DATE: December 8, 2020

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SUBJECT: SR 7 "Quiet" Pavement Noise Study

OBJECTIVE

In September 2019, DelDOT installed asphalt rubber bituminous concrete along SR 7 between Milltown Road and SR 72 as part of a pavement and rehabilitation project, with the goal of reducing roadway traffic noise. DelDOT requested this study in order to determine the effectiveness of this "quiet" pavement in terms of overall noise reduction.

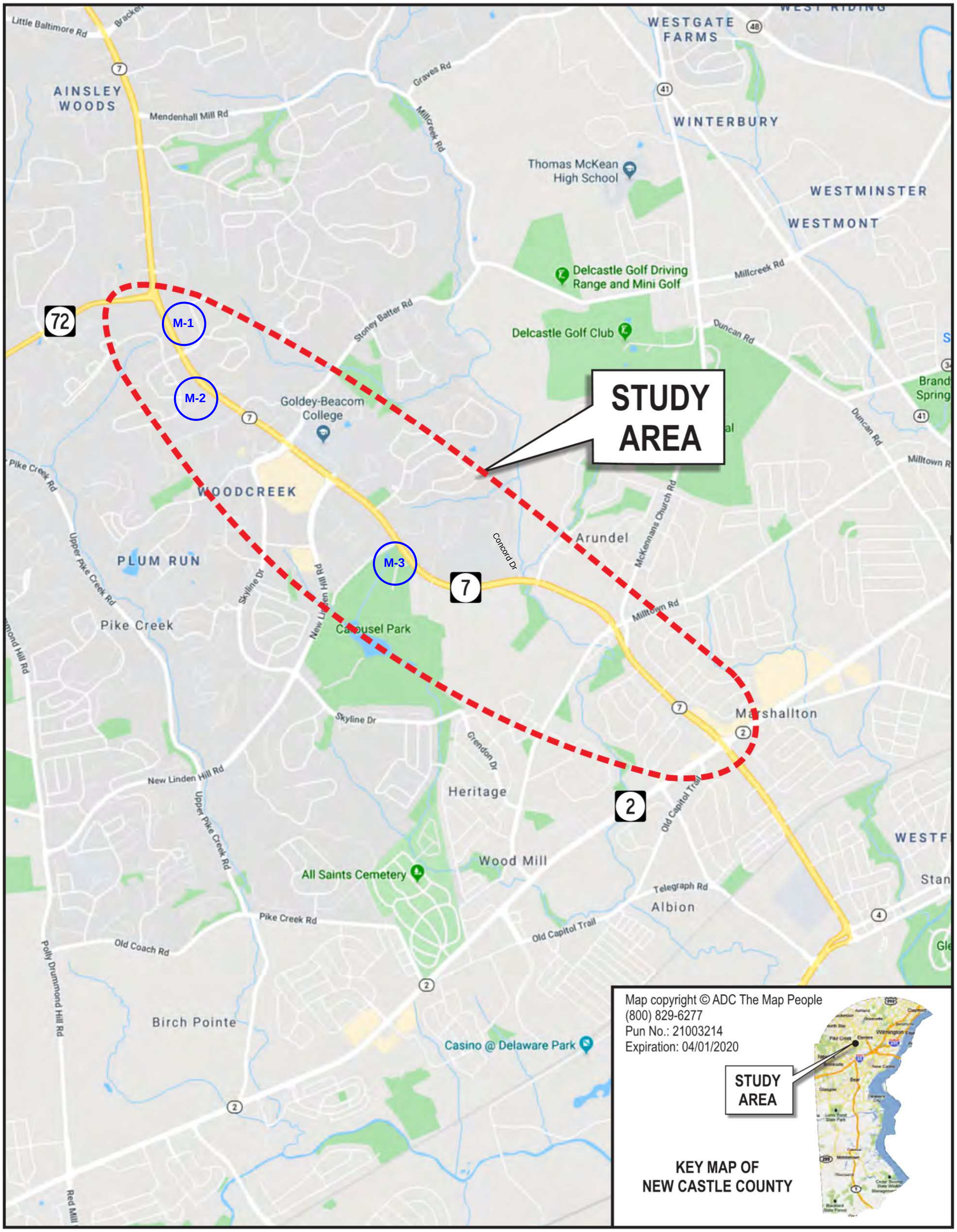
BACKGROUND

Traffic noise is caused by a combination of sources such as tire-pavement interaction, aerodynamic disturbances, powertrain mechanics, and exhaust. At faster highway speeds, tire noise is generally the dominant source. This study examines the effects of reducing tire noise with the installation of an asphalt rubber bituminous concrete (see attached specification). The gap-graded aggregate used in this pavement, combined with rubber that is contained in the asphalt binder, can provide noise reductions over a range of frequencies between 400 Hz to 4 kHz. While not currently approved by the FHWA as a noise mitigation measure, there are no other restrictions on the application of noise-reducing pavements, such as the pavement used in this study, in roadway design or maintenance.

DelDOT installed asphalt rubber bituminous concrete (henceforth referred to as "quiet" pavement) in September 2019 along the section of SR 7 between Milltown Road to the south and SR 72 to the north. The cost for this project, based on the winning contractor bid price, was $97/ton[1]. Comparatively, standard asphalt pavement (Specification attached) has cost approximately $90/ton for recent DelDOT projects of similar size.

In this section, SR 7 is a 4-lane roadway that is partly divided and traverses residential and commercial areas with numerous intersections, some of which are signalized. SR 7 has speed limits of 40 mph to the south of Concord Drive, and 50 mph to the north. See the vicinity map in Figure 1.

[1] Pavement costs can vary significantly based on factors that include quantities, the number of concurrent and similar regional projects, general state of the economy, etc.



SR 7 QUIETER PAVEMENT STUDY

VICINITY MAP

Figure 1

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Delaware Department of Transportation

A "before" study (Phase 1) was conducted prior to pavement installation on May 7, 2019. Subsequently, two "after" studies (Phases 2 and 3) were conducted on October 15, 2019 and July 2, 2020 respectively. The intent of the phase 3 "after" study was to determine if any potential noise reductions documented in the phase 2 study were sustained over a longer period of time.

MEASUREMENTS AND ANALYSIS

For each measurement phase, noise measurements and traffic video were recorded at three sites in the SR 7 study area, designated as receptors M-1, M-2 and M-3.

Site M-1 is the northern-most receptor, located in right-of-way and 30 feet from SR 7 NB edge of shoulder, to the south of Granville Road and adjacent to the ManorCare Health Services facility. The site elevation is approximately 5 feet higher than the roadway. The quiet pavement application begins just south of this location, making site M-1 a "control" site with noise levels that should be relatively unchanged between phases.

Site M-2 is in the maintenance area of Limestone Hills development, 30 feet from SR 7 SB edge of shoulder, between the terminus of Attic Court and SR 7, and north of the entrance to St. Philips Lutheran Church. The site elevation is approximately the same as that of the roadway. Quiet pavement was present in this section of SR 7 for Phases 2 and 3.

Site M-3 is the southern-most receptor, located in the right-of-way and approximately 55 feet from SR 7 SB edge of shoulder, to the south of Stable Lane and adjacent to the New Castle County Carousel Park. The site elevation is approximately 2 feet higher than the roadway. As with site M-2, quiet pavement was present in this section of SR 7 for Phases 2 and 3.

More details on these sites, including photographs, location details, and conditions are included in the data sheets at the end of this memo.

Noise measurements were conducted simultaneously during the hours between 11:30 am and 3:30 pm at each site, for each phase. Data was collected using three Rion NL-52 sound level meters capable of recording averaged equivalent sound levels (Leq) and 1/3 octave band levels for frequencies between 400 Hz and 4 kHz. All measurements were recorded in 5-minute intervals to allow discrete removal of potential corrupting data not directly associated with typical highway traffic noise such as sirens, horns, small engines, roadway maintenance etc. The measurement intervals also allow processing of the data for comparisons between single hours.

TRAFFIC NORMALIZATION

Noise measurements were recorded during the same hours of the day to help minimize traffic variability, however traffic volumes and classifications still vary from day-to-day and month-to-month. For this reason, traffic volumes were recorded and counted during each session so that these differences can be accounted for. To quantify the effects of variable traffic on noise, a simple noise model was constructed using the FHWA Traffic Noise Model 2.5 (TNM) and noise level differences were predicted for each site. These differences are applied as correction factors to the noise data, thus normalizing the traffic for each session. The corrections are small (between 0.1 to 0.8 dBA) but allow for more realistic comparisons between phases. All data presented is normalized for traffic in this way.

Prior to initiating this study, different noise study options were discussed with DelDOT with varying levels of complexity. Based on those discussions, DelDOT requested that this study be performed based on simple wayside noise measurements. While the processed noise data was normalized for traffic variations, noise levels obtained during a wayside noise study can also be affected by other variables such as specific vehicle and tire types, speeds, weather, and pavement conditions including temperature, compaction and wear. To obtain these types of information, a much more controlled and expanded study would be required which would require significantly more resources than were used for this study. It is therefore noted that variables such as those listed above could contribute to some of the variances seen in the data.

RESULTS

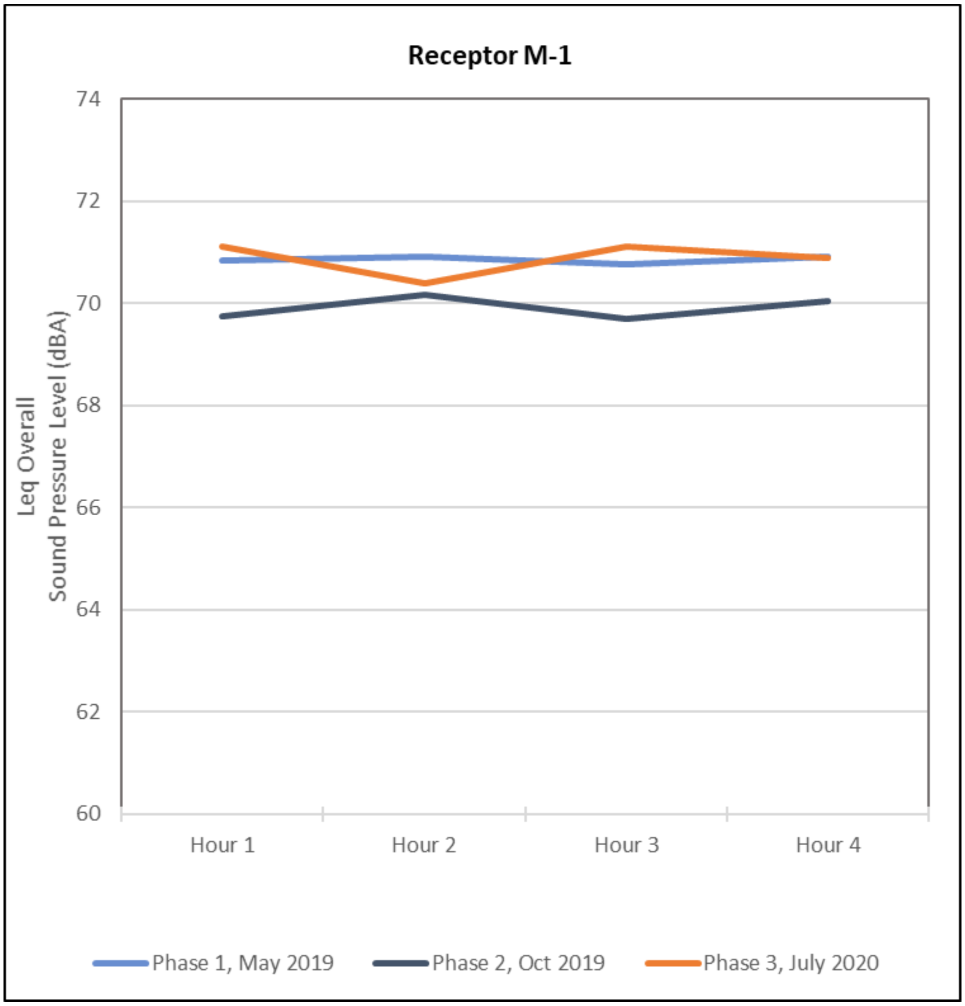
Overall hourly Leq and 1/3 octave band data averaged over four hours are shown on the following pages for each phase, with an explanation of correlations, noise reductions and other characteristics.

For assessment of noise reductions, 3 dBA is generally considered to be the threshold of perception by the human ear. Current DelDOT Noise Policy Implement D-03 defines a “benefited receptor” as any site that receives a noise reduction of 8 dBA or greater as the result of an abatement measure. The Noise Policy also assigns a design goal that requires at least 75% of impacted receptors receive a noise reduction at least a 5 dBA.

Receptor M-1

Receptor M-1 is the "control" site, being just north of the roadway section where quiet pavement was applied. As expected, overall noise levels and 1/3 octave band levels do not change dramatically between Phases 1, 2 and 3. Differences between phases are typically within 2 dBA for both overall Leq and frequency analysis. These differences illustrate the potential for variance when normalizing for traffic classifications and volumes only.

Figure 1: M-1 Leq

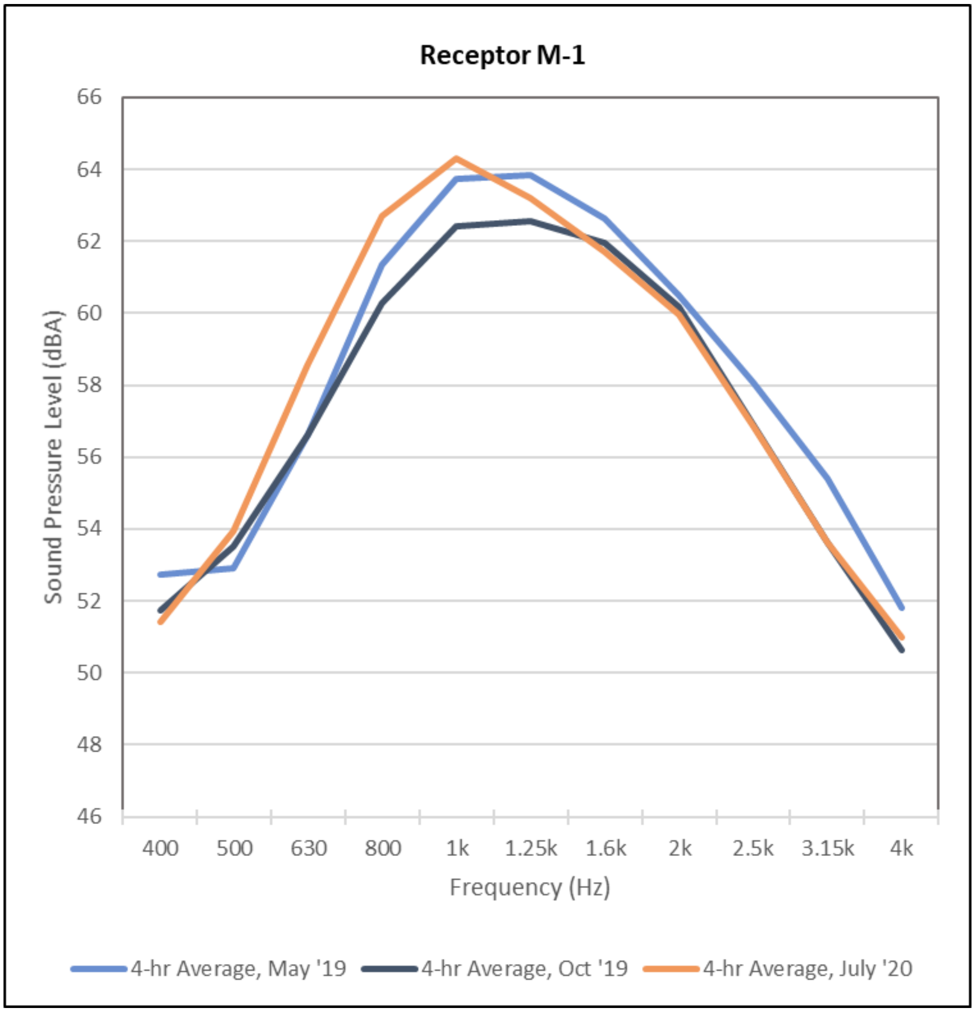


M-1 Leq (dBA)

	Hour 1	Hour 2	Hour 3	Hour 4
Phase 1, May 2019	70.8	70.9	70.8	70.9
Phase 2, Oct 2020	69.7	70.2	69.7	70.0
Phase 3, July 2020	71.1	70.4	71.1	70.9

Receptor M-1 (continued)

Figure 2: M-1 Frequency Analysis, 4-hr Average



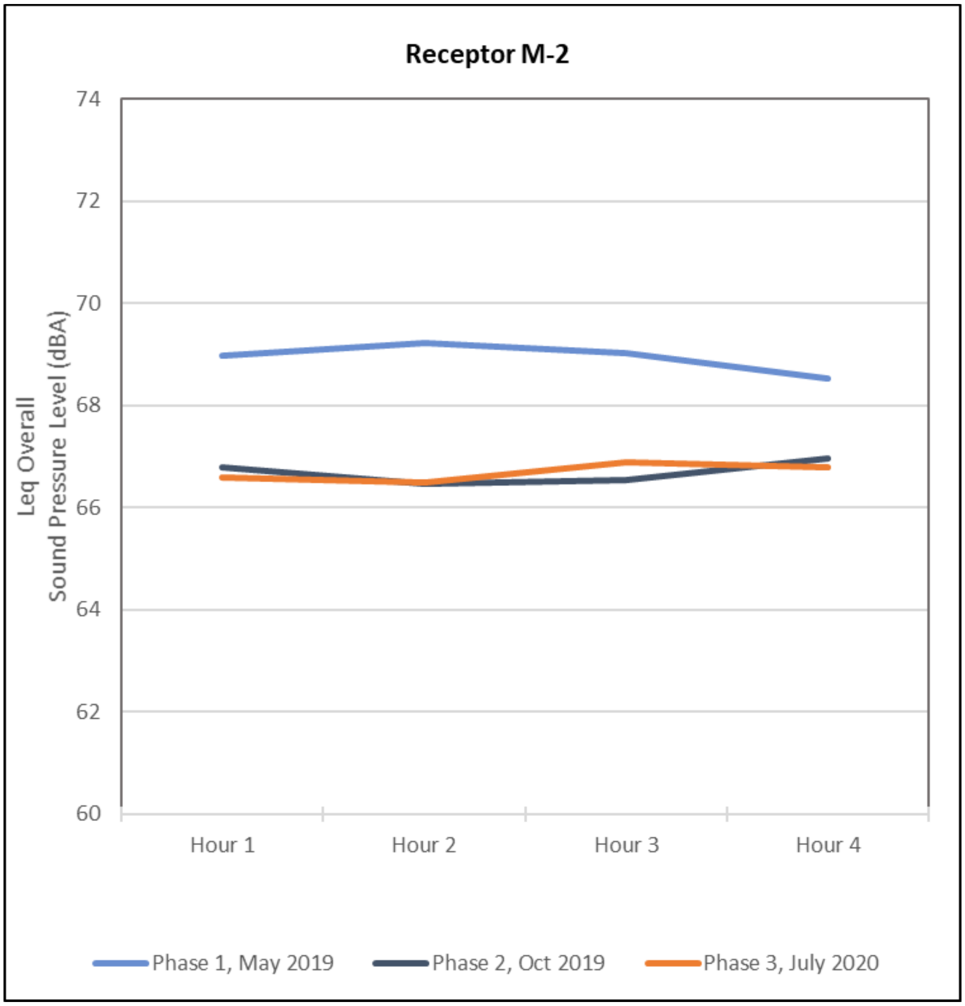
M-1 Frequency Analysis (dBA)

Octave Band Center Frequency (Hz)											
	400	**500**	**630**	**800**	**1k**	**1.25k**	**1.6k**	**2k**	**2.5k**	**3.15k**	**4k**
Phase 1, May 2019	52.7	52.9	56.6	61.3	63.7	63.8	62.6	60.5	58.1	55.4	51.8
Phase 2, Oct 2020	51.7	53.5	56.6	60.3	62.4	62.6	62.0	60.2	56.9	53.6	50.6
Phase 3, July 2020	51.4	54.0	58.6	62.7	64.3	63.2	61.7	60.0	56.9	53.6	51.0

Receptor M-2

Receptor M-2 Leq data shows overall noise reductions of approximately 2 to 3 dBA with the quiet pavement. The data also shows very good agreement between Phases 2 and 3.

Figure 3: M-2 Leq



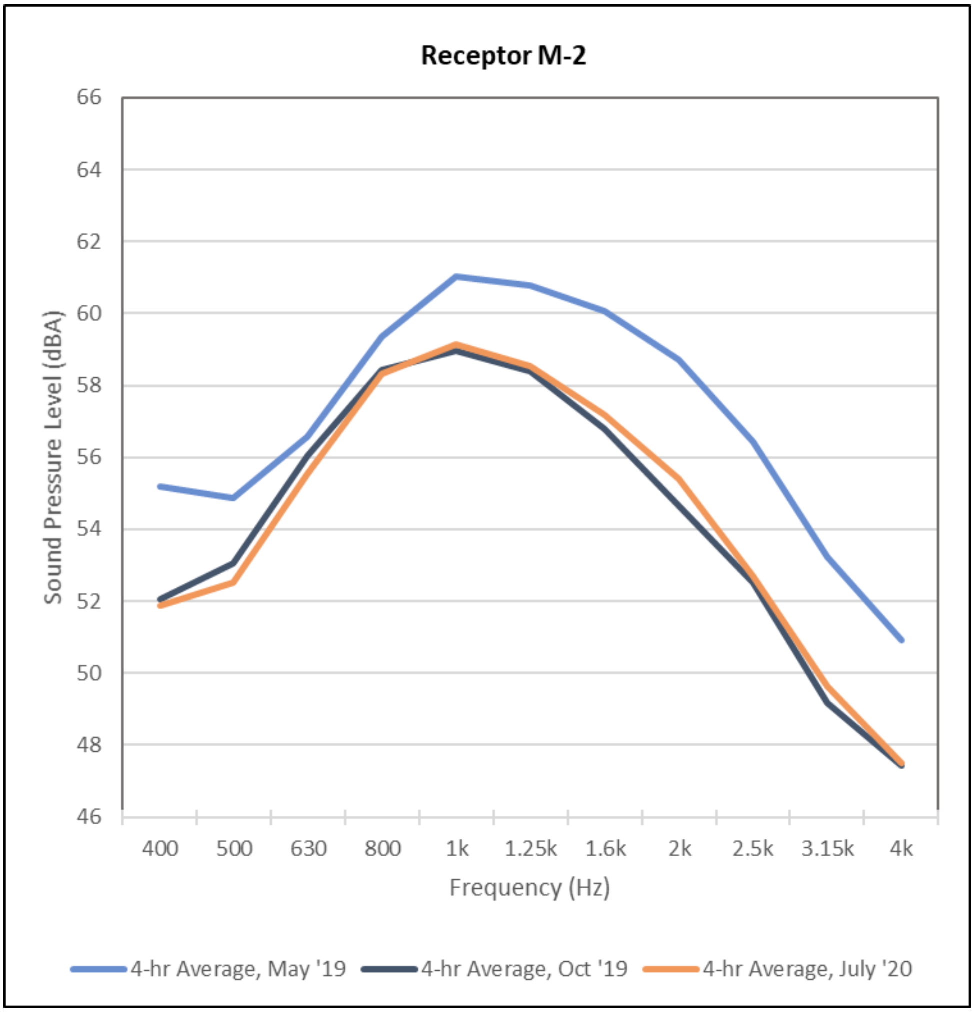
M-2 Leq (dBA)

	Hour 1	Hour 2	Hour 3	Hour 4
Phase 1, May 2019	69.0	69.2	69.0	68.5
Phase 2, Oct 2020	66.8	66.5	66.5	67.0
Phase 3, July 2020	66.6	66.5	66.9	66.8

Receptor M-2 (continued)

The frequency analysis shows reductions of approximately 1 to 4 dBA at the 1/3 octave band frequencies, with minimum reductions at 630 to 800 Hz, and maximum reductions at the higher frequencies. It should be noted that while frequency band analysis provides insight to the relative contributions of various frequencies to overall noise levels, such differences are not easily perceptible by the human ear. Perceptible reductions are best represented with overall noise levels using Leq.

Figure 4: M-2 Frequency Analysis, 4-hr Average



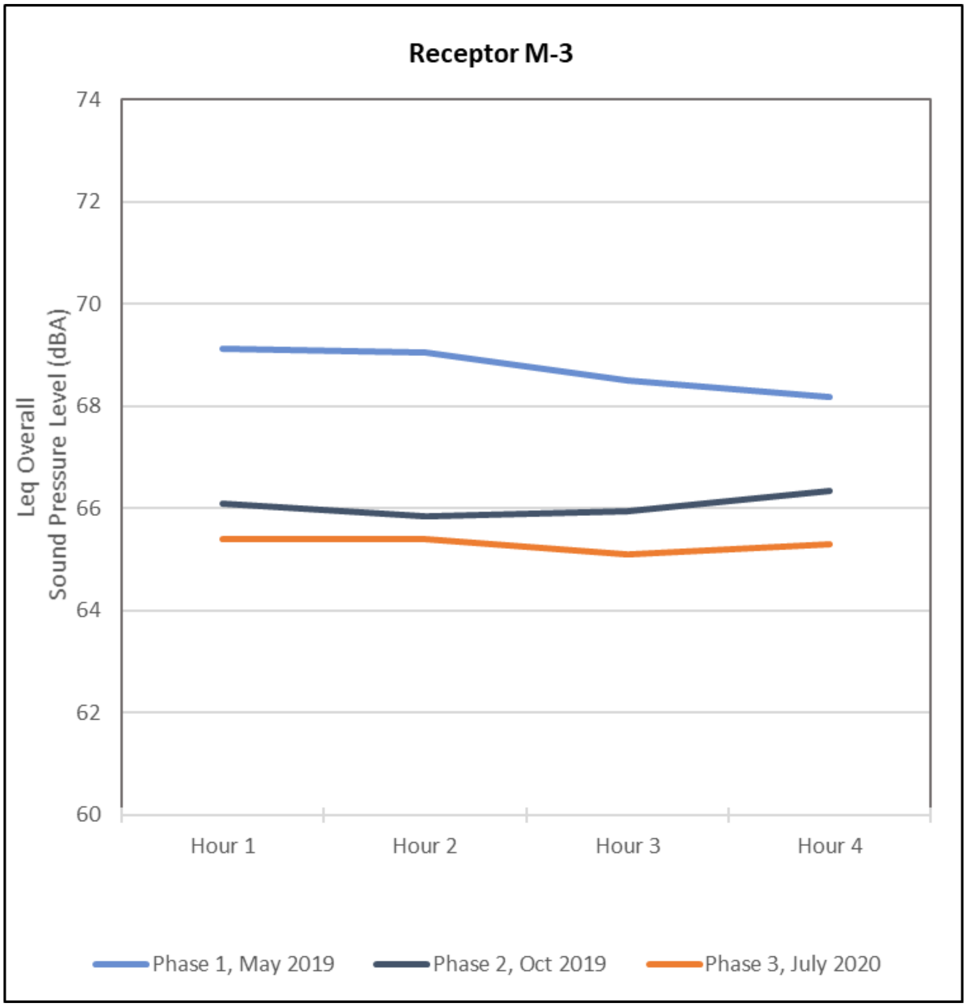
M-2 Frequency Analysis (dBA)

	Octave Band Center Frequency (Hz)										
	400	**500**	**630**	**800**	**1k**	**1.25k**	**1.6k**	**2k**	**2.5k**	**3.15k**	**4k**
Phase 1, May 2019	55.2	54.9	56.6	59.3	61.0	60.8	60.1	58.7	56.5	53.2	50.9
Phase 2, Oct 2020	52.1	53.1	56.1	58.4	59.0	58.4	56.8	54.7	52.5	49.2	47.4
Phase 3, July 2020	51.9	52.5	55.5	58.3	59.1	58.6	57.2	55.4	52.7	49.6	47.5

Receptor M-3

Receptor M-3 Leq data shows overall noise reductions of approximately 2 to 4 dBA with the quiet pavement. The correlation between Phase 2 and 3 data is not as good as with receptor M-2 and is likely the result of other variables besides ideal traffic counts.

Figure 5: M-3 Leq



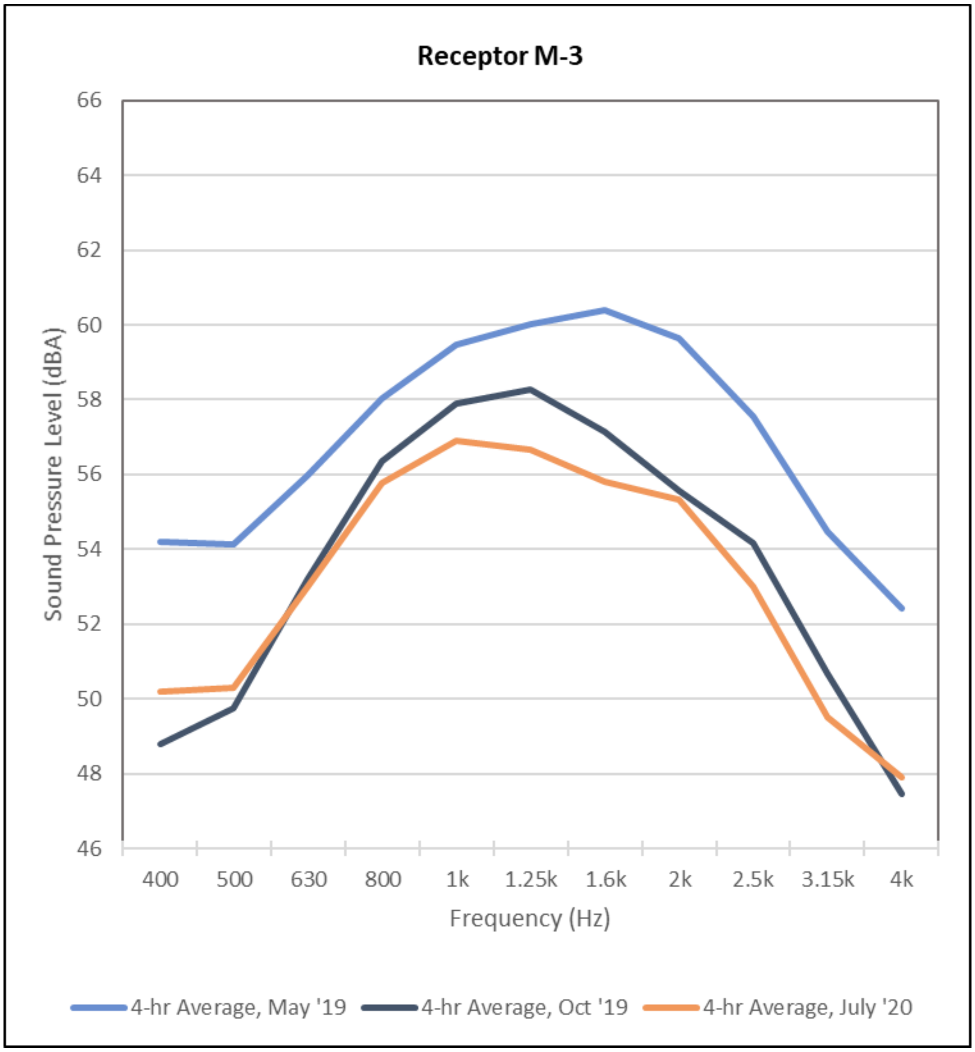
M-3 Leq (dBA)

	Hour 1	Hour 2	Hour 3	Hour 4
Phase 1, May 2019	69.1	69.1	68.5	68.2
Phase 2, Oct 2020	66.1	65.8	65.9	66.3
Phase 3, July 2020	65.4	65.4	65.1	65.3

Receptor M-3 (continued)

The frequency analysis shows reductions of 2 to 5 dBA at the 1/3 octave band frequencies, with minimum reductions at 800 Hz to 1 kHz, and maximum reductions generally at the lowest and highest frequencies. Again, it should be noted that discrete frequency analysis is not a good metric for perceptible differences, which are best represented by the overall average Leq data.

Figure 6: M-3 Frequency Analysis, 4-hr Average



M-3 Frequency Analysis (dBA)

	Octave Band Center Frequency (Hz)										
	400	**500**	**630**	**800**	**1k**	**1.25k**	**1.6k**	**2k**	**2.5k**	**3.15k**	**4k**
Phase 1, May 2019	54.2	54.1	56.0	58.0	59.5	60.0	60.4	59.6	57.5	54.5	52.4
Phase 2, Oct 2020	48.8	49.8	53.2	56.4	57.9	58.3	57.1	55.6	54.2	50.7	47.5
Phase 3, July 2020	50.2	50.3	53.0	55.8	56.9	56.7	55.8	55.3	53.0	49.5	47.9

Summary of Results

Receptor M-1 is the control site and shows that sound level variations of up to 2 dBA are possible even after normalizing the data for observed traffic.

Receptor M-2 shows excellent agreement in Phases 2 and 3 for both overall Leq and 1/3 octave band levels. Overall Leq data shows reductions of approximately 2 to 3 dBA with the quiet pavement. Frequency analysis shows reductions of up to 4 dBA for some middle to upper range 1/3 octave frequencies.

Receptor M-3 Phase 2 and 3 data does not agree as well as with receptor M-2, however the results are generally within 1 dBA. Overall Leq reductions with quiet pavement are 2 to 4 dBA. Frequency analysis shows reductions of nearly 5 dBA for the lowest and upper range 1/3 octave frequencies.

CONCLUSIONS

The intent of this noise study was to determine the effectiveness of quiet pavement in reducing roadway traffic noise. The study found that quiet pavement reduced overall traffic noise by 2 to 4 dBA, based upon measured, averaged Leq with traffic normalization. Phase 2 and Phase 3 after-study noise reductions are both in the 2 to 4 dBA range, indicating very little change due to pavement wear in the 8 months between those two studies. Since sound level changes of 3 dBA are generally considered to be the threshold of perception by the human ear, quiet pavement has the potential to provide perceptible noise reductions at sites where the actual performance is in the upper range of reductions determined by this study.

From the standpoint of noise mitigation, DelDOT policy defines a benefited receptor as any site that receives a reduction of 8 dBA or greater, with a design goal that requires at least 75% of impacted receptors receive a noise reduction at least a 5 dBA. Based on this policy, quiet pavement, which this study found to have produced noise reductions of 2 to 4 dBA, would not provide sufficient noise mitigation to satisfy DelDOT's minimum standards.

While quiet pavement does not provide the performance necessary to meet current standards of abatement for impacted receptors, it could potentially affect the determination of noise impacts if Federal guidance is ever modified to recognize quiet pavement as a noise modeling parameter. At the time of this study, 23 CFR §772.9 states "Average pavement type shall be used in the FHWA TNM for future noise prediction unless a highway agency substantiates the use of a different pavement type for approval by the FHWA". If quiet pavement were to eventually be approved for noise prediction by FHWA, then the associated noise reductions of 2 to 4 dBA could affect the results of a noise impact analysis, where 1 dBA can be the difference between a receptor that is impacted, and not impacted.

Potential Future Research: This study concluded that the installation of asphalt rubber bituminous concrete resulted in a 2 to 4 dBA reduction in noise compared to the "before" condition, which consisted of aged "standard" pavement. It may be beneficial to perform future research on the level of noise reduction that might be achieved by installing new "standard" (e.g., DelDOT Type C) pavement to replace aged "standard" (e.g., DelDOT Type C) pavement. This research would show the comparative noise reduction benefit of new "quiet" pavement versus new "standard" pavement.

M-1 RECEPTOR DATA SHEET

Dates
2019-05-07
2019-10-15
2020-07-02

Location
Near ManorCare Health facility

Meter Type
Rion NL-52

Calibrator Type
NC 74

Measurement Parameters (all)
Start: 11:30 am End: 3:30 pm
Meas. Interval: 5 minutes
Test Duration: 4 hours

Site Location

Images

M-2 RECEPTOR DATA SHEET

Dates
2019-05-07
2019-10-15
2020-07-02

Location
Limestone Hills
maintenance area

Meter Type
Rion NL-52

Calibrator Type
NC 74

Measurement Parameters (all)
Start: 11:30 am   End: 3:30 pm
Meas. Interval: 5 minutes
Test Duration: 4 hours

Site Location

Images

M-3 RECEPTOR DATA SHEET

Dates
2019-05-07
2019-10-15
2020-07-02

Location
Near New Castle County Carousel Park

Meter Type
Rion NL-52

Calibrator Type
NC 74

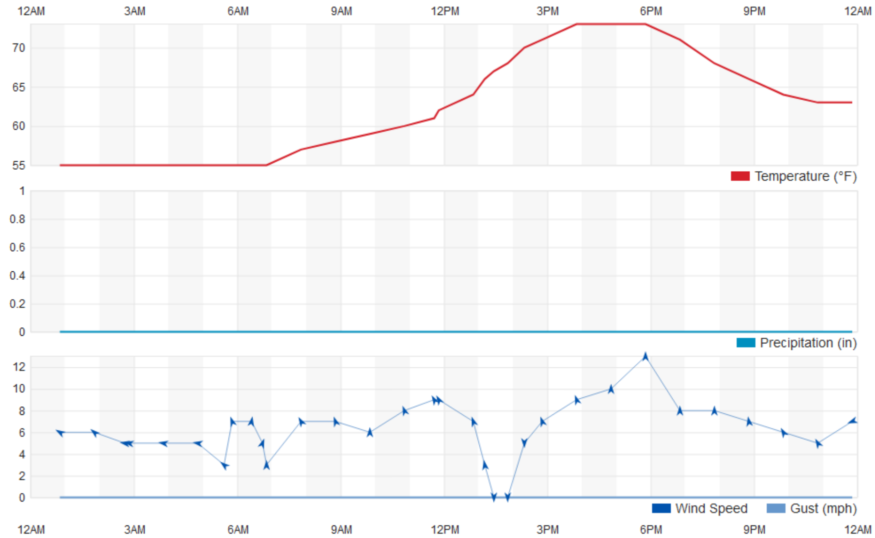
Measurement Parameters (all)
Start: 11:30 am End: 3:30 pm
Meas. Interval: 5 minutes
Test Duration: 4 hours

Site Location

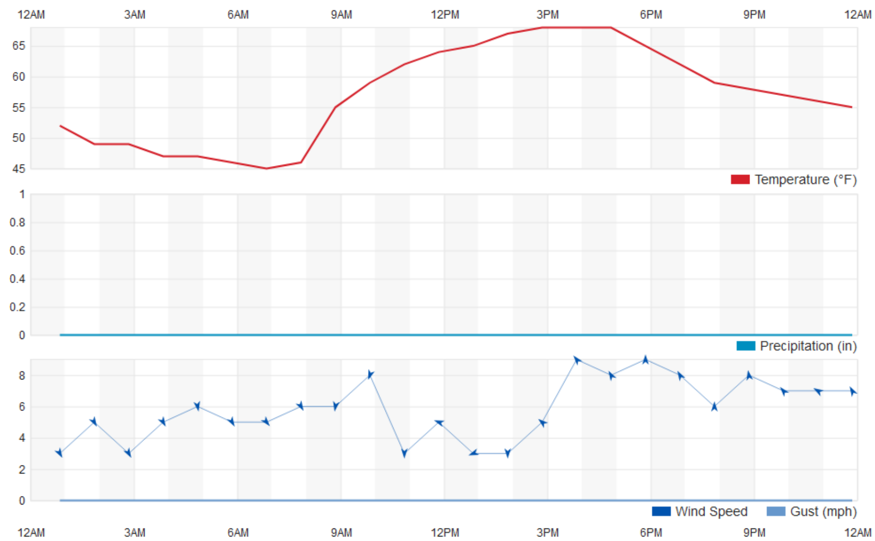
Images

<u>Weather</u> (Wilmington Airport, DE)

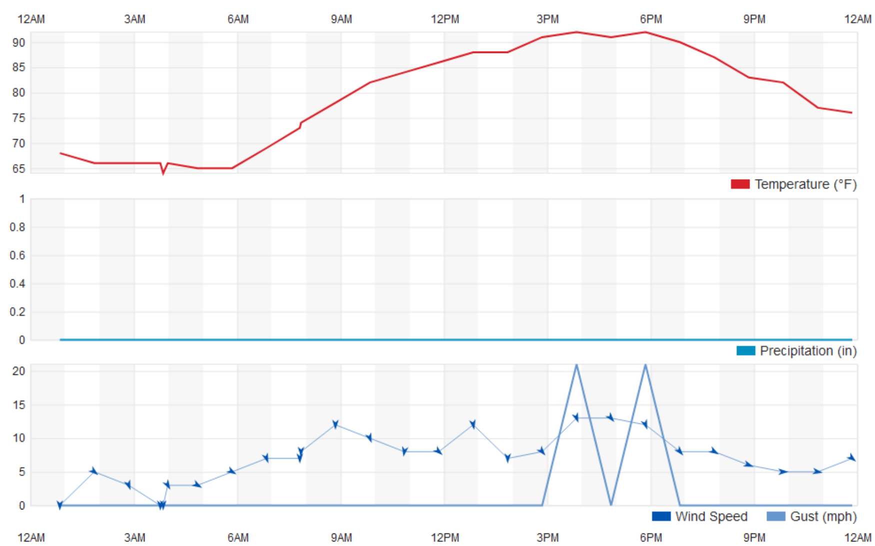
May 7, 2019



Oct 15, 2019



July 2, 2020



401582 - ASPHALT RUBBER BITUMINOUS CONCRETE

Description:

Asphalt Rubber Bituminous Concrete consists of furnishing and mixing gap graded aggregates and asphalt-rubber binder, spreading, and compacting the mixture as shown in the Contract documents or as directed by the Engineer. The requirements of Section 401 Bituminous Pavement and Special Provision 401699 shall apply except as modified herein.

Materials:

Asphalt Binder. The asphalt binder shall meet the requirements of Superpave performance grade asphalt as referenced in the Contract documents, according to AASHTO M332 PG 64E-22,

Asphalt-Rubber Binder. Shall be terminal blend, which incorporates 6-7% ground tire rubber in the asphalt. Such that the rubber is solubilized and does not separate.

The Contractor may elect to use additives to the liquid blend to increase workability. Proposed additives must be included in the submission of the proposed binder mix and approved by the Engineer prior to production.

At least two weeks before its intended use, the Contractor shall furnish samples of the asphalt-rubber binder proposed for use on the project to the Engineer. The samples shall consist of 4 one-quart size cans of the asphalt-rubber binder.

The method and equipment for combining the rubber and paving asphalt shall be so designed and accessible that the Engineer can readily determine the percentage by weight for each material being incorporated into the mixture.

Stabilizers. Cellulose fiber or mineral fiber stabilizers must be used by the producer, they shall meet the requirements below and be specifically designed for use in hot-mix asphalt paving mixtures. The producer shall supply the Engineer with certified test results showing the stabilizers are specifically designed for hot-mix asphalt paving mixtures. A representative of the manufacturer of the stabilizers shall be present at initial production to provide technical assistance.

Cellulose Fibers. Cellulose fibers shall conform to the following requirements:

Test Property	Test Method	Specification Limits
Ash Content, % Non-Volatiles Max.	ASTM D128	23
pH	AASHTO MP8	6.5 to 8.5
Moisture Content, % Max by Mass	AASHTO MP8	5.0
Fiber Length, Max inches	AASHTO MP8	0.25

Mineral Fibers. Mineral fibers shall be made from virgin basalt, diabase, slag, or other silicious rock and shall conform to the following requirements:

Test Property	Test Method	Specification Limits
Fiber Length, Max inches	AASHTO MP8	0.25
Fiber Thickness, Max inches	AASHTO MP8	0.0002
Shot Content No. 60 Sieve No. 230 Sieve	ASTM C612	 85 - 95 60 - 80

Job Mix Formula. The mix shall conform to the gradation requirements detailed in Table A:

Table A - Mix Gradation

Sieve Designation	**Percent by Mass Passing**	**Tolerances**
19.0 mm (3/4")	100	∀0
12.5 mm (1/2")	90 - 100	∀6
9.5 mm (3/8")	50 - 80	∀6
4.75 mm (#4)	20 - 35	∀6
2.36 mm (#8)	16 - 24	∀4
0.075 mm (#200)	8 -11	∀2

All fine and coarse aggregate must be non-carbonate.

The mix shall satisfy the following criteria:

Property	Criteria
Air Voids	4% ∀ 2
Voids in Mineral Aggregates (VMA)	18% ∀ 1.5
Draindown	0.3 % maximum
RAP/RAS	0%

The mix design shall be submitted to the Engineer for approval at least 14 calendar days prior to production.

Production:

Equipment utilized in the proportioning of asphalt-rubber binder shall include the following:

1. An asphalt-rubber binder storage tank equipped with a heating system to maintain the proper temperature of the binder and internal mixing unit capable of maintaining a homogeneous mixture of asphalt and rubber.

When continuous mixing type asphalt production plants are used to produce the asphalt rubber bituminous concrete , the asphalt-rubber binder shall be proportioned by an asphalt meter of the mass flow, Coriolis effect type.

Construction Methods:

The mixing, hauling, placement, and compaction of this mix shall be as per the applicable sub-sections of 401 Bituminous Pavement except as modified herein.

This mix shall be placed at a minimum atmospheric and pavement surface temperatures of 551F. Spread (lay down) temperature for this mix is specified as 2901F to 3251F.

Hauling Units:

Hauling units shall be as specified in Section 401.03 and the following:

The time between plant mixing and shipment shall not exceed one hour, i.e. the mix shall not be stored in the silo for more than one hour.

The haul trucks shall deliver the mix to a material transfer device capable of continuously re-mixing and/or re-blending the material internally to ensure that the mix is free from physical and thermal segregation. The material transfer device shall be self-propelled and capable to move freely between delivery trucks and the asphalt paver, equipped with a hopper insert, without requiring additional equipment.

Method of Measurement:

The method of measurement is per ton placed and accepted by the Engineer. The demonstration will not be measured for payment unless all Specifications are met.

Basis of Payment:

The Basis of Payment will be for the accepted quantity of asphalt rubber bituminous concrete pavement at the Contract unit price per ton for furnishing, preparing, hauling, and placing all materials, including tack coat; for removing material from around manholes, drainage inlets, valves, and similar features; for removing and replacing excess asphalt cement; and for all labor, equipment, tools, and incidentals required to complete the work, including the correction of defective work for the demonstration.

Basis of Payment will also include applicable pay adjustments per 401699, except plant production is tested in 250 ton sub-lots.

DIVISION 400 — BITUMINOUS MATERIALS

SECTION 401 — BITUMINOUS PAVEMENT

401.1 Description.

This work consists of providing, placing, and compacting bituminous pavement.

401.2 Materials.

A.	Release Agents	Section 1010
B.	Tack Coat	Section 1011
C.	Thin Lift Tack Coat	PG 64-22
D.	Asphalt Cement	Section 1012
E.	Asphalt Production	Section 1014
F.	Joint Sealant	Section 1042

401.3 Construction.

A. Before Paving.

Conduct a pre-paving meeting to discuss joint layout, material delivery, striping layout, maintenance of traffic for paving, and equipment. Include the engineer, the Department's Materials & Research Section, and other appropriate parties.

B. Mix Design.

Develop the JMF in accordance with Section 1014 and submit test results for review a minimum of 30 calendar days before application. Include aggregate type and gradation and percentages of polymer-modified emulsion, water, and cement by dry aggregate weight.

C. Delivery of Mixture.

Deliver no less than 100 tons per hour to the project site or as approved by the engineer.

D. Hauling Equipment.

1. Provide trucks with tight, clean, smooth, metal beds thinly coated with an emulsified oil, soap solution, or other approved release agent to prevent the bituminous mixture from adhering to the truck bed.
2. Ensure that truck beds have no holes or cracks and are free from debris.
3. Provide truck bed tarps made of canvas or other waterproof material, and free of rips, tears, and holes, that will cover the truck bed from front to back and will overlap the sides and rear of the truck body.
   a. Fasten the front of the tarp to the truck body and protect the fastening using an air foil or air dam.
   b. Use a minimum of 3 straps on the sides to hold the tarp over the sides of the body. If the tarp does not reach over the back of the body, straps on the rear of body are also required.

E. Paver.

1. Use a self-propelled unit with a screed or strike-off assembly that automatically controls grade leveling and slope, is heated, and is capable of spreading and finishing bituminous pavement materials to the specified lane widths and thicknesses.
2. Equip the paver with an attachment that confines the material at the end of the gate and extrudes the asphalt material to form a compacted wedge-shaped pavement safety edge.
3. Equip the paver with a tack spray application system for thin lift paving operations.

F. Rollers.

1. Provide a self-propelled static or vibratory steel wheel type roller equipped with scrapers or a pneumatic-tire oscillating type roller equipped with smooth tires of equal size and diameter.
2. Use rollers equipped with a system for moistening each wheel or roller while in use.
3. Use a number and weight of rollers sufficient to compact the mixture to the required density without crushing aggregate or displacing the mixture.
4. Do not use rollers that mar the surface.

G. Weather Limitations.

1. Place bituminous pavement materials only when the surface is dry and unfrozen, and the weather is not foggy or rainy. The Department will consider the presence of frost particles in the roadbed or on the surface as a reason to prohibit placement.
2. Do not place subsequent lifts, release materials, or open to traffic until the mat temperature is below 140 degrees F.
3. The Department will not allow placement of bituminous concrete when the air temperature at the paving location is below the temperatures indicated in Table 401-A below.

Table 401-A. Minimum Ambient Air Temperature for Placement of Types of Bituminous Concrete

Material Type	**Temperature**
BCBC	32 ° F
B	32 °F
C	40 °F
Stone Matrix Asphalt, Thin Lift, and Wedge Lift	50 °F

H. Preparing Base or Existing Surface.

Clear surface of debris. Apply and cure tack coat before placing the mixture. Apply a tack coat on all curbs, gutters, manholes, or other structure surfaces the mixture will contact.

I. Tack Coat.

Apply on all dry and broom-cleaned surfaces at a uniform surface application rate in accordance with Table 401-B. Apply at a temperature range of 120 to 160 degrees F using pressurized distribution equipment with a spray bar or other approved system that results in uniform coverage across the pavement surface. Apply in advance of the asphalt paving operation. Do not permit activity on the tack surface until the material has set per the manufacturer's recommendations, but no farther than needed for the current working day's operation.

Table 401-B. Tack Coat Application Rates

Surface Type	Residue Rate (gallons per sy)	Application Rate, Undiluted* (gallons per sy)	Application Rate, Diluted 1:1 (gallons per sy)
New Asphalt	0.03 - 0.05	0.05 – 0.08	0.09 – 0.15
Existing (aged) Asphalt	0.05 - 0.07	0.08 – 0.11	0.15 – 0.21
Milled Surface (asphalt and PCC)	0.06 – 0.08	0.09 – 0.12	0.18 – 0.24
PCC	0.04 – 0.07	0.06 – 0.11	0.12 - -.21

*Undiluted emulsion is 67% asphalt and 33% water

J. Placement.

1. Place the mixture in a continuous operation using an approved paver. The Department will not allow stopping the paver to adjust the attachment described in Section 401.3.E.2. at crossroads, driveways, or obstructions.
2. Ensure that the outside edges of pavement are in true alignment parallel to the roadway centerline with the longitudinal joint in the surface course at the lane line. Plan placement of the surface course to ensure that the longitudinal joints in the surface course are parallel to the lane lines and not in the wheel path of vehicles using the roadway. Conduct surface course paving operations to utilize the full lane width unless directed by the engineer. Make longitudinal joints parallel to the centerline unless otherwise specified in the contract. Place a longitudinal joint between the travel way and shoulder on the shoulder side with a 6 inch offset of the lane line. Establish and follow reference lines or other approved markings to control the true alignment of the longitudinal joints.
3. When paving multiple lifts or courses, offset individual successive lifts a minimum of 6 inches.
4. After placement of a bituminous concrete course, place the subsequent bituminous concrete lift within 10 calendar days. If more than 10 calendar days elapse between the placement of any 2 bituminous courses, spray a fog coat of CSS-l-h on the exposed base course.
5. If the contractor cannot complete spreading and compacting a full truck load of mixture by sunset, do not unload the truck unless the engineer has granted approval for nighttime paving.

K. Compaction.

Compact the bituminous pavement mixture after spreading, striking off, and correcting surface irregularities.

L. Compaction Testing.

1. Perform quality control of pavement compaction by testing in-place pavement density. The contractor is limited to taking a single core on the first day of paving or after the change of a JMF for gauge calibration. Repair core holes in accordance with 401699 - Quality Control/Quality Assurance of Bituminous Concrete, Appendix A Repairing Core Holes in Hot-Mix Asphalt Pavement.
2. The engineer will perform quality assurance testing, evaluate material production, and evaluate compaction quality in accordance with 401699 - Quality Control/Quality Assurance of Bituminous Concrete.

M. Joints.

Construct joints to meet surface and compaction requirements. Tack all vertical contact surfaces before placing new mixture against the surface. Except for joints created from newly placed adjacent passes, seal all new pavement joints that do not call for an overlay. Seal all joint openings. Submit the joint sealant material appropriate for the dimension of the opening, for approval. For joint openings exceeding 1/4-inch width, the engineer may require corrective action.

N. Wearing Surface.

The maximum allowable longitudinal or transverse deviation is 1/4-inch in 10 feet. Provide a 10-foot straight edge for testing.

401.4 Method of Measurement.

A. The quantity of bituminous pavement materials will be measured as the actual number of tons placed and accepted. The weight will be calculated in accordance with Section 109.1.

B. The Department will not measure the safety edge.

401.5 Basis of Payment.

A. The Department will pay for the accepted quantity of bituminous pavement materials at the contract unit price per ton. Payment constitutes full compensation for:

1. Preparing the surface;
2. providing, preparing, and placing all materials, including tack coat, joint sealant, and safety edge;
3. removing material from around manholes, drainage valves, and similar features;
4. removing and replacing excess asphalt cement; and
5. constructing the safety edge.

B. The Department will pay for Superpave Type B, placed instead of Superpave Type BCBC, at the contract unit price for Superpave Type BCBC. The Department will make the asphalt cement cost adjustment based on the virgin asphalt of the Superpave Type B.

C. The Department will make adjustments to payments in accordance with Special Provision 401699.

D. The Department will apply any incentive or disincentive pay adjustments as established by special provision 401699.

ITEM	DESCRIPTION	UNIT
401005	SUPERPAVE, TYPE C, PG 64-22 (CARBONATE STONE)	TON
401006	SUPERPAVE, TYPE C, PG 70-22 (CARBONATE STONE)	TON
401007	SUPERPAVE, TYPE C, PG 76-22 (CARBONATE STONE)	TON
401014	SUPERPAVE, TYPE B, PG 64-22	TON
401015	SUPERPAVE, TYPE B, PG 70-22	TON
401016	SUPERPAVE, TYPE B, PG 76-22	TON
401021	SUPERPAVE, TYPE BCBC, PG 64-22	TON
401029	SUPERPAVE TYPE C, PG 64-22, PATCHING	TON

ITEM	DESCRIPTION	UNIT
401030	SUPERPAVE TYPE B, PG 64-22, PATCHING	TON
401031	SUPERPAVE TYPE BCBC, PG 64-22, PATCHING	TON
401036	SUPERPAVE TYPE C, PG 64-22, WEDGE	TON
401037	SUPERPAVE TYPE B, PG 64-22, WEDGE	TON
401044	SUPERPAVE TYPE C, PG 64-22 (NON-CARBONATE STONE)	TON
401045	SUPERPAVE TYPE C, PG 70-22 (NON-CARBONATE STONE)	TON
401046	SUPERPAVE TYPE C, PG 76-22 (NON-CARBONATE STONE)	TON
401053	SUPERPAVE TYPE C, PG 64-22, THIN LIFT	TON
401054	SUPERPAVE TYPE C, PG 70-22, THIN LIFT	TON
401055	SUPERPAVE TYPE C, PG 76-22, THIN LIFT	TON