Accelerated Innovation Deployment (AID) Demonstration Project:

Asphalt Rubber Bonded Wearing Course (AR BWC) along I-93

Final Report
March 17, 2017

New Hampshire DOT
Department of Transportation

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INTRODUCTION

ACCELERATED INNOVATION DEPLOYMENT (AID) DEMONSTRATION GRANTS

The Accelerated Innovation Deployment (AID) program is one aspect of the multi-faceted Technology and Innovation Deployment Program (TIDP) approach, which provides funding and other resources to offset the risk of trying an innovation. The AID Demonstration funds are available for any project eligible for assistance under title 23, United States Code. Projects eligible for funding shall include proven innovative practices or technologies such as those included in the EDC initiative. Innovations may include infrastructure and non-infrastructure strategies or activities, which the award recipient intends to implement and adopt as a significant improvement from their conventional practice.

The Federal Highway Administration (FHWA) Accelerated Innovation Deployment (AID) Demonstration grant program, which is administered through the FHWA Center for Accelerating Innovation (CAI), provides incentive funding and other resources for eligible entities to offset the risk of trying an innovation and to accelerate the implementation and adoption of that innovation in highway transportation.

Projects deemed eligible for funding included proven innovative practices or technologies, including infrastructure and non-infrastructure strategies or activities, which the applicant or subrecipient intends to implement and adopt as a significant improvement from their conventional practice. The AID Demonstration funds were available for any project eligible for assistance under title 23, United States Code.

Entities eligible to apply included State departments of transportation (DOT), Federal Land Management Agencies, and tribal governments as well as metropolitan planning organizations (MPOs) and local governments which applied through the State DOT as subrecipients.

REPORT SCOPE AND ORGANIZATION

This report documents the New Hampshire Department of Transportation demonstration grant award for pavement preservation using Asphalt Rubber Bonded Wearing Course. The report presents details relevant to the employed project innovation(s), the overarching TIDP goals, performance metrics measurement and analysis, lessons learned, and the status of activities related to adoption of Asphalt Rubber Bonded Wearing Course as conventional practice by the New Hampshire Department of Transportation.

PROJECT OVERVIEW

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The project included construction of an asphalt rubber bonded wearing course (AR BWC) along I-93 NB and SB in Manchester, NH for a total project length of 3.4 miles (approximately 1.7 miles each direction). This section of interstate was previously rehabilitated in 2008 as part of the Interstate Pavement Preservation Program and was exhibiting paver segregation and premature cracking. The AR BWC treatment is an innovative pavement preservation technique with a proven record of success and was expected to address the existing roadway surface distress and add significantly to the pavement life before more extensive work is required. AID Demonstration funding was used to finance the construction cost of this treatment. The project fulfilled the TIDP goals of accelerating the adoption of innovative technologies, elevating performance standards, improving service life, and sustainability.

LESSONS LEARNED

Through this project, the New Hampshire Department of Transportation gained valuable insights with regard to the innovative Asphalt Rubber Bonded Wearing Course (AR BWC) pavement preservation treatment used. The following were some of the lessons learned:

- Place AR BWC during warm weather, especially if the placement occurs at night
- Safety needs of traffic control may limit the ability to reopen lanes immediately after paving

PROJECT DETAILS

BACKGROUND

The project involved construction of an asphalt rubber bonded wearing course (AR BWC) along I-93 NB and SB in Manchester, NH for a total project length of 3.4 miles (approximately 1.7 miles each direction). See Figure 1. Interstate 93 (I-93) from I-293 to Exit 7 in Manchester, NH was previously rehabilitated in 2008 under the Interstate Pavement Preservation Program (IPPP). The 2008 work consisted of a 2-inch travelway inlay followed by a 1-1/2 inch full width wearing course overlay. The project also included sealing the longitudinal cracks that extended below the cold plane depth. Cracking and tearing appeared in the wearing course surface immediately after construction. Corrective action was undertaken by the Contractor at that time, and overall the section is performing well. However, paver (gear box) segregation and end load segregation have become more apparent in the wearing course and a crack has now developed in the center of each driving lane due to the segregation. The cracking was first noted in 2012 but was beginning to open further as more water was allowed to enter.

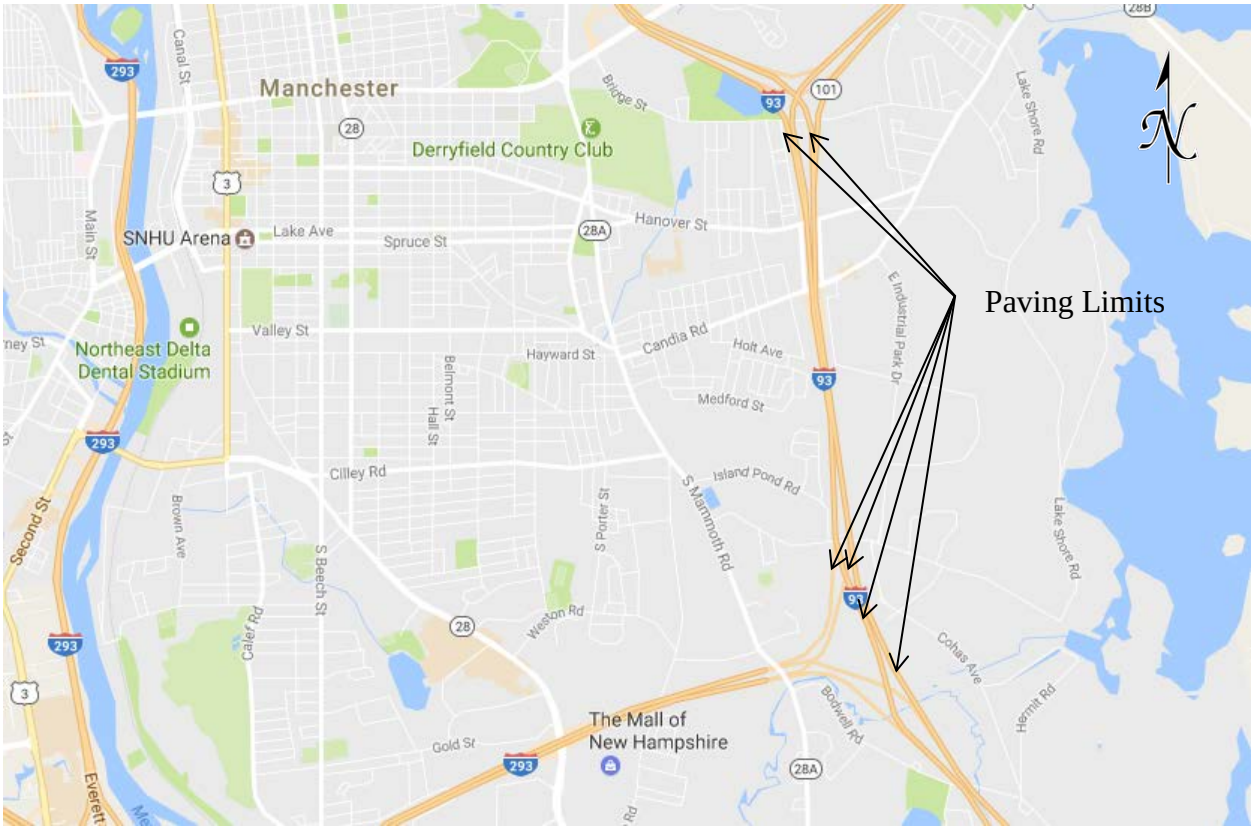

Figure 1 – Project Location Map

PROJECT DESCRIPTION

The project addressed surface defects along the roadway segment before more extensive work is required. An asphalt rubber bonded wearing course (AR BWC) treatment was proposed as a cost-effective, high performance pavement preservation technique. The accelerated deployment of this technology filled a void for the New Hampshire Department of Transportation as a cost-effective preservation option for high-speed and/or high-volume roads.

The bonded wearing course (BWC) treatment, also known as an ultrathin bonded wearing course or paver placed surface treatment, was developed in France in 1986 and introduced in the United States during the early 1990s. The treatment consists of an ultrathin (3/8 to 3/4 inch) gap graded hot-mix asphalt (HMA) mixture applied over a warm polymer-modified asphalt emulsion "membrane", all in a single pass. The emulsion membrane seals the existing surface and bonds the HMA to the underlying pavement. The thickness of the membrane allows it to migrate upwards into the mix, filling voids in the aggregate and creating an interlayer of high cohesion that does not delaminate or bleed when applied correctly. BWC can be applied and opened to traffic quickly. Bonded wearing courses are primarily used in high traffic areas as a surface treatment over HMA and PCC surfaces. The material can be placed over structurally sound pavements as a maintenance treatment, and may also be used in new construction and rehabilitation projects as the final wearing course.

Originally patented as Novachip, early installations of BWC were performed by a limited number of licensed applicators. A large number of states have placed and evaluated the technology. Research reports documenting the favorable performance of the BWC are available from Pennsylvania, Texas, North Carolina, Alabama, Louisiana, California, Washington, Florida, Kansas, New Jersey, and Oklahoma among others. Licensing under Novachip expired in 2010, enabling the treatment to be utilized by any contractor willing to invest in the equipment and technology.

The asphalt rubber bonded wearing course (AR BWC) pavement preservation technique utilizes ground tire rubber in the HMA binder. The rubber provides increased flexibility without increasing the rutting potential of the mixture. As a result, the surface course is better able to bridge small cracks in the underlying pavement and tolerate minor movements under service loads. Successful use of AR BWC in the United States dates to 2007 or earlier. The California Department of Transportation has developed standard specifications for this treatment and has substantial experience with the technology. Installations have also occurred in Massachusetts and New York.

The New Hampshire DOT had very limited experience with bonded wearing course treatments. An experimental project constructed in 2004 compared the performance of the treatment with a chip seal, rubber chip seal, 3/4–inch paver shim, and 3/8-inch plant-mix surface treatment. The BWC was performing well at the time of its overlay in 2010. Two additional installations occurred in New Hampshire in 2009 and 2012. New Hampshire placed its first AR BWC in 2013.

Initial, favorable results have provided hope that the bonded wearing course, specifically the AR BWC, will provide the Department with the option it seeks for pavement preservation on high

speed and/or high volume roads. Many years of positive experience with rubberized chip seals further enhances the attractiveness of this technology. The New Hampshire Department of Transportation considers the proposed AR BWC to be a significant improvement over conventional HMA overlays. Documented benefits of this treatment include sealing and waterproofing the existing surface; resistance/remediation of raveling and delamination; reduced user delays due to quick, one-pass construction, immediate traffic return, and possible night construction; noise reduction; retention of bridge clearances and guardrail heights; sustainability from the use of recycled materials; improved performance; and longer lasting pavements. There is also a recognized safety improvement achieved through increased pavement skid numbers and reduced vehicle spray during rain events.

ARBWC is a pavement preservation technique which may also provide additional benefits, such as:

- Decreased duration of construction schedule
- Improved ride (smoothness) due to slower ongoing deterioration
- Reduced levels of traffic noise
- Improved visibility during wet pavement conditions

DATA COLLECTION AND ANALYSIS

Performance measures consistent with the project goals were jointly established for this project by NHDOT and FHWA to qualify, not to quantify, the effectiveness of the innovation to inform the AID Demonstration program in working toward best practices, programmatic performance measures, and future decision making guidelines

The performance goals for this innovation include improved safety and enhanced performance and service life of the pavement section. The treatment is expected to relieve existing surface distress and improve ride while minimizing the impact to the traveling public.

The New Hampshire Department of Transportation obtained pavement condition data before and after installation of the asphalt rubber bonded wearing course, and will continue to gather information at one-year intervals following construction for a minimum of five years. This data will include ride, rutting, cracking and pavement condition index (PCI). Installation of the AR BWC will be monitored to assess and document any unanticipated difficulties or challenges that arise.

This section discusses how the New Hampshire Department of Transportation established baseline criteria, monitored and recorded data during the implementation of the innovation, and analyzed and assessed the results for each of the performance measures related to these focus areas.

SAFETY AND SCHEDULE

The New Hampshire Department of Transportation is always concerned with the safety of both the workers delivering the project and the users of our infrastructure during construction. One of the purported benefits of ARBWC is the reduction of lane closure duration because traffic can be allowed onto the pavement shortly after placement. The amount (lane mile or tonnage) of pavement placed each night of paving was similar to the amount that would be placed by a similar thin asphalt overlay. NHDOT construction staff found that in order to provide safe lane changes, traffic control did not allow lanes to be reopened until the nightly paving was completed. However, safety needs aside, the lower placement temperature of the ARBWC could conceivably allow newly paved lanes to be opened sooner to traffic.

QUALITY

Traffic Noise

Harris Miller Miller & Hanson Inc. (HMMH), under contract with the Department, performed a noise measurement analysis to assess tire/pavement noise levels from the AR BWC. A segment of I-93 in Concord, NH, which received a 1.5-inch inlay of Superpave pavement in the summer of 2016, was selected to provide comparison noise levels.

HMMH conducted On-board Sound Intensity (OBSI) evaluations of both segments of I-93 in September of 2016. The OBSI measurements indicated there was not a perceptible difference in the overall sound intensity levels (dBA) between the AR BWC and the Superpave inlay.

The HMMH evaluation also provided the distribution of sound intensity levels in 1/3 octave bands which showed a different distribution of frequencies, which may be perceived differently by receptors adjacent to the roadways. The graph below is from page 11 of the HMMH report, which is included in its entirety in Appendix A.

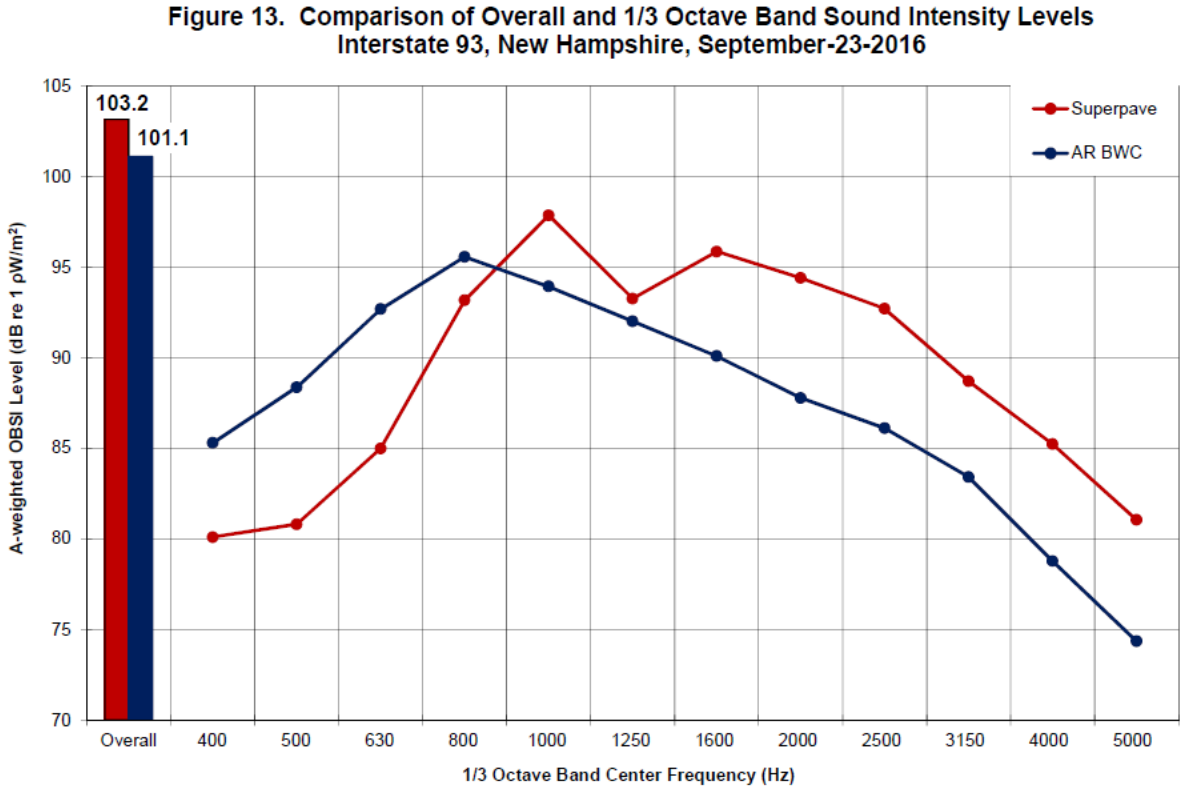

Figure 2 – OSBI Comparison

Pavement Condition

In order to track the pavement condition, initial measurement of the IRI (International Roughness Index) were gathered in November 2016. The same comparison segment used for the noise evaluation was also measured. The IRI values measured for the two segments do not vary necessarily enough to be considered significantly different:

- ARBWC – IRI average value of 38.81 (ranges between 30.99 and 57.12)
- Superpave – IRI average value if 41.61 (ranges between 29.80 and 56.53)

These segments of pavement will be evaluated for IRI each year as part of the Department's pavement management program. Changes to the pavement smoothness over time can be evaluated to determine how the AR BWC ages as compared to the Superpave overlay.

The New Hampshire DOT uses a number of pavement preservation techniques (such as chip seals, micro surfacing, thin lift HMA, and BWC) to maintain state roadways. These treatments are thin and some use emulsions so the placement timeframe is limited to the warmer months (generally Memorial Day to Labor Day). This project included some ramp widening work, which resulted in the placement of the AR BWC on I-93 occurred at night in late May of 2016. In the early winter of 2017, it was observed that the ARBWC has begun to show signs of raveling along the transverse butt joints where the spray paver had stopped and restarted. This could be caused by several different factors including an insufficient quantity of mix being delivered to the site and/or the ambient air temperatures being too cold for placement. The Department favorably views the AR BWC as an appropriate tool for pavement preservation, but will update the specifications to include appropriate temperature conditions for placement and require the Contractor to submit a mix delivery plan to ensure an adequate quantity of mix can be delivered to the site. In general, AR BWC should be placed during the warmest summer months to have both warm overnight air temperatures and pavement temperatures to avoid placement issues with the asphalt mat.

Safety to Road Users – Wet Pavement Visibility

Traffic on wet pavement generates water spray that can impact visibility. The Department conducted a survey to assess driver comfort with the visibility conditions based on video taken in three conditions:

- Wet conditions on recently placed ARBWC
- Wet conditions on a nearby segment which received a micro-surfacing treatment in late 2013.
- Dry conditions

During video acquisition, a car followed a dump-truck with a visual target attached to the rear of the truck. The visual target was two panels with a printed checkerboard pattern of five-inch white and black squares. The car followed the truck at a relatively constant distance to remain somewhat within the spray generated by the truck but far enough to see the rear-view mirrors of the truck. It is likely that the following distance was probably less than would be observed under normal driving conditions. Both vehicles used safety lights.

The survey referenced a video where all three conditions were shown simultaneously. This screenshot of the video shows ARBWC on the left; dry conditions in the middle; and micro-surfacing on the right.

Figure 3 – Screen shot from Spray Survey

The survey was sent out Department wide and received 150 responses. Each question was asked of both wet conditions.

1. How obstructed was your view of the leading vehicle?
2. How much concentration would the driving condition require?
3. How confident would you feel in the driving condition?
4. How much control do you feel you would have in the driving condition?
5. How risky would it feel to drive in the driving condition?

Figure 4 shows the average response to the questions. The two conditions received similar ratings, but the ARBWC segment was rated less favorably in every question. Complete survey results are included in Appendix B.

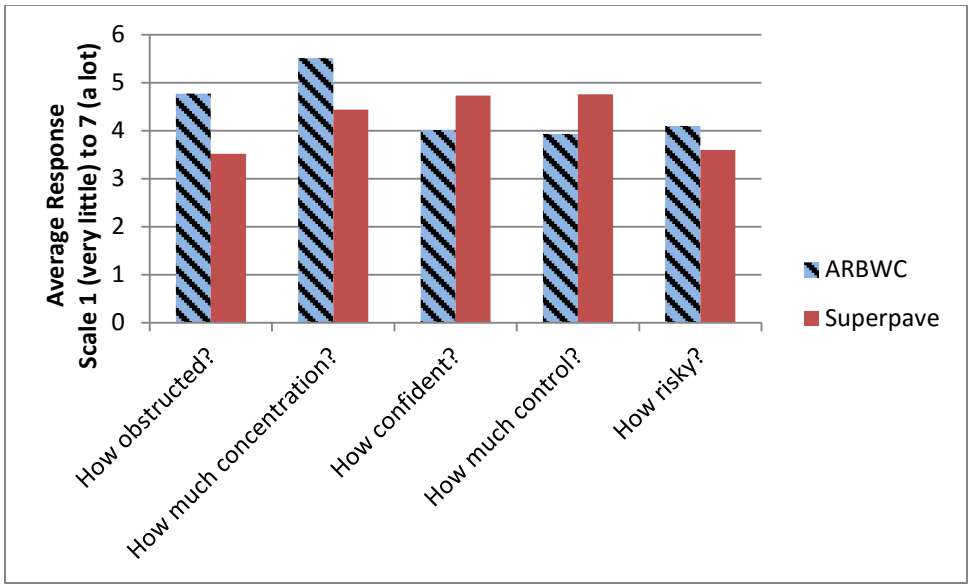

Figure 4 – Results of Spray Survey

Department maintenance personnel have noted that the ARBWC pavement remains wet longer than traditional pavements. In addition, research staff noted that the spray was not as fine on the ARBWC compared to the Superpave asphalt. These differences may be due to the open-graded nature of the ARBWC, which has larger voids that can harbor water for longer periods of time.

USER SATISFACTION

Recipients of TIDP AID grants were required to report on specified performance indicators relevant to the individual project's goals and resource constraints. Formal goals and targets were not predefined for all recipients, including goals for user satisfaction unlike under the FHWA Highways for LIFE program where requirements for user satisfaction included achieving a performance goal of 4 or more on a Likert scale from 1 to 7 (approximately 57 percent or more participants showing favorable response) for the following two questions:

- How satisfied is the user with the new facility compared with its previous condition?
- How satisfied is the user with the approach used to construct the new facility in terms of minimizing disruption?

Determining customer satisfaction from the traveling public was not possible. NHDOT staff responsible for maintaining I-93, including the segment that received the AR BWC, have noted the pavement remains wet after a rain or snowmelt event for a longer period of time as compared to our conventional dense graded HMA. This is typical of a gap-graded structure like BWC.

Several staff from the City of Manchester Department of Public Works (City DPW) visited the construction site during paving activities. According to Todd Connors, Engineering Manager, staff "were surprised by the speed with which the operation moved, but found the treatment to be a good fit for some of our road work." The City DPW has decided to use bonded wearing course on two projects in the 2017 construction season. See Appendix C for the email from Todd Connors.

RECOMMENDATIONS AND IMPLEMENTATION

RECOMMENDATIONS

The New Hampshire Department of Transportation determined from the results of our data analysis and sense of satisfaction from the facility users that the AR BWC will officially be added to the preservation treatment toolbox and will be considered for use on future projects involving high traffic volumes which exhibit signs of paver segregation deterioration.

The Department also identified the following areas that could be improved upon in future applications of this innovation:

- Revise the placement temperature and/or seasonal requirements to minimize tearing of the asphalt mat to prevent future raveling from occurring;
- Require the Contractor to submit a mix delivery plan to ensure that an adequate quantity of mix can be produced and delivered to the project site; and
- Require the use of a Material Transfer Vehicle (MTV) to minimize the occurrence of butt joints and stops and starts of the paver. The MTV will also help with thermal segregation of the mix which will also minimize tearing of the mat.

STATUS OF IMPLEMENTATION AND ADOPTION

Since the completion of the Asphalt Rubber Bonded Wearing Course (AR BWC) along I-93. the New Hampshire Department of Transportation has undertaken the activities listed below to implement AR BWC into our standard operating procedures as a significant improvement from our traditional practice for similar type projects.

- Revised the ARBWC and BWC design gradation for all mix Types (A thru C) by removing the ¼-inch screen. This will make the mix easier to produce and place.
- Increased the use of BWC on pavement preservation projects including two Interstate and three non-Interstate projects in 2017 with at least three additional projects proposed for 2018.

Our plan for full adoption of Asphalt Rubber Bonded Wearing Course is as follows:

- Monitor the 2017 placements of the 2017 projects for mix production and placement issues;
- Complete the ARBWC and BWC specification revisions for full implementation on the 2018 projects; and
- Require the use of a MTV for the 2018 projects.

REFERENCES

From Appendix A from Application

The AID grant application narrative identified a number of states that have documented success with conventional BWC. The SHRP2 publications and Pavement Preservation Journal article referenced below provide additional support for this treatment as a viable, cost-effective preservation option on high-speed/high-volume HMA roadways. Finally, a summary of recent discussions with states that have utilized the *asphalt rubber* BWC over the past 7+ years is presented. The rubberized BWC is considered superior to conventional BWC in its ability to bridge small cracks in the underlying pavement and tolerate minor movements under service loads. Anecdotal evidence and experience with other rubberized wearing courses (e.g. rubber chip seal) suggests that the rubberized option would provide an additional 2 or more years of service life over conventional BWC.

1. SHRP2 Report S2-R26-RR-1, *Preservation Approaches for High-Traffic-Volume Roadways*. http://onlinepubs.trb.org/onlinepubs/shrp2/SHRP2_S2-R26-RR-1.pdf Based in part on a 2008 survey of state DOT practices. There are numerous references to BWC as a beneficial preservation option throughout this document, particularly for HMA-surfaced roadways. A sampling of pertinent evidence follows:
    a. Page 17. Ultra-thin bonded wearing courses are generally considered appropriate for high-volume roads.
    b. Page 26-27, Figure 2.8 and 2.9. Approximately 40 - 45% of agencies use the thin bonded wearing course on rural and urban high-volume HMA roadways.
    c. Page 66, Table 3.19. The expected performance (treatment service life) of ultra-thin BWC applied to HMA-surfaced pavements is 7 to 12 years.
2. SHRP2 Report S2-R26-RR-2, *Guidelines for the Preservation of High-Traffic-Volume Roadways*. http://onlinepubs.trb.org/onlinepubs/shrp2/SHRP2-S2-R26-RR-2.pdf Many of the above references are repeated in this volume. Of additional note:
    a. Page 15. Ultra-thin bonded wearing course is identified as applicable for use on high-volume HMA-surfaced pavements.
3. Pavement Preservation Journal, Summer 2014, *Bonded Wearing Courses Get Big Boost in Vermont*. http://www.nxtbook.com/naylor/FPPQ/FPPQ0214/index.php?startid=27 This article describes the evolution of the BWC treatment as a cost effective, go-to process within VTrans' pavement preservation program.
4. Teleconference with Caltrans 5/8/14 (Haiping Zhou, Srikanth Balasubramanian)
    a. AR BWC has been used quite extensively across state, on many projects, including northern/mountainous regions. Supplemental specification used since 2007; recently incorporated in update to standard specifications. Caltrans Maintenance Technical Advisory Guide (MTAG) includes a chapter on AR BWC. The MTAG guides engineers in project selection, design, construction, materials, and troubleshooting. http://www.dot.ca.gov/hq/maint/FPMTAGChapter11-BondedWearingCourse.pdf
    b. Limited quantitative data on cost/benefit performance, but based on their experience has absolutely proven itself to be beneficial. Is not considered experimental, and they

are very comfortable using on high volume roadways. They are not aware of a single failure.

c. They have found the AR BWC to perform better than conventional, particularly in resistance to fatigue. Better resistance to reflective cracking in lab and field (unless crack too wide or too much sealant). Controls water (spray) and noise well. They expect a life of 7+ years, with final performance dependent on existing pavement condition.
d. Cost is slightly higher than dense mix, due to additional tack coat material.
e. Suggested that grant application review team speak with FHWA CA Division engineer Steve Helow, who is also very knowledgeable re Caltrans use of AR BWC.

5. Teleconference with Mass DOT 5/8/14 (Edmund Naras)
    a. Placed AR BWC in 2008 (four miles) on I-295 in Attleboro (46K ADT), adjacent to PG 64-28 BWC. Both sections are performing well. The 64-28 had a slight appearance of wear in the wheelpaths after 5-6 years in service that is not noticeable in the AR BWC. Great performance in both sections, essentially distress free.
    b. Three other interstate BWC projects (PG binder) since 2005. All performing well. ADT 43K - 170K.
    c. SHRP2 (R-26) Implementation Assistance Program recipient (Lead Adopter). Advertising project with 950,000 SY of BWC this summer. Three binder grades, including one AR. US Route 3, 90-100K ADT. Mr. Naras stated that they wouldn't be putting this material down on roads with such traffic volumes if they weren't confident of the treatment's performance and service life.
6. Email from NYSDOT 3/19/14 (Thomas Kane)
    a. Haven't done a large amount of Rubber BWC, but have done some. Generally has performed fine. Unsure if there is a reduction in reflective cracking versus conventional BWC.
    b. Cost dependent on number of contractors, number of lane miles done, etc.

Appendix A
NHDOT I-93 OBSI
Superpave and AR BWC, memo dated October 21, 2016

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TECHNICAL MEMORANDUM

To:	Jonathan Evans New Hampshire Department of Transportation Bureau of Environment, Air & Noise Program Manager
From:	Eric Cox, HMMH Senior Consultant
Date:	October 21, 2016
Subject:	NHDOT I-93 OBSI – Superpave and AR BWC
Reference:	HMMH Project Number 306610.001

1. INTRODUCTION

Harris Miller Miller & Hanson Inc. (HMMH) conducted On-board Sound Intensity (OBSI) tire/pavement noise measurements on behalf of the New Hampshire Department of Transportation Bureau of Environment (NHDOT) on September 23, 2016 for two roadway test sections located along Interstate Route 93 (I-93) between Concord and Manchester, NH. The pavements types measured were Superpave and Asphalt Rubber Bonded Wearing Course (AR BWC). This technical memorandum provides the results of the I-93 OBSI testing.

The measurements were conducted in substantial conformance with American Association of State Highway and Transportation Officials (AASHTO) Standard No. T 360-16[1]. At each of the two test section locations, a minimum of three OBSI vehicle runs were conducted in each direction of travel. In accordance with the AASHTO standard, each test section was 440 feet in length. In addition to measuring the OBSI level for each pavement type, HMMH recorded supplementary data such as the ambient air temperature, pavement surface temperature, wind speed, tire inflation pressure and hardness, and the test vehicle speed.

In accordance with the AASHTO T 360-16 standard, the measurement data were reduced as follows: the leading and trailing edge sound intensity probe data from each test run were averaged on an energy basis. The energy averages for the individual runs then were averaged together arithmetically. Finally, the data were compiled to provide the overall OBSI level for each test section and also one-third octave band data. The overall OBSI level can be used to characterize various pavements types for cross-comparison and also to evaluate an individual pavement type over time.

2. DOCUMENTATION

2.1 Vehicle and Speed

A 2016 Toyota Camry with a curb weight of 3240 pounds was used for the OBSI testing. All measurements were conducted at a uniform test speed of 60 mph verified to within +/- 1 mph using a handheld GPS unit.

2.2 Tire Characteristics

An ASTM F2493 Standard Reference Test Tire (SRTT) was used for the OBSI testing. Table 1 provides a summary of the various test tire parameters verified prior to conducting the measurements.

Table 1. Test Tire Characteristics

Date & Time	Date Code	Mileage (mi)	Pressure (psi)	Durometer	Tread Depth (in)
9/23/2016 @ 11:30 PM	4013	10	30.0	70	0.328

[1] AASHTO Designation: T 360-16 “Standard Method of Test for Measurement of Tire/Pavement Noise Using the On-Board Sound Intensity (OBSI) Method”, April 2016

2.3 Instrumentation

The HMMH-owned OBSI measurement instrumentation and custom-built test vehicle mounting rig included a Bruel & Kjaer PULSE real-time data acquisition system as well as two GRAS 40AI/26AK tire-mounted precision (Type-I) sound intensity probes and a Bruel & Kjaer 4231 acoustic calibrator.

All acoustical instrumentation meets American National Standards Institute (ANSI) Type-I specifications and has current calibrations traceable to the National Institute of Standards and Technology (NIST). Additional field calibrations were conducted before and after the OBSI testing and the results were within 0.5 dBA.

2.4 Roadway Sections

The NHDOT provided the test section locations for the OBSI measurements. The following list identifies each pavement type and provides the general location of each associated roadway test section:

- **Section 1: Superpave**
  between mile markers 36 and 37 along I-93 south of Concord, NH near to the interchange with I-89
- **Section 2: Asphalt Rubber Bonded Wearing Course**
  between mile markers 19 and 21 along I-93 south of Manchester, NH near to the interchange with I-293

2.5 Site Conditions

The OBSI measurements were conducted under appropriate conditions at all test locations:

- Roadway surfaces were dry
- Minimal sand or loose debris was present on pavement
- No large reflective objects were within 20 inches of the edge of the pavement
- All test sites were located on roadway segments which were generally flat and straight

3. MEASUREMENTS

3.1 Test Section Summary

Table 2 provides a detailed summary of the roadway test sections including locations and directions of travel, pavement types, the latitude and longitude of the beginning point of each measurement, and the total length of each OBSI measurement run. Representative photographs for each test location are shown in Appendix A.

Table 2. Summary of Roadway Test Sections

Test Section	Location	Direction of Travel	Pavement Type	Beginning Latitude/Longitude	Length (ft)
01	I-93 Concord	Northbound	Superpave	43.18019 / -71.53004	440
01	I-93 Concord	Southbound	Superpave	43.18319 / -71.52580	440
02	I-93 Manchester	Northbound	AR BWC	42.97176 / -71.41325	440
02	I-93 Manchester	Southbound	AR BWC	42.97554 / -71.41424	440

3.2 OBSI Testing Summary

Table 3 provides a detailed summary of the OBSI testing including the date and time range when each set of measurements were conducted.

Table 3. Summary of I-93 OBSI Measurements

Date	Start Time	End Time	Test Section	Location	Direction of Travel	Pavement Type
9/23/2016	12:55 AM	1:05 AM	01	I-93 Concord	Northbound	Superpave
9/23/2016	12:15 AM	12:25 AM	01	I-93 Concord	Southbound	Superpave
9/23/2016	3:00 AM	3:20 AM	02	I-93 Manchester	Northbound	AR BWC
9/23/2016	2:10 AM	2:25 AM	02	I-93 Manchester	Southbound	AR BWC

3.3 Meteorological Data

Table 4 provides atmospheric data collected during the OBSI testing, including air/pavement temperatures.

Table 4. Summary of Meteorological Data

Date & Time	Test Section Summary	Avg Pavement Temp (°F)	Air Temp (°F)	Relative Humidity (%)	Wind Speed (mph)
9/23/2016 @ 12:40 AM	I-93 NB Concord – Superpave	61.7	66.0	67.2	3.0
9/23/2016 @ 1:10 AM	I-93 NB Concord – Superpave	61.1	70.5	58.6	2.0
Average	***I-93 NB Concord – Superpave***	***61.4***	***68.3***	***62.9***	***2.5***
9/23/2016 @ 12:10 AM	I-93 SB Concord – Superpave	64.2	67.7	68.2	1.0
9/23/2016 @ 12:30 AM	I-93 SB Concord – Superpave	66.0	70.0	61.5	0.0
Average	***I-93 SB Concord – Superpave***	***65.1***	***68.9***	***64.9***	***0.5***
9/23/2016 @ 2:55 AM	I-93 NB Manchester – AR BWC	61.7	66.9	58.3	1.5
9/23/2016 @ 3:25 AM	I-93 NB Manchester – AR BWC	62.9	68.0	58.2	1.5
Average	***I-93 NB Manchester – AR BWC***	***62.3***	***67.5***	***58.3***	***1.5***
9/23/2016 @ 2:00 AM	I-93 SB Manchester – AR BWC	60.4	68.3	65.8	0.0
9/23/2016 @ 2:30 AM	I-93 SB Manchester – AR BWC	63.3	70.0	56.2	0.0
Average	***I-93 SB Manchester – AR BWC***	***61.9***	***69.2***	***61.0***	***0.0***

4. RESULTS

4.1 Measured OBSI Levels

This section summarizes the results of the OBSI testing as measured under the atmospheric conditions identified above. Tables 5 – 8 below and Figures 1 – 8 included at the end of this report provide the overall and one-third octave band OBSI levels measured for each roadway test section as well as the instantaneous time-history data collected during each of the measurement runs.

Table 5. Section 1: I-93 Northbound Concord – Superpave

Run	Overall	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000
1	102.9	80.2	80.0	83.1	91.2	97.4	92.5	95.0	95.1	93.7	89.4	87.2	82.4
2	103.3	80.4	81.3	84.4	92.7	97.9	93.6	96.1	95.0	93.5	89.0	85.1	81.3
3	103.3	80.4	80.6	84.0	92.7	97.9	93.5	96.0	95.0	93.6	89.0	85.5	81.4
Average	***103.2***	***80.3***	***80.6***	***83.9***	***92.2***	***97.8***	***93.2***	***95.7***	***95.0***	***93.6***	***89.1***	***85.9***	***81.7***
PI Index		2.2	1.8	1.6	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.4
Coherence		0.90	0.95	0.98	0.99	0.99	0.99	0.99	0.99	0.98	0.96	0.92	0.86
Deviation	0.5	0.3	1.4	1.2	1.5	0.5	1.1	1.1	0.1	0.2	0.5	2.0	1.1

Table 6. Section 1: I-93 Southbound Concord – Superpave

Run	Overall	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000
1	103.0	79.5	81.4	86.3	94.3	97.7	93.3	95.9	93.6	91.7	88.2	84.3	80.3
2	102.9	79.8	81.2	86.5	94.3	97.7	93.4	95.7	93.3	91.3	87.7	83.6	79.4
3	103.3	80.2	80.1	85.5	93.8	98.3	93.1	96.3	94.2	92.2	88.8	85.5	81.3
Average	***103.1***	***79.8***	***80.9***	***86.1***	***94.1***	***97.9***	***93.3***	***96.0***	***93.7***	***91.8***	***88.2***	***84.5***	***80.4***
PI Index		2.2	1.8	1.5	1.2	1.1	1.2	1.2	1.2	1.2	1.2	1.2	1.3
Coherence		0.91	0.96	0.99	0.99	1.00	0.99	0.99	0.99	0.98	0.97	0.94	0.88
Deviation	0.4	0.6	1.3	1.0	0.5	0.7	0.3	0.6	0.9	0.9	1.1	1.8	1.9

Table 7. Section 2: I-93 Northbound Manchester – AR BWC

Run	Overall	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000
1	101.3	85.4	88.4	92.9	95.7	94.0	92.3	90.3	88.1	86.4	83.8	79.2	74.7
2	101.4	85.4	88.3	93.0	96.0	94.2	92.0	90.4	87.9	86.4	83.7	79.2	74.8
3	101.2	85.4	88.6	93.1	95.9	93.8	91.8	90.0	87.7	86.2	83.4	78.8	74.6
Average	***101.3***	***85.4***	***88.4***	***93.0***	***95.9***	***94.0***	***92.0***	***90.3***	***87.9***	***86.3***	***83.6***	***79.1***	***74.7***
PI Index		1.4	1.4	1.3	1.1	1.2	1.2	1.2	1.2	1.3	1.2	1.2	1.3
Coherence		0.96	0.99	1.00	0.99	0.99	0.99	0.99	0.98	0.98	0.96	0.93	0.82
Deviation	0.1	0.0	0.2	0.2	0.3	0.3	0.5	0.4	0.3	0.3	0.4	0.4	0.2

Table 8. Section 2: I-93 Southbound Manchester – AR BWC

Run	Overall	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000
1	100.9	85.1	88.1	92.1	95.2	93.8	92.1	90.1	87.7	86.0	83.3	78.6	74.0
2	100.7	84.9	88.1	92.2	94.8	93.8	91.6	89.7	87.4	85.7	83.0	78.2	73.7
3	101.1	85.6	88.6	92.7	95.7	93.9	92.1	89.9	87.7	85.9	83.2	78.6	74.3
Average	***100.9***	***85.2***	***88.3***	***92.3***	***95.2***	***93.8***	***92.0***	***89.9***	***87.6***	***85.9***	***83.2***	***78.4***	***74.0***
PI Index		1.3	1.3	1.3	1.1	1.2	1.2	1.2	1.2	1.3	1.2	1.2	1.3
Coherence		0.95	0.99	1.00	0.99	0.99	0.99	0.99	0.98	0.98	0.96	0.92	0.81
Deviation	0.5	0.8	0.5	0.6	0.8	0.1	0.5	0.3	0.3	0.4	0.3	0.4	0.7

4.2 Normalized OBSI Levels

Because OBSI measurements are dependent on both the ambient air and pavement surface temperatures (and also the test vehicle speed), the AASHTO T 360-16 standard includes a provision for normalizing OBSI test data to a standard air temperature of 68 °F using an -0.04 dBA per degree Fahrenheit relationship.

The normalized OBSI data for each roadway test section is provided in Table 9 below and Figures 9 – 12 included at the end of this report. Since all of the OBSI measurements were conducted at night with an air temperature of around 66 to 70 °F, the overall effect of temperature normalizing the data to 68 °F is minimal.

Table 9. OBSI Levels Normalized to an Air Temperature of 68 °F

Test Section	Overall	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000
I-93 NB – *Superpave*	***103.2***	80.3	80.7	83.9	92.2	97.8	93.2	95.7	95.1	93.6	89.1	85.9	81.7
I-93 SB – *Superpave*	***103.1***	79.9	80.9	86.1	94.2	97.9	93.3	96.0	93.8	91.8	88.3	84.5	80.4
I-93 NB – *AR BWC*	***101.3***	85.3	88.4	93.0	95.9	94.0	92.0	90.2	87.9	86.3	83.6	79.1	74.7
I-93 SB – *AR BWC*	***100.9***	85.3	88.3	92.4	95.3	93.9	92.0	89.9	87.7	85.9	83.2	78.5	74.0

4.3 Results Comparison

The average OBSI level for each test pavement type is shown in Table 10 below and Figure 13 included at the end of this report. Overall, the Asphalt Rubber Bonded Wearing Course (AR BWC) pavement surface has an OBSI tire/pavement noise level that is about 2 dBA lower than was observed for the Superpave test section.

Table 10. Comparison of OBSI Levels for Superpave and AR BWC Pavements

Pavement Surface	Overall	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000
Superpave	***103.2***	80.1	80.8	85.0	93.2	97.9	93.3	95.9	94.4	92.7	88.7	85.2	81.1
AR BWC	***101.1***	85.3	88.4	92.7	95.6	93.9	92.0	90.1	87.8	86.1	83.4	78.8	74.4

Figure 1. Measured Overall and 1/3 Octave Band Sound Intensity Levels
Section 1 Northbound - Superpave
Interstate 93, Concord NH, September-23-2016

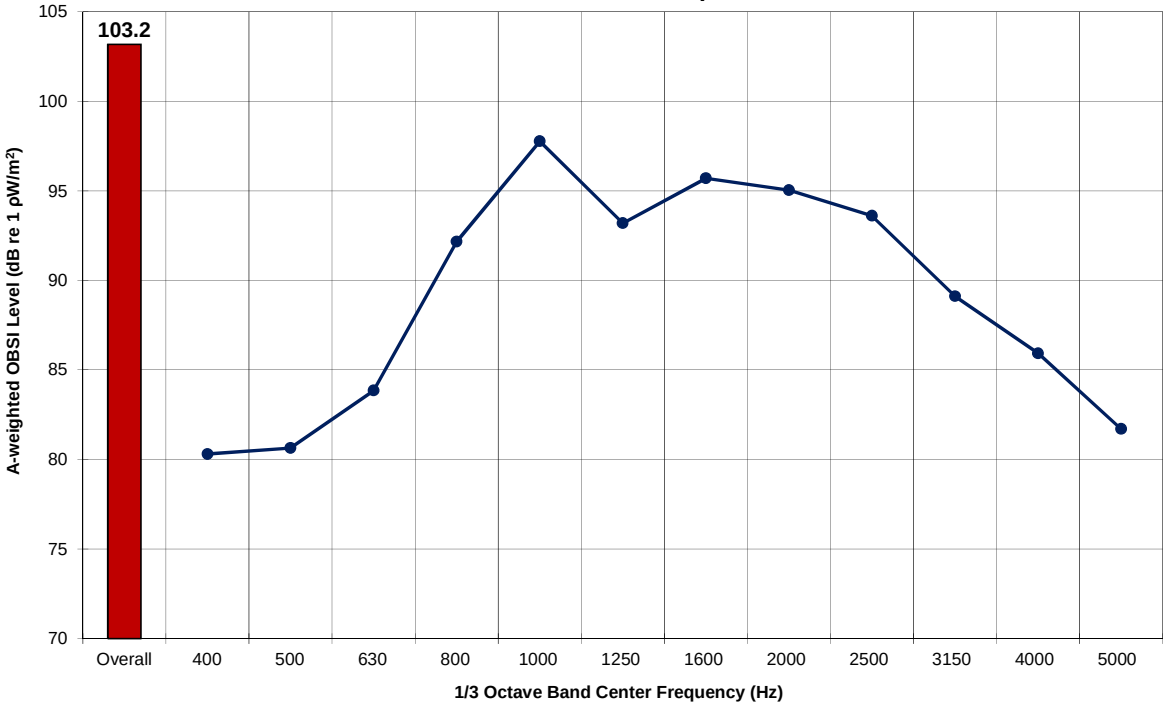


Figure 2. Measured Overall and 1/3 Octave Band Sound Intensity Levels
Section 1 Southbound - Superpave
Interstate 93, Concord NH, September-23-2016

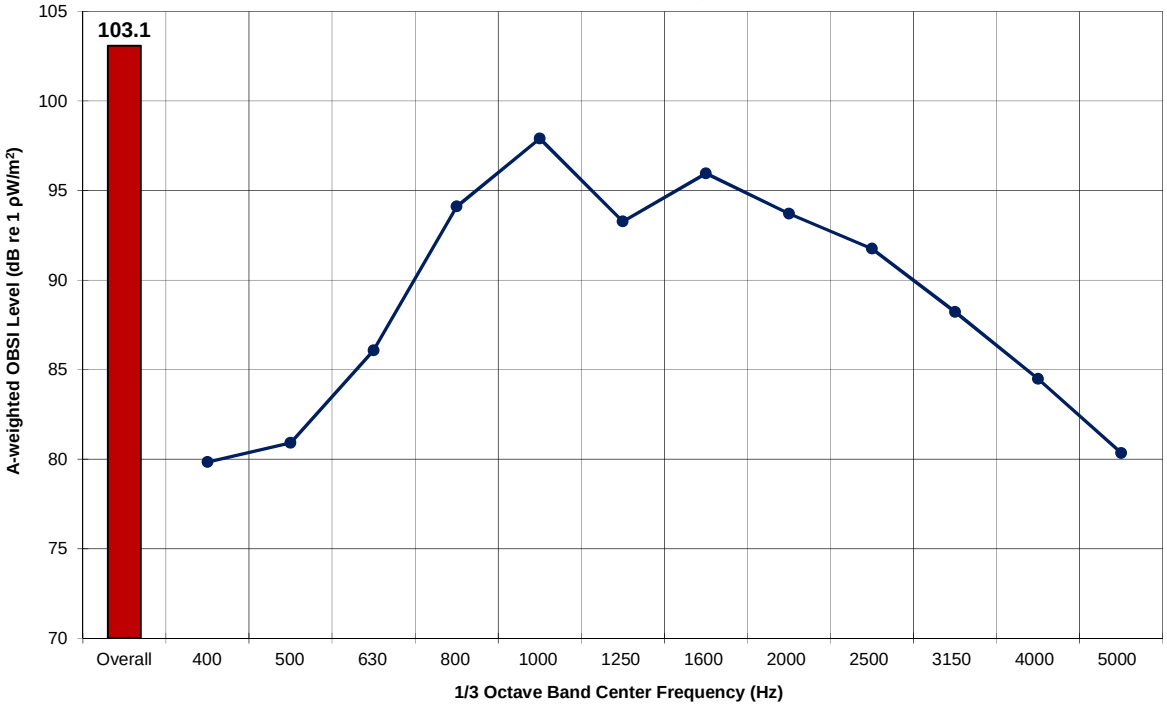


Figure 3. Measured Overall and 1/3 Octave Band Sound Intensity Levels
Section 2 Northbound - AR BWC
Interstate 93, Manchester NH, September-23-2016

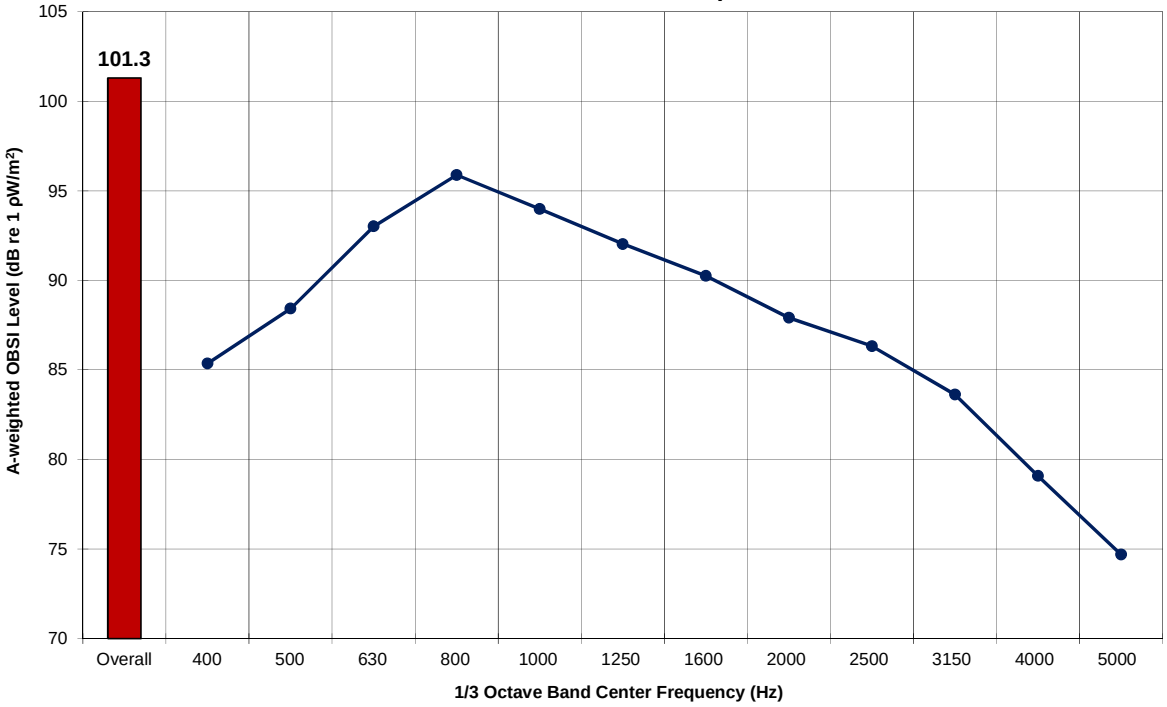


Figure 4. Measured Overall and 1/3 Octave Band Sound Intensity Levels
Section 2 Southbound - AR BWC
Interstate 93, Manchester NH, September-23-2016

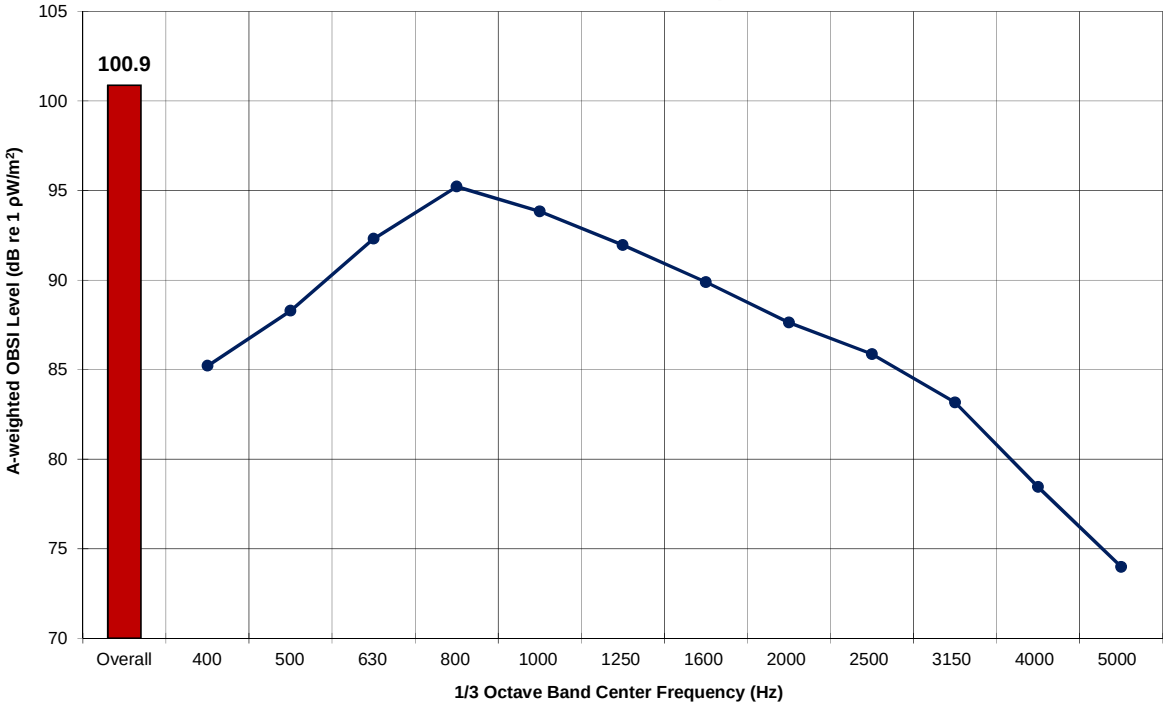


Figure 5. Measured Overall Sound Intensity Level Time History
Section 1 Northbound - Superpave
Interstate 93, Concord NH, September-23-2016

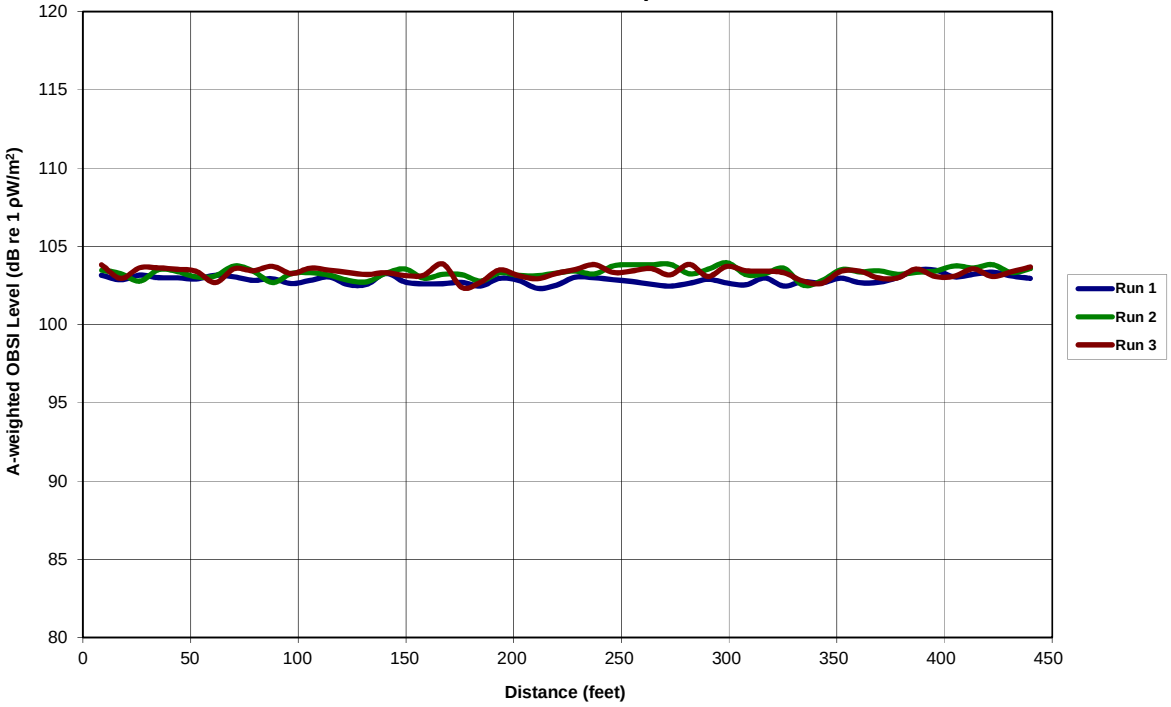


Figure 6. Measured Overall Sound Intensity Level Time History
Section 1 Southbound - Superpave
Interstate 93, Concord NH, September-23-2016

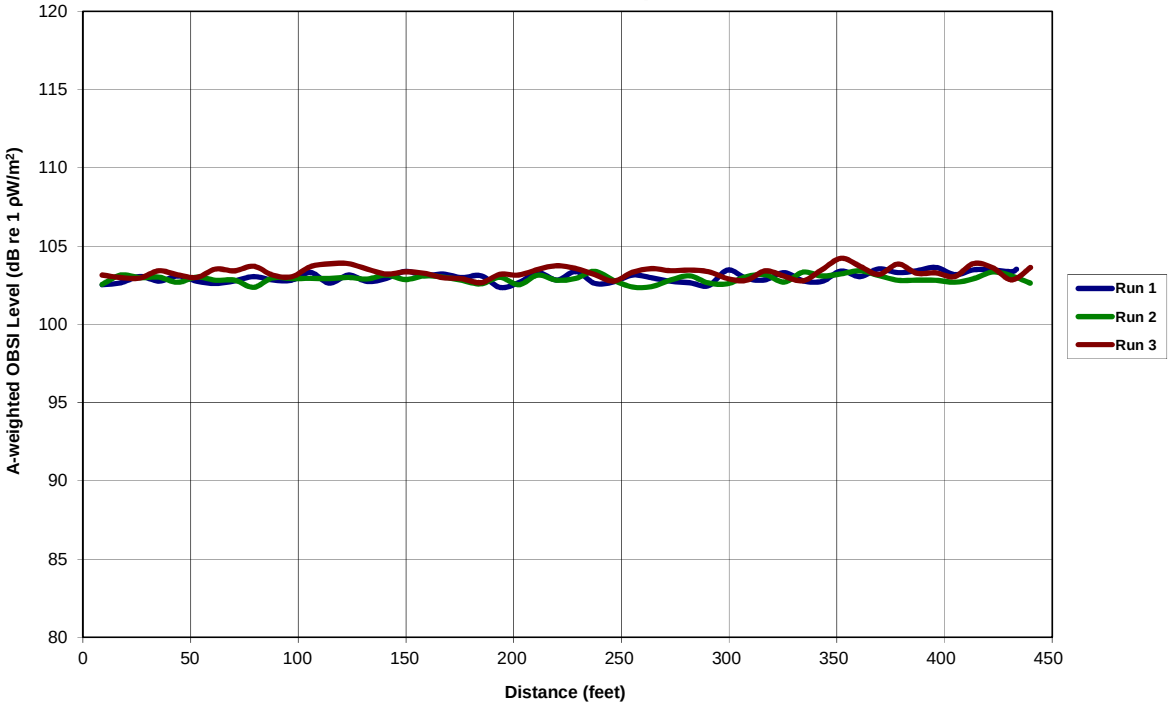


Figure 7. Measured Overall Sound Intensity Level Time History
Section 2 Northbound - AR BWC
Interstate 93, Manchester NH, September-23-2016

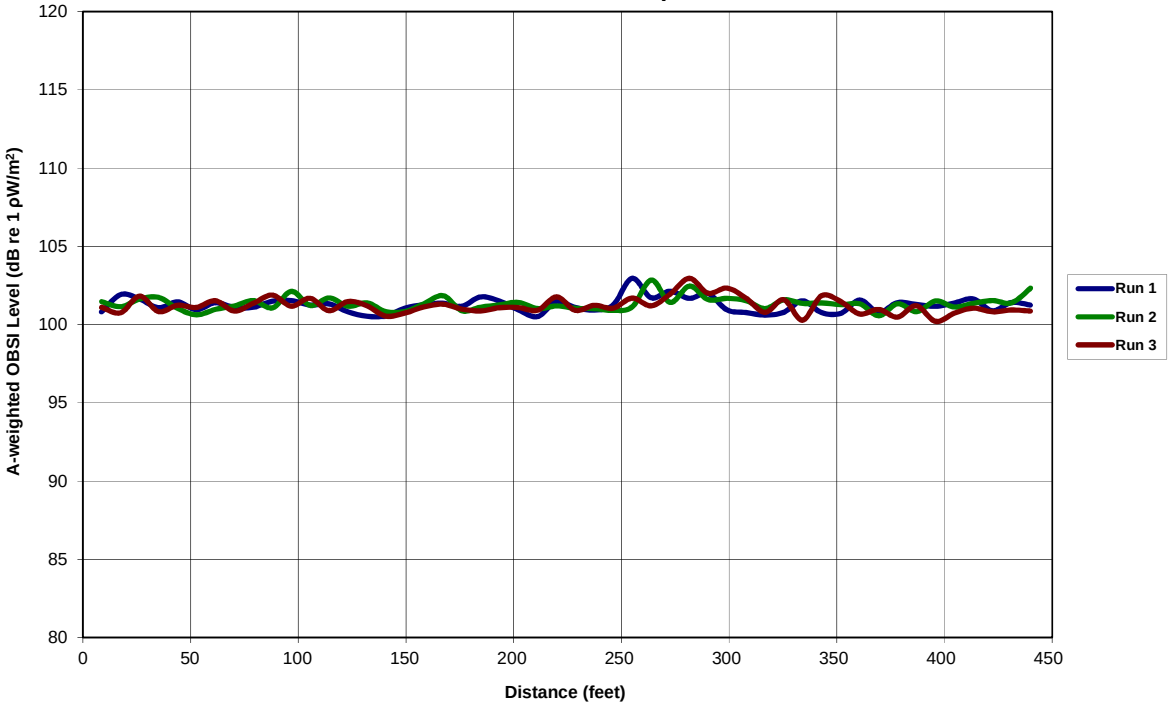


Figure 8. Measured Overall Sound Intensity Level Time History
Section 2 Southbound - AR BWC
Interstate 93, Manchester NH, September-23-2016

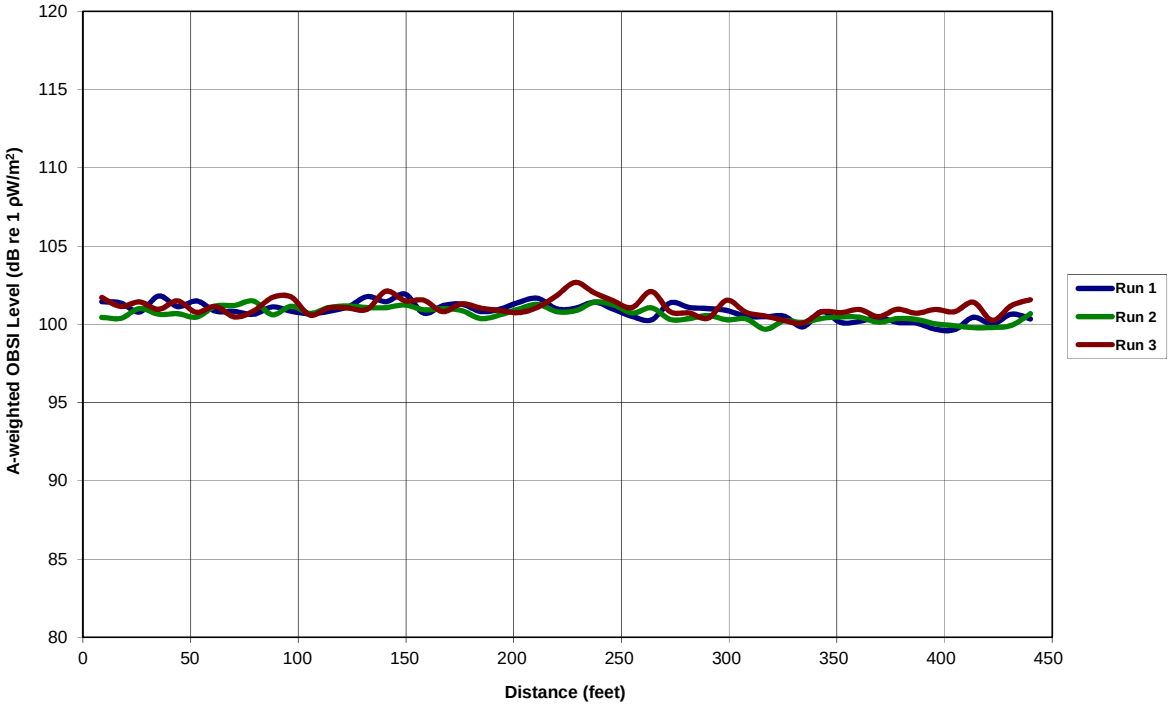


Figure 9. Normalized Overall and 1/3 Octave Band Sound Intensity Levels
Section 1 Northbound - Superpave
Interstate 93, Concord NH, September-23-2016

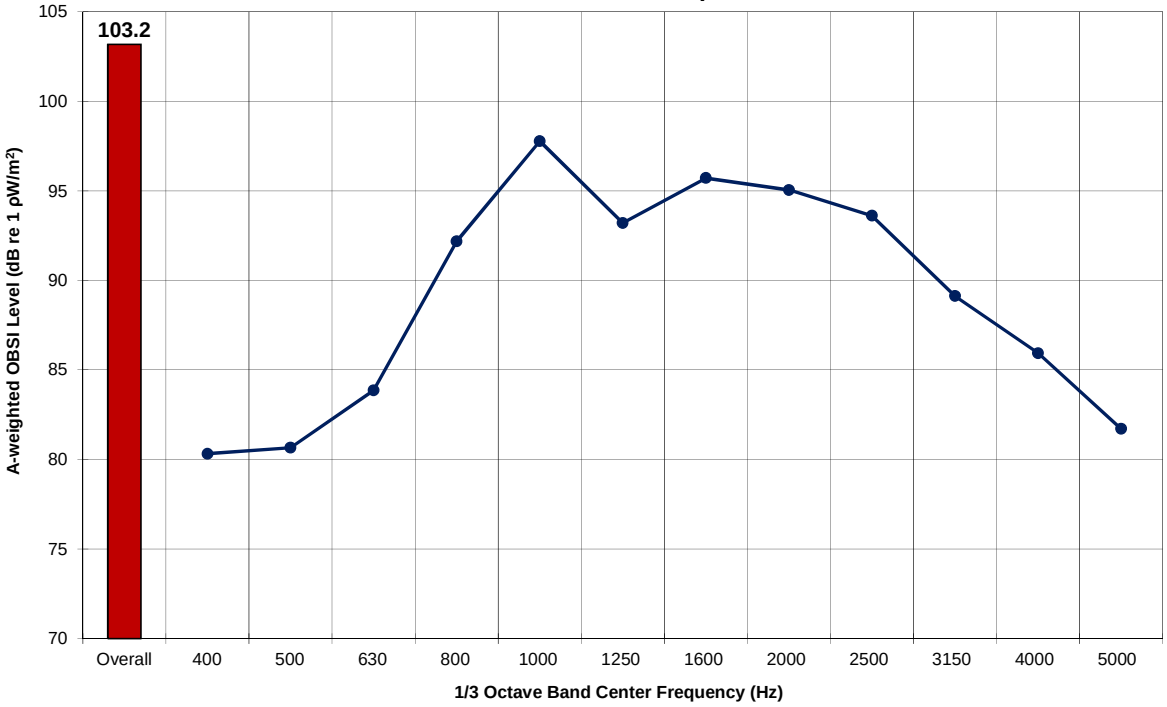


Figure 10. Normalized Overall and 1/3 Octave Band Sound Intensity Levels
Section 1 Southbound - Superpave
Interstate 93, Concord NH, September-23-2016

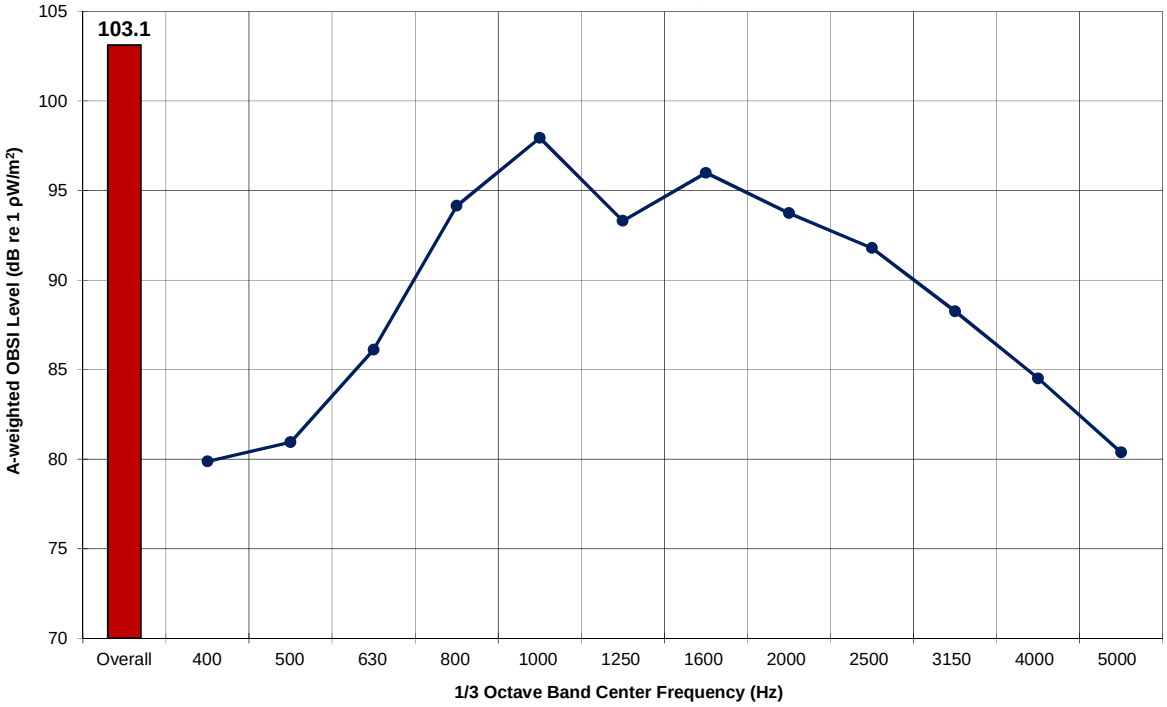


Figure 11. Normalized Overall and 1/3 Octave Band Sound Intensity Levels
Section 2 Northbound - AR BWC
Interstate 93, Manchester NH, September-23-2016

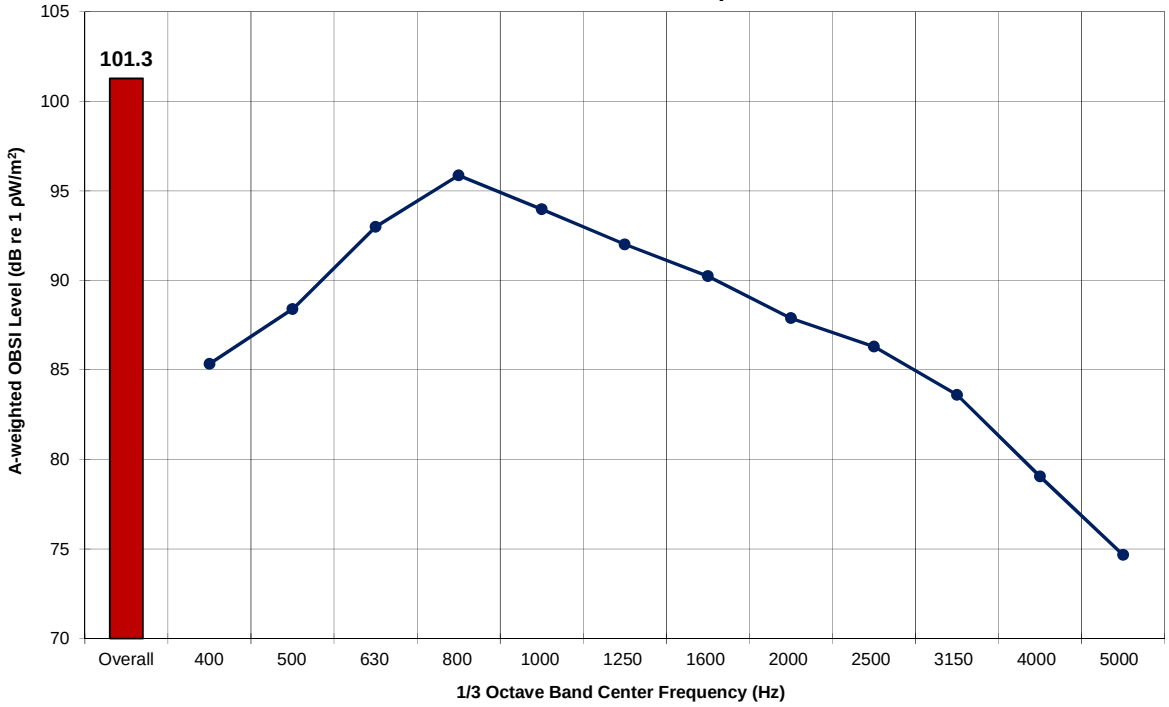


Figure 12. Normalized Overall and 1/3 Octave Band Sound Intensity Levels
Section 2 Southbound - AR BWC
Interstate 93, Manchester NH, September-23-2016

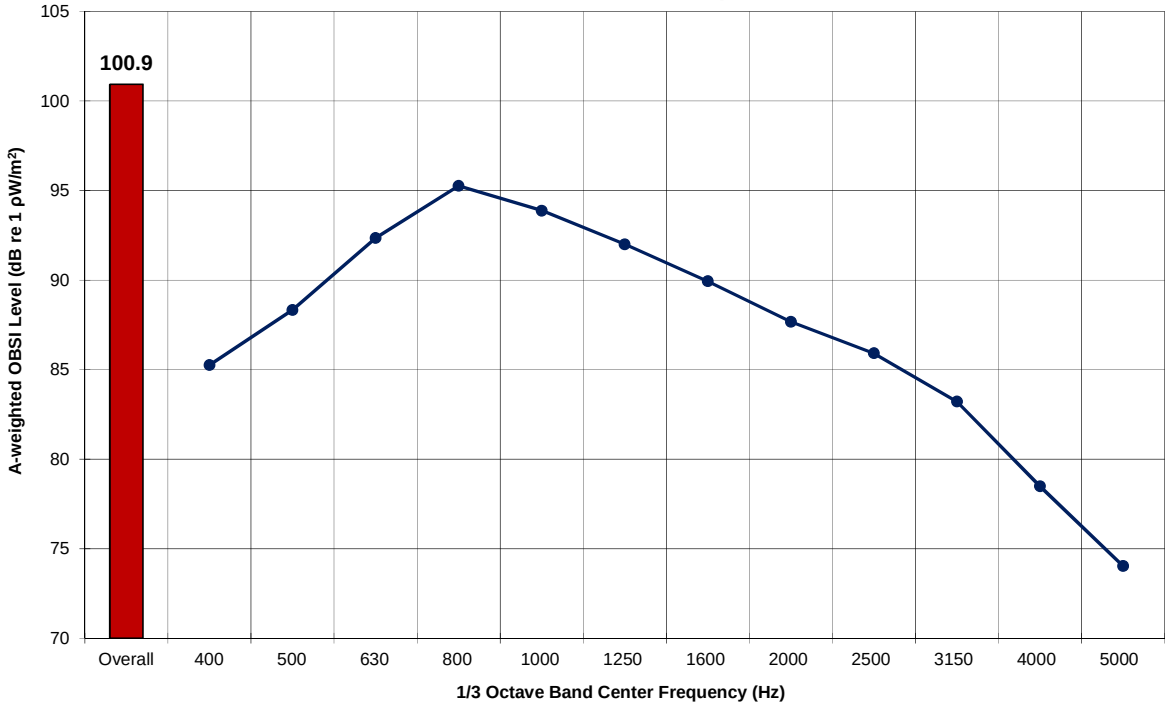
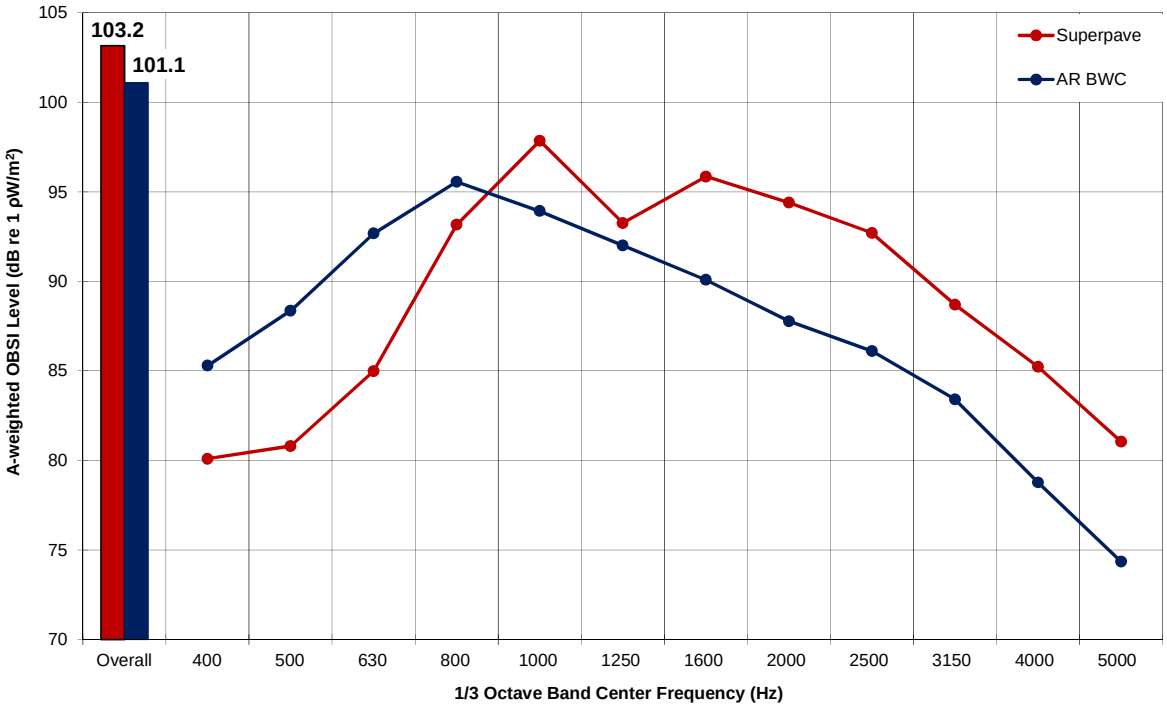


Figure 13. Comparison of Overall and 1/3 Octave Band Sound Intensity Levels
Interstate 93, New Hampshire, September-23-2016



APPENDIX A. PHOTOGRAPHS

I-93 Northbound Concord NH – Superpave

I-93 Southbound Concord NH – Superpave

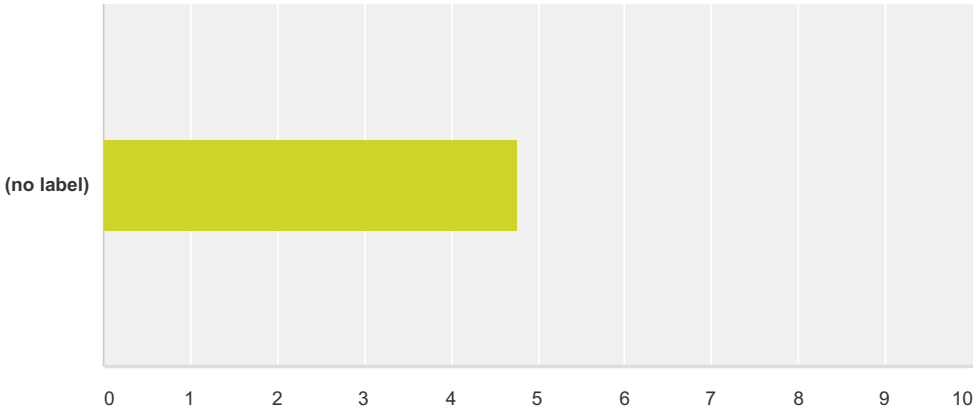
I-93 Northbound Manchester NH – AR BWC

I-93 Southbound Manchester NH – AR BWC

Appendix B
Wet Pavement Spray Survey Results

Q1 How obstructed was your view of the vehicle in the left screen?

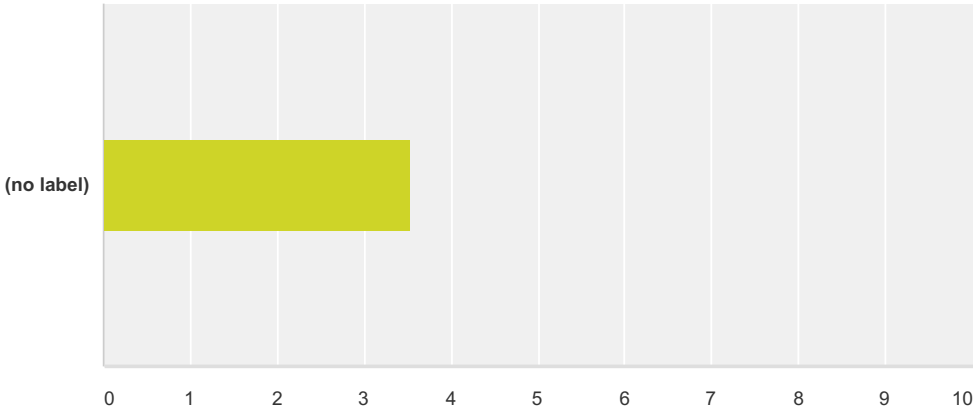
Answered: 149 Skipped: 1



	Very little	(no label)	(no label)	(no label)	(no label)	(no label)	Very much	Total	Weighted Average
(no label)	**2.68%** 4	**2.68%** 4	**10.74%** 16	**17.45%** 26	**36.91%** 55	**24.16%** 36	**5.37%** 8	149	4.77

Q2 How obstructed was your view of the vehicle in the right screen?

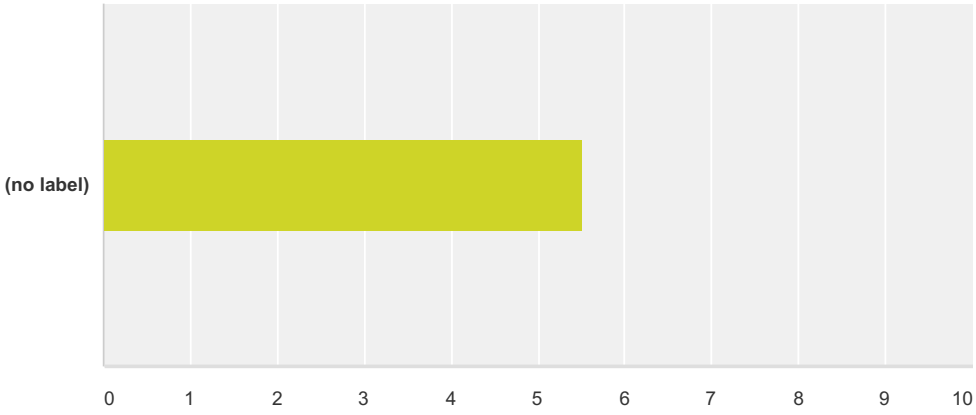
Answered: 149 Skipped: 1



	Very little	(no label)	(no label)	(no label)	(no label)	(no label)	Very much	Total	Weighted Average
(no label)	**6.71%** 10	**12.08%** 18	**30.87%** 46	**28.86%** 43	**16.78%** 25	**3.36%** 5	**1.34%** 2	149	3.52

Q3 How much concentration would the left driving condition require?

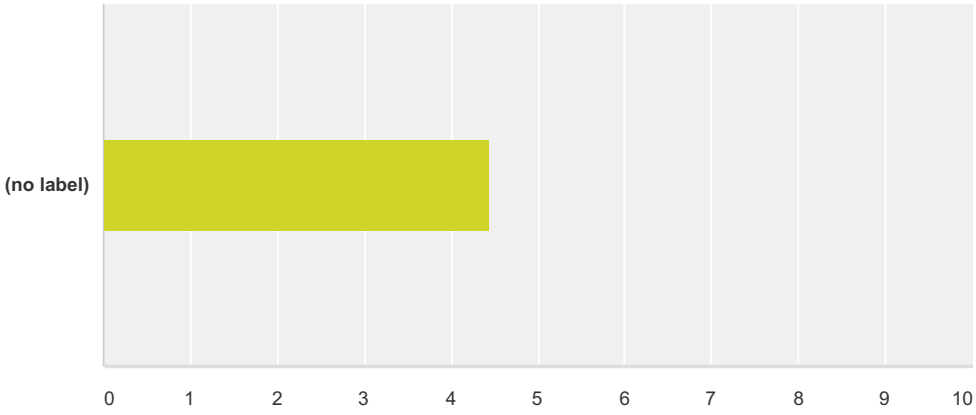
Answered: 148 Skipped: 2



	Very little	(no label)	(no label)	(no label)	(no label)	(no label)	A lot	Total	Weighted Average
(no label)	**1.35%** 2	**1.35%** 2	**3.38%** 5	**14.19%** 21	**27.03%** 40	**24.32%** 36	**28.38%** 42	148	5.51

Q4 How much concentration would the right driving condition require?

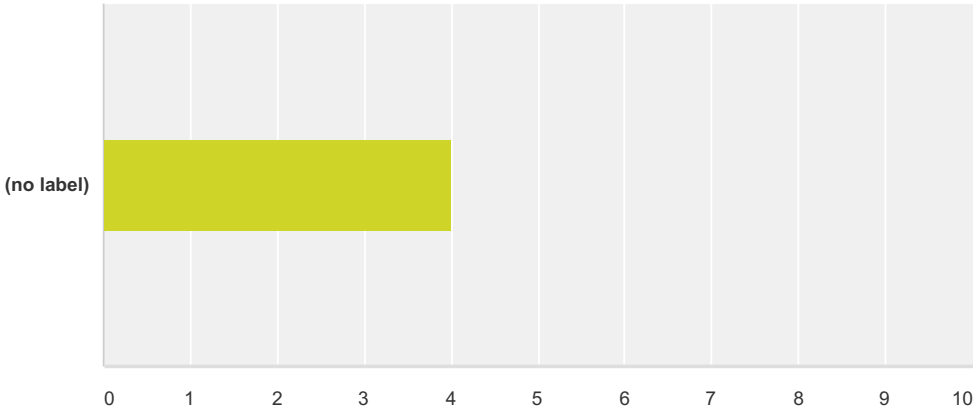
Answered: 149 Skipped: 1



	Very little	(no label)	(no label)	(no label)	(no label)	(no label)	A lot	Total	Weighted Average
(no label)	**2.01%** 3	**8.72%** 13	**16.11%** 24	**24.16%** 36	**26.85%** 40	**9.40%** 14	**12.75%** 19	149	4.44

Q5 How confident would you feel in the left driving conditions?

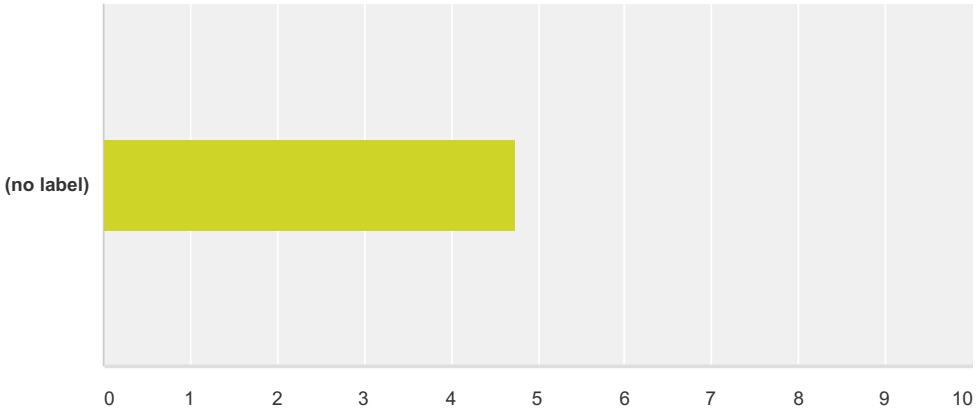
Answered: 146 Skipped: 4



	Not confident	(no label)	(no label)	(no label)	(no label)	(no label)	Very confident	Total	Weighted Average
(no label)	**4.79%** 7	**16.44%** 24	**17.81%** 26	**23.97%** 35	**17.81%** 26	**9.59%** 14	**9.59%** 14	146	4.01

Q6 How confident would you feel in the right driving conditions?

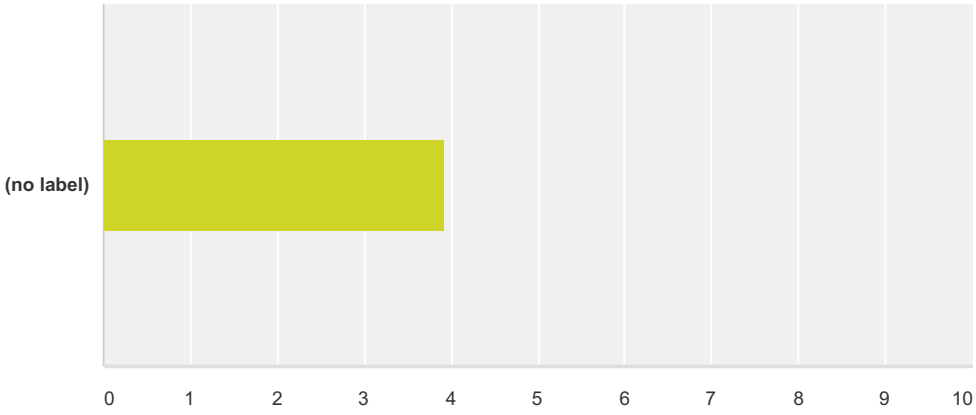
Answered: 149 Skipped: 1



	Not confident	(no label)	(no label)	(no label)	(no label)	(no label)	Very confident	Total	Weighted Average
(no label)	**3.36%** 5	**2.68%** 4	**14.09%** 21	**20.13%** 30	**26.85%** 40	**22.82%** 34	**10.07%** 15	149	4.73

Q7 How much control do you feel you would have in the left driving condition?

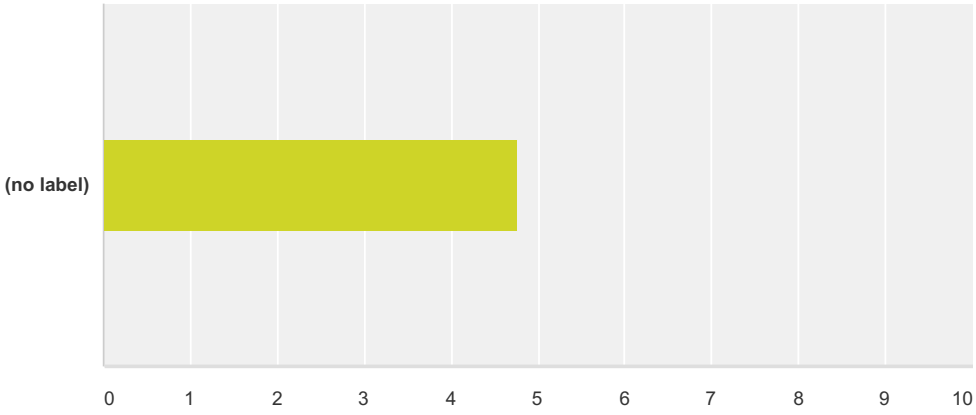
Answered: 144 Skipped: 6



	Very little	(no label)	(no label)	(no label)	(no label)	(no label)	A lot	Total	Weighted Average
(no label)	**4.86%** 7	**13.19%** 19	**20.14%** 29	**25.00%** 36	**23.61%** 34	**9.03%** 13	**4.17%** 6	144	3.93

Q8 How much control do you feel you would have in the right driving condition?

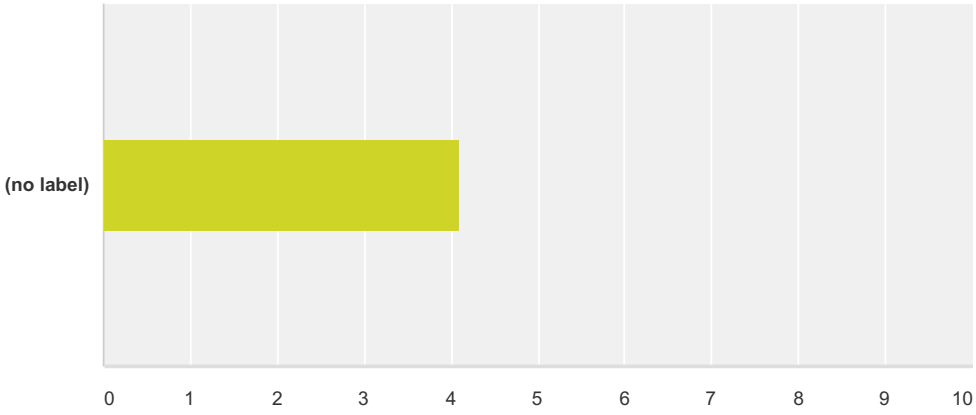
Answered: 147 Skipped: 3



	Very little	(no label)	(no label)	(no label)	(no label)	(no label)	A lot	Total	Weighted Average
(no label)	**1.36%** 2	**3.40%** 5	**10.20%** 15	**23.13%** 34	**31.97%** 47	**24.49%** 36	**5.44%** 8	147	4.76

Q9 How risky would it feel to drive in the left driving condition?

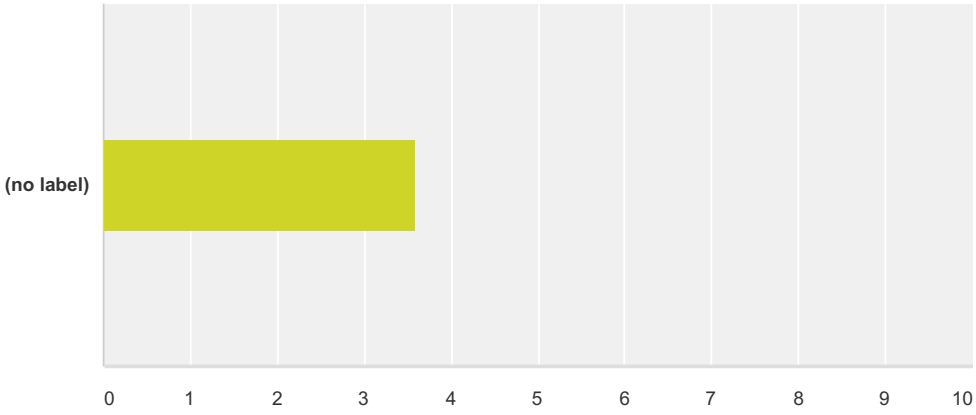
Answered: 147 Skipped: 3



	Not risky	(no label)	(no label)	(no label)	(no label)	(no label)	Very risky	Total	Weighted Average
(no label)	**3.40%** 5	**19.05%** 28	**12.24%** 18	**19.05%** 28	**25.85%** 38	**16.33%** 24	**4.08%** 6	147	4.10

Q10 How risky would it feel to drive in the right driving condition?

Answered: 149 Skipped: 1



	Not risky	(no label)	(no label)	(no label)	(no label)	(no label)	Very risky	Total	Weighted Average
(no label)	**2.68%** 4	**23.49%** 35	**20.13%** 30	**26.85%** 40	**20.13%** 30	**4.70%** 7	**2.01%** 3	149	3.60

#	Please describe any other differences between the left and right videos due to the driving conditions.	Date
1	I thought they were pretty similar	1/13/2017 1:34 PM
2	Beter visibility on the right one.	1/11/2017 10:57 AM
3	LEFT: surface might dry-up quicker, better traction. RIGHT: potential glare,reduced traction. Assumptions:video done on same day and weather conditions, same truck & weight, same speed, same slopes, same windshield wiper speed, same vehicle following the truck.	1/10/2017 10:37 AM
4	At times it appeared there was less spray from the tires on the right but I really cant be sure. Both made me nervous because I never follow that close anyway.	1/9/2017 1:04 PM
5	Your video was so pixelated and so poorly done that I'm most certain that most don't even know what they answered to.	1/9/2017 8:51 AM
6	left side looked a little more foggy	1/6/2017 8:03 AM
7	Regarding survey questions 7 & 8, I checked the same circle for both questions but I'd like to clarify my answers. I feel like my vehicle's performance, and my ability to control my vehicle's performance would be equivalent in both scenarios, but the visibility on the right was distinctly better than the visibility on the left… in other words, I would expect my braking distance to be equivalent, but my decision distance and brake reaction time to be longer for the conditions on the right. It's kinda remarkable if the conditions were actually equivalent.	1/6/2017 7:17 AM
8	The truck in the left video did look to be a little further away from the viewer	1/5/2017 2:54 PM
9	very hard to see on the left.	1/5/2017 10:50 AM
10	Left video has slightly obscured view of the vehicle passing. Right view allows the viewer to see vehicle in high speed lane well past the truck.	1/5/2017 10:28 AM
11	There appears to be a lot of spray into the passing lane which would obstruct the passing driver's view.	1/5/2017 9:26 AM
12	Left screen had more spray coming up from the roadway when vehicles passed.	1/5/2017 9:20 AM
13	The road seemed clearer on the right screen. The answer is irrelevant in my case since I would leave 2 seconds (or 3 times what the video shows) of following distance between the truck ahead and me plus I wouldn't listen to distracting/annoying music while driving too fast and too close in the rain.	1/5/2017 8:44 AM
14	Left visibility seems slightly worse than the right	1/5/2017 8:39 AM

15	The left condition seems to hold more water instead of it all being at the surface like in the right condtion. Might be problems during winter conditions at pavement joints where typical pavement meets ARBWC.	1/5/2017 8:19 AM
16	Spray from the left, along with possibility of material loss from the truck causing damage makes following that close irresponsible. Even the center screen is following a bit close.	1/5/2017 7:32 AM
17	needs new wiper blades ?	1/5/2017 7:29 AM
18	Left side had slightly more spray, somewhat less visibility.	1/5/2017 7:21 AM
19	more cars pass the plow on the left screen creating more spray everywhere.	1/4/2017 3:26 PM
20	Differences between the two seem minimal	1/4/2017 2:02 PM
21	There appears to be a lot more spray coming off the tires on the left video	1/4/2017 1:26 PM
22	left is a little blurrier	1/4/2017 1:25 PM
23	The right is lighter & definately not as obsured	1/4/2017 1:06 PM
24	There seemed to be more spray in the left view, but more following distance; visibility in the right frame seemed better to me, but the truck looked a little closer than it should be.	1/4/2017 1:05 PM
25	the videos in the left and right appeared very similar with no significant difference between the two driving conditions for the vehicle following the large truck.	1/4/2017 12:58 PM
26	There is less spray from the vehicle on the right vs. the one on the left	1/4/2017 12:03 PM
27	I feel the differences would be further magnified in the dark	1/4/2017 11:34 AM
28	There was very little difference in the left and right video screens.	1/4/2017 11:18 AM
29	Left seemed to be more spray from truck, or worse window wipers.	1/4/2017 10:43 AM
30	My visibility in the right driving condition was not significantly less (barely measurable) than the left driving condition.	1/4/2017 10:40 AM
31	The left side seemed more blurry, the rain seemed more prevelant. the right side seemed like i had more visibility, and seeing was a little bit more clear than the left side.	1/4/2017 10:36 AM
32	It seemed the tire marks of the truck in front were more prominent on the left leading me to think the water was standing on the road more...	1/4/2017 10:34 AM
33	view of signs much better in right view	1/4/2017 10:34 AM
34	The distance was closer on one of the videos	1/4/2017 10:31 AM
35	The right video is slightly clearer than the left video.	1/4/2017 10:26 AM
36	The right was a little better, but not enough to say so. Whereas, novochip or an open graded mix has a more significant reduction in spray.	1/4/2017 10:22 AM
37	The only difference I noticed is the fog/humidity due to temperatures.	1/4/2017 10:14 AM
38	Left is slightly more blurry	1/4/2017 10:11 AM
39	Driving in the left lane was slightly worse than the right lane as far as visibility goes.	1/4/2017 10:05 AM
40	Cars passing truck traveling to fast on both sides, risk of hydroplaining with that much water comming off the tires.	1/4/2017 9:53 AM
41	the left seemed slightly more obscured than right	1/4/2017 9:52 AM

Appendix C
Email from Todd Connors
Engineering Manager of City of Manchester DPW

Klemann, Elizabeth

From: Connors,Todd <tconnors@manchesternh.gov>
Sent: Monday, March 13, 2017 11:37 AM
To: Scholz, Ann
Cc: Klemann, Elizabeth
Subject: RE: Asphalt Rubber Bonded Wearing Course (AR BWC) along I-93 Project

Follow Up Flag: Follow up
Flag Status: Flagged

Ann –

Several of the DPW engineering staff visited the BWC project one night during the construction. We were surprised by the speed with which the operation moved, but found the treatment to be a good fit for some of our road work. It appears the thin lift would allow temperatures to moderate more quickly and traffic to return to the road.

Our observations centered around choosing the right road candidate for BWC. When roads with an acceptable level of deterioration are identified, we determined that it would best be used on bridges and large projects. We would expect complications centered around traffic control and short sections of street. Given the difficulties with closing City streets during the work day, this may also be preferred as a night operation.

The City is in the process of awarding a contract to All-State Materials for work this spring/summer. We have decided to use the treatment across the Notre Dame Bridge (Bridge Street) as well as the Granite Street interchange from Elm Street to Main Street. Our staff would appreciate a look at your final report as we continue to educate ourselves on the various pavement preservation techniques. The NHDOT experiences are always a good source of information.

Please forward any project information to my attention. You are also welcome to send a copy to the Manchester Board of Mayor and Alderman as an official and direct effort to share the information. I will make sure this gets distributed throughout the DPW and to our Highway Commission. I will also mention it to the BMA at one of my regular updates.

Please let me know if you have any questions or need anything else. Thanks,

Todd D. Connors, PE
Engineering Manager
Department of Public Works
Phone: 603-624-6444

475 Valley Street
Manchester, NH 03103
www.manchesternh.gov

From: Scholz, Ann [mailto:Ann.Scholz@dot.nh.gov]
Sent: Friday, March 10, 2017 10:26 AM

To: Connors,Todd
Cc: Klemann, Elizabeth
Subject: RE: Asphalt Rubber Bonded Wearing Course (AR BWC) along I-93 Project

Good morning Todd,

We are putting together a final report for FHWA on the subject project. From what you learned about this type of pavement treatment, has the City used it? Eric Thibodeau, our Pavement Mgmt Chief thought you were considering it for a South Willow Street project. Your thoughts on the installation would be appreciated.

If there was any official method of sharing the project information throughout the city, please reply with that process at your earliest convenience.

Thank you,
Ann

Ann M. Scholz, P.E.
Research Engineer
NHDOT Bureau of Materials & Research
Tel: (603) 271-1659

From: Connors,Todd [mailto:tconnors@manchesternh.gov]
Sent: Wednesday, February 11, 2015 2:36 PM
To: Ann Scholz
Subject: RE: Asphalt Rubber Bonded Wearing Course (AR BWC) along I-93 Project

Ann –

Thanks for reaching out to us. We are interested is learning about this particular treatment and providing feedback on the application. Please pass along any information we could review to better educate ourselves on the design, goals, objectives, or criteria used by NHDOT to selection this treatment as an appropriate course of action.

Todd D. Connors, PE
Engineering Manager
Department of Public Works
Phone: 603-624-6444

475 Valley Street
Manchester, NH 03103
www.manchesternh.gov

From: Ann Scholz [mailto:AScholz@dot.state.nh.us]
Sent: Wednesday, February 11, 2015 2:27 PM
To: Connors,Todd
Subject: FW: Asphalt Rubber Bonded Wearing Course (AR BWC) along I-93 Project

Sorry, my signature wasn't included. Here is my contact information.

Ann M. Scholz, P.E.
Assistant Research Engineer
NHDOT Bureau of Materials & Research
PO Box 483, 5 Hazen Drive
Concord, NH 03302-0483
FedEx/UPS Zip: 03301
Tel: (603) 271-8995
Fax: (603) 271-8700
Email: ascholz@dot.state.nh.us
On the Web: www.nh.gov/dot/research

From: Ann Scholz
Sent: Wednesday, February 11, 2015 2:22 PM
To: 'tconnors@manchesternh.gov'
Subject: FW: Asphalt Rubber Bonded Wearing Course (AR BWC) along I-93 Project

Good afternoon Todd,

Thank you for your interest in the future paving project. We are still planning to advertise the project in April with hopes of starting in July. This will be a night paving project requiring warm temperatures. I'll keep you informed about the project so you can decide how much you or other Manchester PW officials want to be on-site. I need to document the project for our requirements as recipients of the AID grant. I don't have much more to add than what Kathy described in her email.

Best, Ann

From: Keegan, Katherine [mailto:Katherine.Keegan@aecom.com]
Sent: Wednesday, February 11, 2015 1:52 PM
To: Ann Scholz
Cc: Todd D. Connors (tconnors@manchesternh.gov)
Subject: FW: Asphalt Rubber Bonded Wearing Course (AR BWC) along I-93 Project

Ann,

Please see Todd's contact information below for this project.

Good luck with the project!

Best,
Kathy

From: Connors,Todd [mailto:tconnors@manchesternh.gov]
Sent: Wednesday, February 11, 2015 1:31 PM
To: Keegan, Katherine
Cc: Clougherty, Tim; Sheppard, Kevin
Subject: RE: Asphalt Rubber Bonded Wearing Course (AR BWC) along I-93 Project

Kathy –

We are interested in participating. Please feel free to pass along my contact information to the DOT. Thanks,

Todd D. Connors, PE
Engineering Manager
Department of Public Works

Phone: 603-624-6444

475 Valley Street
Manchester, NH 03103
www.manchesternh.gov

From: Keegan, Katherine [mailto:Katherine.Keegan@aecom.com]
Sent: Tuesday, February 10, 2015 1:26 PM
To: Connors,Todd
Cc: Clougherty, Tim; Sheppard, Kevin
Subject: FW: Asphalt Rubber Bonded Wearing Course (AR BWC) along I-93 Project

Hi Todd,

I have been contacted by NHDOT to ask if you folks at the City would be interested in supporting them in a FHWA Aid grant project for accelerated innovations. They are paving an Asphalt Rubber Bonded Wearing Course on a section of I-93 shown in the map in the email below.

Since it is a grant project, they are required to provide some documentation and feedback to FHWA. What they are looking for from you, is the 'Customer Satisfaction' component. In talking with Ann Scholz from the DOT, this seems very non-specific. (See her brief email at the bottom). In simple terms, I think they will want to know your opinion of the end product (compared to how it is now) and possibly feedback on the process itself (traffic impacts, paving process). This would afford you the opportunity to visit the site during construction as well if you want. I don't think they are looking for anything formal but to interview you about it after the fact, but Ann would be the one to provide you those details.

I told the DOT I would reach out to you and if you were interested, then I would connect you directly. We are happy to attend and support any site visits with you and provide them any written feedback if that is what is required.

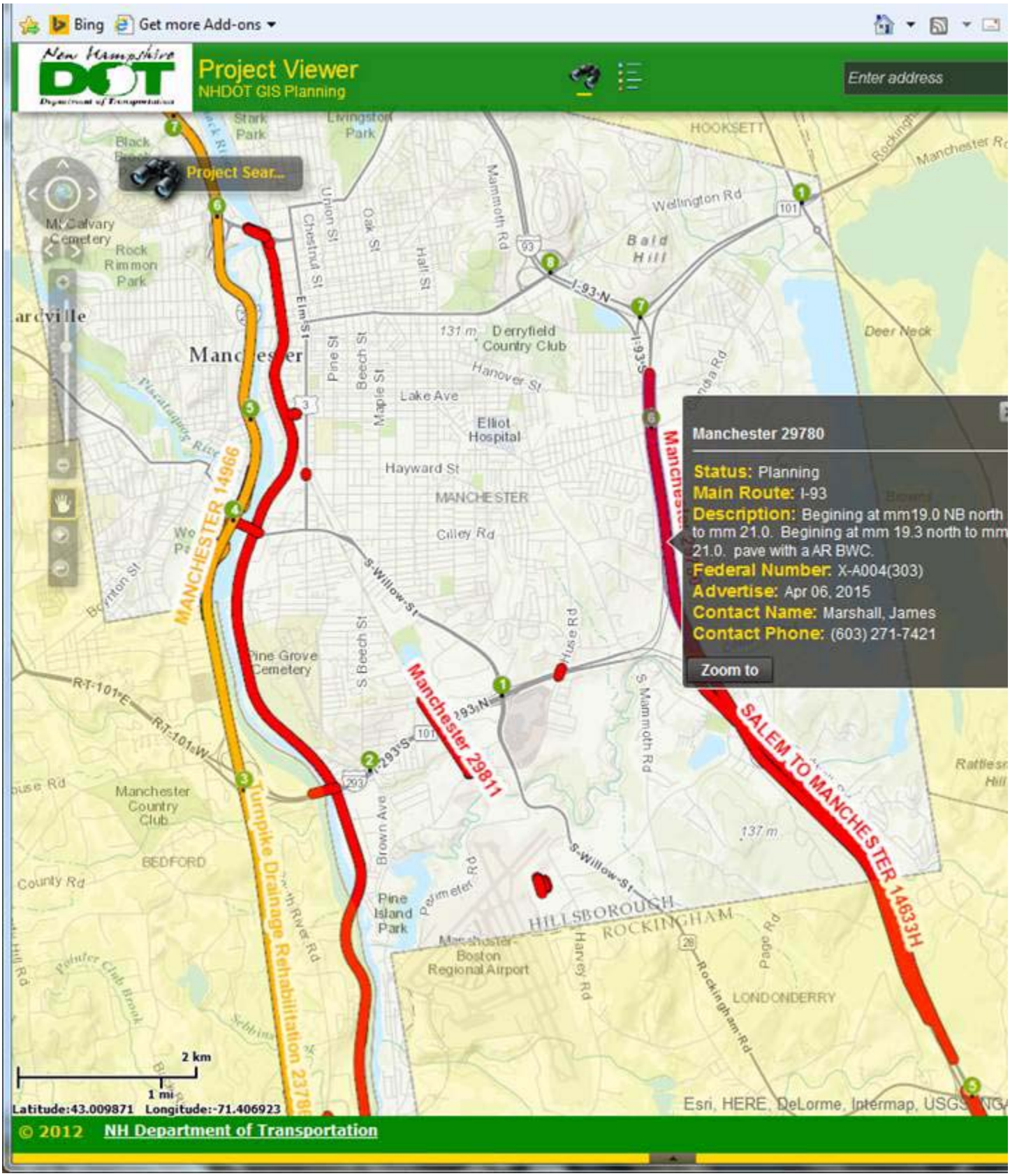
Please let me know so I can get back to them.

Thanks!
Kathy

From: Ann Scholz [mailto:AScholz@dot.state.nh.us]
Sent: Tuesday, February 10, 2015 1:16 PM
To: Keegan, Katherine
Cc: Gould, Jonathan
Subject: RE: Asphalt Rubber Bonded Wearing Course (AR BWC) along I-93 Project

Kathy,
Let me know if you have any problems with reading the description off of this screen shot of our project viewer. Our goals is to inform the City officials of the project as this is the first time we've used this type of treatment. We've used AR Gap-graded course in other areas but this is a bonded wearing course.

Thanks for your coordination effort.
Ann



Ann M. Scholz, P.E.
Assistant Research Engineer

From: Keegan, Katherine [mailto:Katherine.Keegan@aecom.com]
Sent: Monday, February 09, 2015 4:08 PM
To: Ann Scholz
Cc: Gould, Jonathan
Subject: RE: Asphalt Rubber Bonded Wearing Course (AR BWC) along I-93 Project

Hi Ann,

Thanks for checking in. Do you have time for a phone call tomorrow to discuss this?

I'm available 1:00 to 1:30, or 2:30 to 4:00pm. Let me know what time works for you and I'll give you a call at Tel: (603) 271-8995

Thanks,
Kathy

Katherine Keegan, M.Eng, PE
Pavement Engineering Group Leader

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katherine.keegan@aecom.com

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250 Apollo Drive
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F 978.905.2101
www.aecom.com

From: Ann Scholz [mailto:AScholz@dot.state.nh.us]
Sent: Monday, February 09, 2015 4:03 PM
To: Keegan, Katherine
Subject: FW: Asphalt Rubber Bonded Wearing Course (AR BWC) along I-93 Project

Hi Katherine,

I haven't heard back from Jon and Eric Thibodeau suggested contacting you next. Can you offer additional details about engaging the City of Manchester with this proposed pavement project?

Thank you, Ann

Ann M. Scholz, P.E.
Assistant Research Engineer
NHDOT Bureau of Materials & Research

From: Ann Scholz
Sent: Monday, January 26, 2015 1:26 PM
To: 'Jonathon.Gould@aecom.com'
Subject: Asphalt Rubber Bonded Wearing Course (AR BWC) along I-93 Project

Good afternoon Jon,

I'm in the process of developing a data collection and implementation plan regarding the subject project for reporting the performance to FHWA. One of the data collection items is customer satisfaction (before and after).
Eric Thibodeau suggested contacting you since AECOM has been hired to develop a pavement management strategy and had expressed interest of bringing City officials out for a site visit during construction.
If that is still an option, I'd like to mention this planned site visit in the plan and then provide some response from the City about what they saw and their impression.

I'd be happy to discuss other ideas as well. Thank you, Ann

Ann M. Scholz, P.E.
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