip seal surface with water, and apply slurry seal, Section 32 01 13.61 within 48 hours of chip seal application.

3.8 FIELD QUALITY CONTROL
A. Emulsion density testing, ASTM D 6937. If testing shows material non-compliance, remove installed product and halt operations until new material is delivered and is known to be in compliance.
B. Measure the total amounts of material installed, and verify it meets the application rate.

3.9 AFTER APPLICATION
A. Raise reflective tabs that were covered over by application.
B. Clean Street Fixtures.
C. Do not apply pavement markings or striping material until layout and method of
payment has been determined by ENGINEER and final application of slurry material has been in place at least 14 days, or as permitted by ENGINEER. Layout must be verified by ENGINEER prior to application.

3.10 REPAIR

A. Remove non-compliant product found after installation and apply acceptable product.
B. Remove spatter, mar and overcoat from curb, gutter, sidewalk, guard rails, guide posts, etc.
C. Remove overcoat from Street Fixtures.
D. Make edge and end lines straight. Provide a good appearance.
E. Leave no streaks, holes, bare spots, or cracks through which liquids or foreign matter could penetrate to the underlying Pavement.
F. Repair collateral damage caused by construction.

END OF SECTION
SECTION 32 01 13.68
HIGH DENSITY MINERAL BOND SEAL

PART 1     GENERAL

1.1. **SECTION INCLUDES**
A. Application of an asphalt-aggregate *bond* seal coat as a high density roadway surface preservation treatment.

1.2 **REFERENCES**
A. AASHTO Standards:
   T 59 Standard Method of Test for Emulsified Asphalts.
   T 111 Standard Method of Test for Mineral Matter or Ash in Asphalt Materials.
B. ANSI Standards:
   B74.8 Ball Mill Test for Friability of Abrasive Grain.
C. ASTM Standards:
   C 128 Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate.
   C 170 Compressive Strength of Dimension Stone.
   C 1326 Knoop Indentation Hardness of Advanced Ceramics.
   D 1644 Nonvolatile Content (Solids by weight).
   D 2172 Quantitative Extraction of Bitumen From Bituminous Paving Mixtures.
   D 2196 Rheological Properties of Non-Newtonian Materials by Rotational (Brookfield type) Viscometer.
   D 2486 Determining Wear Resistance in Cycles.
   D 2939 Emulsified Bitumens Used as Protective Coatings.
   D 3740 Evaluation of Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.
   D 6937 Determining Density of Emulsified Asphalt.
   D 3960 Determining Volatile Organic Compound Content of Paints and Related Coatings.
   E 70 pH of Aqueous Solutions with the Glass Electrode.

1.3 **SUBMITTALS**
A. Mix Design: Provide the following. Allow ENGINEER 10 days to evaluate the submittal.
   1. Date of mix design. If older than 60 days from date of submission, recertify mix design.
   2. Proportions of aggregate, filler, water, polymer, and emulsion in the mix.
   3. Residual in-place bitumen content, in *pounds per square yard*.
   4. Residual in-place aggregate or mineral solids content, in *pounds per square yard*.
   5. Thickness target for each application coat, in *gallons per square yard*.
6. Total minimum thickness, in \textit{gallons per square yard}.
7. Results of a wear resistance test current within one (1) calendar year of the proposed mix design.

B. Before Placement: Submit at least 48 hours before delivery.
1. Traffic control plan, Section 01 55 26.
2. List of construction equipment to be used.
3. Certificate from emulsion supplier stating emulsion meets requirements in this section.
4. Names, certification levels, and years of experience of testing agency's field technicians that are assigned to the Work. Verify laboratory complies with ASTM standards.
5. Warranty.

C. Reports: If requested by ENGINEER, submit the following.
1. List of five (5) projects that have successful product applications on bituminous surfaces. Provide names of project contacts.
2. Source and field quality control testing reports performed by CONTRACTOR and Suppliers.

1.4 \textbf{QUALITY ASSURANCE}
A. Foreman of CONTRACTOR's crew or Supplier's representative has completed at least three (3) projects of similar scope. If crew foreman does not have such experience, Supplier must provide a full-time representative on site during application.
B. Use a laboratory that complies with ASTM D 3740 and follows Section 01 45 00 requirements.
C. Verify mixture delivered to site contains the same emulsion specified in the mix design.
D. Do not change source of the asphalt emulsion or aggregate without supporting changes in the mix design.
E. Reject product that does not meet requirements.

1.5 \textbf{WEATHER}
A. Temperature:
1. Apply surface treatment material if air and pavement surface temperatures in the shade are 55 deg F. and rising.
2. Cease application if air or pavement surface temperatures are projected to fall below 45 deg F. within 48 hours.
B. Moisture and Wind:
1. Do not apply surface treatment material to a wet surface (no visible standing water or high sheen), during rain, 24 hours prior to forecast rain, or in unsuitable windy weather.
2. Cease work if weather or other conditions prolong opening pavement surface to traffic.

1.6 \textbf{NOTICE}
A. Follow Laws and Regulations concerning when and to whom notices are to be given at least three (3) days before applying surface treatment material.
B. Indicate application time and when the surface can be used. If necessary, include a map showing closed-off areas.

C. Provide phone numbers of at least two (2) individuals who represent the CONTRACTOR who can be reached at any time during the work.

D. Warn of potential vehicle tow away and other construction issues affecting neighborhood.

E. Should work not occur on specified day, issue an updated notice.

1.7 ACCEPTANCE

A. General:
   1. Acceptance is by Lot.
   2. If non-complying material has been installed and no price for the material is specified, apply price adjustment against cost of work requiring complying material as part of its installation, Section 01 29 00.
   3. Dispute resolution, Section 01 35 10.
   4. Opening surface treatment to vehicular traffic does not constitute acceptance.
   5. Observation of CONTRACTOR’s field quality control testing does not constitute acceptance. Such testing, however, may be used by ENGINEER for acceptance if requirements of Section 01 35 10 are met.

B. Asphalt Binder:
   1. Lot size is total contracted product placement. Sub-lot size is one (1) day's production.
   2. Of all sub-lot samples collected, randomly select one and test it for the physical properties in this section. The lot is acceptable if this single test meets requirements. If the test does not meet requirements, continue testing other samples for compliance.
   3. At ENGINEER's discretion, a lot with deficient sub-lot properties may be accepted if pay for the lot is reduced using one of the following applicable pay factors, or lot may be accepted at 50 percent pay if lot is in Reject.

<table>
<thead>
<tr>
<th>Pay Factor</th>
<th>Number of Non-complying Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.00</td>
<td>0</td>
</tr>
<tr>
<td>0.90</td>
<td>1</td>
</tr>
<tr>
<td>0.80</td>
<td>2</td>
</tr>
<tr>
<td>0.70</td>
<td>3</td>
</tr>
<tr>
<td>Reject</td>
<td>4</td>
</tr>
</tbody>
</table>

C. Placement:
   1. Mat appearance.
      a. No runoff onto concrete curbs, gutter pans, and shoulders.
      b. No streaking, drilling, drag marks, or squeegee marks.
      c. No light spots.
      d. No de-bonding.
      e. Straight longitudinal edges with proper joints.
   2. Mat thickness, bitumen content and aggregate content.
a. Lot size is one (1) day's production. Sub-lot size is 0.5 lane mile.
b. Collect and test five (5) equally spaced samples from the initial sub-lot. Upon review of the initial sub-lot test results and at ENGINEER's discretion, acceptance of subsequent sub-lots may be based upon one or less samples from each subsequent sub-lot.

3. Pay Adjustment: Not applicable. Correct mat deficiencies at no additional cost to OWNER.

1.8 WARRANTY
A. Both the CONTRACTOR and Supplier shall provide a two (2) year minimum written warranty when the existing pavement is in an appropriate condition (CONTRACTOR and Supplier to determine condition). Warranty covers delaminating, peeling and premature surface wear.
1. Before placement notify ENGINEER if pavement condition or application condition voids the warranty.
2. ENGINEER may allow or cancel product application at no cost to OWNER if warranty cannot be given.
B. Acceptable performance after two (2) year period is no delaminating, peeling, or inter-aggregate loss in surface wear. Mechanical disturbances by snow plow chatter, studded tires, etc. are excluded from warranty. Repair defective coverage at no additional cost to OWNER.

PART 2 PRODUCTS

2.1 ASPHALT BINDER
A. Crack Pouring Asphalt: Rubberized asphalt or asphalt rubber hot pour, Section 32 01 17.
B. Tack Coat: SS or CSS grade, Section 32 12 13.13. Use a tack coat that is compatible with seal coat application.
C. Emulsified Asphalt: Inorganic, non-ionic, thixotropic mineral colloid at 25 deg C that meets the following requirements. Inorganic is defined as a non-carbon based emulsifier.

<table>
<thead>
<tr>
<th>Table 1 – Emulsion Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Criterion</td>
</tr>
<tr>
<td>------------------</td>
</tr>
<tr>
<td>Brookfield Viscosity at 77 deg F (Spindle 5, 20 rpm), cPs</td>
</tr>
<tr>
<td>pH</td>
</tr>
<tr>
<td>Density, lbs/gal</td>
</tr>
<tr>
<td>Asphalt Cement Content, percent by weight</td>
</tr>
<tr>
<td>Solids Content, percent by weight</td>
</tr>
<tr>
<td>Ash Content, percent by weight</td>
</tr>
</tbody>
</table>
2.2 AGGREGATE
A. Clean and free from organic matter or other detrimental substances. Composed of sand, clay, slate and corundum. Properties of slate and corundum as follows.
   1. Slate

   Table 2 – Slate
   Physical Properties
<table>
<thead>
<tr>
<th>Criterion</th>
<th>Standard</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Gravity</td>
<td>C 128</td>
<td>2.7</td>
<td></td>
</tr>
<tr>
<td>Compression, psi</td>
<td>C 170</td>
<td>11,000</td>
<td></td>
</tr>
</tbody>
</table>

   2. Refined Corundum:

   Table 3 – Corundum
   Physical Properties
<table>
<thead>
<tr>
<th>Criterion</th>
<th>Standard</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Gravity</td>
<td>C 128</td>
<td>3.9</td>
<td></td>
</tr>
<tr>
<td>Knoop 100 Hardness</td>
<td>D 1326</td>
<td>2,000</td>
<td></td>
</tr>
<tr>
<td>Ball Mill Friability (14 grit)</td>
<td>B74.8</td>
<td>50</td>
<td></td>
</tr>
</tbody>
</table>

2.3 ADDITIVES
A. Water is clean, non-detrimental, and free from salts and contaminant.
B. Polymers and other additives as necessary to achieve mix design performance.

2.4 MIX DESIGN
A. Completed high density mineral bond material, prior to being loaded for install, must meet the following requirements.

   Table 4 – Mix Properties
<table>
<thead>
<tr>
<th>Criterion</th>
<th>Standard</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asphalt Content, percent by weight</td>
<td>D 2172</td>
<td>17</td>
<td>20</td>
</tr>
<tr>
<td>Solids Content, percent by weight</td>
<td>D 1644</td>
<td>55</td>
<td>63</td>
</tr>
<tr>
<td>Initial Brookfield Viscosity at 77°F (Spindle 4, 20 rpm), cPs</td>
<td>D 2196</td>
<td>5,500</td>
<td>9,000</td>
</tr>
<tr>
<td>Ash Content, percent by weight</td>
<td>T 111</td>
<td>38</td>
<td></td>
</tr>
<tr>
<td>Ash Content of Solids, percent by weight</td>
<td>T 111</td>
<td>65</td>
<td></td>
</tr>
<tr>
<td>Density, lbs/gal</td>
<td>T 59</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td>E 70</td>
<td>6.0</td>
<td>8.0</td>
</tr>
<tr>
<td>Total Inorganic Aggregate Content, percent by weight</td>
<td>T 111</td>
<td>37</td>
<td></td>
</tr>
<tr>
<td>Total Sand Content, percent by weight</td>
<td>T 111</td>
<td>6.0</td>
<td></td>
</tr>
<tr>
<td>Maximum VOC, g/L</td>
<td>D 3960</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Resistance to Re-emulsification</td>
<td>D 2939</td>
<td>No re-emulsification</td>
<td></td>
</tr>
<tr>
<td>Wear Resistance, percent loss by weight</td>
<td>D 2486</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

NOTES:
(a) Ash content as a percentage of solids content.
(b) Ash content of completed mix minus ash content of base non-ionic emulsion. Total inorganic aggregate content is defined as slate, refined corundum, and sand.
(c) ASTM D 2486 (Modified): Prepare sample at 48 wet mils on glass panel. Dry at 77 deg F for three (3) days. Immerse in water for 24 hours at 77°F. Test scrub resistance with 1,000 gram brass brush for 12,000 cycles. Report percent of dry film lost.

PART 3 EXECUTION

3.1 CONSTRUCTION EQUIPMENT
A. Paver: Use a continuous flow mixing unit.
   1. Capable of applying at least 15,000 square yards of material per day.
   2. Equipped with full sweep agitation system to assure proper suspension of fine aggregates.
   3. Equipped with an operator control station that adjusts material spread rate in accordance with project calibration process.
   4. Equipped with a filtering system to catch particles that plug nozzles.
   5. Equipped with a retractable spray bar capable of applying mixture without drilling. The bar should be positioned to meet calibration requirements.
B. Storage Tanks:
   1. When delivering mix from the central mixing plant to a job site storage tank, use only storage tanks with a capacity to contain the entire transport load.
   2. Ensure that all site storage tanks have internal full sweep mixing mechanisms and mixing capability that can provide at any given point in the tank a homogenous mix.

3.2 PREPARATION
A. Paver Calibration: On a test strip at least 300 feet long, determine the correct pump settings, spray bar height, and ground speed for the application equipment. Apply material with pump settings at 80 percent of maximum output (plus or minus 5 percent) and a ground speed of 300 to 400 feet per minute.
   1. Do not begin or continue application without ENGINEER’s knowledge of the calibration process and equipment settings.
   2. Do not deviate from calibration settings without ENGINEER’s knowledge.
B. Surface Repair: Method of payment to be determined by ENGINEER if any of the following repairs are required.
   1. Raising low areas to grade, lowering high areas to grade, hole patching, inlays.
   2. Providing tack coat on highly absorbent, polished, oxidized, or raveled asphalt surfaces or on brick and concrete surfaces.
   3. Crack sealing and crack repairing, Section 32 01 17.
   4. Pushing or shoving pavement repairs.
      a. Mill damaged area at least three (3) inches below required surface elevation.

C. Masking: Mask-off Street Fixtures, end of streets, intersections.

D. Traffic Control:
1. Implement traffic control plan requirements. Provide safe passage for pedestrians and vehicles. Do not proceed without flaggers if work requires maintaining two-way vehicular traffic.
2. Grind off existing pavement markings and lane stripes. If existing markings and stripes are to be reestablished, use reflective tabs to mark existing locations before applying surface treatment material. Unless specified otherwise, cost is included in the work of this section.

E. Cleaning:
1. Remove loose material, mud spots, sand, dust, oil, vegetation and other objectionable material.
2. Do not flush water, or apply pressurized water over cracked pavement unless ENGINEER allows its' use and a sufficient time is allowed for drying.

3.3 PROTECTION
A. Trees, Plants, Ground Cover:
1. Protect trees, plants and other ground cover from damage.
2. Prune trees to allow equipment passage underneath, Section 32 01 93. Repair tree damage at no additional cost to OWNER.

B. Protect structures, curb, gutter, sidewalks, guard rails, guide posts, etc. from physical damage.

3.4 APPLICATION
A. General: Two separate applications coats are required. The first application must be thoroughly set and free of any damp areas before the second application begins.

B. Spreading:
1. Keep material delivery at a constant rate even if forward speed of lay-down machine varies.
2. Do not reduce application rate along edges or around manhole covers.
3. Apply both applications right to the edge of the pavement. Do not leave uncovered areas near curbs, Street Fixtures, or edges on either application.
4. Make straight lines at all locations.
5. Place product out to right-of-way line on side streets and intersections.
6. Use hand squeegees to spread mix in areas that cannot be reached with distribution spray bar.
   a. Provide complete and uniform coverage.
   b. Avoid unsightly appearance from hand work.

C. Joints:
1. Make transverse joints straight-cut butt type, not over-lap type.
2. Place longitudinal joints on lane lines. Limit overlap to three (3) inches maximum.
3. Stop and correct paving operation if longitudinal or transverse joints have uncovered
areas or unsightly appearance.

D. Lines:
   1. Make straight lines along lip of gutters, shoulders, end of streets, and in street intersections. No runoff on these areas will be permitted.
   2. Vary edge lines no more than one (1) inch per 100 feet.

3.5 **TOLERANCES**
   A. First application = **0.20 gallons per square yard minimum.**
   B. Second application = **0.16 gallons per square yard minimum.**

3.6 **FIELD QUALITY CONTROL**
   A. Emulsion density testing, AASHTO T 59. If testing shows material non-compliance, remove installed product and halt operations until new material is delivered and is known to be in compliance.
   B. Measure the total amounts of material installed, and verify it meets the application rate.

3.7 **AFTER APPLICATION**
   A. Raise reflective tabs that were covered over by application.
   B. Clean Street Fixtures.
   C. Do not apply permanent pavement markings or striping material until layout and method of payment has been determined by ENGINEER, and final application of surface treatment material has been in place at least 10 days, or as permitted by ENGINEER. Layout must be verified by ENGINEER prior to application.

3.8 **REPAIR**
   A. Remove delaminated or non-compliant product found after installation and apply acceptable product.
   B. Remove spatter, mar and overcoat from curb, gutter, sidewalk, guard rails, guide posts, etc.
   C. Remove overcoat from Street Fixtures.
   D. Make edge and end lines straight. Provide a good appearance.
   E. Leave no streaks, holes, bare spots, or cracks through which liquids or foreign matter could penetrate to the underlying pavement.
   F. Repair collateral damage caused by construction.

3.9 **OPENING TO TRAFFIC**
   A. Cure time depends on type of asphalt, mixture characteristics and weather. Keep traffic off surface until material does not track out.

END OF SECTION
PART 1 GENERAL

1.1. SECTION INCLUDES
A. Stone and asphalt binder slurry spread in variably thick cross-sections as a roadway surface treatment.

1.2 REFERENCES
A. ASTM Standards:
   C 88  Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
   C 117 Amount of Material Finer Than 0.075 mm Sieve in Aggregate.
   C 131 Resistance to Degradation of Small-Size coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
   C 136 Sieve Analysis of Fine and Coarse Aggregates.
   C 142 Clay Lumps and Friable Particles in Aggregates.
   D 5 Penetration of Bituminous Materials.
   D 36 Softening Point of Bitumen (Ring-and-Ball Apparatus).
   D 242 Mineral Filler for Bituminous Paving Mixtures.
   D 244 Emulsified Asphalts.
   D 1664 Coating and Stripping of Bitumen-Aggregate Mixtures.
   D 2170 Kinematic Viscosity of Asphalts (Bitumens).
   D 2419 Sand Equivalent Value of Soils and Fine Aggregate.
   D 3319 Accelerated Polishing of Aggregates Using the British Wheel.
   D 3628 Selection and Use of Emulsified Asphalts.
   D 3740 Evaluation of Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.
   D 4791 Flat or Elongated Particles in Coarse Aggregate.
   D 5821 Determining the percentage of Fractured Particles in Coarse Aggregate.

1.3 SUBMITTALS
A. Mix Design: Provide the following. Allow ENGINEER 10 days to evaluate the submittal.
   1. Date of mix design. If older than 365 days from date of submission, recertify mix design.
   2. Target Grading Curve for aggregate.
   3. Percentages of emulsion, aggregate, water and additives in the mix.
   4. Emulsion type and time target for opening up a thoroughfare to traffic.
   5. Results of asphalt stripping test and wet track abrasion test.
   6. Type and minimum amount of polymer solids to be incorporated in the asphalt.
emulsion by the Supplier. (in general, three (3) percent based on asphalt weight is considered minimum).

7. Identity of additives added to the emulsion mix or to any of the component materials for control of the quick traffic properties.

8. Slurry application rate.

9. Aggregate physical properties (this section article 2.2). The information is for suitability of source and not for project control. A new report may be required if aggregate source is changed. Test results shall not be older than 455 days from date of submission.

B. Before Placement: Submit at least 48 hours before delivery:
1. Traffic control plan, Section 01 55 26.
2. List of the construction equipment to be used.
3. Aggregate hardness, soundness and polishing test results (this section article 2.3). Aggregate analysis to be no more than 180 days old.
4. Meter settings for micro-surfacing machine. Previously determined settings for the meters may be submitted providing such determinations are no more than 180 days old and the materials used in such determinations match those specified herein.
5. Test results of five (5) day settlement test, ASTM D 244, on emulsions stockpiled longer than 36 hours by CONTRACTOR. This submittal may be waived, providing the CONTRACTOR's storage unit has continuous mixing capability, or the emulsion has had additional emulsion blended into it before use.
6. Certificate by emulsion supplier identifying:
   a. the mix design for which the emulsion is formulated.
   b. the emulsion meets requirements of this section article 2.1
   c. the type of polymer modifier added to the emulsion.
   d. the amount of polymer modifier added to the emulsion.
7. Asphalt Bill of Lading: Identify weight of asphalt, weight of emulsified asphalt (after water has been added and that asphalt binder complies with Section 32 12 03 requirements).

C. Reports: If requested by ENGINEER, submit source and field quality control testing reports performed by CONTRACTOR and Suppliers.

1.4 QUALITY ASSURANCE
A. Foreman of CONTRACTOR's crew has completed at least three (3) projects of similar scope.
B. Use a laboratory that follows and complies with ASTM D 3740 and Section 01 45 00 requirements.
C. Verify asphalt emulsion delivered to site is the same emulsion specified in the mix design.
D. Do not change source of asphalt emulsion or aggregate without supporting changes in the mix design.
E. Reject product that does not meet requirements.
1.5 **WEATHER**

A. Temperature:
   1. Apply surface treatment material when air and pavement surface temperatures in the shade are above 45 deg F and rising.
   2. Do not apply surface treatment material if air or pavement surface temperatures are below 55 deg F and falling, or if the finished product will freeze before 24 hours.

B. Moisture and Wind: Do not apply micro-surface during rain, to a wet surface (no visible standing water or high sheen), during rain, if humidity prolongs curing, or in unsuitable windy weather.

1.6 **NOTICE**

A. Follow Laws and Regulations concerning when and to whom notices are to be given at least three (3) days before applying surface treatment material.

B. Indicate application time and when new surface can be used. If necessary, include a map showing closed-off areas.

C. Provide phone numbers of at least two (2) individuals who represent the CONTRACTOR who can be reached at any time during the work.

D. Warn of potential vehicle tow away and other construction issues affecting neighborhood.

E. Should work not occur on the specified day, issue an updated notice advising when work will be performed.

1.7 **ACCEPTANCE**

A. General:
   1. Acceptance is by Lot.
   2. If non-complying material has been installed and no price for the material is specified, apply pay adjustment against cost of work requiring micro-surface seal material as part of its installation. Section 01 29 00.
   3. Dispute resolution, Section 01 35 10.
   4. Opening surface treatment to vehicular traffic does not constitute acceptance.
   5. Observation of CONTRACTOR’s field quality control testing does not constitute acceptance. Such testing; however, may be used by ENGINEER for acceptance if requirements of Section 01 35 10 are met.

B. Mix Design: Use the following as a guide in evaluating the mix design:
   1. Residual Asphalt: 5.5 to 10.5 percent by dry weight of aggregate.
   2. Mineral Filler: 0 to three (3) percent by dry weight of aggregate.
   3. Polymer Based Modifier: Less than three (3) percent solids based on bitumen weight content.

C. Asphalt Binder:
   1. Lot size is total contracted product placement. Sub-lot size is one (1) day production.
   2. Of all sub-lot samples collected, randomly select one and test it for the physical properties in this section. The lot is acceptable if this single test meets requirements. If the test does not meet requirements, continue testing other samples for compliance.
3. At ENGINEER’s discretion, a Lot with deficient sub-lot properties may be accepted if pay is adjusted using one of the following applicable pay factors, or accepted at 50 percent pay if lot is in Reject.

<table>
<thead>
<tr>
<th>Pay Factor</th>
<th>Number of Non-complying Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.00</td>
<td>0</td>
</tr>
<tr>
<td>0.90</td>
<td>1</td>
</tr>
<tr>
<td>0.80</td>
<td>2</td>
</tr>
<tr>
<td>0.70</td>
<td>3</td>
</tr>
<tr>
<td>Reject</td>
<td>4</td>
</tr>
</tbody>
</table>

D. Aggregate:
1. Lot size is one (1) day production with 500 tons sub-lots.
2. Collect samples randomly from mixing equipment and test gradation, ASTM C 136. Lot will be acceptable if:
   a. Average gradation of each sieve for the lot is within Target Grading Band for that sieve, and
   b. Number of Samples in Lot with any sieve measurement outside of Target Grading Band does not exceed two (2), and
   c. No Sample varies from Target Grading Band by more than target tolerance on any one (1) sieve.
3. Price Adjustment: Aggregate gradation defects may be accepted if a 2.5 percent price reduction is applied against the Lot for each condition not met. Maximum price reduction for the Lot is five (5) percent.

E. Placement:
1. Mat Appearance:
   a. No runoff onto concrete curbs, gutter pans, and shoulders.
   b. No streaking, drilling, drag marks, or squeegee marks.
   c. No light spots.
   d. No de-bonding.
   e. Straight longitudinal edge lines with proper joints.
2. Pay Adjustment: Not applicable. Correct deficiencies at no additional cost to OWNER.

PART 2 PRODUCTS

2.1 ASPHALT BINDER
A. Crack Pouring Asphalt: Rubberized asphalt or asphalt rubber hot pour, Section 32 01 17.
B. Tack Coat: SS-1 or CSS-1, Section 32 12 13.13. Use a tack coat that is compatible with seal coat application.
C. Emulsified Asphalt: CSS-1h quick-traffic type, ASTM D 3628 with a two (2) hour return to traffic quickset. The use of polymer solids is CONTRACTOR’s choice.
Table 1 – Physical Properties

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Standard</th>
<th>Target</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tests on emulsion</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Viscosity @ 25°C, SSF</td>
<td>D 244</td>
<td>32</td>
<td>15</td>
<td>90</td>
</tr>
<tr>
<td>Sieve test, percent</td>
<td>D 244</td>
<td>0.01</td>
<td>--</td>
<td>0.30</td>
</tr>
<tr>
<td>Settlement, 5 day, percent</td>
<td>D 244</td>
<td>3.5</td>
<td>--</td>
<td>5</td>
</tr>
<tr>
<td>Storage Stability, 1 day, percent</td>
<td>D 244</td>
<td>0.6</td>
<td>--</td>
<td>1</td>
</tr>
<tr>
<td>Residue by distillation</td>
<td>D 244</td>
<td>64.2</td>
<td>62</td>
<td>--</td>
</tr>
<tr>
<td><strong>Tests on Residue from evaporation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Penetration @ 25°C, 0.1mm</td>
<td>D 140</td>
<td>51</td>
<td>40</td>
<td>90</td>
</tr>
<tr>
<td>Softening point, deg C</td>
<td>D 36</td>
<td>60</td>
<td>57</td>
<td>--</td>
</tr>
<tr>
<td>Kinematic viscosity, cSt/sec</td>
<td>D 2170</td>
<td>--</td>
<td>650</td>
<td>--</td>
</tr>
<tr>
<td>Saybolt Furol viscosity @ 77°F.</td>
<td>D 2170</td>
<td>--</td>
<td>--</td>
<td>50</td>
</tr>
<tr>
<td>Polymer solids based on mass of residual asphalt, percent</td>
<td>--</td>
<td>3 to 6</td>
<td>3</td>
<td>--</td>
</tr>
</tbody>
</table>

NOTES
(a) Cement mixing test waived.
(b) Polymer solids are to be milled or blended into the asphalt or emulsifier solution before the emulsification process.

2.2 AGGREGATE

A. Material:
1. Clean and free from organic matter or other detrimental substances.
2. Stone, slag or other high quality particle or combination, 100 percent crushed with the following properties.

Table 2 – Physical Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Standard</th>
<th>Max</th>
<th>Min</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angularity (fractured faces), percent</td>
<td>D5821</td>
<td>80</td>
<td>--</td>
</tr>
<tr>
<td>Wear (hardness or toughness), percent</td>
<td>C131</td>
<td>--</td>
<td>30</td>
</tr>
<tr>
<td>Soundness (weight loss in 5 cycles), percent</td>
<td>Na&lt;sub&gt;2&lt;/sub&gt;SO&lt;sub&gt;4&lt;/sub&gt; C88</td>
<td>--</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Mg&lt;sub&gt;2&lt;/sub&gt;SO&lt;sub&gt;4&lt;/sub&gt; C88</td>
<td>--</td>
<td>25</td>
</tr>
<tr>
<td>Clay content (sand equivalent), percent</td>
<td>D2419</td>
<td>65</td>
<td>--</td>
</tr>
<tr>
<td>Polishing, BPN</td>
<td>D3319</td>
<td>35</td>
<td>--</td>
</tr>
</tbody>
</table>

NOTES
(a) Angularity of aggregate retained on No. 4 sieve with at least one (1) mechanically fractured face or clean angular face.
(b) Wear of aggregate retained on No. 8 sieve.
(c) Soundness for combined coarse and fine aggregate.
(d) Clay content before additives.

B. Gradation: Analyzed by ASTM C 136 on a dry weight and percent passing basis:
1. Material passing any sieve and retained on the next consecutive sieve is 45 percent
maximum.

2. For heavy-duty surface applications use 100 percent crushed material.

3. Target Grading Curve must lie within one of the following Master Grading Bands. Field Samples shall not vary from the Target Grading Curve by more than the target tolerance.

Table 3 – Master Grading Band and Target Tolerance Limits

<table>
<thead>
<tr>
<th>Sieve</th>
<th>Master Grading Band Limits</th>
<th>Target Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Type II</td>
<td>Type III</td>
</tr>
<tr>
<td>1/2 in.</td>
<td>–</td>
<td>100</td>
</tr>
<tr>
<td>3/8 in.</td>
<td>100</td>
<td>&gt;85</td>
</tr>
<tr>
<td>No. 4</td>
<td>70 – 90</td>
<td>60 – 87</td>
</tr>
<tr>
<td>No. 8</td>
<td>45 – 70</td>
<td>40 – 60</td>
</tr>
<tr>
<td>No. 16</td>
<td>28 – 50</td>
<td>28 – 45</td>
</tr>
<tr>
<td>No. 30</td>
<td>19 – 34</td>
<td>19 – 34</td>
</tr>
<tr>
<td>No. 50</td>
<td>12 – 25</td>
<td>12 – 25</td>
</tr>
<tr>
<td>No. 100</td>
<td>7 – 18</td>
<td>7 – 18</td>
</tr>
<tr>
<td>No. 200</td>
<td>5 – 15</td>
<td>4 – 8</td>
</tr>
</tbody>
</table>

NOTES
(a) Target tolerances is the allowable variation from the Target Grading Curve.
(b) Portion retained on No. 4 sieve.
   • clean and free of clay coatings
   • more than 80 percent of the particles by weight, with at least 1 mechanically fractured face or clean angular face.
(c) Portion passing No. 200 sieve includes mineral filler, ASTM C 117.

2.3 ADDITIVES
   A. Use water that is clean, non-detrimental, and free from salts and contaminant.
   C. Portland cement, hydrated lime, limestone dust, fly ash, or aluminum sulfate to regulate setting time and improve workability.
   D. Limestone dust, fly ash, and rock dust to alter aggregate gradation.

2.4 MIX DESIGN
   A. Proportioning: Using procedures for mix design developed by the International Slurry Surfacing Association, determine the proportions of aggregate, mineral filler (minimum and maximum), water (minimum and maximum), polymer modified asphalt emulsion, and additives in the mix.
   B. Set and Cure Time: Select to meet opening to traffic requirements.
   C. Striping: More than 90 percent of bituminous-coated particles retain asphalt coating, ASTM D 1664.
   D. Wet Track Abrasion: ASTM D 3910.
      1. 50 grams per square foot maximum in a one (1) hour soak, and
      2. 75 grams per square foot maximum in a six (6) day soak.
PART 3 EXECUTION

3.1 CONSTRUCTION EQUIPMENT

A. Mixing Equipment: Use a storage and mixing device capable of accurately proportioning and delivering aggregate, emulsified asphalt, mineral filler, additive, and water on a continuous flow basis to a spreader box,
   1. Capable of applying at least 15,000 square yards per day.
   2. Equipped with proportioning devices based upon either volume or weight control.
   3. Its mixer is to be a multi-blade, multi-shaft unit:
      a. Autonomous if lay-downs are longer than 600 feet.
      b. Truck mounted is permitted for lay-downs less than 600 feet.

B. Spreader:
   1. Equipped with a spreader box that has a front seal so no loss of the mixture occurs at road contact and an adjustable rear seal to act as a final strike-off device.
   2. Equipped with a secondary strike-off device to improve surface texture.

C. Rut Filling Box: Wide enough to bridge ruts.

3.2 PREPARATION

A. Meter Calibration: On a test trip at least 500 feet long, determine the correct meter settings on the mixing equipment. Settings are to produce a product that complies with the following:
   1. Thirty (30) minutes maximum initial set time. Initial set occurs when blotting of the micro-surface yields only water (no emulsion).
   2. No distress when exposed to traffic two (2) hours after placement.

B. Surface Repair: Method of payment to be determined by ENGINEER if any of the following repairs are required.
   1. Raising low areas to grade, lowering high areas to grade, hole patching, inlays.
   2. Providing tack coat on highly absorbent, polished, oxidized, or raveled asphalt surfaces or on brick and concrete surfaces.
   3. Crack sealing and crack repairing, Section 32 01 17.
   4. Pushing or shoving pavement repair.
      a. Mill damaged area at least three (3) inches below required surface elevation.

C. Masking: Mask off Street Fixtures, end of streets and intersections.

D. Traffic Control:
   1. Implement traffic control plan requirements. Provide safe passage for pedestrians and vehicles. Do not proceed without flaggers if work requires maintaining two-way vehicular traffic.
   2. Grind off existing pavement markings and lane stripes. If existing markings and stripes are to be reestablished, use reflective tabs to mark existing locations before
applying surface treatment material. Unless specified otherwise, cost is included in the work of this section.

E. Cleaning:
   1. Remove loose material, mud spots, sand, dust, oil, vegetation, and other objectionable material.
   2. Do not flush water or apply pressurized water over cracked pavement, unless ENGINEER allows its use and a sufficient time is allowed for drying.

3.3 PROTECTION
A. Trees, Plant, Ground Cover:
   1. Protect trees, plants and other ground cover from damage.
   2. Prune trees to allow equipment passage underneath, Section 32 01 93. Repair tree damage at no additional cost to OWNER.

B. Protect structures, curb, gutter, sidewalks, guardrails, guide posts, etc. from physical damage.

3.4 SPOT LEVELING
A. Where rut deformation is less than 1/2 inch apply only amount of micro-surfacing needed to level the surface (scratch course).

B. Where rut deformation exceeds 1/2 inch:
   1. Mill high spots.
   2. Use a rut-filling box.
   3. Use multiple placements when ruts exceed 1-1/2 inches. For every inch of micro-surfacing add 1/8th to 1/4 of an inch of material as a crown (allows for compaction under traffic).
   4. Allow three (3) days cure time under traffic.

3.5 APPLICATION
A. General:
   1. Machine meter settings must match mix design.
   2. Pre-wet existing pavements surface to prevent premature breaking or to improve bonding.
   3. Wait at least two (2) hours if an adjacent pass has broken and started to cure.
   4. When cured, the micro surface material shall present a uniform, skid-resistant appearance with all cracks filled.

B. Additives: During application, water and additives may be increased or decreased (per mix design) for better consistency or set time.

C. In the Spreader Box:
   1. No spreading of material remaining in box when mixer is shut off.
   2. No additional water added to the box.
   3. No lumping, balling or unmixed aggregate.
   4. No segregation of the emulsion and aggregate fines from the coarse aggregate.
   5. No breaking of emulsion.
   6. No overloading. Carry a sufficient amount of slurry in all parts of the spreader for
D. Spreading:
   1. Dampen surface immediately before micro surface application. All surfaces are to be uniformly damp with no free water standing on the surface or in cracks when seal coat is applied.
   2. If coarse aggregate settles to bottom of mix, remove micro surface from pavement.
   3. If the adjacent lane has broken and started to cure, do not apply micro surface coat until at least two (2) hours have elapsed between placing the lane and that of adjacent lane. Butt joint adjacent lanes at edges and provide complete sealing at joint.
   4. In areas where spreader box cannot be used, apply slurry by hand.

E. Joints:
   1. Make transverse joints straight-cut butt type, not over-lap type.
   2. Place longitudinal joints on lane lines. Limit overlap to three (3) inches maximum.
   3. Tolerance for joint match is 1/4 inch difference in elevation when measured with a 10 feet long straight edge over the joint.
   4. Stop and correct paving operation if longitudinal or transverse joints have uncovered areas or unsightly appearance.

F. Lines:
   1. Make straight lines along lip of gutter and shoulders. No runoff on these areas will be permitted.
   2. Vary edge lines no more than two (2) inches per 100 feet.

3.6 TOLERANCES
   A. Type II aggregate thickness = 16 to 18 pounds per square yard.
   B. Type III aggregate thickness = 20 to 25 pounds per square yard.

3.7 FIELD QUALITY CONTROL
   A. If sieve analysis shows aggregate gradation non-compliance, either remove the material or blend in other aggregates to bring it into compliance. This may require a new mix design. Screening may be required at the stockpile to remove any defective materials.
   B. Measure the total amounts of material installed, and verify it meets the application rate.

3.8 AFTER APPLICATION
   A. Raise reflective tabs that were covered over by application.
   B. Clean Street Fixtures.
   C. Do not apply pavement markings or striping material until layout and method of payment has been determined by ENGINEER and final application of slurry material has been in place at least 14 days, or as permitted by ENGINEER. Layout must be verified by ENGINEER prior to application.
   D. If coarse aggregate settles to the bottom of the mix, remove and replace the application. The slurry when cured shall be uniform and skid-resistant.

3.9 REPAIR
   A. Remove spatter, mar, and overcoat from curb, gutter, sidewalk, guard rails, guide posts, etc.
B. Remove overcoat from Street Fixtures.
C. Make edge and end lines straight. Provide a good appearance.
D. Leave no streaks, holes, bare spots, or cracks through which liquids or foreign matter could penetrate to the underlying pavement.
E. Repair collateral damage caused by construction.

3.10 OPENING TO TRAFFIC
A. Cure time depends on type of asphalt, mixture characteristics and weather. Keep traffic off surface until material does not track out.

END OF SECTION