MAINE DEMONSTRATION PROJECT: RECONSTRUCTION OF LAMSON AND BOOM BIRCH BRIDGES

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 adoption of innovations and new technologies, thereby improving safety and highway 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 is focused on accelerating the adoption of innovations in the highway community. "Innovations" is an inclusive term used by HfL to encompass technologies, materials, tools, equipment, procedures, specifications, methodologies, processes, and practices used in the financing, design, or construction of highways. HfL is based upon the realization that there are available innovations within the highway community that, if widely and rapidly adopted, would result in significant benefits to the highway motorist, user, and owner agency.

Although innovations themselves are important, HfL is as much about changing the highway community's attitude toward them—from a culture that looks at innovation as something that will only add to one's work, delay the project, add to the cost or increase risk, to one that sees it as an opportunity to provide a 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 are providing.

The HfL pilot program, described in Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) Section 1502, includes funding demonstration highway construction projects. Funding demonstration projects provides a means for HfL to promote and document improvements in safety, construction-related congestion, and quality that can be achieved through the application of project performance goals and innovations. This report discusses the details of one such HfL demonstration project.

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

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The Maine DOT submitted application and was approved for FY 2007 Highways for LIFE program funding. The Maine projects are two bridges on rural roads that both involve detours of about 15 miles that impact school buses, commercial trucks and emergency vehicles. Both bridge locations also involve environmentally sensitive water courses that restrict the construction footprints and scope. These issues caused the Maine DOT to select full road closures, accelerated bridge construction techniques including prefabricated bridge elements, and aggressive public interaction for both of these projects. The Boom Birch Bridge carrying SH 116 over Birch Stream Near Old Town and the Lamson Bridge carrying SH 4 over Lamson Stream near Addison were both constructed over the summer of 2007. The bridge constructions began in June, and the projects were reopened to traffic in early September before the school year started.
These projects demonstrated the successful use of long-lasting precast concrete bridge elements from the pile caps up to the decking. They also demonstrated that projects could be constructed in as much as 80% shorter timeframes with less negative impacts to motorists.</td></tr>
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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
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 yard	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	milliliters	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)		
^oF	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	^oC
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
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 (exact degrees)		
^oC	Celsius	1.8C+32	Fahrenheit	^oF
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	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

*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)

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ACKNOWLEDGMENTS

The project team would like to acknowledge the invaluable insights and guidance of the Federal Highway Administration Highways for Life Team Leader (Mr. Byron Lord) and Program Coordinators Ms. Mary Huie and Ms. Kathleen Bergeron who served as the Technical Panel on this demonstration project. Their vast knowledge and experience with the various aspects of construction, technology deployment and technology transfer helped immensely in developing both the approach and the technical matter for this document. The team is also indebted to the Maine Department of Transportation engineers Mr. Robert Bulger and Mr. Robert Ellena for their tireless advice, assistance, and coordination they provided in the conduct of this project. Special thanks are due to Mr. Bulger for providing information which made the economic analysis possible. Finally, the project team is also grateful to the FHWA Division Office and particularly to Ms. Maria Drozd for all the support received.

LIST OF ABBREVIATIONS AND SYMBOLS

AADT – Average Annual Daily Traffic
AASHTO – American Association of State Highway and Transportation Officials
CPX – Close Proximity
DHV – Design Hourly Volume
DOT – Department of Transportation
FHWA – Federal Highway Administration
FY – Fiscal Year
HfL – Highways for LIFE
HMA – Hot Mix Asphalt
IRI – International Roughness Index
LRFD – Load and Resistance Factor Design
MSE – Mechanically Stabilized Earth
OBSI – On-Board Sound Intensity
OSHA – Occupational Safety and Health Administration
SAFETEA-LU – Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users
SI – Sound Intensity
SRTT – Standard Reference Test Tire
VE – Value Engineering

INTRODUCTION

HIGHWAYS FOR LIFE DEMONSTRATION PROJECTS

The Highways for Life (HfL) pilot program, described in Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) Section 1502, includes funding demonstration highway construction projects. Demonstration projects are a means for the HfL program to promote and document improvements in safety, construction-related congestion, and quality that can be achieved through the application of project performance goals and innovations.

SAFETEA-LU establishes a maximum of 15 demonstration projects per year that may receive HfL funding. The amount of funding provided by HfL for a demonstration project may be up to 20 percent of the total project cost, but not more than $5 million. In addition, the Federal share for a HfL project may be up to 100 percent, thus waiving the typical State match portion. At the request of a State, a combination of funding and waived match may be applied to the project.

A State Department of Transportation (DOT) highway project may be considered for HfL demonstration funding if the project involves constructing, reconstructing, or rehabilitating a route or connection on an eligible Federal-aid highway and uses innovative technologies, manufacturing processes, financing, or contracting methods that improve safety, reduce congestion due to construction, and improve quality and user satisfaction. To provide a target for each of these areas, HfL has established demonstration project performance goals.
HfL project promotion involves showing the highway community and the public how these demonstration projects are designed, built, and perform. Broadly demonstrating and promoting successes will, in turn, provide the impetus for more widespread application of the performance goals and innovations in the future.

The HfL project performance goals put the emphasis on the highway motorist and user needs and reinforce the importance of addressing safety, congestion, user satisfaction, and quality in every project. The HfL performance goals are intended to define the desired end result while encouraging innovative solutions, thereby raising the bar in highway transportation service and safety. Setting motorist/user based performance goals also is intended to serve as a new business model for how a State DOT manages its highway project delivery process.

Project Solicitation, Evaluation and Selection

Open solicitations for HfL project applications were made in Federal FY 2006, 2007, and 2008. This was done through mailed letters and various print media advertisements. Applications were submitted by the State DOT through the Federal Highway Administration (FHWA) Division Office. Once the applications were received by the HfL team, they were reviewed in detail by the HfL consultant team for completeness and clarity. The consultant team contacted each applicant to discuss technical issues and obtain commitments on project issues. These verbal questions and comments were then sent to and responded to by the applicants in writing.

The project selection panel consisted of seven individuals representing the FHWA program offices of Infrastructure, Safety, and Operations, Resource Center - Construction and Project Management Team, a Division Administrator or Assistant Division Administrator, and two members of the Headquarters HfL Team. The application and supplemental information was sent to each of the panel members in advance of meeting for individual evaluation and rating. The panel then convened to reach a consensus on which projects to recommend for approval. In this evaluation, the panel gave priority to projects that:

- Addressed achieving the HfL performance goals for safety, construction congestion, quality, and user satisfaction.
- Delivered and deployed innovative technologies, manufacturing processes, financing, contracting practices, and performance measures that will demonstrate substantial improvements in safety, congestion, quality, and cost-effectiveness. The criterion was that the technology had to be innovative to the applicant State, even if it may be a standard practice in adjacent States.
- Included innovation(s) that will lead to change in the administration of the State's highway program to more quickly construct long-lasting, high quality, cost-effective projects that improve safety and reduce congestion.
- Would be ready for construction within 1 year of approval of the project application. For purposes of the HfL Program, the FHWA considers a project to be "ready for construction" when the FHWA Division Office authorizes the construction project.
- The applicant State DOT demonstrates a willingness to participate in subsequent technology transfer and information dissemination activities associated with the project.

HfL Project Performance Goals

The HfL performance goals are focused on the expressed needs and wants of the highway user and motorist. HfL has set these goals at a level that represents the best of what the highway community can do, not just the average of what has been done. HfL desires that all applicable goals be used for each demonstration project. The HfL demonstration project performance goals are:

- 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—An incident rate for worker injuries to be less than 4.0, based on incidents reported via Occupational Safety and Health Administration (OSHA) Form 300.
    - Facility Safety After Construction—20 percent reduction in fatalities and injuries as reflected in 3-year average crash rates, using pre-construction rates as the baseline.
- Construction Congestion
    - Faster Construction—50 percent reduction, compared to traditional methods, in the duration that highway users are impacted.

    - Trip Time During Construction—Less than 10 percent increase in trip time during construction as compared to the average pre-construction speed using 100 percent sampling.
    - Queue Length During Construction—A moving queue length less than 1⁄2 mile (travel speed 20 percent less than posted speed) in a rural area, or a moving queue length less than 11⁄2 mile (travel speed 20 percent less than posted speed) in an urban area.
- Quality
    - Smoothness—International Roughness Index (IRI) of less than 48 inches/mile.
    - Noise—tire-pavement noise measurement of less than 96.0 dbA using the On Board Sound Intensity (OBSI) test method.
- User Satisfaction—User satisfaction in two areas is determined: (1) how satisfied the user is with the new facility compared with its previous condition, and (2) how satisfied the user is with the approach used to construct the new facility in terms of minimizing disruption. A five-point Likert scale is to be used for measurement, and the goal for each area is 4+.

Seventeen (17) HfL demonstration projects have been approved and funded in 15 States at the present time. These include:

- FY 2006—Iowa, Minnesota, and South Carolina
- FY 2007—Arizona, California, Georgia, Maine, Maryland, Missouri, Montana, North Dakota,, Oregon, Utah, and Virginia
- FY 2008—Michigan and South Carolina

REPORT SCOPE AND ORGANIZATION

This report discusses Maine DOT’s HfL demonstration project which consists of the reconstruction of two short span bridges. Project details of most relevance to the HfL program including traffic management during construction, innovative design and construction highlights, HfL performance metrics measurement, as well as a return on investment analysis are presented in the following chapters of this report. Finally, a record of the technology transfer activities that took place during the construction of this project and a summary of the lessons learned are also presented.

SUMMARY OF FINDINGS AND LESSONS LEARNED

INTRODUCTION

The Maine HfL project included the reconstruction of two rural, short-span bridges— the Lamson Bridge near Addison and the Boom Birch Bridge near Old Town. These bridges were deemed to be structurally deficient by the Maine Department of Transportation (Maine DOT).

Key innovations on the Lamson Bridge replacement project included the following:

- Full roadway closures.
- The use of a full system of prefabricated components to accelerate the construction schedule. These included:
  - A concrete voided slab superstructure where the precast/prestressed beams functioned as a single unit deck after transverse post-tensioning
  - Precast abutments.
  - Modular, precast retaining walls that also functioned as return wingwalls

The Boom Birch Bridge replacement project included the following key innovations:

- Full roadway closures.
- Prestressed concrete simple spans on precast, post-tensioned pier and abutment caps.
- Lightweight construction.
- Multiple pile anti-corrosion systems.

A majority of the innovations adopted were primarily aimed at increasing the construction speed.

KEY OBSERVATIONS

The following were key observations from these projects:

- The innovations adopted on both these projects helped them meet their accelerated construction schedules with ease. The Lamson Bridge project was completed in 56 days and the Boom Birch Bridge project in 46 days. The estimated construction time for both these projects using conventional construction methods was approximately 270 days.
- Both projects were fully successful in meeting the HfL goals for safety, construction congestion, and user satisfaction.
- For the quality goal, the metrics for noise and smoothness indicated that the Lamson project had a minimally higher noise level and a rougher pavement. On the Boom Birch project, the post-construction noise level was noticeably quieter and the pavement was significantly smoother.
- The durability of both bridges is expected to be superior to conventional cast-in-place construction due to the use of better quality materials and construction procedures.

- On the Lamson Bridge project, it was estimated from an analysis of initial construction and user costs that, using the innovative HfL project delivery approach realized a cost savings of approximately 15 percent over traditional construction methods.

LESSONS LEARNED

Some of the lessons learned from this demonstration project are:

- It demonstrates that the HfL program concepts of realizing the benefits of accelerated bridge construction do not apply only to large, complex bridge or other horizontal infrastructure projects in urban settings but also to smaller rural bridges.
- The accelerated bridge construction process does offer significant cost savings even on a first-cost comparison basis.
- Early and frequent interaction with the public on the projects improved the public’s opinion and overall approval of them.

MAINE HFL PROJECT DETAILS

The Maine HfL project included the reconstruction of the Lamson Bridge near Addison and the Boom Birch Bridge near Old Town (see figure ***1***). Both of these reconstruction projects involved full road closures of two-lane rural roads with relatively long designated detour routes. Among other aspects, this project demonstrates that the HfL program concepts do not apply only to large, complex bridge projects but also to smaller rural bridges. The majority of the bridges on the national inventory are short span rural bridges like these two Maine DOT bridges.

Figure 1. Maine HfL projects.

LAMSON BRIDGE

Lamson Bridge (Project No. BR-1264(000)X) carries Basin Road (State Aid Route 4), a rural minor collector, over Lamson Stream in the town of Addison, Washington County, Maine. The Lamson Bridge, built in the 1930s, was deemed as being structurally deficient due to substructure deterioration and a determination was made by Maine DOT to replace the bridge (see ***figure 2***). The current annual average daily traffic (AADT) on the bridge is 680 vehicles, with 8 percent of those being heavy trucks, and a design hourly volume (DHV) of 95 vehicles.

A number of HfL innovations were adopted during the reconstruction of this bridge project which are discussed in the following paragraphs.

Figure 2. The Lamson Bridge was constructed in the 1930's.

The Lamson Bridge is located in a narrow corridor with extremely poor sight distances and 1:1 side slopes necessitating a full road closure—a highlighted innovation for the project—for the majority of the construction time. The reconstruction project was further complicated by the proximity of bedrock near the roadway surface and location of the bridge in a marine environment. To construct a standard width bridge and approaches, retaining walls were required. The shortest available detour was about 16 miles from one end of the project to the other. ***Figures 3, 4, and 5*** show the plan view, typical cross section, and elevation of the new Lamson Bridge.

At two town meetings, residents including commercial fishermen, the Town Selectman, and the Road Commissioner expressed concern about the duration of a full road closure and the associated impacts to the local economy. This site presents several construction challenges, including the installation of 120 linear feet of precast retaining wall that required a significant amount of excavation. The intention was to deliver a high-quality, long-lasting product that was completed in the minimum realistic timeframe. Keeping the road closure to a minimum was further aided by leaving the existing stone portion of the stream abutments (see ***figure 6***) in place and keeping the construction of the new substructure in the dry, because no extra time was needed to construct cofferdams and to remove the abutments in this highly sensitive marine environment.

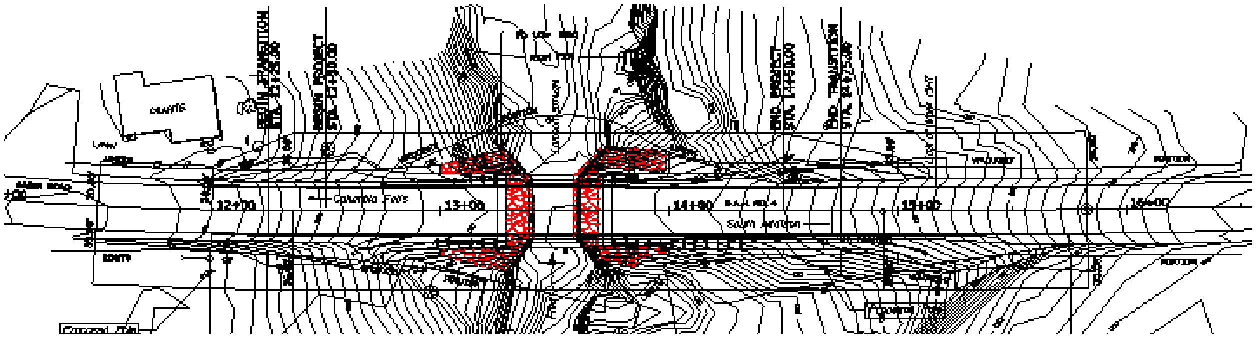


Figure 3. Plan view of the new Lamson Bridge.

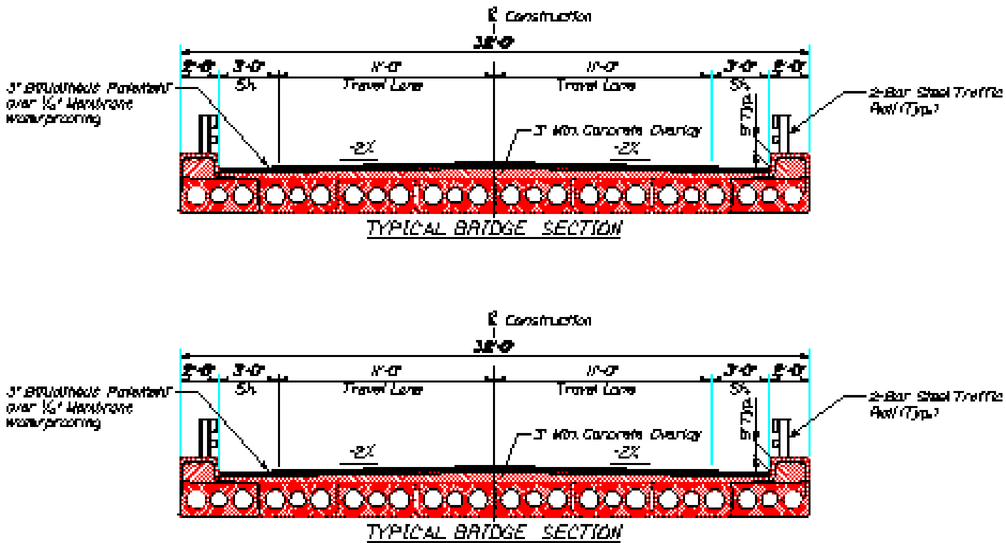


Figure 4. Typical cross section of the new Lamson Bridge deck.

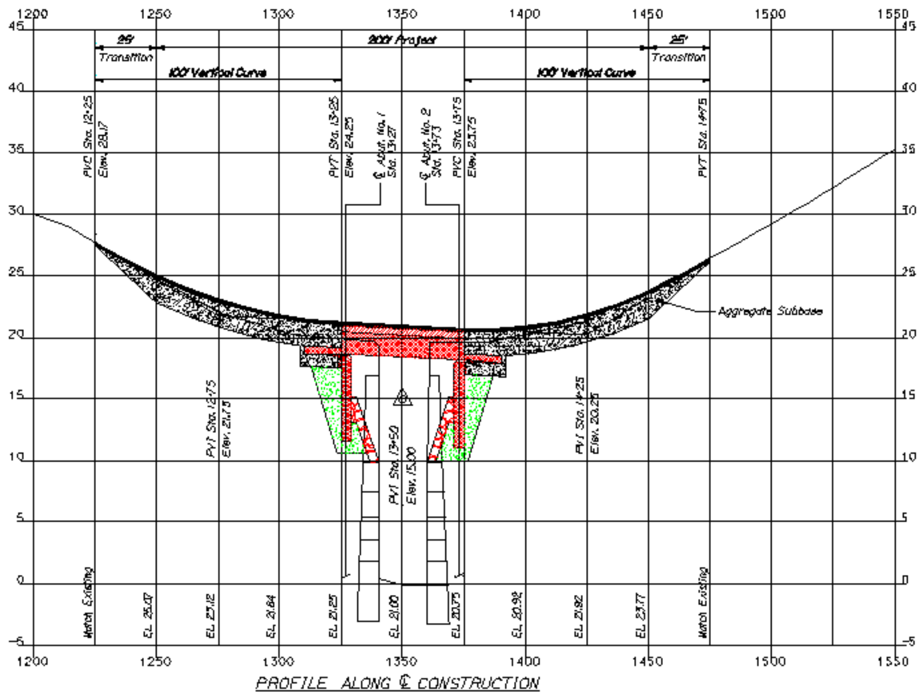


Figure 5. Profile of the new Lamson Bridge and roadway.

Figure 6. The Lamson Bridge Project maintained and preserved the existing cut stone block wall (on the bottom) for historic and environmental reasons.

A typical timeframe for the removal and replacement of this type and size bridge is about 9 months using a cast-in-place substructure with footings founded on bedrock. Maine DOT's proposed structure incorporated a precast and precast/prestressed concrete system—a highlighted innovation for the project—that allowed a one-lane reopening after approximately 2 months and a full two-lane roadway opening only 3 months after the initial closure. After some consideration, this amount of time was chosen as a good compromise to accommodate the residents' concerns without significantly increasing the cost of construction. The scheduling of this road closure was also discussed at the formal public meeting. Maine DOT suggested starting the closure on June 15, 2007, to coincide with the public school summer break, but the residents requested a road closure date of July 15, 2007.

Early in the design process, the Maine DOT Environmental Office expressed concern that construction in this location could impact endangered species and would require a full Section 7 review. It was decided to increase the proposed bridge span and work behind the existing stream abutments. This took the new construction entirely out of the water, effectively made environmental concerns a non-issue, and removed the new bridge substructure from a corrosive marine environment.

The new Lamson Bridge included wider travel lanes and wider paved shoulders and raised the sag curve low point about 1 foot vertically. These improvements provided for safer vehicle travel and allowed pedestrians to cross the new bridge safely while cars passed in both directions. The DOT is also planning to set the speed limit in this location at 30 mph after completion of the project. It was not feasible to provide for higher speeds here which require significantly lowering the vertical grade due to the proximity of residential property adjacent to bridge and a rock ledge near each crest curve. ***Figures 7 and 8*** show placing the abutment forms and the superstructure beams.

Figure 7. Placement of the abutment forms for the Lamson Bridge.

Figure 8. Looking westbound on the Lamson Bridge construction site. Note the precast concrete backwall, the precast, segmental retaining wall panels, and the post-tensioning duct pockets in the fascia beam.

While precast/prestressed concrete bridge superstructures had been in common use for many years in Maine, the Lamson Bridge replacement project used a full system of prefabricated components. The combination of precast/prestressed and transversely post-tensioned beams and precast abutments had only been used twice in Maine, and they had not been used previously in conjunction with precast retaining walls that functioned as return wingwalls to the abutments. The use of a concrete voided slab superstructure where the precast/prestressed beams functioned as a single unit deck after transverse post-tensioning saved time and effort on deck construction, as illustrated in ***figure 9.*** As mentioned earlier, the use of such accelerated bridge construction methods was the central aspect of innovations used on this project and embody the core ideology of the HfL program.

Project work for the new bridge involved a full road closure and a 16-mile detouring of traffic, removal of the existing bridge superstructure and cast-in-place portion of the abutments, and construction of a new wider (28 feet curb-to-curb) bridge consisting of a 46-foot single span, precast/prestressed concrete superstructure with integral abutments. The superstructure included a 3-inch hot-mix asphalt (HMA) wearing surface with membrane waterproofing placed on a cast-in-place concrete leveling slab and a standard two-bar steel bridge rail, as shown in ***figure 10.***

Also included were new full depth HMA approach roadways, guardrail, mechanically stabilized earth (MSE) retaining walls, riprap, grading, and drainage. Specifically, 200 feet of approach roadway, shoulder, and transitions (1000 square yards of pavement), 1320 square feet of modular precast concrete retaining walls, 350 feet of guardrail, 50 cubic yards of riprap, and two drainage structures with 60 feet of pipe were constructed or installed.

Figure 9. Looking eastbound on the Lamson Bridge Project across the top of the adjacent prestressed voided deck beams. The beams were post-tensioned transversely so the deck would act as a single unit (note the precast segmental retaining wall units on-grade in the background, next to the local residents who took interest in the construction progress).

Figure 10. Placing the asphalt concrete wearing surface on the Lamson Bridge.

Due to the subsurface conditions, the precast abutments originally were designed to be supported by steel H-piles placed (not driven) in shafts drilled with a down-hole hammer and socketed into the underlying rock to achieve the necessary length and fixity. However, because of the relatively shallow rock and the decision to work behind the existing rock stream abutments, the contractor submitted a value engineering (VE) proposal to use cast-in-place spread footings instead of the H-piles. This proposal was accepted by the Maine DOT.

The prime contractor for the Lamson bridge replacement was CPM Constructors. The road was closed to traffic on July 15, 2007. Following the completion of the bridge (***figure 11***), and roadway reconstruction, the road was reopened on August 31, 2007, before the start of the school year. The total cost of construction was $912,000.00.

Figure 11. The completed Lamson Bridge Project.

BOOM BIRCH BRIDGE

Boom Birch Bridge (Project No. BR-1266(100)X) carries the Southgate Road (State Highway 116), a rural minor collector, over Birch Stream in the town of Old Town, Penobscot County, Maine. Boom Birch Bridge was 69 years old, in structurally deficient condition, and in need of immediate replacement, as shown in ***figure 12***. The Federal Highways Sufficiency Rating was only 21.8 out of 100. The deck was rated in “poor” condition and the substructure in “serious” condition. The AADT was 590 vehicles, with 8 percent of those being heavy trucks, and a DHV of 108 vehicles.

Figure 12. The Boom Birch Bridge was constructed in the late 1930's.

The environmental conditions, wetlands on one side and a river confluence on the other side, prohibited the use of an "on-site" detour on this project. Additionally, the age and severely deteriorated condition of the existing timber bent substructure precluded the use of phased (one lane at a time) construction. Consequently, it was determined to fully close the roadway and bridge to accelerate bridge removal and new bridge construction. This required maintaining a 14-mile detour on local roads. This closure decision and the long detour created much concern among local municipal officials, emergency responders, and the school district administrators. The Maine DOT met and worked with focus groups of these concerned stakeholders to achieve a workable solution. ***Figures 13 and 14*** show the plan view and typical cross section of the new Boom Birch Bridge.

At two town meetings, residents and municipal officers expressed concerns about the duration of a full road closure, delays to fire and rescue response, commuting time increases, bus travel time, and the associated impacts to their local economy. The town manager expressed her support for the detour if the DOT could "fast track" the closure. Residents were greatly concerned that the bridge closure might extend into the school year. Setting a goal to open the new bridge in time to resume school-related traffic and a bus route on September 1, 2007, the closure was limited to 6.5 weeks.

The existing alignment was very straight and provided for adequate construction zone sight distance and safety. The proposed alignment was effectively the same, with the addition of a very slight crest curve over the bridge. The new alignment maintained the approach roadway profile at the existing elevations while increasing the elevation of the middle of the bridge by 1 foot. This allowed for improved deck drainage and added under-clearance for recreational boating under the bridge, as was requested by both boaters and residents.

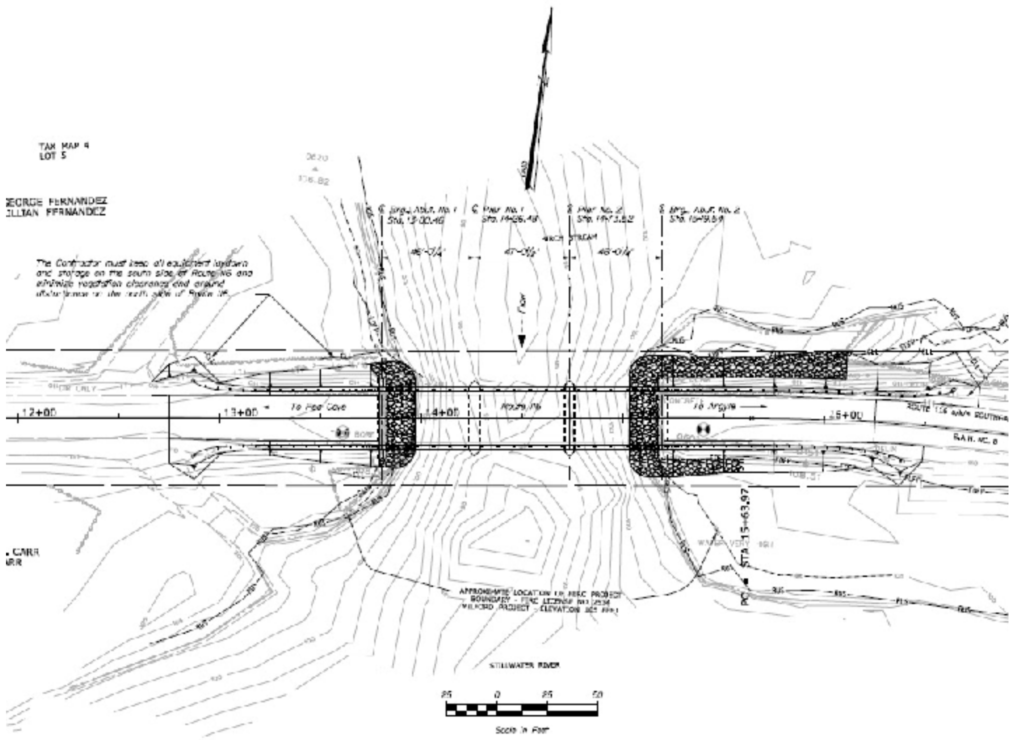


Figure 13. Plan view of the new Boom Birch Bridge.

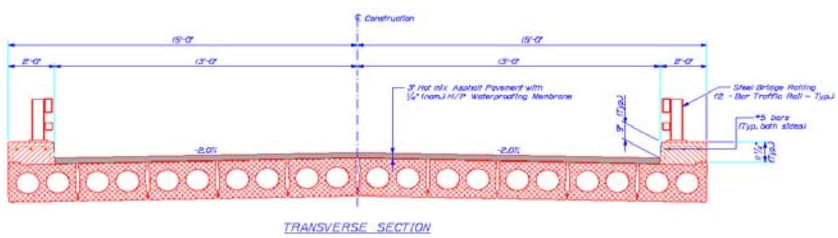


Figure 14. Typical cross section of the Boom Birch bridge deck.

The substructure of the existing Boom Birch Bridge consisted of timber bent piles and timber crib abutments. The timber ends at the top of the piers showed crushing and splintering from years of ice loads. The abutment cribs had evident scour. The deck had been extensively patched. The ongoing deck slab spalling caused a direct hazard to traffic. The bridge was rated structurally deficient, and substructure problems threatened potential failure in a relatively short number of years. Therefore, it was determined that a completely new bridge replacement was needed for safe traveling over the Birch Stream. The replacement bridge width, though only 26 feet curb to curb, was 5 to 6 feet wider than the previous superstructure.

The bridge inspector for this region flagged Boom Birch Bridge as a top priority due to its poor substructure condition rating. This warning remained effective throughout the programming process. This bridge replacement was fast-tracked through the programming and design phases as an accelerated construction project.

Project work consisted of a full road closure and rerouting traffic through a 14-mile detour, removal of the existing bridge, and construction of the new bridge. The new bridge consisted of three 47-foot prestressed concrete simple spans on precast, post-tensioned piers and abutments, as shown in ***figure 15***. Plain elastomeric pads were used as bearings, and the wearing surface consisted of a 3-inch bituminous layer on a high-performance membrane waterproofing. The superstructure included cast-in-place concrete curbs and a standard two-bar steel bridge rail. The project also called for the construction of 210 feet of approach roadway, 500 cubic yards of heavy riprap blanket and side slope protection, 375 feet of guide rail, drainage features, and the re-grading of a gravel boat ramp within the project limits.

Figure 15. Installation of the precast bridge abutment.

The Boom Birch Bridge was Maine's first bridge with precast post-tensioned pier caps, shown in ***figure 16***. Pile driving for Boom Birch was no different from typical bents. However, the precast caps would save weeks of form construction, curing, and form stripping. Each of the three cap segments had a rectangular void to fit over the piles. Once each cap was placed and post-tensioned, the remaining void space was filled with a high-performance, fast-curing concrete.

Figure 16. Installation of the precast post-tensioned pier caps.

All of the design was based on the American Association of Highway and Transportation Officials (AASHTO) load and resistance factor design (LRFD) code. Replacement in-kind, with steel beams, and precast deck panels was estimated, but proved to be not only considerably longer construction time, but also more expensive. The post-tensioned abutment caps and pier caps were designed by hand calculation. The pier pile group was designed by hand and checked with FB-Pier software. The simple span butted slabs were substantially designed with LEAP's CONSPAN software and checked by hand calculations.

This all pre-cast bridge was not only constructed rapidly, it was also relatively lightweight construction. The governing load criterion utilized 84 percent of the new pile bents' design capacity. Small load increases would have likely increased pier costs substantially by changing the required pier type from a pile bent to a wall pier. The pile cap for a wall pier would have to be placed at least 15 feet below streambed due to the highly scour susceptible soils at this site. Obviously, the deep cofferdam work would have had a large impact on the construction costs and schedule of this small project, not to mention the significantly greater impact on this environmentally sensitive area.

A typical timeframe for the removal and replacement of this bridge would have been about 9 months. Bents on piles, with cast-in-place caps would typically have been considered for both the abutments and piers. However, precast caps have never been used for pier bents in Maine before, and rarely for abutments. Boom Birch Bridge was the first multi-span bridge using precast post-tensioned pier and abutment caps. To further accelerate construction, cast-in-place concrete was eliminated from the bridge travel way (i.e., there was no cast-in-place concrete deck slab). All traffic was directly supported by the superstructure beam members, which were butted, precast/prestressed concrete voided slabs that were post-tensioned transversely. High-performance waterproofing membrane was placed on top of the butted slabs and doubled over the beam ends at the piers. All of these materials and designs promoted simple and rapid construction that is expected to have long-term durability.

As soon as the required concrete compressive strength was attained in the pier cap voids, the contractor placed the bearings (sheets of plain elastomer). Then the butted voided deck beams were erected and post-tensioned. Like the pier caps, the butted beams were prefabricated under controlled conditions in a manufacturing plant, ***figure 17***. Temporary barriers allowed opening the bridge before the cast-in-place curbs were fully cured.

Figure 17. Placement of the superstructure beams.

The 21-inch-deep beams were non-continuous, which means each simple span rotates independently under live load. At the piers between the beam ends, a ½-inch thickness of preformed expansion joint filler acts as a spacer, allowing the beam ends to rotate without harm to the superstructure. The caps for each abutment were precast in four segments, and the caps for each pier were precast in three segments. Transverse field post-tensioning held these segments together.

Another innovation on this project was the use of multiple pile anti-corrosion systems. Because of accelerated corrosion on exposed piles, the DOT has begun to install a two-coat system of hot-dipped galvanizing top-coated with an epoxy paint system. In addition to the double coating (one sacrificial and one barrier), a sacrificial zinc anode cathodic protection was installed at each piling. This new multiple protection system is expected to prolong the life of the substructure. The prime contractor for the Boom Birch bridge replacement was Wyman & Simpson. The environmental in-water work window did not start until July 15, 2007. This delayed the removal of the existing bridge, and consequently the beginning of the closure to the second half of summer. The road was closed to traffic on July 16, 2007. Following the completion of the bridge and roadway reconstruction, the road was reopened on September 1, 2007 (see ***figure 18***).

Figure 18. The completed Boom Birch Bridge.

PROJECT GOALS

Improve Safety

Both the Lamson and Boom Birch Bridge replacements improved safety by eliminating the hazards associated with structurally and functionally deficient bridges. Additionally, the projects improved the alignment of the approach roadways and upgraded the traffic delineation and safety features.

Work zone safety for the motorists and workers was improved by using total road closures with concrete road barriers. The Maine DOT has a “zero work injury” policy.

Reduce Congestion

The Maine DOT significantly reduced the traffic congestion caused by the replacement of the two bridges by using full road closures and prefabricated bridge elements. The desired result was to reduce the total construction time by approximately 80 percent.

Improve Quality and Durability

The quality and durability of both bridges were improved significantly by using bridge components prefabricated in a controlled environment, which provided a higher degree of quality control as compared to conventional cast-in-place construction method. This should result in a longer bridge component performance life with reduced maintenance needs. The use of high-performance concrete with specified higher strength precast/prestressed concrete (7.5 ksi compressive strength) reduced the structure's permeability to water and salts and will likely increase its durability. The durability of bridge travel surfaces was also likely improved and bridge maintenance costs and water damage potentially reduced through the use of integral abutments and waterproofing membranes under the HMA deck overlay. Maine DOT's cost-conscious customers were pleased and well served by getting a high-value product at the lowest long- term (life cycle) cost.

Improve User Satisfaction

The Maine DOT was fully committed to addressing the highway users, adjoining residents, local governments, and environmental needs and desires in the design and construction of both of these bridge/roadway replacement projects. The DOT satisfied all these concerns by totally replacing the structurally and functionally deficient structures with long-lasting, high-quality structures that were constructed very rapidly, as compared to conventional techniques. With this effort, Maine DOT continued to build public confidence in its effectiveness in providing safe and efficient transportation.

DATA ACQUISITION & ANALYSIS

SAFETY

During construction of the Lamson and Boom Birch projects, there were no worker injuries or motorist incidents. Since the completion of the projects, and as of the date of this report, no motorist or highway user safety incidents have been reported.

CONGESTION

Using cast-in-place bridge construction for this type and scope of project typically would require between 24 and 36 weeks. The Boom Birch project was completed in 6.5 weeks, a reduction of between 73 and 82 percent, and the Lamson project was completed in 8 weeks, a reduction of between 67 and 78 percent.

QUALITY

Lamson "On-board" Sound Intensity

On-board sound intensity (OBSI) testing was conducted prior to the Lamson project construction on July 2, 2007, and after rehabilitation on November 15, 2007. Testing included the approach to the bridge as well as the bridge itself, and was conducted at 35 mph.

OBSI measurements were made using the latest accepted technique, which included dual vertical sound intensity probes and an ASTM Standard Reference Test Tire (SRTT). The sound measurements were recorded using the Bruel and Kjaer PULSE software and data collection system. A minimum of three runs were made in the right wheel path of each traffic direction. The two microphone probes simultaneously collected noise from the leading and trailing tire/pavement contact areas. ***Figure 19*** shows the dual probe instrumentation and the tread pattern of the SRTT.

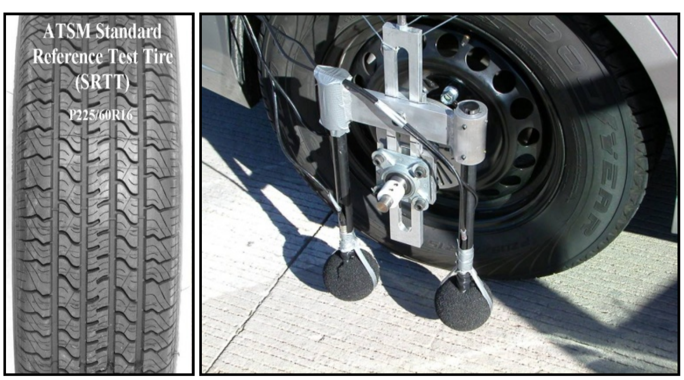
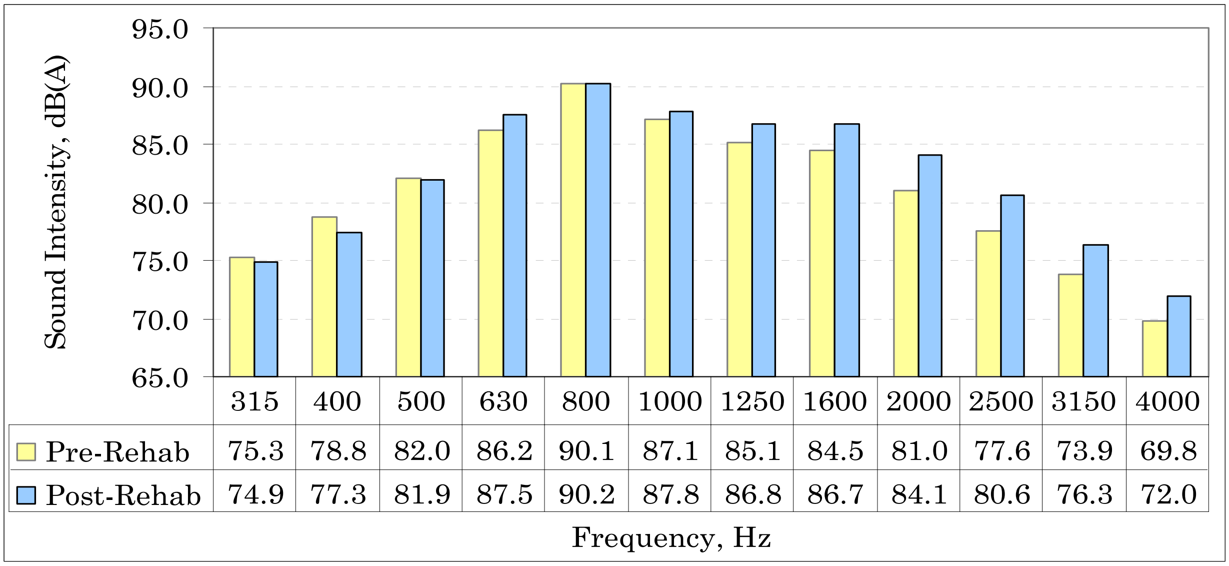


Figure 19. SI dual probe system and the SRTT.

The average of the front and rear SI values was then computed with the Bruel & Kjaer PULSE software, which utilizes Fourier transform to analyze the raw data signals over the full length of the project to produce sound intensity values. Raw noise data were normalized for the ambient air temperature and barometric pressure at the time of testing. The resulting mean SI levels are A-weighted to produce the noise-frequency spectra in 1/3rd octave bands, as shown in ***figure 20.***



	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000
Pre-Rehab	75.3	78.8	82.0	86.2	90.1	87.1	85.1	84.5	81.0	77.6	73.9	69.8
Post-Rehab	74.9	77.3	81.9	87.5	90.2	87.8	86.8	86.7	84.1	80.6	76.3	72.0

Figure 20. Lamson mean A-weighted SI frequency spectra.

Global noise levels were calculated by averaging values from the northbound and southbound lanes and then using logarithmic addition of the 1/3 octave band frequencies between 315 and 4000 Hz. The global noise levels are 94.8 and 95.8 dB(A) for pre- and post-rehabilitation, respectively. Even though the original project surface was distressed and weathered, the newly constructed asphalt overlay is 1.0 decibel higher than the original construction. The slight increase in noise is in the upper frequencies (1000 Hz and higher) and is not as noticeable to the human ear as lower frequencies. For reference, a 3.0 decibel difference in noise is considered noticeable. Both the pre- and post-test results met the project goal of 96 dB(A) or less.

Lamson Smoothness Testing

Smoothness testing at Lamson was done in conjunction with noise testing utilizing a laser profiler manufactured by International Cybernetics Corporation built into the noise test vehicle. ***Figure 21*** is an image of the test vehicle showing the laser positioned in-line with the right rear wheel. A minimum of three test runs were performed in each wheel path in each direction. The northbound and southbound test runs are averaged to produce a singe IRI value with units of in/mile.

Figure 21. Laser profiler mounted behind the test vehicle.

The overall IRI values are 301 and 389 in/mi for pre- and post-construction, respectively. ***Figure 22*** shows large peak values north of the bridge in the general location as distresses in the original pavement. Irregularities in the new overlay at the location of the original distressed pavement contributed substantially to an increased IRI. ***Figure 23*** is an image of the post-construction pavement showing irregularity in the surface located where the highest IRI values occur.

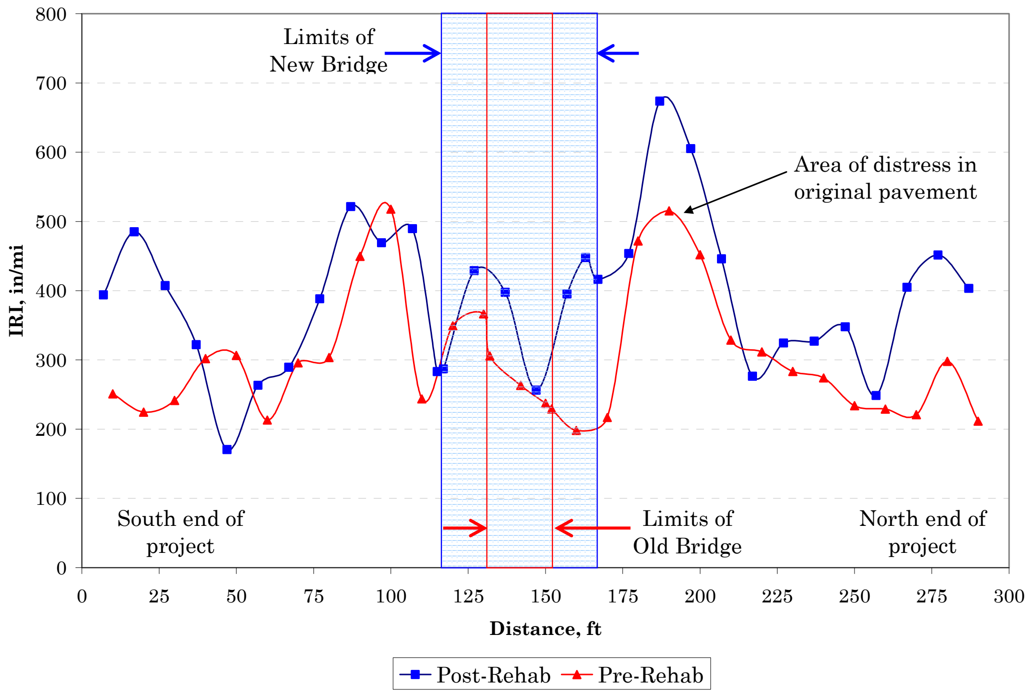
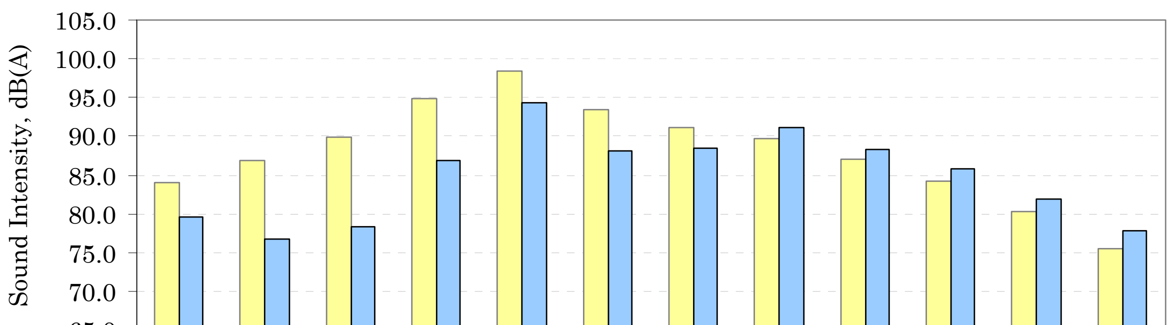


Figure 22. Lamson mean IRI values.

Figure 23. Finished Lamson Bridge pavement (note the irregularity in the right foreground).

Boom Birch "On-board" Sound Intensity

OBSI testing was performed prior to the Boom Birch construction on July 3, 2007, and after rehabilitation on November 17, 2007. Testing included the approach to the bridge as well as the bridge itself, and was conducted at 45 mph. The test equipment and procedures were the same as used on the Lamson project. The Boom Birch resulting mean SI levels are A-weighted to produce the noise-frequency spectra in 1/3rd octave bands as shown in ***figure 24.***



	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000
Pre-Rehab	83.9	86.8	90.0	94.8	98.3	93.4	91.2	89.6	87.0	84.2	80.3	75.5
Post-Rehab	79.5	76.7	78.4	86.9	94.4	88.2	88.4	91.1	88.4	85.8	81.9	77.7

Frequency, Hz

Figure 24. Boom Birch mean A-weighted SI frequency spectra.

The global noise levels are 102.3 and 98.7 dB(A) for pre- and post-rehabilitation, respectively. There has been a significant 3.6 dB(A) reduction in noise with the new construction due to the relatively smooth pavement and bridge deck improvements, even though the project goal of 96dB(A) or less was not attained. The decrease in noise is mostly in the lower frequencies (1000 Hz and lower), which means the traffic noise will not carry as far.

Boom Birch Smoothness

Smoothness testing at Boom Birch was done in conjunction with noise testing utilizing the same equipment and procedures as Lamson. The overall IRI values are 262 and 137 in/mi for pre- and post-construction, respectively. Post-construction IRI was remarkably and significantly smoother. ***Figure 25*** shows peak values corresponding to bridge abutments and center pier locations where slight humps occur. ***Figure 26*** shows the finished pavement.

Durability

For these two bridge replacement projects, Maine DOT elected to use prefabricated concrete bridge elements for their superior quality and durability over cast-in-place concrete. The existing timber pile foundations were replaced with concrete on the Lamson Bridge, and steel piles with a two-layer corrosion protection system were used on the Boom Birch Bridge. Both bridges used a concrete deck system, waterproof membrane, and a 3-inch hot-mixed asphalt (HMA) concrete wearing surface. As a result, these new bridges will likely last longer and perform better than the previous bridges.

USER SATISFACTION

The Maine DOT sent a survey letter to local agencies and residents in Addison and Old Town. The Old Town/Boom Birch project letter asked two questions:

- How satisfied were you with the results of the new bridge compared to the condition of the previous bridge?
- How satisfied were you with the approach used (45 day construction schedule under a bridge closure with a detour) to complete the bridge in terms of minimizing disruption? Please consider that a normal construction project of this size would have taken 6-9 months and would have still required a detour or a single lane through the project. This later option would have required a staged construction method and would have doubled the cost of the project. Due to environmental and archeological restrictions, construction a temporary bridge (like the one between Old Town & Milford) was not an option.

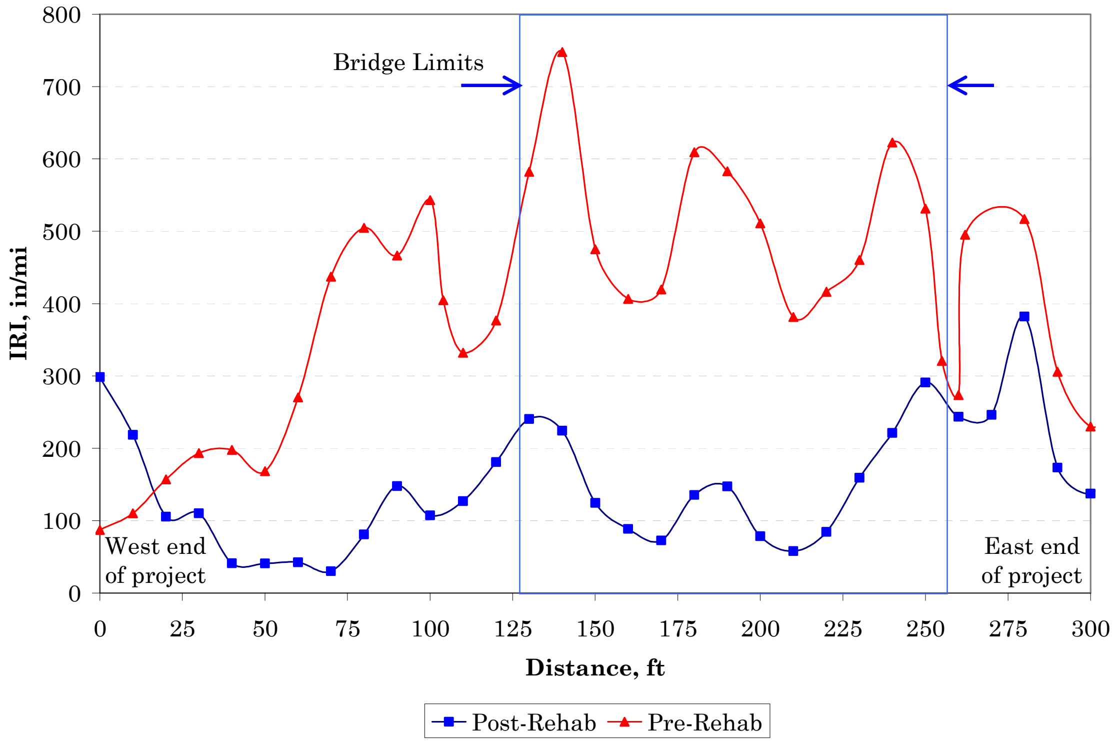


Figure 25. Boom Birch mean IRI values.

Figure 26. Boom Birch post-construction pavement.

The Addison/Lamson project asked two questions:

- How satisfied were you with the results of the new bridge compared with the condition of the previous bridge?
- How satisfied were you with the bridge construction schedule used (60 day full roadway closure with a detour) to complete the project in terms of minimizing disruption? Please consider that a typical bridge construction project of this size would have taken 6-9 months, and would have required a detour or a single lane through the project. This later option would have required a staged construction method and would have doubled the cost of the project. Due to the roadway geometry in the vicinity of Lamson Stream, construction of a temporary bridge was not an option.

Three responses were received for the Boom Birch project and nine for the Lamson project. All responses indicated complete satisfaction with the reconstructed bridge and roadway. Regarding the second questions, the replies were generally satisfied or very satisfied. However, a few did note concern over the added cost of the lengthy detours and the potential for increased response time to respond to an incident. Appendix A contains all of the original responses to the surveys.

TECHNOLOGY TRANSFER

Because the two bridge projects in Maine particularly demonstrated the applicability and benefits of PBES and full road closure on rural roads, it was determined to use a Project Demonstration Showcase as part of the technology transfer plan. A team consisting of representatives from the MEDOT, FHWA Maine Division, FHWA HfL team and ARA Inc., planned, coordinated and implemented the “showcase”.

The Maine HfL Projects “showcase” was held on August 13, 2007 at the Black Bear Inn Conference Center just off the University of Maine campus in Orono, ME. The intent of the showcase was to demonstrate the advantages and constructability of using prefabricated bridge elements and to encourage both the Maine DOT representatives and invitees from other northeastern states to be more innovative in project development. As such, the Maine projects showcase was advertised among the NASHTO states, their FHWA counterparts, and nearby Canadian provinces; (see the invitees list in Appendix B). Approximately 30 people participated in the one day showcase including a number from various segments in the Maine DOT. Participants also included bridge engineers from several states and the Province of Ontario.

The showcase consisted of a morning session of presentations at the Conference Center, an afternoon visit to the active Boom Berch construction site and a return to the Conference Center for a question and answer and wrap-up session. The showcase agenda is also shown in the Appendix C . The showcase benefited greatly by having Messrs.David Cole, the Commissioner of the Maine DOT, and Jonathan McDade, the Maine FHWA Division Administrator, open the meeting with their support and enthusiastic encouragement. Several subject area experts from the Maine DOT described in detail the key elements of design and construction of both the Boom Birch and the Lamson bridge projects. A representative of the prime contractor, Wyman & Simpson, talked about the construction phasing and the attributes of the precast design. There were presentations on an Overview of the Highways for LIFE (HfL) program efforts and the National Perspective on Prefabricated Bridge Elements. Mr. Devin Anderson of the Maine DOT moderated the showcase.

During the Boom Birch construction project field visit, all of the participants got to see the erected precast elements up close and to speak with contractor personnel who were actually doing the work on a day-to-day basis. The precast pile caps, pier columns and caps were already in place and post-tensioned. The contractor was about to place precast superstructure elements. Environmental mitigation activities were also obvious at this sensitive work site. The construction workforce eagerly shared their experiences and answered questions from the showcase participants. After about two hours on the work site, the participants returned to the Conference Center for a one-half hour question and answer and wrap-up session.

During the evening of and on the day after the day of the workshop, several of the participants took the opportunity to travel the 90 miles to the Lamson bridge construction site. The cast-in-place abutments and precast deck beams were already in-place and post tensioned transversely. The contractor was in the process of setting the precast wingwall elements at the time of the site visit.

Proceedings of the Maine showcase were both videotaped and photographed. A DVD of these proceedings was developed and distributed. A feature article about the Maine projects and showcase was included in Issue No. 4 of the HfL bi-monthly newsletter, the “Innovator”.

The Maine projects HfL showcase was deemed a success. Participants had an opportunity to hear about and see first hand on the ground the positive attributes of setting project stretch goals and meeting those goals with prefabricated bridge elements and full road closures. The Maine DOT project personnel were also lauded for their efforts among their peers and contemporaries. This public praise and acknowledgement encouraged these Maine DOT folks to try more innovation on future Maine highway projects.

ECONOMIC ANALYSIS

A key aspect of the HfL demonstration projects is to quantify inasmuch as possible the value of innovations deployed. This quantification entails a comparison of the benefits and costs associated with the innovative project delivery approach adopted on a given HfL project with those from a more traditional delivery approach (i.e., an approach which does not include the project's highlighted innovations) for a project of similar size and scope. The latter type of project is referred to herein as a *baseline* case and is an important component of the economic analysis.

The following paragraphs discuss the cost comparisons for the Boom Birch bridge reconstruction project in Old Town, Maine. Cost information for the Lamson Bridge was not available for use in this report. The Maine DOT supplied most of the cost figures for the as-built project and the baseline case.

CONSTRUCTION COST COMPARISONS – TRADITIONAL VERSUS ACCELERATED HFL DELIVERY

Construction Time

The Boom Birch Bridge HfL accelerated reconstruction project was complete in 45 calendar days. It was estimated that the baseline case would have taken approximately 100 calendar days to complete.

Detour

As indicated earlier in the report, during the reconstruction of the bridge, a decision was made to fully close the roadway and bridge to vehicular traffic. This helped accelerate the bridge removal and replacement. However, this also required maintaining a 14-mile detour on local roads increasing the costs incurred by roadway users or user costs in the form of delay costs and vehicle operating costs. The baseline approach would have been to construct a temporary "on site" detour bridge and maintaining traffic on it. This would result in increased costs due to temporary bridge construction, maintenance of traffic (MOT) for the duration of the projects, as well as increased queuing as vehicles are delayed by the work zone. The Maine DOT project engineer for this project indicated that in the year 2007 when this project was built temporary bridge costs rose very steeply over and above the prices of the already increased costs of construction materials such as petroleum products, prestressed concrete, and steel. To further aggravate matters, the temporary bridge at this site, by necessity, would have been roughly 40 percent longer than the bridge structure due to the prevailing alignment and environmental issues and would be more expensive to build because of deeper piling and pinning requirements.

Construction Costs

Table 1 presents the differences in construction costs between the baseline versus the as-built alternatives. All these cost estimates were provided by Maine DOT project engineer assigned to this job. In providing these cost estimates, Maine DOT noted that their estimate of a construction method cost differential was very inexact. This was because of the following factors:

- Some of the principal cost factors, such as the difference in construction crew time, are not directly addressed in Maine DOT's line itemized project documents.
- Another particular item, the cost of a temporary bridge structure, is very significant to the difference, but has shown an extremely steep increase in unit based cost in the three years prior to the construction (data from these years was used to determine the unit costs for the temporary bridge structure).

With these factors in mind, it is advisable to consider the information presented as a subjective analysis of the likely cost differential, rather than a rigorous computation of a cost differential. Several other assumptions were made for the selection of significant cost factors and for determining some unit costs which are noted in table 1.

Table 1. Boom Birch bridge capital cost calculation table.

Cost Category	**Baseline Case**			**As Built**		
	Unit Cost	**Quantity**	**Total**	**Unit Cost**	**Quantity**	**Total**
Bridge construction	$183/sft[1]	4230 sft	$774,090	$110/sft	4230 sft	$465,300
Construction Engineering[2]	$1000/day	100 days	$100,000	$1425/day	45 days	$64,125
Bridge Approach Work + Mobilization + Other [3]	--	--	$678,735	--	--	$644,735
Reduced Abutment and Substructure Cost			-$105,000	N/A	N/A	N/A
Leveling slab (Avg. Depth 3.875 in)			$35,000	N/A	N/A	N/A
Temporary Traffic Control Signals			$40,000	N/A	N/A	N/A
Total Cost			**$1,522,825**			**$1,174,160**

Notes:
[1] Includes 200 ft x 14 ft temporary bridge structure.
[2] Includes quality control costs.
[3] 210 feet of approach roadway, 500 cubic yards of heavy riprap blanket and side slope protection, 375 feet of guide rail, drainage features, and the re-grading of a gravel boat ramp within the project limits. Increase mobilization costs were applied to the traditional delivery project.

User Costs

Three categories of user costs are generally used in an economic analysis or lifecycle costs analysis. These include:

- Vehicle operational costs (VOC).
- Delay costs.
- Crash costs or safety related costs.

The cost-differential in the vehicle operating and delay costs were included in this analysis to identify the differences in costs between the baseline and as-built alternatives. Because of the relatively short anticipated duration of the bridge reconstruction project using either of the delivery approaches (100 days for traditional versus 45 days for accelerated) and also taking into account that the site under consideration is in a rural area with relatively low crashes, it was decided not to compute crash costs. The following paragraphs describe the cost differences between the two approaches from a vehicle operation and delay standpoint.

Vehicle Operation Costs

The following assumptions were made in computing these costs:

- Based on the data provided by Maine DOT, the AADT was assumed to be 590 vehicles with 8 percent trucks.
- The VOC per mile for autos and trucks were assumed to be $0.28/mi and $1.45/mi, respectively based on national statistics.
- The vehicle miles traveled per day for the baseline case was assume to be the length of the “on site” detour bridge which is 200 ft or 0.04 mi approximately.
- The vehicle miles traveled per day for the as-built scenario is 14 miles (the length of the detour).
- The project duration for the baseline case was assumed to be 100 days per Maine DOT’s experience.
- The project duration for the as-built case was 45 days.

Using the proportion of the trucks and autos in the traffic mix and the respective unit VOCs, a composite cost per mile traveled for the traffic mix was determined to be $0.37/mile.

Using these assumptions and cost figures the following computations are made:

Additional vehicle miles traveled for the as-built case	= 590(vehicles)*45(days)*14 (mi)
	= 371,700 mi.
Additional VOC incurred	= 371,700 (mi) * $0.37/mi
	= $137,381

Delay Costs

The following assumptions were made in computing these costs:

- The delay costs were based on Maine DOT’s estimated disincentive clause of $1000/day for project delays. This number apparently accounted for standardized cost per-hour-per-person for the traffic and commuters encountered on this roadway. Using this information and the detour length a composite cost of $3.6/hour was estimated for delay costs.
- An estimated additional travel time of 10 minutes was assumed for the baseline case based on Maine DOT recommendations.

- Using a 30 mi/hour average speed and a 14 mile detour length a 28-min trip time is computed to traverse the detour for the as-built case.
- The project durations for the baseline and as-built cases was assumed to be the same as before, i.e., 100 days for the baseline case and 45 days for the as-built case respectively.

Using these assumptions and cost figures the following computations are made:

Additional costs associated with increased travel time for the baseline case:
= 590 (vehicles) *0.17 (hr) *3.6 ($/hr) * 100 (days)
= $36,108
Additional costs associated with increased travel time for the as-built case
= 590 (vehicles) *0.47 (hr) *3.6 ($/hr) * 45 (days)
= $44,922
Additional travel time costs incurred for the as-built case
= $44,922 - $36,108
= $8,814

Cost Summary

Based on the information presented it is clear that, from a construction cost standpoint, the baseline case alternative would have cost Maine DOT approximately $348,665 more than the accelerated construction scenario. However, the full lane closures and the accompanying detours offset the cost saving by approximately $146,195. Therefore, the net savings on this project were roughly $202,470. Using the estimated total costs for constructing the bridge using traditional practices, the innovative HfL project delivery approach realized a cost savings of approximately 13 percent—a significant difference. As noted earlier in the report, the use of precast elements on the project will likely increase its durability thus making this innovative project delivery approach even more significant.

APPENDIX A – USER SATISFACTION SURVEYS

May. 23. 2008 12:04PM No. 5492 P. 2

Maine Department of Transportation
Bridge Program

Re: Old Town Boom-Birch Bridge Replacement Survey
From: Bob Bulger
MDOT-Bridge Program
16 State House Station
Augusta, Maine 04333

Dear Sir/Madam,

October 18, 2007

We at the Department of Transportation are interested in your feedback concerning the above referenced project completed this summer on route 116. If you would kindly take the time to answer the following questions, we would greatly appreciate your input and if you could return this survey to the address above.

1. How satisfied were you with the results of the new bridge compared to the condition of the previous bridge?

   We were very satisfied with the way things worked out. And the way they graded and fixed the side of the road and lots adjoined to it.

2. How satisfied were you with the approach used (45 day construction schedule under a bridge closure with a detour) to complete the bridge in terms of minimizing disruption? Please consider that a normal construction project of this size would have taken 6-9 months and would have still required a detour or a single lane through the project. This later option would have required a staged construction method and would have doubled the cost of the project. Due to environmental and archeological restrictions, construction a temporary bridge (like the one between Old Town & Milford) was not an option.

   We thought it was great and we know a lot of people above us were very pleased when it opened so quickly and didn't have the extra mile to travel with the Detour.

Thank you for your time,
Bob Bulger, PE
Project Designer/Engineer

Maine Department of Transportation
Bridge Program

OCT 26 2007

Re: Old Town Boom-Birch Bridge Replacement Survey
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October 18, 2007

We at the Department of Transportation are interested in your feedback concerning the above referenced project completed this summer on route 116. If you would kindly take the time to answer the following questions, we would greatly appreciate your input and if you could return this survey to the address above.

1. How satisfied were you with the results of the new bridge compared to the condition of the previous bridge?

We are very impressed with the new bridge. The old bridge was loud and bumpy and in pretty sad shape. This New bridge is very good looking from above and below in the water. It is very quiet and we love the height from below when kayaking beneath it. It's an excellent job!

2. How satisfied were you with the approach used (45 day construction schedule under a bridge closure with a detour) to complete the bridge in terms of minimizing disruption? Please consider that a normal construction project of this size would have taken 6-9 months and would have still required a detour or a single lane through the project. This later option would have required a staged construction method and would have doubled the cost of the project. Due to environmental and archeological restrictions, construction a temporary bridge (like the one between Old Town & Milford) was not an option.

We appreciate the cost savings by completely shutting down the bridge. Our biggest disappointment is that there was not at least a foot bridge constructed so residents would have the option of parking on one side and walking across. The extra mileage and gas (at \$3.00/gallon) was an extreme financial burden on our family as with two working parents going in different directions - we were running two cars every day for a total of 50 extra miles per day 5-6 days per week on top of our normal gas bills. This was approx. \$100.00 extra dollars per week for our family with two children. In short, we were greatly burdened for this time period. We wish there could have been some type of fuel assistance offered. We had heard that the Argyle Road bridge construction at least had a foot bridge and we don't understand why this project couldn't have done the same thing

Thank you for your time,
Bob Bulger, PE
Project Designer/Engineer

03May. 23. 2008::12:05PM978273976 OLD TOWN FIRE RESCUE No. 5492 P. 4 01/01
Mar. 5. 2008 9:59AM No. 4934 P. 1

Maine Department of Transportation
Bridge Program

Re: Old Town Boom-Birch Bridge Replacement Survey
From: Bob Bulger
MDOT-Bridge Program
16 State House Station
Augusta, Maine 04333

Dear Sir/Madam, October 18, 2007

We at the Department of Transportation are interested in your feedback concerning the above referenced project completed this summer on route 116. If you would kindly take the time to answer the following questions, we would greatly appreciate your input, and if you could return this survey to the address above.

1. How satisfied were you with the results of the new bridge compared to the condition of the previous bridge?

Very Satisfied

2. How satisfied were you with the approach used (45 day construction schedule under a bridge closure with a detour) to complete the bridge in terms of minimizing disruption? Please consider that a normal construction project of this size would have taken 6-9 months and would have still required a detour or a single lane through the project. This later option would have required a staged construction method and would have doubled the cost of the project. Due to environmental and archeological restrictions, construction of a temporary bridge (like the one between Old Town & Milford) was not an option.

I was very concerned about response time if we had a fire in the area beyond the bridge. Response time was going to be an issue. We were lucky we did not have an incident during closure.

Post-it® Fax Note 7671	Date 3/5/08 # of pages 2
To James Lavoie	From Bob Bulger
Co./Dept. Town of Old Town	Co. Maine DOT
Phone # 827-3400	Phone # 624-3434
Fax # 827-3976	Fax # 624-3491

Thank you for your time,
Bob Bulger, PE
Project Designer/Engineer

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION
16 STATE HOUSE STATION
AUGUSTA, MAINE
04333-0016

JOHN ELIAS BALDACCI
GOVERNOR

DAVID A. COLE
COMMISSIONER

OCT 30 2007

OCT 26 2007

October 24, 2007

MSAD #37
P O Box 79
1 Sacarap Road
Harrington, Maine 04643

Re: Addison – Lamson Bridge Replacement Survey

Dear Sir/Madam,

We at the Department of Transportation are interested in your feedback concerning the above referenced project completed this summer on Basin Road. If you would kindly take the time to answer the following questions, we would greatly appreciate your input and please return this survey to the address above.

1. How satisfied were you with the results of the new bridge compared to the condition of the previous bridge?

   Very satisfied

2. How satisfied were you with the bridge construction schedule used (60 day full roadway closure with a detour) to complete the project in terms of minimizing disruption? Please consider that a typical bridge construction project of this size would have taken 6-9 months, and would have still required a detour or a single lane through the project. This later option would have required a staged construction method and would have doubled the cost of the project. Due to the roadway geometry in the vicinity of Lamson Stream, construction a temporary bridge was not an option.

   As the Transportation Director for M.S.A.D #37, this was a bit of an inconvenience to bus routes but we were able to reroute with not much trouble.
   I was pleased that it didn't take longer.

Thank you for your time,
Bob Ellena, PE
Project Designer/Engineer
Bridge Program

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION
16 STATE HOUSE STATION
AUGUSTA, MAINE
04333-0016

JOHN ELIAS BALDACCI
GOVERNOR

DAVID A. COLE
COMMISSIONER

October 24, 2007

OCT 3 1 2007

Resident

Re: Addison – Lamson Bridge Replacement Survey

Dear Sir/Madam,

We at the Department of Transportation are interested in your feedback concerning the above referenced project completed this summer on Basin Road. If you would kindly take the time to answer the following questions, we would greatly appreciate your input and please return this survey to the address above.

1. How satisfied were you with the results of the new bridge compared to the condition of the previous bridge? We are very satisfied with the bridge. It's a great Job.

2. How satisfied were you with the bridge construction schedule used (60 day full roadway closure with a detour) to complete the project in terms of minimizing disruption? Please consider that a typical bridge construction project of this size would have taken 6-9 months, and would have still required a detour or a single lane through the project. This later option would have required a staged construction method and would have doubled the cost of the project. Due to the roadway geometry in the vicinity of Lamson Stream, construction a temporary bridge was not an option.

   Very satisfied.

Thank you for your time,
Bob Ellena, PE
Project Designer/Engineer
Bridge Program

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AUGUSTA, MAINE
04333-0016

JOHN ELIAS BALDACCI
GOVERNOR

DAVID A. COLE
COMMISSIONER

October 24, 2007

OCT 31 2007

Resident

Re: Addison – Lamson Bridge Replacement Survey

Dear Sir/Madam,

We at the Department of Transportation are interested in your feedback concerning the above referenced project completed this summer on Basin Road. If you would kindly take the time to answer the following questions, we would greatly appreciate your input and please return this survey to the address above.

1. How satisfied were you with the results of the new bridge compared to the condition of the previous bridge?

   Very satisfied

2. How satisfied were you with the bridge construction schedule used (60 day full roadway closure with a detour) to complete the project in terms of minimizing disruption? Please consider that a typical bridge construction project of this size would have taken 6-9 months, and would have still required a detour or a single lane through the project. This later option would have required a staged construction method and would have doubled the cost of the project. Due to the roadway geometry in the vicinity of Lamson Stream, construction a temporary bridge was not an option.

   Satisfied

Thank you for your time,
Bob Ellena, PE
Project Designer/Engineer
Bridge Program

STATE OF MAINE
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16 STATE HOUSE STATION
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04333-0016

JOHN ELIAS BALDACCI
GOVERNOR

DAVID A. COLE
COMMISSIONER

OCT 31 2007

October 24, 2007

Pleasant River Ambulance
183 U.S. Highway 1
Columbia, Maine 04623

Re: Addison – Lamson Bridge Replacement Survey

Dear Sir/Madam,

We at the Department of Transportation are interested in your feedback concerning the above referenced project completed this summer on Basin Road. If you would kindly take the time to answer the following questions, we would greatly appreciate your input and please return this survey to the address above.

1. How satisfied were you with the results of the new bridge compared to the condition of the previous bridge?

   a Huge improvement but should have been built up more.

2. How satisfied were you with the bridge construction schedule used (60 day full roadway closure with a detour) to complete the project in terms of minimizing disruption? Please consider that a typical bridge construction project of this size would have taken 6-9 months, and would have still required a detour or a single lane through the project. This later option would have required a staged construction method and would have doubled the cost of the project. Due to the roadway geometry in the vicinity of Lamson Stream, construction a temporary bridge was not an option.

   Being an emergency service, the shortest time for disruption was greatly appreciated.

Notification about the project beforehand was greatly appreciated and such notifications always will be

Thank you for your time,
Bob Ellena, PE
Project Designer/Engineer
Bridge Program

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04333-0016

JOHN ELIAS BALDACCI
GOVERNOR

DAVID A. COLE
COMMISSIONER

OCT 30 2007

October 24, 2007

John Woodward
Addison Town Office
Addison, Maine 04606

Re: Addison – Lamson Bridge Replacement Survey

Dear Sir/Madam,

We at the Department of Transportation are interested in your feedback concerning the above referenced project completed this summer on Basin Road. If you would kindly take the time to answer the following questions, we would greatly appreciate your input and please return this survey to the address above.

1. How satisfied were you with the results of the new bridge compared to the condition of the previous bridge?

   Very

2. How satisfied were you with the bridge construction schedule used (60 day full roadway closure with a detour) to complete the project in terms of minimizing disruption? Please consider that a typical bridge construction project of this size would have taken 6-9 months, and would have still required a detour or a single lane through the project. This later option would have required a staged construction method and would have doubled the cost of the project. Due to the roadway geometry in the vicinity of Lamson Stream, construction a temporary bridge was not an option.

   Very

Thank you for your time,
Bob Ellena, PE
Project Designer/Engineer
Bridge Program

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION
16 STATE HOUSE STATION
AUGUSTA, MAINE
04333-0016

JOHN ELIAS BALDACCI
GOVERNOR

DAVID A. COLE
COMMISSIONER

October 24, 2007

OCT 31 2007

Resident

Re: Addison – Lamson Bridge Replacement Survey

Dear Sir/Madam,

We at the Department of Transportation are interested in your feedback concerning the above referenced project completed this summer on Basin Road. If you would kindly take the time to answer the following questions, we would greatly appreciate your input and please return this survey to the address above.

1. How satisfied were you with the results of the new bridge compared to the condition of the previous bridge? Great improvement

2. How satisfied were you with the bridge construction schedule used (60 day full roadway closure with a detour) to complete the project in terms of minimizing disruption? Please consider that a typical bridge construction project of this size would have taken 6-9 months, and would have still required a detour or a single lane through the project. This later option would have required a staged construction method and would have doubled the cost of the project. Due to the roadway geometry in the vicinity of Lamson Stream, construction a temporary bridge was not an option.

   Inconvenient, increased expense

Thank you for your time,
Bob Ellena, PE
Project Designer/Engineer
Bridge Program

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION
16 STATE HOUSE STATION
AUGUSTA, MAINE
04333-0016

JOHN ELIAS BALDACCI
GOVERNOR

DAVID A. COLE
COMMISSIONER

NOV 01 2007

October 24, 2007

Resident

Re: Addison – Lamson Bridge Replacement Survey

Dear Sir/Madam,

We at the Department of Transportation are interested in your feedback concerning the above referenced project completed this summer on Basin Road. If you would kindly take the time to answer the following questions, we would greatly appreciate your input and please return this survey to the address above.

1. How satisfied were you with the results of the new bridge compared to the condition of the previous bridge?

   Very satisfied. The bridge is much wider, as well as the entrance and exit to it

2. How satisfied were you with the bridge construction schedule used (60 day full roadway closure with a detour) to complete the project in terms of minimizing disruption? Please consider that a typical bridge construction project of this size would have taken 6-9 months, and would have still required a detour or a single lane through the project. This later option would have required a staged construction method and would have doubled the cost of the project. Due to the roadway geometry in the vicinity of Lamson Stream, construction a temporary bridge was not an option.

   The time closed was okay. I realize they done the work as fast as possible and we do appreciate that. Driving 16 miles to go 1 mile is not fun, but we coped with it

Thank you for your time,
Bob Ellena, PE
Project Designer/Engineer
Bridge Program

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION
16 STATE HOUSE STATION
AUGUSTA, MAINE
04333-0016

JOHN ELIAS BALDACCI
GOVERNOR

DAVID A. COLE
COMMISSIONER

October 24, 2007

NOV 06 2007

Resident

Re: Addison – Lamson Bridge Replacement Survey

Dear Sir/Madam,

We at the Department of Transportation are interested in your feedback concerning the above referenced project completed this summer on Basin Road. If you would kindly take the time to answer the following questions, we would greatly appreciate your input and please return this survey to the address above.

1. How satisfied were you with the results of the new bridge compared to the condition of the previous bridge?

   wonderful – not only do we drive over the bridge – we kayak under it – the improvement, both bottom and top is great

2. How satisfied were you with the bridge construction schedule used (60 day full roadway closure with a detour) to complete the project in terms of minimizing disruption? Please consider that a typical bridge construction project of this size would have taken 6-9 months, and would have still required a detour or a single lane through the project. This later option would have required a staged construction method and would have doubled the cost of the project. Due to the roadway geometry in the vicinity of Lamson Stream, construction a temporary bridge was not an option.

   considering the topography and the scope of the project the schedule, from start to finish, was amazing

Thank you for your time,
Bob Ellena, PE
Project Designer/Engineer
Bridge Program

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JOHN ELIAS BALDACCI
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DAVID A. COLE
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October 24, 2007

NOV 06 2007

Resident

Re: Addison – Lamson Bridge Replacement Survey

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1. How satisfied were you with the results of the new bridge compared to the condition of the previous bridge?

   Very.

2. How satisfied were you with the bridge construction schedule used (60 day full roadway closure with a detour) to complete the project in terms of minimizing disruption? Please consider that a typical bridge construction project of this size would have taken 6-9 months, and would have still required a detour or a single lane through the project. This later option would have required a staged construction method and would have doubled the cost of the project. Due to the roadway geometry in the vicinity of Lamson Stream, construction a temporary bridge was not an option.

   Fine.

Thank you for your time,
Bob Ellena, PE
Project Designer/Engineer
Bridge Program

APPENDIX B – LIST OF INVITEES TO THE SHOWCASE

Members:

Adeyemi, Olu.A <FHWA>	OluAAdeyemi@fhwa.dot.gov
Anderson, Devin	Devin.Anderson@maine.gov
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Brillhart,	David jbrillhart@dot.state.nh.us
Bursich,	Hugo Bursich.Hugo@strescon.com
Butts, John	jbutts@acm.org
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Carrara, Joe	jcarrara@ipcarrara.com
Cater, John <FHWA>	John.Cater@fhwa.dot.gov
Chilstrom, Joseph.E <FHWA>	Joseph.E.Chilstrom@fhwa.dot.gov
Cole, David A	DavidACole@maine.gov
Colgrove III, George	george.colgrove@state.vt.us
Concelliere, Joseph	joseph.concelliere@po.state.ct.us
Constable, Derek <FHWA>	Derek.Constable@fhwa.dot.gov
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Goodspeed, Charlie	chgi@unh.edu
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Gruhn, Arthur	Arthur.Gruhn@po.state.ct.us
Hall, David R <FHWA>	David.R.Hall@fhwa.dot.gov
Hoffman, Allen <FAA>	Allen.Hoffman@faa.dot.gov
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Hogg, Richard	rhogg@state.pa.us
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Krusinski, Laura	Laura.Krusinski@maine.gov
Lord, Byron <FHWA>	Byron.Lord@dot.gov
Lwin, Myint <FHWA>	Myint.Lwin@dot.gov
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Moore, James A	jmoore@dot.state.nh.us
Muretic, Carol	CMURETIC@state.pa.us

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Taylor, Joyce	Joyce.Taylor@maine.gov
Tukey, James	James.Tukey@maine.gov
Williams, William <FHWA>	William.Williams@fhwa.dot.gov
Zirlin, Julie <FHWA>	Julie.Zirlin@dot.gov

APPENDIX C – SHOWCASE AGENDA
Maine Highways for LIFE Project Workshop on Boom Birch and Lamson Bridges

August 13, 2007

8:00 a.m.

- **Call to Order, Introductions** Devin Anderson, Maine DOT (10 min.)
- **Welcome** David Cole, Commissioner, Maine DOT (10 min.)
- **Maine's Bridges for Tomorrow** Jonathan McDade, Federal Highway Administration, Maine Division Administrator (10 min.)
  Description of Projects: A discussion of issues in the areas of environment, geotechnical, emergency responders, and corrosion protection (60 min.)

  Boom Birch Bridge, Old Town, Maine Robert Bulger, Maine DOT

  Lamson Bridge, Addison, Maine Robert Ellena, Maine DOT

  Geotechnical Considerations Laura Krusinski, Maine DOT

- **Highways for LIFE Program Overview** Gary Hoffman, Applied Research Assoc. (15 min.)

Break (15 min.)

10:00 a.m.

- **Prefabricated Bridges – National Perspective** Mary Lou Ralls (30 min.)
- **Decision on Full-Road Closure** Catherine Small, Maine DOT (20 min.)
- **Contractor Perspective on Contract Requirements** Wyman & Simpson (20 min.)
- **Open Q & A** (Devin Anderson – Moderator) (20 min.)

Lunch (11:30 – 12:30)

12:30 p.m.

Travel to Boom Birch Site

- **Observe erection of prefabricated elements** (30 minutes)
- **Q & A of Field Staff**

1:00 p.m.

Return to Conference Center

- **Review of Things Learned and Wrap Up** Devin Anderson – Moderator (20 min)