New Hampshire Demonstration Project:
Auburn-Candia Resurfacing Project

Final Technical Brief
May 2015

HIGHWAYS FOR LIFE
Accelerating Innovation for the American Driving Experience.

U.S. Department of Transportation
Federal Highway Administration

FOREWORD

The purpose of the Highways for LIFE (HfL) pilot program is to accelerate the use of innovations that improve highway safety and quality while reducing congestion caused by construction. **LIFE** is an acronym for **L**onger-lasting highway infrastructure using **I**nnovations to accomplish the **F**ast construction of **E**fficient and safe highways and bridges.

Specifically, HfL focuses on speeding up the widespread adoption of proven innovations in the highway community. Such "innovations" encompass technologies, materials, tools, equipment, procedures, specifications, methodologies, processes, and practices used to finance, design, or construct highways. HfL is based on the recognition that innovations are available that, if widely and rapidly implemented, would result in significant benefits to road users and highway agencies.

Although innovations themselves are important, HfL is as much about changing the highway community's culture from one that considers innovation something that only adds to the workload, delays projects, raises costs, or increases risk to one that sees it as an opportunity to provide better highway transportation service. HfL is also an effort to change the way highway community decision makers and participants perceive their jobs and the service they provide.

The HfL pilot program, described in Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) Section 1502, includes funding for demonstration construction projects. By providing incentives for projects, HfL promotes improvements in safety, construction-related congestion, and quality that can be achieved through the use of performance goals and innovations. This report documents one such HfL demonstration project.

Additional information on the HfL program is at www.fhwa.dot.gov/hfl.

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As a part of the Federal Highway Administration (FHWA) Highways for LIFE initiative, a Federal grant of $2,000,000 was provided to the New Hampshire Department of Transportation (NHDOT) for this project, which was in addition to FHWA's 80 percent contribution under the Federal-aid highway funding program. The Auburn-Candia project involved resurfacing of a 14.8-mile segment (7.4 miles eastbound and 7.4 miles westbound) of NH Route 101, from the Manchester-Auburn line to the Auburn-Candia line. The project scope primarily included a mill-and-fill operation with a 2-inch intermediate course placed in the two travel lanes, followed by a 1.5-inch wearing course installed over both lanes. Additional work included guardrail upgrade, roadway drainage structures adjustment, and pavement work on the Exit 2 and Exit 3 ramps. The resurfaced highway segment, last paved under the 1999/2000 Federal Resurfacing Program, includes three bridges in each direction.

This project incorporated six innovations: recycled asphalt pavement, warm mix asphalt technology, asphalt-rubber wearing surface course, highly modified asphalt wearing surface course, Safety Edge pavement, and smart work zone techniques.

The project was let on May 17, 2012, and the construction was completed in October 2013. The NHDOT's total construction costs on this project, including mobilization and traffic control, were $13.4 million. Although the project could not be evaluated for all of the Highways for LIFE performance goals, NHDOT gained valuable insight into the innovative materials and techniques—both those that were successful and those that need further evaluation. In support of NHDOT's "green" initiatives, the lessons learned from this project may promote the use of recycled materials, such as the milled asphalt material and the ground rubber tires, while providing pavements with extended service life and reduced tire-pavement noise.

Highways for LIFE, RAP, WMA, asphalt-rubber, HiMA, Safety Edge, Smart Work Zone	18. Distribution Statement No restriction. This document is available to the public through the Highways for LIFE website: http://www.fhwa.dot.gov/hfl/

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SI* (MODERN METRIC) CONVERSION FACTORS				
Symbol	**When You Know**	**Multiply By**	**To Find**	**Symbol**
		LENGTH		
(none)	mil	25.4	micrometers	μm
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yards	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	millimeters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
		NOTE: volumes greater than 1000 L shall be shown in m^3		
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela per square meter	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	Newtons	N
lbf/in^2 (psi)	poundforce per square inch	6.89	kiloPascals	kPa
k/in^2 (ksi)	kips per square inch	6.89	megaPascals	MPa
		DENSITY		
lb/ft^3 (pcf)	pounds per cubic foot	16.02	kilograms per cubic meter	kg/m^3
Symbol	**When You Know**	**Multiply By**	**To Find**	**Symbol**
		LENGTH		
μm	micrometers	0.039	mil	(none)
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE		
°C	Celsius	1.8C+32	Fahrenheit	°F
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela per square meter	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	Newtons	0.225	poundforce	lbf
kPA	kiloPascals	0.145	poundforce per square inch	lbf/in^2 (psi)
MPa	megaPascals	0.145	kips per square inch	k/in^2 (ksi)

*SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380. (Revised March 2003)

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS AND SYMBOLS

AR	asphalt-rubber
DOT	department of transportation
FHWA	Federal Highway Administration
HfL	Highways for LIFE
HiMA	highly modified asphalt
IRI	International Roughness Index
NHDOT	New Hampshire Department of Transportation
OBSI	onboard sound intensity
OSHA	Occupational Safety & Health Administration
PDO	property damage only
RAP	recycled asphalt pavement
RN	Ride Number
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users
SRTT	standard reference test tire
TRB	total reused binder
WMA	warm mix asphalt

INTRODUCTION

HIGHWAYS FOR LIFE DEMONSTRATION PROJECTS

The Highways for LIFE (HfL) pilot program, the Federal Highway Administration's (FHWA) initiative to accelerate innovation in the highway community, provides incentive funding for demonstration construction projects. Through these projects, the HfL program promotes and documents improvements in safety, construction-related congestion, and quality that can be achieved by setting performance goals and adopting innovations.

The HfL program—described in the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU)—may provide incentives to a maximum of 15 demonstration projects a year. The funding amount may total up to 20 percent of the project cost, but not more than $5 million. Also, the Federal share for a HfL project may be up to 100 percent, thus waiving the typical State-match portion. At the State's request, a combination of funding and waived match may be applied to a project.

To be considered for HfL funding, a project must involve constructing, reconstructing, or rehabilitating a route or connection on an eligible Federal-aid highway. It must use innovative technologies, manufacturing processes, financing, or contracting methods that improve safety, reduce construction congestion, and enhance quality and user satisfaction. To provide a target for each of these areas, HfL has established demonstration project performance goals.

The performance goals emphasize the needs of highway users and reinforce the importance of addressing safety, congestion, user satisfaction, and quality in every project. The goals define the desired result while encouraging innovative solutions, raising the bar in highway transportation service and safety. User-based performance goals also serve as a new business model for how highway agencies can manage the highway project delivery process.

HfL project promotion involves showing the highway community and the public how demonstration projects are designed and built and how they perform. Broadly promoting successes encourages more widespread application of performance goals and innovations in the future.

Project Solicitation, Evaluation, and Selection

FHWA has issued open solicitations for HfL project applications annually since fiscal year 2006. State highway agencies submitted applications through FHWA Divisions. The HfL team reviewed each application for completeness and clarity, and contacted applicants to discuss technical issues and obtain commitments on project issues. Documentation of these questions and comments was sent to applicants, who responded in writing.

The project selection panel consisted of representatives of the FHWA offices of Infrastructure, Safety and Operations; the Resource Center Construction and Project Management team; the Division offices; and the HfL team. After evaluating and rating the applications and supplemental information, panel members convened to reach a consensus on the projects to recommend for approval. The panel gave priority to projects that accomplish the following:

- Address the HfL performance goals for safety, construction congestion, quality, and user satisfaction.
- Use innovative technologies, manufacturing processes, financing, contracting practices, and performance measures that demonstrate substantial improvements in safety, congestion, quality, and cost-effectiveness. An innovation must be one the applicant State has never or rarely used, even if it is standard practice in other States.
- Include innovations that will change administration of the State's highway program to more quickly build long-lasting, high-quality, cost-effective projects that improve safety and reduce congestion.
- Will be ready for construction within 1 year of approval of the project application. For the HfL program, FHWA considers a project ready for construction when the FHWA Division authorizes it.
- Demonstrate the willingness of the applicant department of transportation (DOT) to participate in technology transfer and information dissemination activities associated with the project.

HfL Project Performance Goals

The HfL performance goals focus on the expressed needs and wants of highway users. They are set at a level that represents the best of what the highway community can do, not just the average of what has been done. States are encouraged to use all applicable goals on a project:

- **Safety**
    - Work zone safety during construction—Work zone crash rate equal to or less than the preconstruction rate at the project location.
    - Worker safety during construction—Incident rate for worker injuries of less than 4.0, based on incidents reported via Occupational Safety and Health Administration (OSHA) Form 300.
    - Facility safety after construction—Twenty percent reduction in fatalities and injuries in 3-year average crash rates, using preconstruction rates as the baseline.

- **Construction Congestion**
    - Faster construction—Fifty percent reductions in the time highway users are impacted by an active construction zone, compared to traditional methods.
    - Trip time during construction—Less than 10 percent increase in trip time compared to the average preconstruction speed, using 100 percent sampling.
    - Queue length during construction—A moving queue length of less than 0.5 mile in a rural area or less than 1.5 miles in an urban area (in both cases at a travel speed 20 percent less than the posted speed).

- **Quality**
    - Smoothness—International Roughness Index (IRI) measurement of less than 48 inches per mile.
    - Noise—Tire-pavement noise measurement of less than 96.0 A-weighted decibels (dB(A)), using the onboard sound intensity (OBSI) test method.

- **User Satisfaction**
    - User satisfaction—An assessment of how satisfied users are with the new facility compared to its previous condition and with the approach used to minimize disruption during construction. The goal is a measurement of 4-plus on a 7-point Likert scale.

SCOPE AND ORGANIZATION

This report documents the New Hampshire DOT's (NHDOT) demonstration project, which incorporated a total of six innovations on resurfacing of NH Route 101 from the Manchester-Auburn line to the Auburn-Candia line. The report presents the details of the innovations relevant to the HfL program, including recycled asphalt pavement (RAP), warm mix asphalt (WMA), asphalt-rubber (AR) wearing surface course, highly modified asphalt (HiMA) wearing surface course, Safety Edge pavement, and smart work zone techniques.

PROJECT OVERVIEW

Background

The Auburn-Candia project involved resurfacing a 14.8-mile segment (7.4 miles eastbound and 7.4 miles westbound) of NH Route 101 from the Manchester-Auburn line to the Auburn-Candia line. Figure 1 shows a map of the project location. The project, located within NHDOT Maintenance District 5, was on a divided highway with two lanes in each direction, and the project limits included Exits 2 and 3.

The project scope primarily included a mill-and-fill operation with a 2-inch-thick intermediate course placed in the two travel lanes, followed by a 1.5-inch wearing course installed over both lanes. Additional work included guardrail upgrade, roadway drainage structures adjustment, and pavement work on the Exit 2 and Exit 3 ramps. The resurfaced highway segment, last paved under the 1999/2000 Federal Resurfacing Program, includes three bridges in each direction.

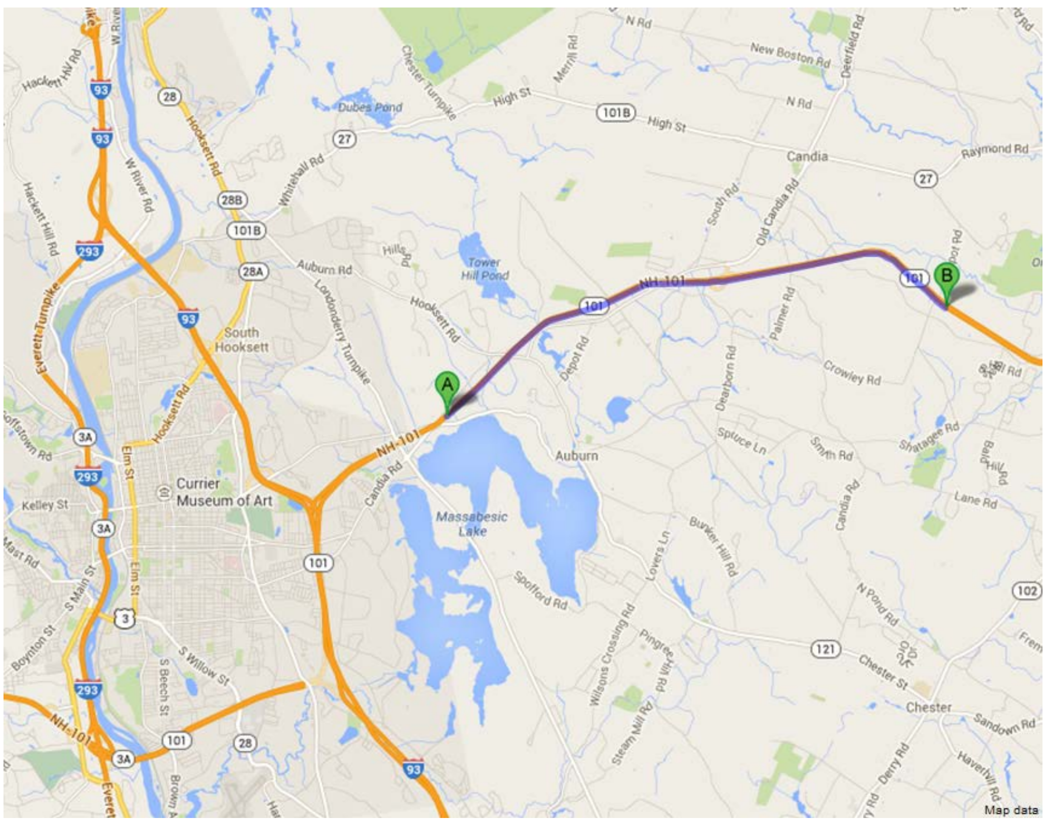

Figure 1. Map. Project location.

Project Description

As a part of the FHWA HfL initiative, a Federal grant of $2,000,000 was accorded to the NHDOT for this project, which was in addition to FHWA's 80 percent contribution under the Federal-aid highway funding program. This project is unique in NHDOT's construction history in the sense that a total of six primary construction innovations have been used in a single project, two of which have never been used in the State. The innovations that were deployed on the Route 101 paving project included:

- High RAP binder content.
- WMA technology.
- AR wearing surface mix (ASTM D6114).
- HiMA (with Kraton D0243 polymer) wearing surface mix.
- Safety Edge pavement.
- Smart work zone techniques.

Bid Information

As shown in table 1, the project received three bids ranging from $13,423,983.10 to $13,753,642.20. The winning bid amount was $13,423,983.10, and the project was awarded to Pike Industries, Inc.

Table 1. Bid comparisons.

Bidder	Total Bid	Percent of Low Bid
west Bid	13,423,983.10	100.00%
2nd Bid	13,602,734.05	101.33%
Highest Bid	13,753,642.20	102.42%

High RAP Binder Content

Although the NHDOT Standard Specification allows up to 1.5 percent of total reused binder (TRB) equivalent to approximately 37 percent RAP, actual TRB usage has mostly been below 1.0 percent, due to the additional testing requirements for TRB greater than 1.0 percent and lack of familiarity with high RAP mixtures. The project contract specified that the total recycled asphalt binder content of the mill-and-fill portion of the project amount to about a third of the total liquid asphalt content in the pavement mix. The mill-and-fill of the binder course for this project consisted of 1.93 percent TRB, which was equivalent to 33.8 percent RAP. This RAP content was the highest amount used in a New Hampshire non-research project. The RAP was also used in the AR and HiMA wearing course mixes, as described below. To ensure consistency, the RAP binder for these mixes came from millings generated from this project.

Warm Mix Asphalt

WMA technology, in the form of Evotherm, was used on the mill-and-fill portion of the project to aid in compaction of the high RAP mixture at reduced mix temperatures. The use of WMA was deemed necessary to achieve the required in-place voids due to the increase in stiffness of the high RAP mixture. Prior to this project, NHDOT did not have any experience utilizing the WMA technology with high RAP or AR mixtures.

AR Wearing Surface

NHDOT's typical surface mixtures include 5.8 percent to 6.2 percent asphalt binder. Although AR binder mix is not permitted in the NHDOT Standard Specification, it was used on this project to promote longevity and prolonged crack resistance. The AR mix, specified at one-half of each barrel for this project, is gap graded with an asphalt cement binder of 7.6 percent, 0.5 percent of which was from the recycled binder. The mix was required to have a minimum of 15.0 percent granulated rubber passing a #16 sieve by weight of total AR binder. The mixture was initially placed without the aid of WMA. However, the WMA technology was also applied to the AR mix to restrict the mix temperature to below 300 °F and to control the strong rubber odors. Figure 2 shows the plant used for the production of the asphalt rubber, and figure 3 shows a picture of the AR wearing course being paved.

Figure 2. Photo. Asphalt plant used for production of AR and HiMA.

Figure 3. Photo. Placement of the AR wearing course.

HiMA Wearing Surface

Similar to the AR mix, the use of an HiMA wearing surface is not allowed in the NHDOT Standard Specification. For this project, however, an HiMA mixture with a total asphalt content of 6.5 percent was placed over half of the project length in each direction to compare its performance to the AR mixture. The modified binder contains 7.5 percent of Kraton D0243 polymer, which is a new styrene-butadiene-styrene polymer manufactured by Kraton Performance Polymers, Inc. The HiMA mixture also included 17.0 percent RAP, which resulted in 1.0 percent TRB. Such a highly polymer-modified, high-RAP, asphalt-rich mixture had never been placed in New Hampshire, and the WMA technology had not been utilized for the HiMA mixtures. Figure 4 shows the HiMA wearing course being constructed on NH Route 101.

Figure 4. Photo. Placement of the HiMA wearing course.

Safety Edge Pavement

The project specifications required the use of a “Ramp Champ” Safety Edge device made by Advant-Edge Paving Equipment LLC on the wearing course pavement (figures 5 and 6). NHDOT’s recent guideline recommends the use of a Safety Edge device to roadways with a paved shoulder 5 feet wide or less. Although NH Route 101 included a 10-foot-wide shoulder, the Safety Edge was applied to all non-guardrail locations to improve edge compaction of the wearing course and to provide additional safety. Figure 7 shows the compaction of the pavement edge. The rollers used were as follows:

- Breakdown Roller: CatCB54 Lo-Hi.
- Intermediate Roller: Cat Rubber.
- Back roller: Hamm Oscillatory.

Figure 5. Photo. “Ramp Champ” Safety Edge device being used on the project (top view).

Figure 6. Photo. “Ramp Champ” Safety Edge device being used on the project (elevation view).

Figure 7. Photo. Compaction of the safety edge.

Smart Work Zone Techniques

Due to the high level of daytime traffic, paving on NH Route 101 was required to be performed during nighttime hours. To address the safety issue near the paver, particularly where the workers are on foot alongside the active travel lane, two smart work zone techniques were planned for use in this project. These techniques included excessive speed warning signs and changeable work zone speed limit signs. However, the NHDOT contract required that the speed limit for the entire project length be reduced, which made the selected innovations less useful.

An alternate smart work zone technique—a Congestion Advisory application, which is one of the Traffic Responsive Systems utilized by NHDOT—was used instead. The application was executed using 24 queue sensors and 20 portable queue trailers installed along the length of the project to monitor traffic speeds and to warn drivers of slowing or stopped traffic in the vicinity of the paving operation. In addition, two portable trailers equipped with "pan, tilt, and zoom" cameras were utilized to allow the NHDOT Traffic Management Center to monitor real-time traffic activities and update the changeable message signs as warranted.

Laboratory Testing of Innovative Materials

The University of Massachusetts Highway Sustainability Research Center conducted extensive laboratory testing on the high RAP, AR, and HiMA mixtures. As part of this effort, an attempt was made to explore the potential benefits of the AR and HiMA mixtures through laboratory performance tests. Since no control mixtures were evaluated as part of this laboratory study, these mixtures were compared to a typical wearing course mixture frequently used in the northeast region: a conventional Superpave 9.5-mm mixture with a PG64-28 binder. The laboratory test results indicated that modification of the asphalt neat binder with rubber or polymer may provide at least three times more cracking resistance. It was also pointed out that the polymer modified mixtures showed more significant cracking resistance.

DATA ACQUISITION

A complete project-related data set required to evaluate the HfL performance goals has not been collected for the NH Route 101 project. This chapter presents a quick summary of the available data.

SAFETY

Tables 2 and 3 show the number of all crashes and number of crashes that occurred during roadway construction or maintenance on NH Route 101. As shown in table 3, a total of 11 crashes occurred during the 2-year project. Five crashes in 2012 were in conjunction with the design of traffic crossovers used while the bridge rehabilitation was being completed. NHDOT personnel noted that the smart work zone signage had no impact on these accidents. In addition, Pike Industries reported a lost time worker injury due to a torn bicep and a burn injury of a subcontractor employee.

Table 2. NH Route 101 – all crashes.

Severity	2004 - 2011	2012	2013	Total
Killed	2	3	0	5
Serious	14	1	1	16
Minor	78	9	18	105
Possible	21	0	1	22
Unknown	3	0	0	3
PDO	165	4	13	182
Total	**283**	**17**	**33**	**333**

PDO = property damage only.

Table 3. NH Route 101 – crashes during roadway construction or maintenance.

Severity	2004 - 2011	2012	2013	Total
Killed	0	0	0	0
Serious	0	1	0	1
Minor	1	3	4	8
Possible	2	0	0	2
Unknown	0	0	0	0
PDO	7	1	2	10
Total	**10**	**5**	**6**	**21**

QUALITY

Smoothness

The HfL performance goal for smoothness is expressed in terms of IRI, but NHDOT utilized the Ride Number (RN) to determine their ride smoothness pay factor. The RN was measured on the finished pavement surfaces; see summary data in table 4. The overall RN for the project was 4.41, and no significant difference in ride quality was found from the different wearing courses placed.

Table 4. Ride Number summary for NH Route 101.

Direction	**Lane**	**AR**	**HiMA**	**Control**	**Overall**
Eastbound	Travel	4.38	4.47	4.48	4.43
Eastbound	Passing	4.37	4.38	4.34	4.37
Westbound	Travel	4.4	4.44	4.5	4.42
Westbound	Passing	4.42	4.42	4.42	4.42
	Average Ride Number	**4.39**	**4.43**	**4.43**	**4.41**

Noise

Sound intensity test data were collected before and after construction of the NH Route 101 project, to provide a measure of the sound quality of the finished pavement. Measurements were made using the current accepted OBSI technique AASHTO TP 76-12, which includes dual vertical sound intensity probes and an ASTM-recommended standard reference test tire (SRTT). Data were collected before construction and on the new pavement surface after the road was opened to traffic. Measurements were recorded and analyzed using an onboard computer and data collection system. Figure 8 shows the dual probe instrumentation and the SRTT.

Figure 8. Photo. OBSI dual probe system and the SRTT.

The average of the front and rear sound intensity values was computed to produce a global value for the project. Raw noise data were normalized for the ambient air temperature and barometric pressure at the time of testing. The resulting mean sound intensity levels were A-weighted to produce the frequency spectra in one-third octave bands, as shown in figure 9. Sound intensity levels were calculated using logarithmic addition of the one-third octave band frequencies across the spectra. The global sound intensity value was 105.6 dB(A) for the existing pavement, and 100.7 dB(A) and 101.8 dB(A) for the new HiMA and AR wearing courses, respectively. Although the sound intensity levels of the newly constructed wearing courses did not meet the HfL goal of less than 96.0 dB(A), a reduction of 4.9 dB(A) and 3.8 dB(A) from the HiMA and AR courses indicate that they are noticeably quieter than the old pavement.

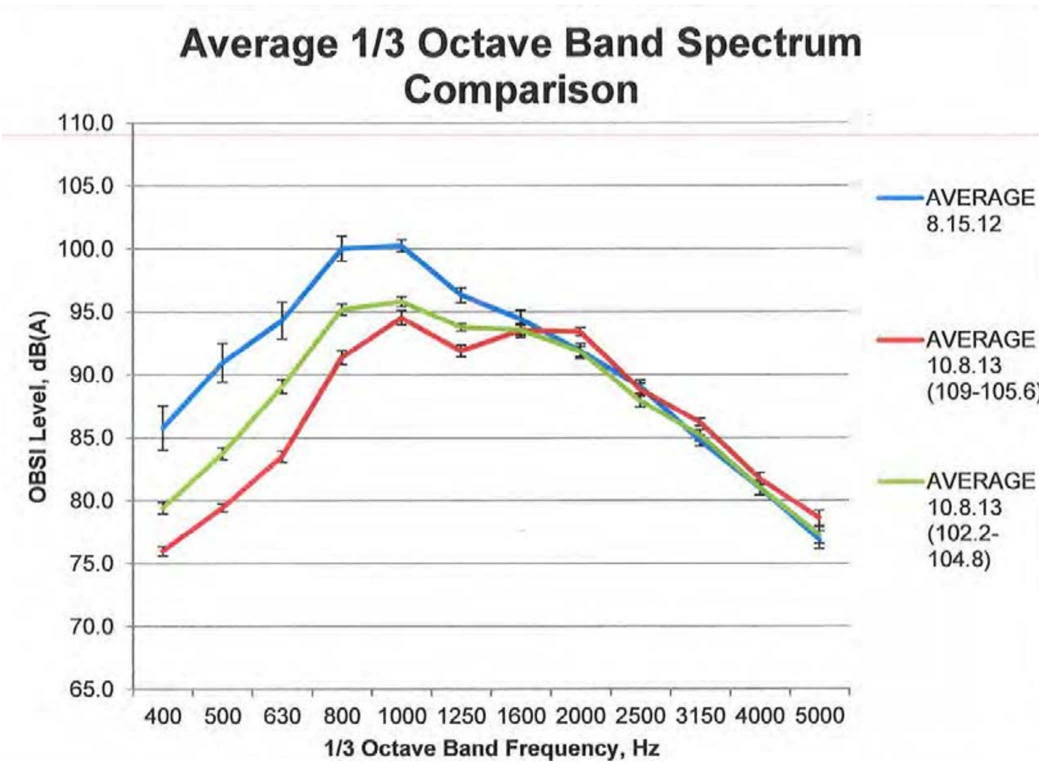

Figure 9. Chart. Mean A-weighted sound intensity frequency spectra before and after construction.

User Satisfaction

Although NHDOT originally planned to conduct a user satisfaction survey, ultimately, it was not conducted. It was believed that many of the innovative features, including the Safety Edge, would not be noticeable to drivers. Based on the results from the pavement smoothness and noise features, it was also assumed that the subjective driver observations would not have made a significant difference in NHDOT's decision making.

LESSONS LEARNED

Although the project could not be evaluated for all of the HfL performance goals, NHDOT gained valuable insight into the innovative materials and techniques used on this project—both those that were successful and those that need further evaluation. The following is a summary of the lessons learned:

- NHDOT successfully paved the high RAP mixture through the use of WMA technology. The DOT did not report any issues on laydown or compaction of the material.
- Although the HiMA and AR wearing courses are currently not permitted in their Standard Specification, NHDOT gained valuable experience on asphalt materials with modified binder. Although the performance of these mixtures in the field is yet to be determined, the laboratory test results indicated that they are superior in cracking resistance when compared to NHDOT's conventional asphalt mixtures. Due to the potential of extending the pavement service life, NHDOT believes that this project will showcase the value of these mixtures in their pavement preservation strategy and highway maintenance.
- The ride quality obtained from the new mixtures (HiMA and AR) were comparable to the control mixtures paved adjacently.
- The new pavement surfaces paved with the HiMA and AR wearing courses were noticeably quieter than the existing pavement.

CONCLUSIONS

Through this project, NHDOT gained valuable insights on the use of high-RAP, WMA, HiMA, and AR mixtures. In support of NHDOT's "green" initiatives, the lessons learned from this project may promote the use of recycled materials, such as the milled asphalt material and the ground rubber tires, while providing pavements with extended service life and reduced tire-pavement noise.