MISSISSIPPI DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION NO. 907-405-9 **CODE: (SP)**

DATE: 04/13/2016

SUBJECT: Polymer Modified Asphalt Rejuvenating Scrub Seal

Section 907-405, Scrub Seal, is hereby added to and made a part of the 2004 Edition of the Mississippi Standard Specifications for Road and Bridge Construction as follows.

SECTION 907-405 -- POLYMER MODIFIED ASPHALT REJUVENATING SCRUB SEAL

907-405.01--Description. This work shall consist of, but not be limited to, furnishing all labor, materials, equipment and transportation for the application of a polymer modified asphalt rejuvenating scrub seal. All ingredients shall be properly proportioned, mixed, and spread on the paved surface in accordance with this Specification and as directed by the Engineer.

907-405.02--Materials.

907-405.02.1--Aggregate. Unless otherwise noted, the aggregate material shall be one of the seal aggregate cover materials listed in and meeting the requirements of Subsection 703.14 of the Standard Specifications.

907-405.02.2--Asphalt Emulsion for Scrub Seal. The asphalt emulsion for scrub seal shall be Grade CMS-1PC meeting the requirements of the following table and shall be composed of a polymer modifier, a petroleum based rejuvenating agent, and asphalt.

Grade CMS-1PC

Property	Test Procedure (AASHTO)	Specification (min)	Specification (max)
Emulsion Properties			
Viscosity, Saybolt-Furol, @ 77°F, SFS	T59	50	350
Storage, 24 hour, %	T59		1
Oil Distillate, %	T59		0.5
Sieve Test, %	T59		0.1
Residue by Distillation(1) @ 350°F, %	T59	60	
Residue Properties From Distillation	T59		
Penetration @ 4°C , 200g weight, 60 sec	T49	30	
Residue Properties From Low Temp Evaporation	PP72		
MSCR @ 52°C, Jnr(3.2)	ASTM D7405		4.0
Polymer Properties(2)			
Swelling in rejuvenating agent, % max weight increase: 48 hrs	ASTM D471		40%
Tensile Strength (psi)	ASTM D412a	800	
Glass Transition Temperature (T_g) – Midpoint by DSC (°C)	ASTM D7426	0	
Latex Density at 23°C (g/cm^3)	ASTM D6937	1.00	1.05
Latex pH	ASTM E70	6.0	8.0
Test on Rejuvenating Agent			
Flash Point, COC, °F	T48	380	
Viscosity, 140°F, CST	201	50	175
Saturate, % by wt	ASTM D2007		30
Asphaltenes	ASTM D2007		1.0
Test on Residue from RTFO			
Weight change, %			6.5
Viscosity Ratio			3

1. Exception to AASHTO T59: Bring the temperature on the lower thermometer slowly to 350°F plus or minus 10°F. Maintain this temperature for 20 minutes. Complete the total distillation in 60 plus or minus 5 minutes.
2. For modifications for Polymer Properties testing, refer to Appendix A Test Modifications.
3. The emulsion supplier shall receive quarterly certificates of analysis from both the polymer and rejuvenating agency manufacturers. The COAs will be provided to the agency upon request.

Appendix A Test Modifications

ASTM D471 Standard Test Method for Rubber Property-Effect of Liquids: Modifications for Polymer Testing, Resistance to Swelling:

1. Using a syringe, place 0.8 gm of latex into an 18-mm diameter DSR mold.
2. Allow the sample to dry at ambient lab conditions (air conditioned) on the bench for 72 hours.
3. Sample should be easily removable from the mold.
4. Take the "button" out of the mold and place the sample into a forced air oven at 40°C (104°F) for

48 hours (on release paper). If at the end of the ambient dry, the sample sticks to the mold, place it into the oven and check it after 1-2 hours.

5. After 48 hours cool and weigh the sample to the nearest 0.0001 gram and record the weight.
6. Put ½-inch of Rejuvenating Agent into a 3-oz penetration tin.
7. Place the "button" on the Rejuvenating Agent, and add another ½ inch Of Rejuvenating Agent, so that the "button" is covered.
8. Put the cap on the penetration tin and place it into the 40°C oven for 48 hours. .
9. Remove the "button from the Rejuvenating Agent, blot surface of the "button" to remove excess Rejuvenating Agent, cool the "button" to room temperature and weigh it.
10. Calculate weight gain of the "button", express as %.

ASTM D412A Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension: Modifications

4. To prepare the polymer film, dilute the waterborne polymer to 40% Total Solids Content and pour 57 g into a Teflon or silicone release mold of dimensions 7'' X 7'' X ¼''.
5. Allow to dry at 23°C (73°F) and 50% RH (controlled conditions) for 7 – 10 days total time, during which time the film should be flipped around once, preferably after 3 or 4 days. The film should be transparent in the end.
6. To drive out any residual water, place the film in an oven at 50°C for 30 min. Dried film thickness should be 25 mil ±5 mils. Discard films <20 mil.
7. Cut out dumbbell-shaped test specimens of dimension 75 mm total length, 25 mm mid-section (L) and 4 mm width of mid-section.
8. Grip in Instron machine with gap size 1 inch, use 8 inch/min cross-head speed.

ASTM D7426 Standard Test Method for Assignment of the DSC Procedure for Determining Tg of a Polymer or an Elastomeric Compound Modifications

Use between 3 – 30 mg dry polymer. Instrument used is TA Q2000 Differential Scanning Calorimeter (DSC). Heating rate is 20°C/min.

ASTM D6937 Standard Test Method for Determining Density of Emulsified Asphalt: Modifications

Replace "Emulsified Asphalt" with "Latex" in text of test method. The testing temperature used should be 25 ±3°C. The calculation in Section 7 should be as follows:

Calculation:
D = (Wf - Wt) * 0.1
S.G. = D / 8.337
Where: Wf = Weight of filled cup (g)
Wt = Weight of empty cup (g)

ASTM E70 Standard Test Method for pH of Aqueous Solutions with the Glass Electrode: Modifications

1. A pH meter with automatic temperature measurement should be used in the evaluation with a calomel cell assembly or combination electrode. Calibration should be made using the procedure with the pH meter, according to ASTM method, prior to testing the pH of the latex. In Section 9, the procedure for measuring pH of the latex should be as follows:

(a) Place the electrode and probe into the dispersion that is to be measured and swirl the sample cup or beaker gently. (You may also use the probe in a stirring motion.)
(b) Wait for the reading to stabilize (usually less than a minute) and read/record this value. Note the temperature if not utilizing an ATC probe.
(c) Take the Electrode and ATC probes from the sample and rinse thoroughly with de-ionized water. Pat dry and place back into appropriate solution recommended by electrode manufacturer for storage.

When a fog seal is required, the asphalt emulsion shall meet the requirements of Subsection 907-702.07.2.

907-405.02.2.1--Certification and Acceptance. The Emulsion supplier shall submit a certification that the polymer modified rejuvenating emulsion meets the requirements of the specification. The certification shall be submitted to the Engineer prior to starting the work. The Engineer will sample the polymer modified rejuvenating emulsion according to Department procedures. Final acceptance of the emulsion for scrub seal will be based on the Manufacturer's Certification and testing conducted by the Department.

907-405.03--Construction Requirements. The attached sign drawings shall be used during scrub seal operations. Prior to any sealing operation, the rectangular "Loose Rock" signs shall be installed and remain in place until all sealing operations are complete. Prior to any daily sealing operation, the portable "Loose Rock" signs shall be installed in accordance with the attached drawings. Portable signs shall be installed and remain in place on a daily basis in the active sealing area. Payment for signs shown on the sign detail drawings shall be made under pay item no. 907-618-A, Maintenance of Traffic.

907-405.03.1--Preparation. The work shall be done in the following order: Prepare the pavement surface; apply the asphalt emulsion for scrub seal and scrub the applied emulsion with a scrub broom as specified herein; apply the aggregate, roll the aggregate, broom the aggregate with a secondary broom when specified; and sweep up and dispose of excess aggregate. Excess aggregate shall be removed from the project unless otherwise approved by the Engineer.

Prior to the scrub seal operation, the Contractor shall remove any and all vegetation within the limits of the scrub seal installation. The use of herbicides will be allowed at the discretion of the Engineer.

If used, the herbicide shall be applied at least 10 days prior to the scrub seal operation, or as directed by the manufacturer of the approved herbicide. The application of the herbicide shall be performed in accordance with all applicable regulations. Any and all fines or clean-up costs for unlawful misuse or discarding of herbicides shall be the sole responsibility of the Contractor. Mixtures and spread rates for the herbicides shall be determined by the manufacturer's specifications. Wash down of equipment or discarding of herbicides shall not enter catch basins or positive drainage facilities.

Prior to the scrub seal operation, the Contractor shall remove all existing thermoplastic striping, thermoplastic legends and raised pavement markers within the scrub seal limits. Removal shall be performed to the satisfaction of the Engineer.

Prior to the scrub seal operation, all drain inlet covers, monument covers, and all other utility covers shall be protected from the Contractor's scrub seal operations by applying a sheet of plastic over the exposed facilities, or other methods approved by the Engineer. All traces of plastic, residual emulsion and aggregate shall be removed from covered objects after the application of the scrub seal and/or prior to final inspection of the project.

Immediately prior to the scrub sealing operations, the Contractor shall sweep the entire pavement surface.

907-405.03.2--Application. The scrub seal shall be applied from edge of pavement to edge of pavement. The edges of the scrub seal application shall be maintained in a neat and uniform line. Scrub seal shall not be applied on concrete gutters or pads unless directed by the Engineer.

The application of the asphalt emulsion for scrub seal shall be applied only when the ambient and pavement temperatures are above 70ºF.

The asphalt emulsion for scrub seal shall be applied with a distributor truck at the following target rates. The actual emulsion application rate shall be determined from the surface demands and aggregate used. Any adjustments of the application rate shall be approved by the Engineer, and manufacturer's representative if necessary.

The optimum application rate of bituminous material is dependent on the chosen seal aggregate gradation as well as the condition of the pavement in which the bituminous surface treatment is to be applied. The application rate of the bituminous material may be adjusted by the Engineer based on field conditions at the time of construction. Following are target application rates for bituminous material.

Seal Aggregate Gradation	Bituminous Material	Target Application Rate (gal/yd^2)	Tolerance
Size No. 7	Emulsified Asphalt	0.33	±0.03
Size No. 8 or 89	Emulsified Asphalt	0.30	±0.03

Note: Emulsified Asphalt shall not be diluted. A sample of emulsified asphalt should be obtained from the Contractor's distributor on the first day of production and thereafter at a frequency not to exceed 1 sample per 50,000 gallons. Because the time between sampling of the emulsified asphalt and the testing of the material can affect the test results, samples should be sent to the MDOT Central Lab for testing as soon as possible.

The asphalt emulsion for scrub seal temperature when applied shall be a minimum of 140º to 180ºF. For smaller areas, the emulsion may be applied with a wand. The emulsion shall be immediately broomed to fill cracks and voids. The emulsion scrub broom shall be as described below.

Immediately following the application of the emulsion to the road surface, the material shall be scrubbed with a scrub broom for the purpose of forcing the emulsion into the existing surface and distributing the emulsion evenly over variable road surface contours.

The application of the asphalt emulsion for scrub seal and scrub broom operation shall cease 40 feet prior to the end of the application. The remaining asphalt emulsion for scrub seal shall be dragged out by the scrub broom, and the remaining emulsified material required to complete the pass shall be applied only by the distributor truck, at the specified rate.

Immediately following the scrubbing of emulsion, aggregate shall be applied at the following application rates.

Size 7 Slag, Stone, Gravel or Expanded Clay	=	0.30 ± 0.02 ft^3 / yd^2
Size 8 Expanded Clay	=	0.25 ± 0.02 ft^3 / yd^2
Size 89 Slag, Stone, or Gravel	=	0.25 ± 0.02 ft^3 / yd^2

The actual aggregate application rate shall be as required by the surface demands and the emulsion used. The rate shall be adjusted, within the specified limit, up or down so that no "bleed through" occurs during rolling.

During the first day of production and at least once a week thereafter, the application rate of the aggregate shall be verified by the Department to assure that the appropriate application rate of the aggregate is applied. The rate can be verified by placing a tarp of at least 1.0 yd^2 area on the roadway surface. After allowing the aggregate spreader to pass over the tarp, the aggregate on the tarp should be collected and weighed to determine the weight of aggregate. The measured weight should then be compared to the target weight calculated using the following formula.

$$W = 0.85(G_{sb})(U_w)(R)(A)(e)$$

Where:

W = target weight of aggregate in lbs.
G_{sb} = bulk specific gravity of aggregate
U_w = Unit weight of water at 70°F = 62.3 lbs./ft^3
R = target application rate in ft^3/yd^2
A = area of tarp in yd^2
e = air voids in loose aggregate = 0.4

G_{sb} for gravel = 2.650
G_{sb} for limestone = 2.700

Note: Bulk specific gravities of expanded clay and steel slag should be obtained from the seal aggregate supplier.

Upon determining the target weight, it should be compared to the actual measured weight. If the difference in the target weight and the actual measured weight is over 2.5 pounds, the aggregate distributor should be adjusted such that the spread rate is within the above tolerance. The above procedure shall be repeated until the spread rate is within the allowable tolerance.

If at any point during production, excessive aggregate is noted, the aggregate application rate should be verified and the spread rate adjusted. The intent is to minimize the amount of excess

aggregate. Excess aggregate removed from the roadway surface after brooming shall be removed from the job site and should not be reused in the aggregate operation.

The dry aggregate shall be spread uniformly to cover the bituminous material with the quantity of mineral aggregate specified by the Engineer. All deficient areas shall be covered by additional material. All excess cover material shall be removed from the surface and stockpiled or used as directed.

A minimum of two self-propelled pneumatic-tired rollers shall be used for the required rolling of the aggregate. The pneumatic-tired rollers shall be in good working condition and actively rolling at all times during the scrub seal operation. The pneumatic-tired rollers shall be minimum 5-ton rollers. The pneumatic-tired rollers shall be operated in such a manner to prevent the dislodging of newly applied aggregate.

907-405.03.3--Stockpile Sites. Sites for stockpiles of materials shall be grubbed and cleaned prior to storing the aggregates, and the ground shall be firm, smooth, and well drained.

907-405.03.4--Equipment. The following equipment shall be used for the scrub-seal operations.

A. Asphalt Distributor. The asphalt distributor for application of the emulsion shall have a full circulation spray bar that is adjustable to at least sixteen feet (16') wide in two (2) feet increments and capable of heating and circulating the emulsion simultaneously. It must have computerized rate control for adjusting and controlling the application from the cab within 0.01 gallons per square yard increments. The distributor shall also be equipped with a volume measuring device and a thermometer for measuring the emulsion temperature in the tank.

B. Scrub Broom. A scrub broom as described herein shall be used to scrub the emulsion after application. The scrub broom frame shall be constructed of metal. The scrub broom shall be attached to and pulled by the distributor truck. The scrub broom must be equipped with a means of raising and lowering the scrub broom at desired points. It shall be towable in the elevated position to the next area of construction. The weight of the broom assembly shall be such that it does not squeegee the emulsion off the roadway surface.

   The main body of the scrub broom shall have a frame size as shown in the drawing at the end of this special provision. The nearest and furthest members, paralleling the back of the distributor truck, and diagonal members shall be equipped with street brooms. The leading member and the trailing member shall have broom heads angled at 10 to 15 degrees off the centerline of the supporting member. The diagonal members shall have broom heads attached in line with the centerline of the supporting member. Each individual street broom attached to the scrub broom assembly shall be 3.5 inches wide x 6.5 inches high x 16 inches long and have stiff nylon bristles. Bristle height is to be maintained at a minimum of five inches (5"). The scrub broom shall be equipped with hinged wing assemblies attached to the main body not to exceed 4.5 feet per side, with diagonals and equipped with street brooms. The purpose of the maximum rigid frame width and the hinged wing extensions is not only for maximum width of 16 feet but to maintain the scrubbing process evenly as contours and cross-sections change across the existing road surface.

C. Aggregate Spreader. A self-propelled aggregate spreader with front discharge that can evenly distribute aggregate.

D. Roller. A minimum of two (2) pneumatic rollers weighing at least five (5) tons each.

E. Power Broom. Two (2) mechanically powered kick-brooms or vacuum type brooms.

907-405.03.5--Opening to Traffic. Unless otherwise advised, the Contractor's operations shall be schedule such that all lanes of traffic are open to the traveling public at the end of each day. Considering time needed for curing and preparation prior to opening traffic, the Contractor should not apply bituminous material two (2) hours before dusk, or longer, to allow sufficient time for bonding of the aggregates.

After the scrub seal has been rolled and the bituminous material has cured a minimum of one (1) hour, or longer if necessary to sufficiently hold the aggregate in place, the Contractor shall perform an initial brooming operation consisting of lightly sweeping excess aggregate material from the surface.

Immediately the next morning, a final brooming shall be performed to remove any remaining excess aggregate material from the previous day's seal operation. If specified, a fog seal will be placed on all sealed routes at a rate of 0.11 gallons per square yard, or as directed by the Project Engineer. The fog seal shall not be placed until after final brooming.

907-405.04--Method of Measurement. Scrub seal shall be measured by the square yard.

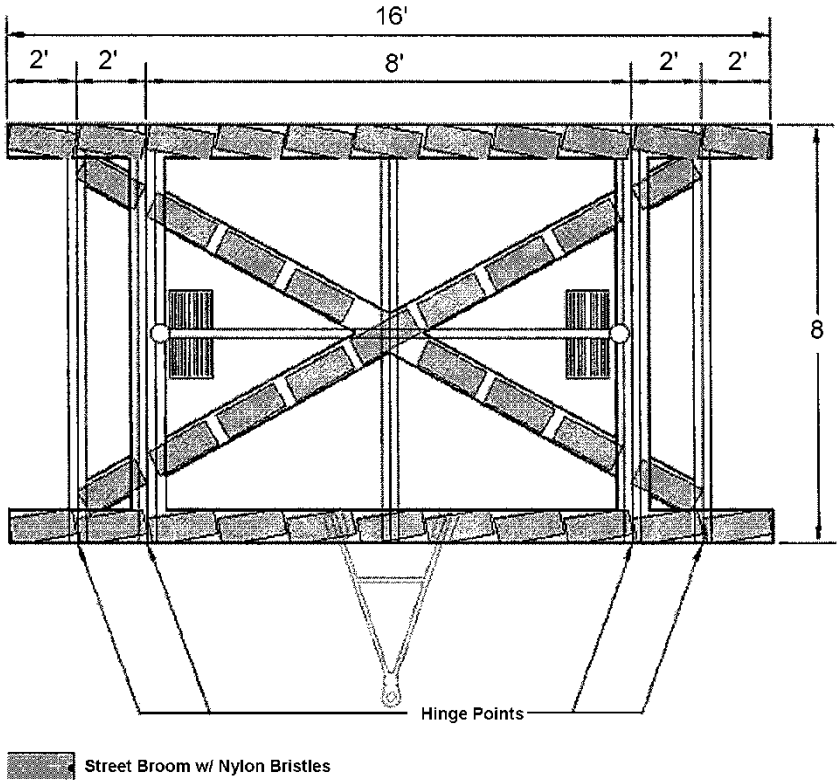
Accepted quantities for fog seal will be measured by the gallon as prescribed in Subsection 109.01. Unless otherwise specified, distributor tank measurement will be used. The volume of material over five percent (5%) above the quantity ordered for each shot will be deducted from measured quantities, except that 15 percent will be allowed for irregular areas where hand spraying is necessary.

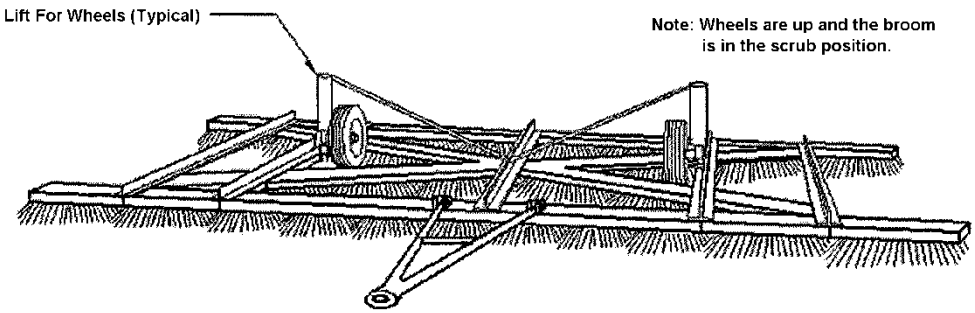
907-405.05--Basis of Payment. Scrub seal, measured as prescribed above, will be paid for at the contract bid price per square yard, which shall be full compensation for furnishing all labor, materials, equipment, temporary markers, vegetation removal, cleaning of the surface, pre-sweeping, post-sweeping, doing all the work involved in mixing, applying and protecting the polymer modified asphaltic rejuvenating scrub seal, and all incidentals necessary to complete the work.

Asphalt for surface treatment will be paid for at the contract unit price per gallon, which shall be full compensation for furnishing all labor, materials, equipment, applying and protecting the fog seal, and all incidentals necessary to complete the work.

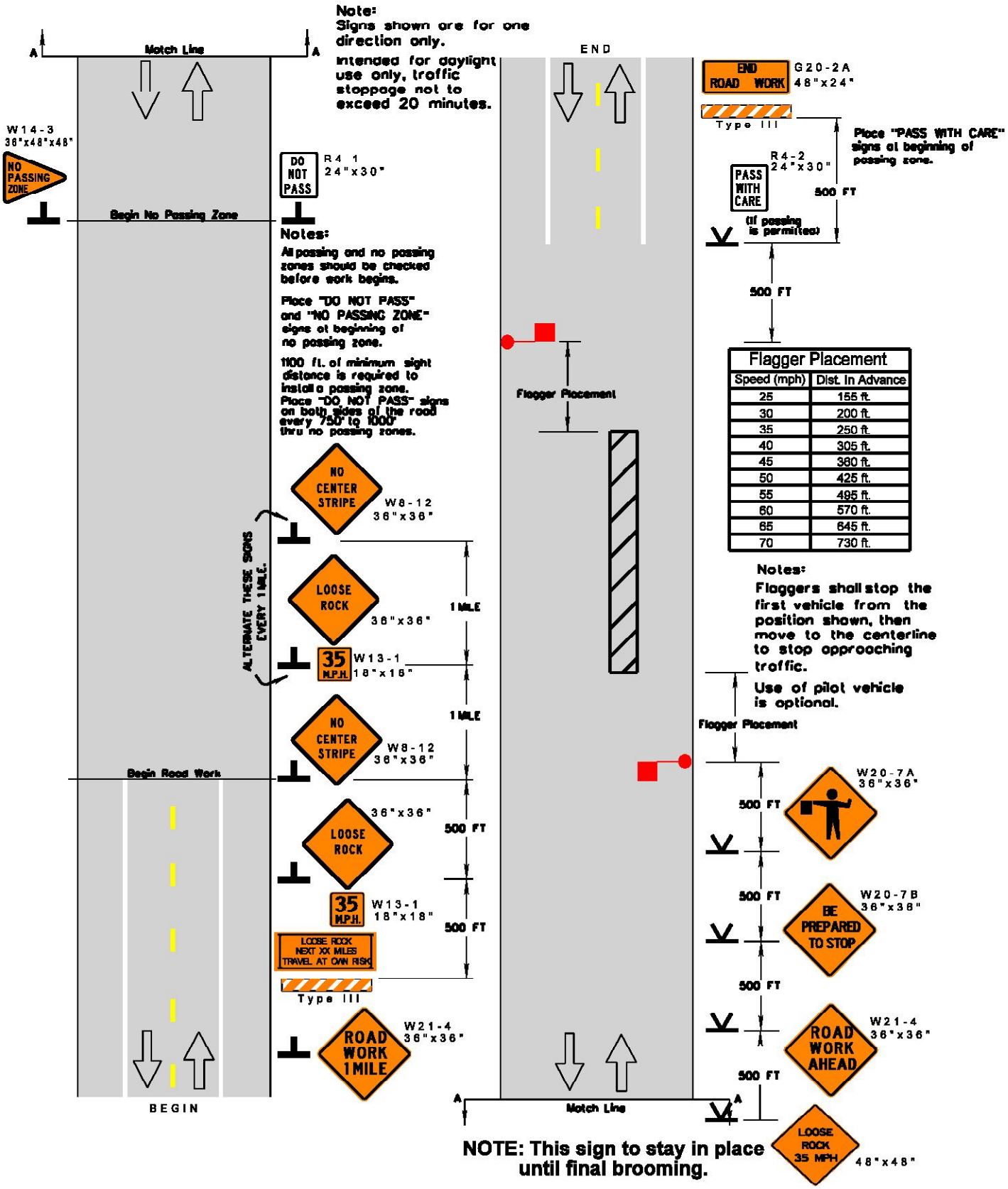
Payment will be made under:

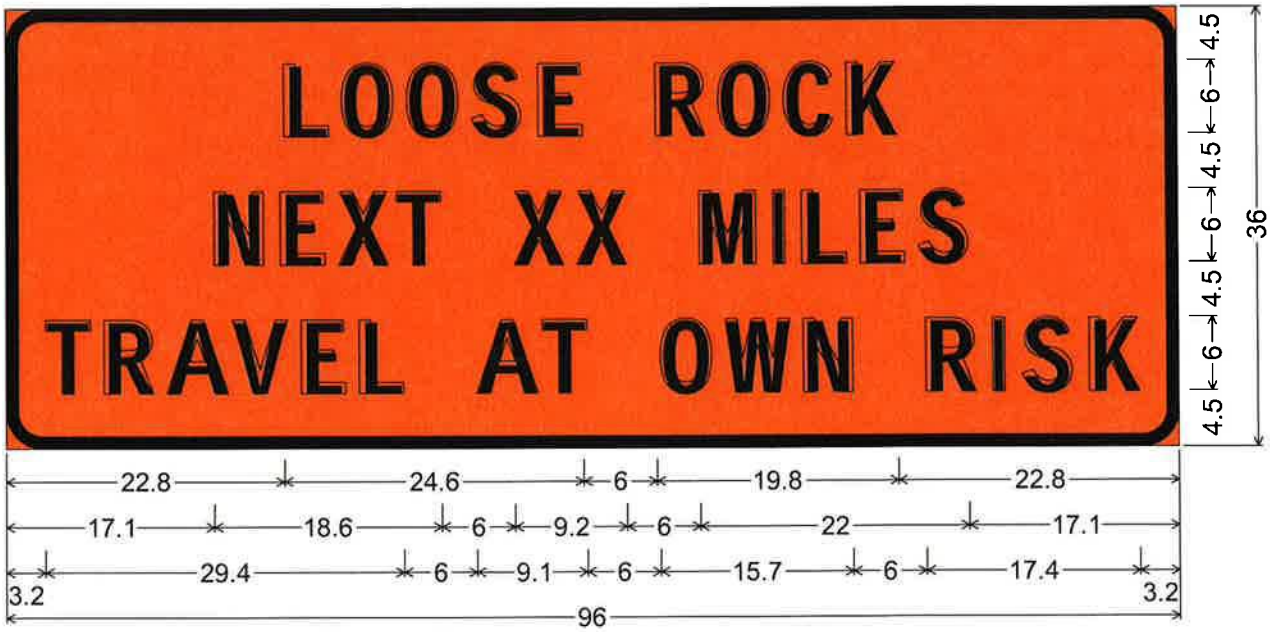
907-405-D:	Scrub Seal	- per square yard
907-405-E:	Fog Seal for Scrub Seal	- per gallon


16'
2'
2'
8'
2'
2'
8
Hinge Points
Street Broom w/ Nylon Bristles


Lift For Wheels (Typical)
Note: Wheels are up and the broom is in the scrub position.

Scrub Broom


Note:
Signs shown are for one direction only.
Intended for daylight use only, traffic stoppage not to exceed 20 minutes.
Match Line
A
A
W14-3
36"x48"x48"
NO PASSING ZONE
Begin No Passing Zone
DO NOT PASS
R4 1
24"x30"
Notes:
All passing and no passing zones should be checked before work begins.
Place "DO NOT PASS" and "NO PASSING ZONE" signs at beginning of no passing zone.
1100 ft. of minimum sight distance is required to install a passing zone.
Place "DO NOT PASS" signs on both sides of the road every 750' to 1000' thru no passing zones.
NO CENTER STRIPE
W8-12
36"x36"
LOOSE ROCK
36"x36"
35 M.P.H.
W13-1
18"x18"
ALTERNATE THESE SIGNS EVERY 1 MILE.
1 MILE
1 MILE
NO CENTER STRIPE
W8-12
36"x36"
Begin Road Work
LOOSE ROCK
36"x36"
500 FT
35 M.P.H.
W13-1
18"x18"
500 FT
LOOSE ROCK NEXT XX MILES TRAVEL AT OWN RISK
Type III
ROAD WORK 1 MILE
W21-4
36"x36"
BEGIN
END
Flagger Placement
END ROAD WORK
G20-2A
48"x24"
Type III
Place "PASS WITH CARE" signs at beginning of passing zone.
R4-2
24"x30"
PASS WITH CARE
(if passing is permitted)
500 FT
500 FT
Flagger Placement
Speed (mph) | Dist. In Advance
25 | 155 ft.
30 | 200 ft.
35 | 250 ft.
40 | 305 ft.
45 | 380 ft.
50 | 425 ft.
55 | 495 ft.
60 | 570 ft.
65 | 645 ft.
70 | 730 ft.
Notes:
Flaggers shall stop the first vehicle from the position shown, then move to the centerline to stop approaching traffic.
Use of pilot vehicle is optional.
Flagger Placement
500 FT
W20-7A
36"x36"
500 FT
W20-7B
36"x36"
BE PREPARED TO STOP
500 FT
W21-4
36"x36"
ROAD WORK AHEAD
500 FT
LOOSE ROCK 35 MPH
48"x48"
Match Line
A
A
NOTE: This sign to stay in place until final brooming.

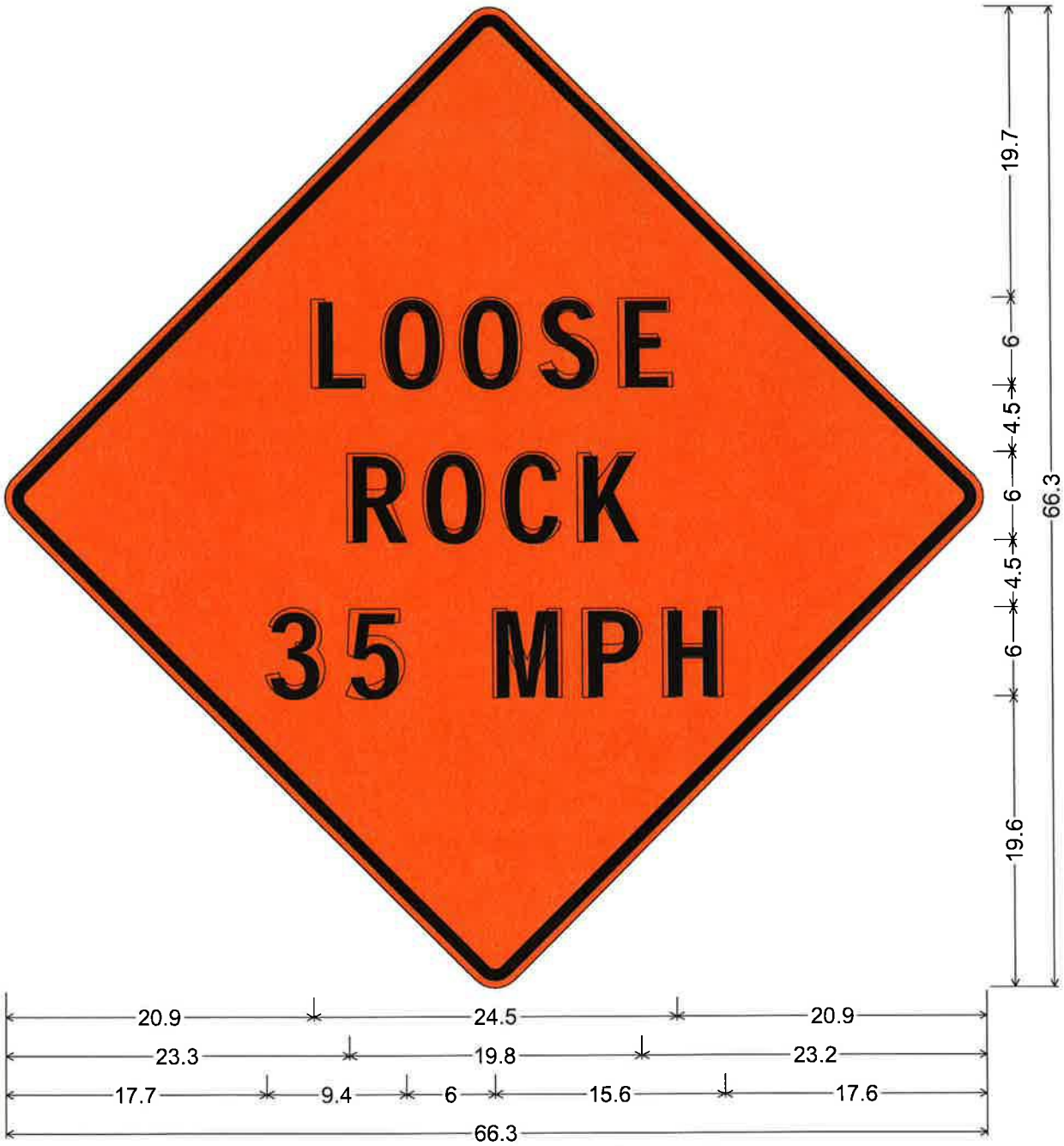


3.0" Radius, 1.0" Border, Black on Orange;
"LOOSE ROCK" D; "NEXT XX MILES" D; "TRAVEL AT OWN RISK" D;
Table of letter and object lefts.

L	**O**	**O**	**S**	**E**	**R**	**O**	**C**	**K**
22.8	27.6	33.0	38.3	43.7	53.4	58.5	63.9	69.0

N	**E**	**X**	**T**	**X**	**X**	**M**	**I**	**L**	**E**	**S**
17.1	22.5	27.3	32.1	41.7	46.9	56.9	63.0	65.3	70.1	74.9

T	**R**	**A**	**V**	**E**	**L**	**A**	**T**	**O**	**W**	**N**	**R**	**I**	**S**	**K**
3.2	8.0	13.2	18.6	24.2	29.0	38.6	44.0	53.7	59.0	65.4	75.4	80.9	83.2	88.6



48.0" across sides 1.9" Radius, 0.8" Border, 0.5" Indent, Black on Orange;
"LOOSE" D; "ROCK" D; "35 MPH" D;
Table of letter and object lefts.

L 20.9	**O** 25.7	**O** 31.0	**S** 36.4	**E** 41.8
R 23.3	**O** 28.4	**C** 33.8	**K** 38.9	
3 17.7	**5** 23.1	**M** 33.1	**P** 39.2	**H** 44.6