Appendix A

Project Alternatives Evaluation – Executive Summary from EA

Revised

Environmental Assessment

BRATTLEBORO, VT – HINSDALE, NH
TRANSPORTATION CORRIDOR
BRF 2000(19)SC

December, 2013

Prepared For:

VTrans Working to Get You There
Vermont Agency of Transportation

New Hampshire DOT

and

U.S. Department of Transportation
Federal Highway Administration

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EIV TECHNICAL SERVICES

CHA

ENVIRONMENTAL ASSESSMENT

For the
BRATTLEBORO, VT – HINSDALE, NH
Route 119 TRANSPORTATION CORRIDOR
BRF 2000(19)SC

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PROJECT SUMMARY

This chapter summarizes information presented in each of the subsequent Environmental Assessment (EA) chapters. It is organized by content section to correspond to each of those chapters. Additional, more detailed information and analyses not found in the main chapters are compiled in the accompanying appendices. Separate document for Exhibits referenced in this EA has been compiled in a separate volume.

A.) INTRODUCTION

The Route 119 crossing of the Connecticut River between downtown Brattleboro, Vermont and Hinsdale, New Hampshire, is the primary transportation link between these two communities. This river crossing has been in existence for more than 160 years, and is the only transportation connection between New Hampshire and Vermont for a distance of approximately 15 miles. It is the southernmost highway crossing of the Connecticut River between New Hampshire and Vermont.

The current Route 119 Connecticut River crossing is accomplished with two metal truss bridges known as the Charles Dana Bridge and Anna Hunt Marsh Bridge; which meet on a mid-channel island. The longer western bridge carries Route 119 over the main channel of the river and the eastern bridge spans a side channel. The bridges were built in 1920 and 1926 respectively. The western bridge is jointly owned by the State of New Hampshire and the Town of Brattleboro, and is maintained by the State of New Hampshire. The eastern bridge is both owned and maintained by the State of New Hampshire.

The existing substructures are a mix of concrete and masonry materials. Vertical and horizontal clearances are inadequate by current AASHTO design standards. In 1988 structural elements were replaced. In 1993 a sidewalk was installed on the north side of both bridges. In 2003 precast concrete deck panels were installed on both bridges. Despite ongoing maintenance efforts, both bridges are considered seriously deteriorated due to river scouring at the foundations, concrete spalling in the abutments and piers, and corrosion to the structural steel framing.

Ten alternatives were considered to replace the aging bridges (See Exhibit A.1 – Project Study Area). The Preferred Alternative locates a replacement structure south of the current crossing area. It would cross the entire Connecticut River with a single multispan between NH 119 in Hinsdale and VT 142 in Brattleboro. The proposed new bridge would be a structure that provides two 12' travel lanes, 10' travel shoulders, a 5' sidewalk on the upstream side, and a grade-separated railroad crossing in Vermont. The final design of this bridge has not been determined. This alternative also includes rehab of the existing historic Route 119 bridges for pedestrian and bicycle usage.

Studies, meetings, and initiatives concerning the existing Route 119 crossing of the Connecticut River have been ongoing since the bridge deficiencies were documented by the New Hampshire Department of Transportation (NHDOT) in 1977. A joint initiative, involving local and state groups, agencies in Vermont and New Hampshire, as well as area regional planning commissions and affected federal agencies, was initiated in February 1996 to identify potential project alternatives.

The project is jointly sponsored by the Vermont Agency of Transportation (VAOT) and NHDOT with financial and oversight assistance from the Federal Highway Administration (FHWA). VAOT is completing the planning and environmental documentation portions of the project, and NHDOT is responsible for the design and construction phases. The Windham Regional Commission in Vermont, the Southwest Regional Planning Commission in New Hampshire, and the Brattleboro/Hinsdale Bridge Committee have participated substantially in the planning phases of the project. NHDOT and the Bridge Committee worked to determine a bridge type that would be functional, cost effective, and aesthetically compatible with the surrounding project area.

B.) PURPOSE AND NEED

1.) PROJECT PURPOSE

The purpose of this project is to provide a safe, functionally efficient, and cost-effective Route 119 transportation corridor across the Connecticut River in the vicinity of downtown Brattleboro, Vermont and Hinsdale, New Hampshire, and to preserve the socio-economic and environmental resources associated with the transportation corridor.

2.) PROJECT NEED

There exists a need for the project to:

a). MAINTAIN A TRANSPORTATION CORRIDOR BETWEEN HINSDALE, NEW HAMPSHIRE AND DOWNTOWN BRATTLEBORO, VERMONT.

This transportation corridor has been in existence for more than 160 years and is the only transportation connection between New Hampshire and Vermont for a distance of approximately 15 miles to the south and 2 miles to the north. Route 119 is the southernmost transportation crossing of the Connecticut River between Vermont and New Hampshire.

b). CORRECT THE SAFETY, STRUCTURAL, AND FUNCTIONAL DEFICIENCIES OF THE EXISTING TRANSPORTATION CORRIDOR

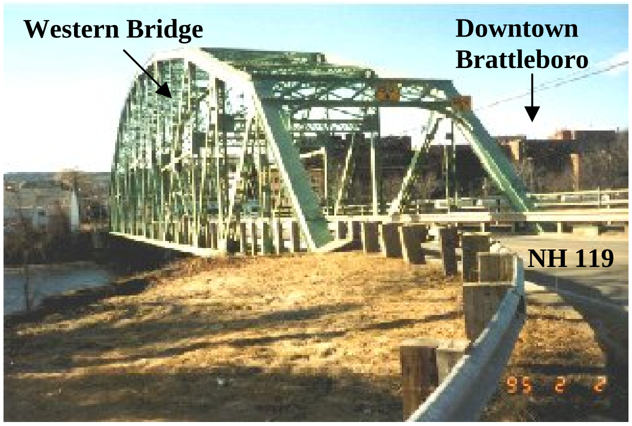

Photo PS-1 Western Bridge: View from the mid-channel island towards downtown Brattleboro.

Both bridges have seriously deteriorated since their original construction in the 1920's. The concrete in the abutments, piers and backwalls is spalled and reinforcing steel is exposed. The truss members have areas of severe corrosion with section loss. The strength of floor beams and stringers is substantially reduced.

Both bridges are classified by the National Bridge Inventory (NBI) Appraisal Rating as having a status of "Structurally Deficient".

Photo PS -2 Eastern Bridge: View from New Hampshire, west towards the Mid-channel Island and Brattleboro

The traffic functionality problems associated with this transportation corridor are compounded by the at-grade railroad crossing of Route 119 between the western bridge and the Route 5/119/142 intersection. This railroad crossing results in vehicles getting backed up eastward across the western bridge, and westward through the same intersection. The blocking of route 119 by the at-grade railroad crossing significantly degrades the ability of Hinsdale and Brattleboro to share emergency services.

Photo PS -3 VT 119 At-Grade Rail Crossing: View from the western bridge, west towards downtown Brattleboro.

The sub-standard geometry and lane widths of the existing bridges and Route 119 approach roadways result in limited sight distances and also contribute to congested traffic conditions. Additionally, when crossing between Brattleboro and Hinsdale during winter months, pedestrians must use the Route 119 shoulders when traveling between the bridges on the mid-channel island since existing asphalt sidewalk behind the guard rail is not maintained during the winter. These conditions combine to create safety concerns for both vehicular traffic at the at-grade RR crossing and pedestrians on the current VT119/VT142/VT 5 intersection.

c). MAINTAIN AREA SOCIAL AND ECONOMIC RELATIONSHIPS

A functional transportation corridor between Brattleboro and Hinsdale facilitates area commerce and social activities, affects area land uses, and allows the communities to share emergency services.

d). PRESERVE THE INTEGRITY OF AREA RESOURCES TO THE EXTENT POSSIBLE

The Brattleboro/Hinsdale transportation corridor has numerous natural and cultural resources that contribute to the social, economic, environmental, and aesthetic qualities of the area.

e). CONSERVE FISCAL RESOURCES

The development and construction of the transportation corridor should, to the greatest extent practicable, conserve fiscal resources.

C.) ALTERNATIVES

1.) ALTERNATIVES IDENTIFICATION

To facilitate local and regional input, the Windham Regional Commission (WRC) organized the Brattleboro/Hinsdale Bridge Committee. The Bridge Committee members included representatives from the Brattleboro Selectboard (VT), Hinsdale Office of Selectmen (NH), Windham Regional Commission (VT), Southwest Regional Planning Commission (NH), the Town of Chesterfield (NH), local citizens, and representatives from area social services, emergency services, and interest groups. The Bridge Committee assisted in developing the project's purpose and need, identifying area resources, conducting public informational forums, developing and refining project alternatives, and the identification of project-related area resource impacts.

A technical Working Group of design specialists was also formed from NHDOT, VAOT, WRC, and consultant engineers. The Working Group helped identify and analyze technical issues, address Bridge Committee comments, provide coordination with resource agencies, formulate project alternatives, and assist with project management. Working group meetings were open to the public and were held in both Brattleboro and Hinsdale.

The following 10 project alternatives, briefly described below, were identified for evaluation: (see Exhibit A.3 – Project Alternatives):

- **No-Action**

- **Alternative A** (Rehabilitation) – Rehabilitation of the existing Route 119 bridges.

- **Alternative B** (Replace on Existing) – Replacement of the existing Route 119 bridges on existing alignment.

- **Alternative C** (Alignment Improvement) – Replacement of the existing Route 119 bridges with minor modifications to the existing highway geometrics.

- **Alternative D** (Grade-Separated) – Replacement of the existing Route 119 bridges on existing alignment, but with a grade-separated railroad crossing in Vermont.

- **Alternative E** (Parallel Structure) – Construction of a parallel set of bridges immediately to the south of the existing bridges. The existing bridges could be rehabilitated and maintained for vehicular traffic or pedestrian/bicycle usage.

- **Alternative E-Modified** (Parallel Tangent Structure) – Construction of a parallel set of tangent type bridges immediately to the south of the existing bridges. The existing bridges could be rehabilitated and maintained for vehicular traffic, or pedestrian/bicycle usage.

- **Alternative F** (Blue Seal) – Construction of a new alignment that touches down on the Vermont side approximately 1,000 ft. south of the existing VT 119 touchdown area, and joins with Route 119 in New Hampshire slightly east of the George's Field/NH 119 intersection. The existing bridges would be rehabilitated and maintained for pedestrian/bicyclist usage. ***This is the project's preferred alternative.***

- **Alternative G** (Georgia Pacific) – Construction on a new alignment that touches down in Vermont approximately 1 mile south of the existing VT 119 touchdown area, and joins with Route 119 in New Hampshire south of the existing NH 119 touchdown location. The existing bridges would be rehabilitated and maintained for pedestrian/bicyclist usage.

- **Alternative H** (Route 9/Main Street) – Construction on a new alignment for the western bridge, which would touch down on the Vermont side to intersect with Route 9, approximately 1,000 ft. north of the existing VT 119 touchdown area, and joins with NH 119 south of the existing NH 119 touchdown location. The existing bridges would be rehabilitated and maintained for pedestrian/bicyclist usage.

2.) PREFERRED ALTERNATIVE DESCRIPTION

While considering input from public meetings and technical support of the Working Group, the Bridge Committee studied the full range of project alternatives and the potential resource impacts of each. In April 1998, the Bridge Committee recommended Alternative F (Blue Seal) as their preferred alternative. Alternative F also received unanimous acceptance from the Brattleboro Selectboard in a letter dated July 7, 1998 and was supported by the Hinsdale Board of Selectmen in a letter dated May 15, 1998. Selection of Alternative F as the project's preferred alternative was approved by the VAOT Secretary on November 25, 1998. NHDOT concurred with the identification of Alternative F as the preferred alternative. The Bridge Committee reaffirmed the selection of Alternative F as their preferred alternative in June 2000 and again in November of 2005. Recent correspondence from the Hinsdale Office of Selectmen and the Brattleboro Selectboard, dated February 27, 2012 and March 20, 2012 respectively, document continued support for the preferred alternative from both involved communities.

Alternative F Description

Alternative F would functionally replace both existing Route 119 bridges with a single bridge, to be located approximately 1,000 ft. south of the existing Route 119 western bridge and form a T-intersection with VT 142. In New Hampshire, Alternative F would slightly realign Route 119 roadway east of the Route 119 George's Field intersection (Exhibit C.1 – Alternative F). The new bridge is to be a steel I-beam girder bridge with aesthetic enhancements and a sidewalk on the upstream side. It would also allow a grade-separated railroad crossing in Vermont. Exhibit C.3 graphically depicts the proposed new bridge. The existing Route 119 bridges would remain open during the project, maintaining two lanes of traffic at all times during construction. After construction, the existing Route 119 bridges would be rehabilitated for pedestrian and bicycle usage and closed to motor vehicle traffic.

3.) ALTERNATIVES EVALUATION CRITERIA

An Alternative Evaluation Table was developed in consultation with the Brattleboro/Hinsdale Bridge Committee to provide a concise alternative evaluation and comparison analysis (see Page ES-9, Table ES-1 – Alternative Evaluation Table). Alternative F, highlighted in the following table, is the project's preferred alternative. Each of the ten project alternatives is analyzed in two areas:

a). PURPOSE AND NEED CRITERIA

The Alternative Evaluation Table also lists seven purpose and need criteria, which are derived from the project's purpose and need statement, and identifies the ability of each alternative to meet these criteria. The table was developed and utilized to summarize and evaluate the project's alternatives.

b). DESIGN CRITERIA

The construction section of the Alternative Evaluation Table presents ten categories involving construction, design, and cost determinations for each alternative. See notes at the bottom of the table for information on different construction and design options available for the alternatives.

D.) AFFECTED ENVIRONMENTS AND IMPACTS

1.) PROJECT ALTERNATIVES

Ten alternatives were identified and evaluated that would maintain the Route 119 transportation corridor between Brattleboro, VT and Hinsdale, NH. Since the project corridor is located along both the Vermont and New Hampshire shorelines of the Connecticut River, resources for both states were identified and evaluated.

Coordination with resource agencies, field investigations, archival research, and GIS data were used to identify and locate area resources. These resources and the 10 project alternatives were then sited onto a set of digital base maps (Exhibit A.6 – Natural Resources Map; Exhibit A.7– Historic & Archaeological Resources; and Exhibit A.8 – Hazardous Materials Map).

Alternative Evaluation Table ES-1

		ALTERNATIVE A	ALTERNATIVE B	ALTERNATIVE C	ALTERNATIVE D	ALTERNATIVE E	ALTERNATIVE E-Modified	ALTERNATIVE F	ALTERNATIVE G	ALTERNATIVE H
	No-Action	Rehabilitation	Replace on Existing	Alignment Improvement	Improvement and Grade Separated	Parallel Structure	Parallel Tangent Structure	Blue Seal (Preferred)	Georgia Pacific	Route 9/Main Street
PURPOSE AND NEED CRITERIA										
Maintain Transportation Corridor	No	No	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Correct Safety Deficiencies	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Correct Structural Deficiencies	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Correct Functional Deficiencies	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Maintain Social Relationships	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	No
Maintain Economic Relationships	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	No
Preserve Area Resources (11)	Yes	Yes	No	No	No	No	No	Yes	No	No
DESIGN CRITERIA										
Design Speed	N/A	25 mph (1)	35 mph (1)	35 mph	35 mph	35 mph	35 mph (1)	35 mph	35 mph	35 mph
Disposition of Existing Bridges	N/A	Used For Traffic	Removed	Removed	Removed	Options (2)	Options (2)	Options (2)	Options (2)	Options (2)
Bridge Typical Section (3)	N/A	10'-2"-10'-2"	10'-12'-12'-10'	10'-12'-12'-10'	10'-12'-12'-10'	10'-12'-12'-10'	10'-12'-12'-10'	10'-12'-12'-10'	10'-12'-12'-10'	10'-12'-12'-10'
Truss Bridge Feasibility (4)	N/A	Yes	Yes	Yes (5)	Yes (5, 6)	Yes (5)	Yes	Yes (6)	Yes (6)	Yes (5)
Grade-Separated Railroad Crossing	N/A	No	No	No	Yes	No (7)	No (7)	Yes	Yes	Yes
Cost for Coal Tar Remediation	N/A	$0	$1,000,000	$1,000,000	$1,000,000	$1,000,000	$1,000,000	$0 (8)	$0 (8)	$0 (8)
Cost for Truss Bridge	N/A	$0	$1,848,035	$833,700	$833,700	$1,903,615	$2,153,725	N/A (4)	$3,147,218	$2,153,725
Estimated ROW Costs	N/A	$0	Low	Low	High	Low	Low	High	Moderate	Moderate
Construction Costs (9)	N/A	$2,528,890	$12,977,930	$14,839,860	$28,526,435	$10,706,098	$10,706,098	$31,500,000	$31,444,385	$28,157,970
Traffic Maintenance During Construction	N/A	Staged Construction	Temporary Bridges	Temporary Bridges	Temporary Bridges	Existing Bridges	Existing Bridges	Existing Bridges	Existing Bridges	Existing (10) & Temporary

PURPOSE AND NEED RATINGS:
Yes - Alternative meets the purpose and need criteria.
No - Alternative does not meet the purpose and need criteria.

CONSTRUCTION NOTES:
(1) Due to design limitation, Alternatives A, B and E-Modified a design speed of 60 km/h (35 mph) is not achievable.
(2) With Alternatives E, E-Modified, F, G and H the existing bridges could be rehabilitated for pedestrians and bicyclists ($1,584,030), vehicle traffic ($1,917,510) or removed ($1,167,180).
(3) Preliminary design speeds and lane widths.
(4) Based upon the desire of the Bridge Committee to evaluate the potential of a new bridge to be a truss type bridge, which could aesthetically complement the existing Route 119 bridges. A project bridge design study is ongoing, which will consider aesthetic requirements. A trust bridge for Alternative F was removed from consideration during the bridge structure type study.
(5) For Alternatives C, D, E and H the east bridge could be a truss.
(6) For Alternative D, F and G, a portion of the bridge could be a truss.
(7) As shown, Alternative E and Alternative E-Modified do not include a grade-separated rail crossing. However, Alternative E and Alternative E-Modified could include a grade-separated rail crossing. The impacts would be similar to Alternative D, and the cost would increase by $11,380,005 over the cost shown for Alternative E and Alternative E-Modified.
(8) Alternatives F and G are south of the existing coal tar deposits, Alternative H is north of the coal tar deposits, estimated remediation costs are in 1984 dollars and would be substantially more in present day estimates.
(9) The costs for Alternative Assumes the existing Route 119 bridges are rehabilitated for vehicular traffic. The costs for Alternatives B, C, D and H assume the existing Route 119 bridges are removed. The costs for Alternatives E, E-Modified, F and G assume the existing Route 119 bridges are rehabilitated for pedestrian usage. **All construction costs are estimated in year 2008 dollars.**
(10) For Alternative H, the west bridge would be utilized for traffic during construction; construction of the east bridge would require a temporary bridge.
(11) See Resource Summary Table, pg. C-20, for individual environmental analyses for each category (see also, Appendix F).

2.) RESOURCE IMPACTS – NON-PREFERRED ALTERNATIVES

Each project alternative location was identified on GIS maps and in the field. Anticipated impacts to area resources were then identified and evaluated for each project alternative. Resource impacts associated with the non-preferred alternatives are fully identified and evaluated in Appendix F, summarized in Chapter D, and identified on Page D-45 in Table D-4 – Resource Summary Table. The Non-Preferred Alternatives are as follows:

- **No-Action Alternative**,
- **Alternative A** (Rehabilitation),
- **Alternative B** (Replace on Existing),
- **Alternative C** (Alignment Improvement),
- **Alternative D** (Grade-Separated),
- **Alternative E** (Parallel Structure),
- **Alternative E-Modified** (Parallel Tangent Structure),
- **Alternative G** (Georgia Pacific),
- **Alternative H** (Route 9/Main Street)

3.) RESOURCE IMPACTS – PREFERRED ALTERNATIVE

Potential resource impacts associated with construction and operation of the project's preferred alternative, **Alternative F**, are fully identified and evaluated in Chapter D, Table D-4, and are summarized below.

a). LAND USE/INDIRECT EFFECTS/CUMULATIVE IMPACTS

Construction of Alternative F would be consistent with area land uses, and result in minimal changes to existing land uses. The potential for indirect growth impact and project-related cumulative growth impacts is minimal. No land use/induced growth mitigation measures are required. This conclusion was reached in coordination with the appropriate Regional Planning Commissions, the town of Brattleboro, VT, and the town of Hinsdale, NH.

b). AGRICULTURAL

No agricultural lands would be impacted by construction of Alternative F. No agricultural mitigation measures are required.

c). SOCIO-ECONOMIC/ENVIRONMENTAL JUSTICE

Construction of Alternative F would have only limited impacts on the area's socio-economic environment. In NH, the reconfiguration of NH 119 would vary only slightly in alignment from the existing Route 119 alignment, and would provide continued vehicle access to the George's Field retail area. The proposed VT 119 touchdown location on Route 142 would be located approximately 1000 feet south of the existing touchdown location. This relocation would continue to provide vehicle access to the downtown Brattleboro area, as well as provide better access to the commercial and industrial areas that are found south on VT 142. Mitigation would consist of maintaining the existing Route 119 bridges for pedestrian and bicycle usage. No additional socio-economic mitigation measures are required.

No identifiable minority/low-income populations, as defined by E.O. 12898, exist within the project area and no environmental justice mitigation measures are required.

d). ACQUISITIONS

As the Vermont side of the project area is substantially more developed than the New Hampshire side, the potential for project residential/commercial acquisitions is greatest within the Vermont area. In Vermont, the following potential project-related acquisitions are identified:

- A residential structure on the west side of VT 142
- The North Country Naturals/Raymond James Metals commercial building (formerly occupied by Blue Seal) on the east side of VT 142
- Relocation of fuel storage tanks under, and adjacent to, the Alternative F alignment between the Vermont shoreline and VT 142
- Right-of-way easement over the NECR railroad line east of VT 142
- 25 parking spaces at the south end of the Marlboro College parking lot

In New Hampshire, the following acquisition is anticipated:

- Relocation of the private access road to Norm's marina and auto recycling center, south of NH 119.
- Private property on mid-channel island.

Total project acquisitions would involve approximately 3.7 acres. Mitigation would include an acquisition and relocation program that would be conducted in accordance with the Uniform Relocation Assistance and Real Property Acquisition Policy Act of 1970, as amended. Relocation assistance would be made available to all residential and business relocations without discrimination.

e). PEDESTRIAN/BICYCLE

Construction of Alternative F would improve the area's pedestrian and bicycle facilities. Pedestrian and bicycle access between downtown Brattleboro and the George's Field retail area in Hinsdale would be maintained, as the existing Route 119 bridges would be rehabilitated for pedestrian and bicycle usage. Also, the proposed new bridge would include a sidewalk on the upstream side, and shoulders. No additional pedestrian/bicycle mitigation measures are required.

f). RECREATIONAL FACILITIES

No area recreational facilities would be physically affected by construction of Alternative F. The Town of Brattleboro has identified the construction of a waterfront (Connecticut River) park as a potential future recreational area. This proposed waterfront park would be located in Vermont on the west bank of the Connecticut River, immediately adjacent to the existing Route 119 western landing. Alternative F would be south of the proposed waterfront facility, and would not impact it. Rehabilitation of the existing Route 119 bridges for pedestrian and bicycle usage would complement waterfront access and the new bridge alignment could enhance the proposed facility by routing traffic away from the proposed recreation area.

g). AIR QUALITY

Construction and operation of Alternative F would not materially alter existing area traffic flows and patterns. Project details were discussed with Vermont and New Hampshire State air quality resource agencies and a project area microscale carbon monoxide (CO) analysis was conducted. Based upon this coordination and CO testing, the project is not anticipated to result in any violations of National Ambient Air Quality Standards (NAAQS), and would not adversely impact existing ambient air quality levels. No air quality mitigation measures are required.

h). NOISE

Traffic noise is variable, and is affected by many factors. Noise level measurements were taken for existing noise levels in the project area. Future area noise levels, with and without Alternative F, were computed using the FHWA Traffic Noise Modeling (TNM) program, version 2.5.

Projected noise levels for the final condition exceeded FHWA Noise Abatement Criteria (NAC) at a single location, a private residence on the west side of VT Route 142 near the landing location. This residence will be acquired by the State and removed as part of the project's construction. Very limited project-related noise impacts are anticipated elsewhere in the evaluated area due to the construction of Alternative F. No noise abatement measures will be required.

i). WATER QUALITY

The Connecticut River is an important water resource for municipal drinking water, fisheries, recreation and wildlife. Project water quality impacts are primarily associated with construction-related activities. New bridge piers within the Connecticut River, associated with construction of Alternative F, may result in some limited and temporary impacts to the river's water quality. Stormwater discharges from the completed Alternative F bridge into the Connecticut River will also occur. However, net stormwater discharges are anticipated to be minimal and would have only a minimal effect upon the receiving waters. Coordination with resource agencies during the project's design phase would take place to insure that stormwater runoff is collected and treated prior to discharge. This condition would improve water quality in the project area relative to existing conditions where stormwater runoff from the existing bridges flows directly into the river. No additional water quality mitigation measures are required.

j). WETLANDS

Area wetlands adjacent to the Alternative F alignment include portions of the mid-channel island, a small wetland area adjacent to the NH 119 touchdown area, an NWI wetland in Vermont between VT 142 and the railroad, and an NWI wetland in New Hampshire south of the NH 119 touchdown area.

Depending upon final bridge design, constructing Alternative F could impact the mid-channel island wetland. The bridge could either pass over the island, or locate a support pier on the southern tip of the island. If the bridge passes over the island, no wetland impacts to the island are anticipated. If a bridge pier is located on the southern tip of the island, up to 0.11 acres of the island wetland could be impacted, depending on the pier size and location. No or very minimal wetland impacts are anticipated from new bridge abutment construction on the east or west banks of the river.

Alternative F's actual wetlands impacts would be determined upon final design. The project would comply with all wetland permitting conditions and requirements. No wetland mitigation would be required.

k). WATERBODY MODIFICATIONS

Alternative F would impact the Connecticut River as a result of the placement of bridge piers within the river, but these impacts are anticipated to be limited. Any construction-related water turbidity or sediment releases resulting in impacts would be short-term and confined largely to the areas of construction. Coordination with resource agencies and the use of BMPs would be utilized to reduce water turbidity and soil sedimentation during construction. No additional waterbody mitigation measures are required.

l). FLOODPLAINS

The proposed eastern and western Alternative F touchdown locations are both above the Connecticut River's 100-year floodplain. As such, any floodplain impacts of Alternative F would be minimal. This conclusion has been supported through consultation with the Federal Emergency Management Agency (FEMA).

Approximately six bridge piers would be located in the floodway of the Connecticut River. The pier spacing would not obstruct the river's floodway. No floodplain mitigation measures are required.

m). FISH AND WILDLIFE/THREATENED AND ENDANGERED SPECIES

The Connecticut River, and its associated shorelines, provide substantial habitat for fish and wildlife.

1). Fish and Wildlife

The Vermont touchdown location is in a developed commercial area with a bulk fuel depot found on the river's edge. The New Hampshire touchdown location has an automobile recycling area located on the upper riverbank and a marina located at the river's edge. The riparian zones, on both sides of the river, are already impacted by the existing development. As such, only limited impacts to the existing riverbank habitats are anticipated due to construction of Alternative F.

The operation of Alternative F would have only a minimal impact on existing fish habitats. Consultation with the United States Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) has supported this conclusion.

Some temporary impacts to fish and wildlife habitats are anticipated to occur during construction activities. The Vermont Fish and Wildlife Department has requested that construction be scheduled to minimize impacts on migrating and spawning fish. Coordination with resource agencies, the use of BMPs during construction, and compliance with construction erosion and sediment control requirements would be utilized to limit impacts to area fisheries. No additional fish and wildlife mitigation measures are required.

2). Threatened and Endangered Species

a) Dwarf Wedge Mussel (*Alasmidonta heterodon*)
The Connecticut River, in the vicinity of Brattleboro, likely supported historic colonies of Dwarf Wedge mussels, a federal endangered species. In 1999 a Dwarf Wedge mussel dive survey was conducted after coordination with both state and federal wildlife resource agencies. No protected mussel species were observed. A follow-up shoreline survey for the shells of this protected species was conducted in 2009. Again, there was no evidence to suggest that this protected species had re-colonized the project area. Based on the results of these field surveys no further project coordination or requirements regarding impacts to the federally endangered Dwarf Wedge mussel are required. No Dwarf Wedge mussel mitigation measures are required.

b) Rare, Fragile, and Sensitive Species
The VT Agency of Natural Resources (VANR) Non-Game Natural Heritage Program (NNHP) and the NH Natural Heritage Bureau (NHB), requested botanical field surveys to determine the presence of and potential project impacts to several rare plant species thought to occur in the area.

Based on field investigations conducted in 2009, only impacts to the local population of *Heteranthera dubia* could be considered noteworthy. This largely depends on the final bridge design and support pier placement. This species is common throughout much of North America but is listed as Endangered in NH since it is on the edge of its natural range. Only a few individuals of this species were observed in the project area and those were off the southern side of the mid-channel island. The NH NHB has requested that they be provided with conceptual plans once they are available. Continued coordination with the NH NHB will be necessary to develop a suitable mitigation strategy if impacts to the local population of this species are unavoidable.

n). HISTORIC

The existing Route 119 bridges are eligible for inclusion in the National Register of Historic Places. The September 5, 2000, VT and NH SHPO Section 106 Letter of Effect determined that the project would have No Adverse Effect on historic properties listed on or eligible for listing on the National Register of Historic Places, provided that the existing bridges are rehabilitated and retained for recreational use. The rehabilitation is to be done in accordance with the Secretary of Interior’s Standards, with VAOT and NHDOT sharing maintenance responsibilities. Also, the

Section 106 Letter of Effect states that community members from both Brattleboro and Hinsdale are to have meaningful input during the final bridge design process to ensure that the new Route 119 Bridge incorporates aesthetic elements to help it conform to the Historic character of the project area.

Project mitigation would consist of rehabilitating and maintaining the existing Route 119 bridges for recreational use, and incorporating certain aesthetic elements into the final bridge design. Overall, project impacts to area historic resources would be minimal. No additional historic mitigation measures are required.

o). ARCHAEOLOGICAL

The Connecticut River is an area of sensitivity for archaeological resources. Project archaeological investigations have determined that, although numerous Euro-American artifacts exist along the Alternative F alignment on both sides of the river, none of the artifacts are from intact archaeological deposits and these artifacts are not considered eligible for the National Register of Historic Places. No Native American artifacts were identified during these surveys. Additionally, the mid-channel island, within the Alternative F alignment area, was determined to have a low potential for intact archaeological resources.

The September 5, 2000, VT and NH SHPO Section 106 Letter of Effect determined the project would have no potential to cause effects on identified archaeological resources. No archaeological mitigation requirements are proposed.

p). HAZARDOUS MATERIALS

Alternative F would have only minimal impacts on any identified hazardous waste sites. The Vermont touchdown area would pass over an existing bulk fuel storage area, which would require either partial or complete relocation. There is an identified hazardous waste site in Brattleboro, consisting of coal tar residues near the existing Route 119 landing. Long-term monitoring of the coal tar residue has determined that the deposit is largely non-migratory and is found approximately 800 feet north of the Alternative F alignment. Construction of Alternative F would not impact these coal tar deposits.

The Alternative F touchdown area in New Hampshire would be adjacent to a marina and auto recycling center. Only the northern and northeastern portions of this area would be affected, not the center and eastern areas of the property where past auto recycling activities have occurred. As such, Alternative F is not anticipated to have any impact to hazardous waste site locations in New Hampshire.

The potential for Alternative F to impact any hazardous materials is minimal. Care will be exercised during the relocation of the Vermont bulk fuel storage tanks, currently situated between the VT shoreline and the New England Central Railroad, and any petroleum releases associated with this relocation effort would be remediated. No additional hazardous materials mitigation requirements are proposed.

q). VISUAL

The Connecticut River corridor, in the project area, has exceptional aesthetic qualities. The visual impacts associated with Alternative F largely depend on the final design of the bridge structure, which has not yet been fully determined. The Alternative F location does not incorporate the mid-channel island as part of the crossing so it requires a long structure to cross the river, mid-span supporting piers, and an elevated travel deck to accommodate a grade-separated railroad crossing in Vermont. Both the piers and high roadway could be considered a visual impact. The roadway elevation of Alternative F, at the Vermont shoreline, is estimated to be at an elevation approximately equal to the top of the truss structure of the existing western Route 119 Bridge.

Although the proposed structure associated with Alternative F would be longer and higher than other bridges in the vicinity, design elements could be incorporated that would allow it to better fit the surrounding context. Mitigation for potential visual impacts would involve selecting bridge design elements that conform to the historic and aesthetic context of the surrounding area. Both communities have identified visual effects as an important criterion in selecting a bridge design and are to have input on its final design.

The existing Route 119 bridges would be rehabilitated in accordance with the Secretary of Interior's Standards and within parameters designed to maintain their historic character. No additional visual mitigation measures are required.

r). CONSTRUCTION

Alternative F would result in limited temporary impacts to the project area during the construction phase of the project. Temporary construction impacts are anticipated primarily for traffic, noise, air and water quality, and wildlife habitat.

No long-term rerouting of traffic would be necessary for the project, as the existing Route 119 bridges would remain open until construction of the new Alternative F Bridge is completed. The requirement to change roadway elevations on VT 142, to provide for the new Alternative F Route 119/142 intersection, may necessitate the temporary closure of VT 142 in the project area.

Air quality and noise impacts, due to construction, would be generally periodic and temporary in nature and located adjacent to construction areas. Locations along VT 142, and areas on the eastern shore of the Connecticut River in New Hampshire, may notice a greater increase in noise and dust levels during construction due to their proximity to the project site. Noise and air quality impacts can be reduced by the use of construction scheduling, public notices, monitored equipment usage, and dust reduction practices.

While construction water quality impacts cannot be avoided, they can be minimized by utilization of best management construction practices, sedimentation and erosion controls, seasonal scheduling of work, and coordination with the governmental and business communities in Brattleboro, Vermont and Hinsdale, New Hampshire. No additional construction-related mitigation requirements are proposed.

4.) RESOURCE SUMMARY

Resources, and the impact of each alternative on these resources, are presented in the following Resource Summary Table. The column associated with Alternative F, the project's Preferred Alternative, is highlighted. Several Alternatives require temporary bridges to maintain traffic during construction, which substantially increases the project's impact area. Alternative F, the project's preferred alternative, does not require a temporary bridge and thereby minimizes the project's area of impact.

For those resources, that did not lend themselves to quantitative analysis, the Bridge Committee identified the following qualitative descriptors to assist in describing an alternative's potential impact upon identified resources:

- None
- Minimal
- Limited
- Moderate
- Substantial

Resource Summary Table

RESOURCE		ALTERNATIVE A	ALTERNATIVE B	ALTERNATIVE C	ALTERNATIVE D	ALTERNATIVE E	ALTERNATIVE E Modified	ALTERNATIVE F	ALTERNATIVE G	ALTERNATIVE H
	No-Action	**Rehabilitation**	**Replace on Existing**	**Alignment Improvement**	**Grade-Separated**	**Parallel Structure**	**Parallel Tangent Structure**	**Blue Seal (Preferred)**	**Georgia Pacific**	**Route 9/Main Street**
Land Use/Induced Growth	None/ Minimal	Minimal/ Minimal	Minimal/ Minimal	Minimal/ Minimal	Substantial/ Minimal	Minimal/ Minimal	Minimal/ Minimal	Minimal/ Minimal	Minimal/ Minimal	Moderate/ Minimal
Agricultural	None	None	None	None	None	None	None	None	None	None
Socio-economic/Enviro Justice	Substantial/ None	Limited/None	Limited/None	Limited/None	Substantial/ None	Limited/None	Limited/None	Limited/None	Substantial/ None	Substantial/ None
Acquisitions-Residential/ Commercial	0 / 0	0 / 0	0 / 2	0 / 2	0 / 13	0 / 1	0 / 1	1 / 1	0 / 0	0 / 4
Acquisition Area (acres)	0	0	0.35	0.49	2.05	1.46	1.4	3.21	4.23	0.94
Pedestrian/Bicycle	None	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Recreational/Section 4(f) **(Alternatives A, B, C, E, and E-Modified would have no 4(f) impacts if the existing bridges are rehabilitated and maintained)**	None/ None	Minimal/ Minimal	Minimal/ Substantial	Minimal/ Moderate	Minimal/ Substantial	Minimal/ Moderate	Minimal/ Moderate	Minimal/ None	Minimal/ None	Minimal/ Substantial
Air Quality	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Noise	Limited	Limited	Limited	Limited	Moderate	Limited	Limited	Limited	Limited	Moderate
Water Quality	None	Minimal	Limited	Limited	Limited	Substantial	Substantial	Limited	Limited	Limited
Wetlands (acres)	None	Minimal	1.68	1.85	2.53	1.60	1.91	0.11	0.66	2.74
Waterbody Modifications	None	None	Limited	Limited	Limited	Limited	Limited	Limited	Limited	Limited
Floodplains (acres)	None	Minimal	1.94	2.08	3.07	1.71	2.07	0.12	3.42	2.92
Fish & Wildlife/Threatened & Endangered Species **(Potential impacts to two NH-listed aquatic plants)**	None / None	Minimal / None	Minimal / Minimal	Limited / Minimal	Limited / Minimal	Limited / Minimal	Limited / Minimal	Limited / Minimal	Limited / None	Limited / Minimal
Historic District Impacts	None	None	Substantial	Substantial	Substantial	Moderate	Moderate	Minimal	Minimal	Substantial
Archaeological	None	None	Limited	Limited	Limited	Limited	Limited	None	Minimal	Limited
Hazardous Materials	None	None	Minimal (Substantial)	Minimal (Substantial)	Minimal (Substantial)	Substantial	Substantial	Minimal	Minimal	Minimal
Visual	None	None	Minimal	Minimal	Substantial	Moderate	Moderate	Limited	Limited	Substantial
Construction	None	Minimal	Limited	Limited	Substantial	Limited	Limited	Limited	Limited	Substantial

***QUALITATIVE DESCRIPTORS (As Determined by the Bridge Committee)*:**

- None
- Minimal
- Limited
- Moderate
- Substantial

Note: Permanent impacts only; temporary impacts are discussed in report text.

E.) COMMENTS AND COORDINATION

1.) PUBLIC PARTICIPATION

Identification of Alternative F as the project's preferred alternative was accomplished after an extensive, thorough, and lengthy public participation process.

At the initiation of the current project in December 1992, local and regional inputs were utilized to identify area transportation requirements and deficiencies to the existing Route 119 transportation corridor. To facilitate these inputs, the Windham Regional Commission (WRC) organized a Brattleboro/Hinsdale Bridge Committee (Bridge Committee). The Bridge Committee members included representatives from the Brattleboro Selectboard (VT), Hinsdale Selectmen (NH), Windham Regional Commission (VT), Southwest Regional Planning Commission (NH), the Town of Chesterfield (NH), local citizens, and representatives from area social services, emergency services and local interest groups.

The purpose of the Bridge Committee was initially to identify area transportation needs and potential solutions to these transportation needs. Subsequent Committee tasks included: assisting VAOT to conduct public informational forums, the identification and evaluation of project alternatives, the identification and evaluation of project resource impacts, and to provide input to identify a preferred project alternative.

Two public informational meetings were held by the Bridge Committee. At the second public informational meeting, an informal poll of the approximately eighty-five people present showed a strong preference for the two most southern alternatives: Alternative F (Blue Seal) and Alternative G (Georgia Pacific).

The Bridge Committee met sixteen times between February 1996 and June 2000. Bridge Committee meetings were open to the public and held in both Brattleboro and Hinsdale. In April 1998, the Bridge Committee identified Alternative F as the project's Preferred Alternative. On June 6, 2000, the Bridge Committee reaffirmed its support of Alternative F as the project's Preferred Alternative.

The Bridge Committee subsequently met several times with NHDOT between 2001 and 2002 to help evaluate potential bridge types and designs. In January 2005, the Bridge Committee reconvened to consider NHDOT's identification of a steel I-beam/concrete deck bridge as the bridge type to be constructed. During 2005, the Bridge Committee met several additional times with NHDOT to provide input on bridge design elements that would retain the functionality of the bridge, while complimenting area aesthetic qualities. In November 2005, the Bridge Committee affirmed NHDOT's identification of a steel I-beam girder bridge, with aesthetic enhancements, as the new Route 119 bridge type.

In early 2012, VAOT requested that community leaders from both Brattleboro and Hinsdale reaffirm their support of the Preferred Alternative. The project was discussed at the February meeting of Hinsdale's Board of Selectmen and continued support for the Preferred Alternative was documented in a letter from that office dated February 27, 2012. The proposed work was similarly discussed by the Brattleboro Selectboard at their March meeting, which also resulted in a letter of support for the Preferred Alternative dated March 20, 2012.

A public meeting was held August 1, 2013 in conjunction with a 30 day public comment period which began July 15. The EA document was made available to the public at several locations for its review. At the meeting the project, alternatives and preferred alternative were presented, and then comments and questions were received. This meeting was held to meet the public comment requirement under NEPA, transcripts and comments are included in Appendix E.

2.) AGENCY COORDINATION

To facilitate the early involvement of federal and state agencies, notice was mailed to federal and state resource agencies of an April 10, 1996 Agency Concerns meeting in Brattleboro, Vermont. The notice provided a brief description of the project and a request for agency comments. At the April 10, 1996 Agency Concerns meeting, the project's purpose and need along with a brief project history, were set forth and additional project comments were solicited.

A project description and area location map were sent to affected resource agencies on August 28, 1996 with a request for additional resource agency comments. On December 16, 1996 a copy of the project's purpose and need statement was mailed to federal and state agencies with a request for agency comments. On January 2, 1998 a copy of the pre-conceptual design drawings of the ten identified project alternatives, an alternative evaluation table, and a copy of the purpose and need statement were mailed to federal and state agencies with a request for comments.

In October 2005, a project status letter with project alternatives and resource impacts maps and matrices, were forwarded to the COE, VANR, and NHDES, with a request for additional project comments. Extensive project coordination has occurred with, and between, the Vermont and New Hampshire State Historic Preservation Officers (SHPO).

3.) PROJECT COMMITMENTS

Federal, state, regional, and municipal agencies, as well as public interest groups, have all been involved with the project since its inception. As a result of this public and agency communication, and extensive public involvement the following project commitments have been made (see Chapter D & E):

- A new committee of community leaders from both Hinsdale and Brattleboro will be formed to provide feedback on the final design of Alternative F's new bridge. The committee's input during the design process will consider aesthetic compatibility as a criterion when determining a final design.

- NHDOT and VAOT are to minimally rehabilitate the existing Route 119 bridges in accordance with the Secretary of Interior's Standards for pedestrians, bicycle or an alternative transportation use.

- VAOT and NHDOT are to share maintenance responsibilities for the rehabilitated Route 119 bridges.

- Right-of-Way Acquisition – Alternative F would require the acquisition of an existing residential structure and an existing commercial building on VT 142 near the VT touchdown location. Relocation assistance will be conducted in accordance with the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended.

- During any removal of fuel tanks, care will be exercised to minimize the potential for petroleum releases, and any releases will be remediated.

- Coordination will be conducted with the VT Fish and Wildlife Department, NH Fish and Game Department, and the National Marine Fisheries Service, to schedule construction activities to minimize impacts on migrating and spawning fish.

- Impacts to two NH-listed Endangered plants, known to occur in the project area, will be determined once preliminary design plans are available and communicated to the NH Natural Heritage Bureau. If impacts to the local populations are determined to be significant and unavoidable, suitable mitigation measures will be implemented as required.

- Best Management Practices, for erosion prevention and sediment control will be utilized during all phases of construction, both on-shore and in-water, to minimize project-related impacts to water quality.

- During construction, efforts will be made to continually minimize and mitigate construction-related impacts to traffic, air, noise, and water quality in the project area.

4.) FEDERAL AND STATE REQUIREMENTS

Project Permitting - Dependent upon final project design, the following federal and state permits will likely be required for the project:

- NHDES 401 Water Quality Certificate
- NHDES Dredge and Fill Permit
- NHDES Wetland Permit
- VANR Vermont Stream Alteration Permit
- COE 404 Wetlands Permit
- COE Section 9 or 10 Navigable Waterways Permit
- VT 401 Water Quality Certificate
- National Pollution Discharge Elimination System (NPDES) Permit
- VT Stormwater Discharge Permit
- Vermont Act 250 Land Use Permit

It is anticipated that all applicable permits will be obtained.

5.) OTHER PROPOSED FEDERAL AND STATE PROJECTS

In Vermont, the Brattleboro Waterfront Park project is proposed for the property immediately south of the existing Route 119 landing. This project was initiated sometime in 2012 and includes a terrace overlooking the river, landscaping, reconfigured parking, and a boat mooring area. No other federal or state projects are known to be planned for the area immediately adjacent to this project's location in either Vermont or New Hampshire.

Appendix B

Traffic Data

Appendix B1

MOE 2020 PM Peak Existing (With Train)

1: Canal St/Main St & VT 142 & Brattleboro Co-op/VT 119 Performance by approach

Approach	EB	WB	NB	SB	NW	All
Denied Delay (hr)	0.1	0.0	71.4	20.0	0.1	91.6
Denied Del/Veh (s)	2.9	0.2	544.4	124.6	1.3	191.4
Total Delay (hr)	1.0	3.6	15.2	15.3	2.6	37.8
Total Del/Veh (s)	27.9	37.1	154.8	95.0	47.5	84.5
Stop Delay (hr)	0.9	3.4	14.9	14.3	2.5	36.1
Stop Del/Veh (s)	26.9	35.2	151.3	88.5	45.7	80.6
Travel Dist (mi)	4.6	15.2	19.6	51.5	39.5	130.4
Travel Time (hr)	1.3	4.4	87.6	37.6	4.4	135.3
Avg Speed (mph)	4	3	1	3	9	3
Fuel Used (gal)	0.4	1.3	20.6	10.0	1.8	34.1
Fuel Eff. (mpg)	11.7	11.6	1.0	5.2	21.7	3.8
HC Emissions (g)	2	9	39	43	6	98
CO Emissions (g)	65	224	1495	1221	242	3246
NOx Emissions (g)	7	23	48	98	23	198
Density (ft/veh)	320	92	34	52	480	99

2: Depot St/Whetstone Sta & VT 119/NH 119 Performance by approach

Approach	EB	WB	NB	SB	All
Denied Delay (hr)	0.0	0.0	0.0	0.0	0.0
Denied Del/Veh (s)	0.0	0.0	0.1	0.1	0.0
Total Delay (hr)	0.0	2.2	0.0	0.3	2.6
Total Del/Veh (s)	0.3	24.8	7.2	31.3	10.9
Stop Delay (hr)	0.0	1.8	0.0	0.3	2.1
Stop Del/Veh (s)	0.0	20.4	6.1	31.3	9.1
Travel Dist (mi)	5.8	95.8	1.3	0.4	103.4
Travel Time (hr)	0.3	5.0	0.1	0.3	5.7
Avg Speed (mph)	21	19	14	1	18
Fuel Used (gal)	0.2	2.8	0.0	0.1	3.1
Fuel Eff. (mpg)	28.6	34.2	30.9	5.5	33.1
HC Emissions (g)	1	28	0	0	29
CO Emissions (g)	27	448	5	4	483
NOx Emissions (g)	5	78	1	0	84
Density (ft/veh)		314			366

9: NH 119 & Georges Field Road Performance by approach

Approach	EB	WB	SB	All
Denied Delay (hr)	0.0	0.0	0.0	0.1
Denied Del/Veh (s)	0.0	0.4	2.3	0.3
Total Delay (hr)	0.3	0.0	0.1	0.4
Total Del/Veh (s)	2.2	0.5	5.2	1.8
Stop Delay (hr)	0.0	0.0	0.1	0.1
Stop Del/Veh (s)	0.1	0.0	4.7	0.3
Travel Dist (mi)	109.8	54.5	2.5	166.8
Travel Time (hr)	3.5	1.7	0.2	5.4
Avg Speed (mph)	31	34	12	31
Fuel Used (gal)	2.9	1.6	0.1	4.6
Fuel Eff. (mpg)	37.3	34.9	31.8	36.4
HC Emissions (g)	21	20	0	41
CO Emissions (g)	357	484	9	850
NOx Emissions (g)	73	63	1	137
Density (ft/veh)	685	1157		895

13: VT 119 & NECR Performance by approach

Approach	NE	SW	All
Denied Delay (hr)	0.0	0.0	0.0
Denied Del/Veh (s)	0.0	0.0	0.0
Total Delay (hr)	0.6	0.3	0.9
Total Del/Veh (s)	4.5	3.5	4.1
Stop Delay (hr)	0.5	0.3	0.8
Stop Del/Veh (s)	3.7	2.9	3.4
Travel Dist (mi)	24.0	4.9	29.0
Travel Time (hr)	2.0	0.5	2.6
Avg Speed (mph)	12	9	11
Fuel Used (gal)	1.6	0.2	1.8
Fuel Eff. (mpg)	14.7	25.1	15.8
HC Emissions (g)	13	1	14
CO Emissions (g)	496	34	531
NOx Emissions (g)	62	5	66
Density (ft/veh)	136	134	176

Total Network Performance

Denied Delay (hr)	91.7
Denied Del/Veh (s)	184.0
Total Delay (hr)	42.6
Total Del/Veh (s)	89.8
Stop Delay (hr)	39.1
Stop Del/Veh (s)	82.6
Travel Dist (mi)	845.0
Travel Time (hr)	164.0
Avg Speed (mph)	12
Fuel Used (gal)	58.5
Fuel Eff. (mpg)	14.5
HC Emissions (g)	324
CO Emissions (g)	9508
NOx Emissions (g)	1006
Density (ft/veh)	200

Total delay due to train conflict is estimated to be:

42.6 hr - 36.6 hr = 6.0 hr

Appendix B2

MOE 2020 PM Peak Existing (Without Train)

1: Canal St/Main St & VT 142 & Brattleboro Co-op/VT 119 Performance by approach

Approach	EB	WB	NB	SB	NW	All
Denied Delay (hr)	0.1	0.0	42.9	8.0	0.1	51.0
Denied Del/Veh (s)	2.9	0.3	326.8	49.5	1.3	106.6
Total Delay (hr)	0.8	3.1	14.9	13.0	2.9	34.7
Total Del/Veh (s)	23.2	31.5	128.0	80.4	53.0	74.6
Stop Delay (hr)	0.8	2.9	14.4	12.0	2.8	32.9
Stop Del/Veh (s)	22.2	29.6	123.8	74.4	51.0	70.8
Travel Dist (mi)	4.6	15.2	23.5	51.6	39.5	134.4
Travel Time (hr)	1.1	3.9	59.0	23.2	4.7	91.9
Avg Speed (mph)	4	4	1	3	8	3
Fuel Used (gal)	0.3	1.2	14.2	6.7	1.9	24.2
Fuel Eff. (mpg)	13.3	12.9	1.7	7.7	20.9	5.5
HC Emissions (g)	1	7	27	33	6	74
CO Emissions (g)	56	195	1060	952	247	2510
NOx Emissions (g)	5	19	42	87	24	178
Density (ft/veh)	369	105	34	60	449	106
Occupancy (veh)	1	4	16	15	5	41

2: Depot St/Whetstone Sta & VT 119/NH 119 Performance by approach

Approach	EB	WB	NB	SB	All
Denied Delay (hr)	0.0	0.0	0.0	0.0	0.0
Denied Del/Veh (s)	0.0	0.0	0.1	0.1	0.0
Total Delay (hr)	0.0	0.2	0.0	0.1	0.4
Total Del/Veh (s)	0.2	2.5	7.5	6.5	1.4
Stop Delay (hr)	0.0	0.0	0.0	0.1	0.1
Stop Del/Veh (s)	0.0	0.1	6.4	6.3	0.4
Travel Dist (mi)	6.2	95.8	1.3	0.4	103.8
Travel Time (hr)	0.3	3.0	0.1	0.1	3.5
Avg Speed (mph)	21	32	13	5	30
Fuel Used (gal)	0.2	2.4	0.0	0.0	2.6
Fuel Eff. (mpg)	28.3	40.5	32.1	19.0	39.2
HC Emissions (g)	1	24	0	0	25
CO Emissions (g)	31	375	4	1	410
NOx Emissions (g)	5	77	0	0	82
Density (ft/veh)		525			598
Occupancy (veh)	0	3	0	0	3

9: NH 119 & Georges Field Road Performance by approach

Approach	EB	WB	SB	All
Denied Delay (hr)	0.0	0.0	0.0	0.1
Denied Del/Veh (s)	0.0	0.4	2.3	0.3
Total Delay (hr)	0.3	0.0	0.1	0.4
Total Del/Veh (s)	2.1	0.5	5.6	1.7
Stop Delay (hr)	0.0	0.0	0.1	0.1
Stop Del/Veh (s)	0.1	0.0	5.1	0.4
Travel Dist (mi)	114.9	54.5	2.5	171.9
Travel Time (hr)	3.6	1.7	0.2	5.5
Avg Speed (mph)	32	34	12	31
Fuel Used (gal)	3.1	1.6	0.1	4.7
Fuel Eff. (mpg)	37.3	35.1	29.8	36.5
HC Emissions (g)	22	20	0	42
CO Emissions (g)	369	474	11	854
NOx Emissions (g)	76	63	1	139
Density (ft/veh)	659	1159		872
Occupancy (veh)	4	2	0	5

13: VT 119 & NECR Performance by approach

Approach	NE	SW	All
Denied Delay (hr)	0.0	0.0	0.0
Denied Del/Veh (s)	0.0	0.0	0.0
Total Delay (hr)	0.1	0.1	0.2
Total Del/Veh (s)	1.0	0.5	0.8
Stop Delay (hr)	0.0	0.0	0.0
Stop Del/Veh (s)	0.2	0.1	0.2
Travel Dist (mi)	25.7	4.9	30.7
Travel Time (hr)	1.7	0.3	1.9
Avg Speed (mph)	15	19	16
Fuel Used (gal)	1.6	0.1	1.8
Fuel Eff. (mpg)	15.7	43.6	17.5
HC Emissions (g)	14	1	15
CO Emissions (g)	540	23	562
NOx Emissions (g)	67	3	69
Density (ft/veh)	166		235
Occupancy (veh)	2	0	2

Total Network Performance

Denied Delay (hr)	51.1
Denied Del/Veh (s)	102.5
Total Delay (hr)	36.6
Total Del/Veh (s)	74.2
Stop Delay (hr)	33.3
Stop Del/Veh (s)	67.6
Travel Dist (mi)	874.7
Travel Time (hr)	118.5
Avg Speed (mph)	13
Fuel Used (gal)	48.8
Fuel Eff. (mpg)	17.9
HC Emissions (g)	301
CO Emissions (g)	8892
NOx Emissions (g)	1006
Density (ft/veh)	214
Occupancy (veh)	67

Appendix B3

WBAPS Report

Annual WBAPS 2017

WEB ACCIDENT PREDICTION SYSTEM

Accident Prediction Report for Public at-Grade Highway-Rail Crossings

Including:

Disclaimer/Abbreviation Key
Accident Prediction List
Collision History

Provided by:

Federal Railroad Administration
Office of Safety Analysis
Highway-Rail Crossing Safety & Trespass Prevention

Data Contained in this Report:

Crossing: 247794v'

Date Prepared: 10/3/2017

U.S. Department
of Transportation
**Federal Railroad
Administration**

USING DATA PRODUCED BY WBAPS

(Web Accident Prediction System)

1200 New Jersey Avenue, SE
Third Floor West
Washington, DC 20590

WBAPS generates reports listing public highway-rail intersections for a State, County, City or railroad ranked by predicted collisions per year. These reports include brief lists of the Inventory record and the collisions over the last 10 years along with a list of contacts for further information. These data were produced by the Federal Railroad Administration's Web Accident Prediction System (WBAPS).

WBAPS is a computer model which provides the user an analytical tool, which combined with other site-specific information, can assist in determining where scarce highway-rail grade crossing resources can best be directed. This computer model does not rank crossings in terms of most to least dangerous. Use of WBAPS data in this manner is incorrect and misleading.

WBAPS provides the same reports as PCAPS, which is FRA's PC Accident Prediction System. PCAPS was originally developed as a tool to alert law enforcement and local officials of the important need to improve safety at public highway-rail intersections within their jurisdictions. It has since become an indispensable information resource which is helping the FRA, States, railroads, Operation Lifesaver and others, to raise the awareness of the potential dangers at public highway-rail intersections. The PCAPS/WBAPS output enables State and local highway and law enforcement agencies identify public highway-rail crossing locations which may require additional or specialized attention. It is also a tool which can be used by state highway authorities and railroads to nominate particular crossings which may require physical safety improvements or enhancements.

The WBAPS accident prediction formula is based upon two independent factors (variables) which includes (1) basic data about a crossing's physical and operating characteristics and (2) five years of accident history data at the crossing. These data are obtained from the FRA's inventory and accident/incident files which are subject to keypunch and submission errors. Although every attempt is made to find and correct errors, there is still a possibility that some errors still exist. Erroneous, inaccurate and non-current data will alter WBAPS accident prediction values. While approximately 100,000 inventory file changes and updates are voluntarily provided annually by States and railroads and processed by FRA into the National Inventory File, data records for specific crossings may not be completely current. Only the intended users (States and railroads) are really knowledgeable as to how current the inventory data is for a particular State, railroad, or location.

It is important to understand the type of information produced by WBAPS and the limitations on the application of the output data. WBAPS does not state that specific crossings are the most dangerous. Rather, the WBAPS data provides an indication that conditions are such that one crossing may possibly be more hazardous than another based on the specific data that is in the program. It is only one of many tools which can be used to assist individual States, railroads and local highway authorities in determining where and how to initially focus attention for improving safety at public highway-rail intersections. WBAPS is designed to nominate crossings for further evaluation based only upon the physical and operating characteristics of specific crossings as voluntarily reported and updated by States and railroads and five years of accident history data.

PCAPS and WBAPS software are not designed to single out specific crossings without considering the many other factors which may influence accident rates or probabilities. State highway planners may or may not use PCAPS/WBAPS accident prediction model. Some States utilize their own formula or model which may include other geographic and site-specific factors. At best, PCAPS and WBAPS software and data nominates crossings for further on-the-ground review by knowledgeable highway traffic engineers and specialists. The output information is not the end or final product and the WBAPS data should not be used for non-intended purposes.

It should also be noted that there are certain characteristics or factors which are not, nor can be, included in the WBAPS database. These include sight-distance, highway congestion, bus or hazardous material traffic, local topography, and passenger exposure (train or vehicle), etc. Be aware that PCAPS/WBAPS is only one model and that other accident prediction models which may be used by States may yield different, by just as valid, results for ranking crossings for safety improvements.

Finally, it should be noted that this database is not the sole indicator of the condition of a specific public highway-rail intersection. The WBAPS output must be considered as a supplement to the information needed to undertake specific actions aimed at enhancing highway-rail crossing safety at locations across the U.S. The authority and jurisdiction to appropriate resources towards the safety improvement or elimination of specific crossings lies with the individual States.

U.S. Department
of Transportation
**Federal Railroad
Administration**

1200 New Jersey Avenue, SE
Third Floor West
Washington, DC 20590

ABBREVIATION KEY

for use with WBAPS Reports

The lists produced are only for public at-grade highway-rail intersections for the entity listed at the top of the page. The parameters shown are those used in the collision prediction calculation.

RANK:	Crossings are listed in order and ranked with the highest collision prediction value first.
PRED COLLS:	The accident prediction value is the probability that a collision between a train and a highway vehicle will occur at the crossing in a year.
CROSSING:	The unique sight specific identifying DOT/AAR Crossing Inventory Number.
RR:	The alphabetic abbreviation for the railroad name.
CITY:	The city in (or near) which the crossing is located.
ROAD:	The name of the road, street, or highway (if provided) where the crossing is located.
NUM OF COLLISIONS:	The number of accidents reported to FRA in each of the years indicated. Note: Most recent year is partial year (data is not for the complete calendar year) unless Accidents per Year is 'AS OF DECEMBER 31'.
DATE CHG:	The date of the latest change of the warning device category at the crossing which impacts the collision prediction calculation, e.g., a change from crossbucks to flashing lights, or flashing lights to gates. The accident prediction calculation utilizes three different formulas, on each for (1) passive devices, (2) flashing lights only, and (3) flashing lights with gates. When a date is shown, the collision history prior to the indicated year-month is not included in calculating the accident prediction value.
WD:	The type of warning device shown on the current Inventory record for the crossing where: FQ=Four Quad Gates; GT = All Other Gates; FL = Flashing lights; HS = Wigwags, Highway Signals, Bells, or Other Activated; SP = Special Protection (e.g., a flagman); SS = Stop Signs; XB = Crossbucks; OS = Other Signs or Signals; NO = No Signs or Signals.
TOT TRNS:	Number of total trains per day.
TOT TRKS:	Total number of railroad tracks between the warning devices at the crossing.
TTBL SPD:	The maximum timetable (allowable) speed for trains through the crossing.
HWY PVD:	Is the highway paved on both sides of the crossing?
HWY LNS:	The number of highway traffic lanes crossing the tracks at the crossing.
AADT:	The Average Annual Daily Traffic count for highway vehicles using the crossing.

PUBLIC HIGHWAY-RAIL CROSSINGS RANKED BY PREDICTED ACCIDENTS PER YEAR AS OF 12/31/2016*

*Num of Collisions: Most recent year is partial year (data is not for the complete calendar year) unless Accidents per Year is 'AS OF DECEMBER 31'.

RANK	PRED COLLS.	CROSSING	RR	STATE	COUNTY	CITY	ROAD	NUM OF COLLISIONS 16*	15	14	13	12	DATE CHG	W D	TOT TRN	TOT TRK	TTBL SPD	HWY PVD	HWY LNS	AADT
1	0.019411	247794V	NECR	VT	WINDHAM	BRATTLEBORO	VT 119	0	0	0	0	0		GT	7	2	20	YES	2	11,100
TTL:	**0.019411**							**0**	**0**	**0**	**0**	**0**								

TEN YEAR COLLISION HISTORY AT PUBLIC AT-GRADE CROSSINGS ON THE ACCIDENT PREDICTION LIST

Crossing	Date/Time	Railroad	City/hwy	Highway User/ User Speed	Type Track/ Train Speed	Weather	Circumstances/ View of Track Obstructed	Warning Devices/ Operating?	Interc/ Lights	# Killed / # Injured

Total Accidents: **0**

Total accidents this report: **0**

Appendix B4

Volume Calculations

10/4/17 Average Midday Hourly Volume Calculation

Calc By: SBH

Checked By: TMC
10/4/2017

Location: VT 119 Railroad Crossing - Brattleboro

Available Count: 11,100 vpd (AADT) from Federal Railroad Administration
@ Crossing WBAPS 2017

Available 24 hr Count: 8,100 vpd (AADT) from NHDOT count Station #219055
@ VT SL 2013

Comparison: 11,100 / 8,100 = 1.37

Volume at RR crossing is 1.37 Volume at VT SL

Average Midday Hourly Volume Calculation:

Midday = 10 AM to 2PM

Average Weekday Midday Count @ STA: 219055 = 649 vph

649 vph * 1.37 = 889.13, say 890 vph

Average Midday Hourly Volume = 890 vehicles per hour (vph)

Assume 50/50 Directional Split

*PUBLIC HIGHWAY-RAIL CROSSINGS RANKED BY PREDICTED ACCIDENTS PER YEAR AS OF 12/31/2016**

*Num of Collisions: Most recent year is partial year (data is not for the complete calendar year) unless Accidents per Year is 'AS OF DECEMBER 31'.

RANK	PRED COLLS.	CROSSING	RR	STATE	COUNTY	CITY	ROAD	NUM OF COLLISIONS					DATE CHG	WD	TOT TRN	TOT TRK	TTBL SPD	HWY PVD	HWY LNS	AADT
								16*	15	14	13	12								
1	0.019411	247794V	NECR	VT	WINDHAM	BRATTLEBORO	VT 119	0	0	0	0	0		GT	7	2	20	YES	2	11,100 ✓
TTL:	**0.019411**							**0**	**0**	**0**	**0**	**0**								

STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION
BUREAU OF TRAFFIC

Bureau of Planning, Traffic Section, Traffic Reports

18-Feb-16

STAT.	TYPE	LOCATION	FC	2008	2009	2010	2011	2012	2013	2014	2015
Town: HINSDALE											
219011	82	NH 119 (BRATTLEBORO RD) SOUTH OF PIERCE RD	07	*	5300	*	*	7300	*	*	6800
219012	82	NH 63/NH 119 (MAIN ST) WEST OF CHURCH ST	07	*	3400	*	*	3200	*	*	4900
219052	62	NH 119 AT WINCHESTER TL	07	*	*	2800	*	*	2700	*	*
219053	62	NH 63 AT CHESTERFIELD TL	07	*	*	1200	*	*	1200	*	*
219054	62	NH 63 (NORTHFIELD RD) AT MASS SL	07	*	*	1200	*	*	1200	*	*
219055	22	NH 119 (BRATTLEBORO RD) AT VERMONT SL	17	*	*	9700	*	*	8100	*	*
219056	82	NH 119 (BRATTLEBORO RD) NORTH OF PROSPECT ST	07	*	*	5000	*	*	5000	*	*
219057	82	NH 63 (NORTHFIELD RD) SOUTH OF TOWER HILL RD	07	*	*	1200	*	*	1400	*	*
219059	82	NH 63 (CHESTERFIELD RD) 0.5 MILE NORTH OF NH 119	07	*	1500	*	*	1300	*	*	1200
219060	82	OXBOW RD NORTH OF MONUMENT ROAD	09	*	350	*	*	250	*	*	440
219061	82	DEPOT ST OVER ASHUELOT RIVER	09	*	420	*	*	300	*	*	380

STATE OF NEW HAMPSHIRE, DEPARTMENT OF TRANSPORTATION - BUREAU OF TRAFFIC
IN COOPERATION WITH U.S. DEPARTMENT OF TRANSPORTATION FEDERAL HIGHWAY ADMINISTRATION
AUTOMATIC TRAFFIC RECORDER DATA FOR THE MONTH OF JUNE 2013

2/22/2016

22 219055 HINSDALE- NH 119 (BRATTLEBORO RD) AT VERMONT SL

MON	DATE	DAY	12 AM	1 AM	2 AM	3 AM	4 AM	5 AM	6 AM	7 AM	8 AM	9 AM	10 AM	11 AM	12 PM	1 PM	2 PM	3 PM	4 PM	5 PM	6 PM	7 PM	8 PM	9 PM	10 PM	11 PM	Total
6	16	1	54	54	32	12	15	52	86	204	313	490	535	707	768	725	738	692	646	520	397	354	266	150	98	53	7961
6	11	3	32	27	42	29	60	133	345	496	518	416	521	550	576	647	708	779	814	720	455	334	252	180	112	90	8836
6	12	4	30	21	31	27	62	135	347	475	519	477	512	555	585	596	631	766	879	736	508	363	258	215	120	82	8930
6	13	5	36	39	42	24	59	154	379	529	477	477	559	561	616	564	626	787	833	752	545	357	288	217	151	73	9145
6	14	6	40	26	37	22	52	114	327	360	545	569	586	674	738	719	775	873	912	833	665	533	476	356	180	106	10518
6	15	7	46	44	28	22	36	80	133	292	489	608	663	709	787	806	759	760	646	635	572	457	354	301	170	107	9504

TYPE	STATION	YEAR	MONTH	NO. DAYS	AVERAGE SUNDAY	AVERAGE WEEKDAY	AVERAGE SATURDAY	AVERAGE DAILY	COMPUTED VOLUME	PERCENT GAIN	PERCENT LOSS
22	219055	2013	June	6	7961	9357	9504	9149	274470		

PEAK HOUR VOLUMES:

	AVERAGE AM:	AVERAGE MIDDAY:	AVERAGE PM:
SUNDAY	490	768	738
WEEKDAY	534	649	860
SATURDAY	608	806	760

AM - 6 AM TO 10 AM
MIDDAY - 10 AM TO 2 PM
PM - 2 PM TO 8 PM

Appendix C

Benefit-Cost Analysis (BCA) Guidance 2018

U.S. Department
of Transportation

Benefit-Cost Analysis Guidance for Discretionary Grant Programs

Office of the Secretary

U.S. Department of Transportation

June 2018

Benefit-Cost Analysis Guidance

Table of Contents

Acronym List

BCA	Benefit-Cost Analysis
BCR	Benefit-Cost Ratio
CMF	Crash Modification Factor
CO_2	Carbon Dioxide
dBA	Decibels Adjusted
FEMA	Federal Emergency Management Agency
GDP	Gross Domestic Product
GHG	Greenhouse Gas
MAIS	Maximum Abbreviated Injury Scale
NHTSA	National Highway Traffic Safety Administration
NOAA	National Oceanic and Atmospheric Administration
NO_x	Nitrogen Oxides
NPV	Net Present Value
O&M	Operating and Maintenance
OMB	Office of Management and Budget
PDO	Property Damage Only
PM	Particulate Matter
SO_2	Sulfur Dioxide
YOE	Year-of-Expenditure Dollars
U.S.	United States of America
USDOT	The United States Department of Transportation
VOC	Volatile Organic Compounds
VSL	Value of a Statistical Life
VTTS	Value of Travel Time Savings
YOE	Year of Expenditure

1. Overview and Background

This document is intended to provide applicants to USDOT's discretionary grant programs with guidance on completing a benefit-cost analysis[1] (BCA) for submittal as part of their application. BCA is a systematic process for identifying, quantifying, and comparing expected benefits and costs of a potential infrastructure project. The information provided in the applicants' BCAs will be evaluated by the United States Department of Transportation (USDOT) and used to help ensure that the available funding under the programs is devoted to projects that provide substantial economic benefits to users and the Nation as a whole, relative to the resources required to implement those projects.

A BCA provides estimates of the anticipated benefits that are expected to accrue from a project over a specified period and compares them to the anticipated costs of the project. As described in the respective sections below, costs would include both the resources required to develop the project and the costs of maintaining the new or improved asset over time. Estimated benefits would be based on the projected impacts of the project on both users and non-users of the facility, valued in monetary terms.[2]

While BCA is just one of many tools that can be used in making decisions about infrastructure investments, USDOT believes that it provides a useful benchmark from which to evaluate and compare potential transportation investments for their contribution to the economic vitality of the Nation. USDOT will thus expect applicants to provide BCAs that are consistent with the methodology outlined in this guidance as part of their justification for seeking Federal support. Additionally, USDOT encourages applicants to incorporate this BCA methodology into any relevant planning activities, regardless of whether the sponsor seeks Federal funding.

This guidance:

- Describes an acceptable methodological framework for purposes of preparing BCAs for discretionary grant applications (see Sections 3, 4, and 5);
- Identifies common data sources, values of key parameters, and additional reference materials for various BCA inputs and assumptions (see Appendix A); and
- Provides illustrative calculations to assist applicants in preparing many of the quantitative elements of a BCA (see Appendix B).

Key changes in this version of the guidance include updated parameter values and additional discussion on the selection of analysis periods and construction cost accounting.

BCAs vary greatly in complexity and workload from one project to the next. USDOT is sensitive to the fact that applicants have different resource constraints, and that complex forecasts and analyses are not always a cost-effective option. However, given the quality of BCAs received in previous rounds of discretionary grant programs from applicants of all sizes, we also believe that a transparent, reproducible,

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[1] "Benefit-cost analysis" and "cost-benefit analysis" are interchangeable names for the same process of comparing a project's benefits to its costs. The U.S. Department of Transportation uses "benefit-cost analysis" to ensure consistent terminology and because one widely used method for ranking projects is the benefit-cost ratio.

[2] As described in Section 6 on Comparing Benefits to Costs, however, it may be appropriate to use a slightly different accounting framework than this when comparing the ratio of benefits to costs.

thoughtful, and well-reasoned BCA is possible for all projects. The goal of a well-produced BCA is to provide a more objective assessment of a project that carefully considers and measures the outcomes that are expected to result from the investment in the project and quantifies their value. If, after reading this guidance, an applicant would like to seek additional help, USDOT staff are available to answer questions and offer technical assistance until the final application deadline has passed.

This guidance also describes several potential categories of benefits that may be useful to consider in BCA, but for which USDOT has not yet developed formal guidance on recommended methodologies or parameter values. Future updates of this guidance will include improved coverage of these areas as research on these topics is incorporated into standard BCA practices.

2. Statutory and Regulatory References

This guidance applies to a wide range of surface transportation projects (e.g., highways, transit, rail, ports) under USDOT's discretionary grant programs.

USDOT will consider benefits and costs using standard data and qualitative information provided by applicants, and will evaluate applications and proposals in a manner consistent with Executive Order 12893 (Principles for Federal Infrastructure Investments, 59 FR 4233) and Office of Management and Budget (OMB) Circular A-94 (Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs). OMB Circular A-4 (Regulatory Analysis) also includes useful information and cites textbooks on benefit-cost analysis if an applicant wants to review additional background material. USDOT encourages applicants to familiarize themselves with these documents while preparing a BCA.

3. General Principles

To determine if a project's benefits justify its costs, an applicant should conduct an appropriately thorough BCA. A BCA estimates the benefits and costs associated with implementing the project as they occur or are incurred over a specified time period.

To develop a BCA, applicants should attempt to quantify and monetize all potential benefits and costs of a project. Some benefits (or costs) may be difficult to capture or may be highly uncertain. If an applicant cannot monetize certain benefits or costs, it should quantify them using the physical units in which they naturally occur where possible. When an applicant is unable to either quantify or monetize the benefits, the sponsor should describe the benefits qualitatively.

In this guidance document, USDOT provides recommended nationwide average values to monetize common sources of benefits from transportation projects (see Appendix A). USDOT recognizes that in many cases, applicants may have additional local data that is appropriate or even superior for use in evaluating a given project. USDOT supports analyses that blend these localized data with national estimates or industry standards to complete a more robust analysis, so long as those local values are reasonable and well-documented.

The following section outlines general principles of BCA that applicants should incorporate.

3.1. Impacts of Transportation Infrastructure Improvements

An efficient, highly functioning transportation system is vital to our Nation's economy and the well-being of its citizens. Infrastructure forms the backbone of that system, and both the public and private sectors have invested substantial resources in its development. At the same time, transportation infrastructure requires ongoing capital improvements to rebuild and modernize aging infrastructure and ensure that it continues to meet the needs of a growing population and economy.

Before investing in transportation infrastructure improvements, a project sponsor should be able to articulate the problem that the investment is trying to solve and how the proposed improvement will help meet that objective. This is particularly important when the project sponsor is seeking funding from outside sources under highly competitive discretionary programs. One of the primary benefits of conducting a BCA is the rigor that it imposes on project sponsors to be able to justify *why* a particular investment should be made, by carefully considering the impact that that investment will have on users of the transportation system and on society as a whole.

Carefully identifying the different impacts a project is expected to have is the first and perhaps most important step in conducting a BCA. Doing so will help frame the analysis and point toward the types of benefits that are most significant to a particular project, allowing the applicant to focus its BCA efforts on those areas. Applicants should clearly demonstrate the link between the proposed transportation service improvements and any claimed benefits. It is important that the categories of estimated benefits presented in the BCA be in line with the nature of the proposed improvement and its expected impacts. When there are significant discrepancies, this can serve to undermine the credibility of the results presented in the analysis.

3.2. Baselines and Alternatives

Each analysis needs to include a well-defined baseline to measure the incremental benefits and costs of a proposed project against. A baseline is sometimes referred to as the "do-nothing base case" or "no-build alternative," although it is perhaps more accurately characterized as a "do minimal" scenario that allows for ongoing operations and maintenance of the facility. A baseline defines the world without the proposed project. As the status quo, the baseline should incorporate factors—including future changes in traffic volumes—that are not brought on by the project itself and would occur even in its absence.

Baselines should not assume that the same (or similar) improvement will be implemented later. For example, if the project applying for funding would accelerate the already planned replacement of a deteriorating bridge, it would be incorrect for the baseline to include the bridge replacement project occurring at a later date. The point of the BCA is to evaluate benefits and costs of the project itself, not whether accelerating the project is cost-beneficial (note that it is possible that the project would not be cost-beneficial under either timeframe). A more appropriate baseline would thus be one in which the bridge replacement did not occur, but could include the (presumably) increasing maintenance costs of ensuring that the existing bridge stays open or the diversion impacts that could occur if the bridge were to be posted with weight restrictions or ultimately closed to traffic at a future date.

Applicants should be careful to avoid using "straw man" baselines that use unrealistic assumptions about how freight and passenger traffic would flow over the Nation's transportation network in the absence of the project, particularly when alternate modes of travel are considered. For example, if a project would construct a short rail spur from a railroad mainline to a freight handling facility, it is unrealistic to assume that, in the absence of the project, firms would ship cargo only by truck for thousands of miles to its final destination as their only alternative. A more realistic description of current traffic would more likely have current cargo traffic going by rail for most of the distance, and by truck for the relatively short distance over which rail transportation is not available.

Demand Forecasting

Applicants should clearly describe both the current use of the facility or network that is proposed to be improved (e.g., current traffic or cargo volumes) and their forecasts of future demand under both the baseline and the "build case." Forecasts of future economic growth and traffic volume should be well documented and justified, based on past trends and/or reasonable assumptions of future socioeconomic conditions and economic development. Where traffic forecasts (such as corridor-level models or regional travel demand models) are used that cover areas beyond the improved facility itself, the geographic scope of those models should be clearly defined and justified. Other assumptions used to translate the usage forecasts into estimates of travel times and delay (such as gate-down times at grade crossings) should also be described and documented.

Forecasts should be provided both under the baseline and the improvement alternative; applicants should take care to ensure that the differences between the two reflect only the proposed project to be analyzed in the BCA and not other planned improvements. Forecasts should incorporate indirect effects (e.g., induced demand) to the extent possible. Applicants should be especially wary of using simplistic growth assumptions (such as a constant annual growth rate) over an extended period of time without taking into account the capacity of the facility. It is not realistic to assume that traffic queues and delays would increase to excessively high levels with no behavioral response from travelers or freight carriers, such as shifting travel to alternate routes, transfer facilities, or time periods.

Applicants should not simply use traffic and travel information from the forecast year to estimate benefits. Instead, benefits should be based on the projected traffic level for each individual year. Given the nature of most traffic demand modeling, in which traffic levels are provided only for a base year and a limited number of forecast years, interpolation between the base and forecast years may be necessary to derive such numbers. However, applicants should exercise extra caution when extrapolating beyond the years covered in a travel demand forecast, given the additional uncertainties and potential errors that such calculations bring; in many cases, it would be more appropriate to cap the analysis period at the year for which a reliable travel growth forecast is available, rather than extrapolating beyond that point.

3.3. Inflation Adjustments

Data obtained for use in BCAs is sometimes expressed in nominal dollars from several different years. Nominal dollars reflect the effects of inflation, and are sometimes also called current or year-of-expenditure dollars. To meaningfully compare the benefits and costs associated with a transportation improvement project, it is important that those values be expressed in common terms. Doing so requires that all costs and benefits be denominated in real dollars (also referred to as constant dollars), using a common base year. A real dollar has the same purchasing power from one year to the next. In a world without inflation, all current and future dollars would be real dollars; however, inflation does tend to exist, which thus causes the purchasing power of a dollar to erode from year to year.

In practice, this means that all monetized values used in a BCA should be expressed in a common base year, with the effects of inflation netted out. Applicants should note that this treatment in BCA likely differs from the way in which costs are presented in a project's budget or plan of finance, in which such expenditures are generally presented in nominal terms.[3]

OMB Circular A-94 and OMB Circular A-4 recommend using the Gross Domestic Product (GDP) Deflator as a general method of converting nominal dollars into real dollars. The GDP Deflator captures the changes in the value of a dollar over time by considering changes in the prices of all goods and services in the U.S. economy.[4] Table A-7 in Appendix A provides values based on this index that could be used to adjust the values of any project costs incurred in prior years to 2017 dollars. Appendix B also provides a sample calculation for making inflation adjustments. If an applicant would like to use another commonly used deflator, such as the Consumer Price Index, the applicant should explicitly indicate that and provide the index values used to make the adjustments.

3.4. Discounting

After accounting for effects of inflation to express costs and benefits in real dollars, a second, distinct adjustment must be made to account for the time value of money. This concept reflects the principle that benefits and costs that occur sooner in time are more highly valued than those that occur in the more distant future, and that there is thus a cost associated with diverting the resources needed for an investment from other productive uses. This process, known as discounting, will result in future streams of benefits and costs being expressed in the same present value terms.

In accordance with OMB Circular A-94, applicants to the discretionary grant programs should use a real discount rate (i.e., the discount rate net of the inflation rate) of **7 percent** per year to discount streams benefits and costs to their present value in their BCA. Applicants should discount each category of benefits and costs separately for each year in the analysis period during which they accrue. Appendix B provides more information on the formulas that should be used in discounting future values to present values, and presents a simplified example table.

3.5. Analysis Period

The selection of an appropriate analysis period is a fundamental consideration in any BCA. By their nature, transportation infrastructure improvements typically involve large initial capital expenditures whose resulting benefits continue over the many years that the new or improved asset remains in service. To capture this dynamic, the analysis period used in a BCA should cover both the initial development and construction of the project and a subsequent operational period during which the on-going service

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[3] See Section 5.1 below for more discussion of this issue.

[4] Note that both the GDP Deflator and the Bureau of Labor Statistics' Consumer Price Index also adjust for changes in the quality of goods and services over time.

benefits (and any recurring costs) are realized. This operational period will generally correspond to the expected service lifetime of the improvement, which can vary significantly for different types of investments.

USDOT recommends that analysis periods be set based on the number of years until the same type of action is anticipated to take place again (i.e., reconstruction, replacement, capacity expansion, etc.). As a rule of thumb, the analysis period should cover of the full development and construction period of the project, plus at least 20 years after the completion of construction during which the full operational benefits and costs of the project can be reflected in the BCA.

Applicants may encounter situations where a longer or shorter analysis period is appropriate. For example, if the project's useful life is less than 20 years (as is the case for many technology or vehicle purchase investments), a shorter timeframe matching that useful life would be appropriate. Conversely, 20 years of operations may be insufficient to provide a full assessment of the benefits of assets, such as major structures or tunnels, that are often designed for a useful life of several decades or more. Longer analysis periods may also help to capture the full impact of construction programs involving multiple phases or phased-in operations.

There is a limit, however to the utility of modeling project benefits over very long time scales. General uncertainty about the future, as well as specific uncertainty about how travel markets and patterns may shift or evolve, means that predictions over an exceedingly long term begin to lose reliability and perhaps even meaning. Additionally, in a BCA, each subsequent year is discounted more heavily than the previous year, and thus each subsequent year is less and less likely to impact the overall findings of the analysis. For these reasons, USDOT recommends that applicants avoid any analysis periods extending beyond 30 years of full operations. Instead of extending the analysis period indefinitely, applicants should establish their reasonable horizon year and then consider an assessment of the value of the remaining asset life in situations where project assets have useful lifetimes that continue beyond the end of the analysis period (as described in Section 5.3 below).

Applicants should clearly describe the analysis period used in their BCA, including the beginning and ending years, and explicitly state their rationale for choosing that period.

3.6. Scope of the Analysis

A BCA should include estimates of benefits and costs that cover the same scope of the project. For example, if the funding request is for a sub-component of a larger project, it would be incorrect to include only the cost of the sub-component but estimate the benefits based on the larger project. In projects with multiple sub-components, the applicant must make clear exactly what portions of the project form the basis of the estimates of benefits and costs.

The scope should also be large enough to encompass a project that has independent utility, meaning that it would be expected to produce the projected benefits even in the absence of other investments. In some cases, this would mean that the costs included in the BCA may need to incorporate other related investments that are not part of the grant request, but which are necessary for the project to deliver its promised benefits.

USDOT allows for a program of projects to be included in a single grant application. In many cases, each of these projects may be related, but also have independent utility as individual projects. Where this is the case, each component of this package should be evaluated separately, with its own BCA. However, in some cases, projects within a package may be expected to also have collective benefits that are larger than the sum of the benefits of the individual projects included in the package. In such cases, applicants should clearly explain why this would be the case and provide any supporting analyses to that effect.

4. Benefits

Benefits measure the economic value of positive outcomes that are reasonably expected to result from the implementation of a project, and may be experienced by users of the transportation system or the public at-large. Benefits accrue to the users of the transportation system because of changes to the characteristics of the trips they make (e.g., travel time reductions).

All of the benefits reasonably expected to result from the implementation of the project or program should be monetized (if possible) and included in a BCA. This section of the guidance document describes acceptable approaches for assessing the most commonly included benefit categories, but it is not intended to be an exhaustive list of all the relevant benefits that may be expected to result from all types of transportation improvement projects.

Benefits should be estimated and presented in the BCA on an annual basis throughout the entire analysis period. Applicants should not simply assume that the benefits of the project will be constant in each year of the analysis, unless they can provide a solid rationale for doing so. For projects that are implemented in phases, the types and amount of benefits may phase-in over a certain period of time as additional portions of the project are completed. Any phasing and implementation assumptions made by the applicant should be thoroughly described in the supporting documentation for the BCA.

Some transportation improvements may result in a mix of positive and negative outcomes (e.g., an increase in travel speeds that may be accompanied by an increase in emissions). In such cases, those negative outcomes would be characterized as “disbenefits” and subtracted from the overall total of estimated benefits.

4.1. Value of Travel Time Savings

One of the most common goals of many transportation infrastructure improvement projects is to improve traffic flows or provide new connections that result in reduced travel times. Estimating travel time savings from a transportation project will depend on engineering calculations and a thorough understanding of how the improvement will affect traffic flows. Such improvements may reduce the time that drivers and passengers spend traveling, including both in-vehicle time and wait time.

Recommended values of travel time savings (VTTS), presented in dollars per person-hour, are provided in Appendix A, Table A-3 of this document. The table includes values for travel by both private vehicle and by commercial vehicle operators. Private vehicle[5] travel includes both personal travel and business travel[6]; the table also includes a blended value for cases where the mix of personal and business travel is unknown. The values are also applicable for in-vehicle travel time; as noted in the table, non-vehicle personal travel time such as waiting or transfer time should be valued at twice this rate. Also, where applicants have specific data on the mix of local and long-distance travel on a facility, they may also develop a blended estimate using the long-distance VTTS values provided in the table; however, where applicants do not have this information, they should apply the general in-vehicle travel time values to all travel in their BCA.

Applicants should note that the values provided in Table A-3 are on a per person basis. However, many travel time estimates are based on vehicle-hours, thus requiring additional assumptions about vehicle occupancy to estimate person-hours of travel time. Applicants are encouraged to rely on localized data or analysis that is specific to the corridor being improved and, where available, by time of day (particularly when travel time savings are being generated by reductions in peak-period delay) in generating assumptions about vehicle occupancy factors, and document those sources and assumptions in the BCA. In the absence of such data, applicants may use the more general, national-level vehicle occupancy factors included in Appendix A, Table A-4.

Reliability

Reliability refers to the predictability and dependability of travel times on transportation infrastructure. Improvements in reliability may be highly valued by transportation system users, particularly for freight movement, in addition to the value that they may place on reductions in mean travel times.

Although improving service reliability can increase the attractiveness of transportation services, estimating its discrete quantitative value in a BCA can be challenging. Users may have significantly varied preferences for different trips and for different origin and destination pairs. How people value reliability may relate more to how highly they value uncertainty in arrival times or the risk of being late than to how they value trip time reductions. At the same time, heavily congested facilities may experience both longer average travel times and greater variability, as the effects of incidents become magnified under those conditions; as a result, reliability and mean travel times may be correlated. Thus, assessing the value of improving reliability is generally more complex than valuing trip time savings, and a perfect assessment in a BCA is unlikely.

At this time, USDOT does not have a specific recommended methodology for valuing reliability benefits in BCA. If applicants nevertheless choose to present monetized reliability improvements in their analysis, they should carefully document the methodology and tools used, and clearly explain how the parameters used to value reliability are separate and distinct from the value of travel time savings used in the analysis.

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[5] In this context, "private vehicle" travel would also include passengers in commercial or public transit vehicles.

[6] Business travel includes only on-the-clock work-related travel. Commuting travel should be valued at the personal travel rate.

4.2. Vehicle Operating Cost Savings

Vehicle operating cost savings frequently result from both freight-related and passenger-related projects. Freight-related projects that improve roads, rails, and ports frequently generate savings to carriers (e.g., reduced fuel consumption and other operating costs). Passenger-related improvements can also reduce vehicle operating or dispatching costs for service providers and users of private vehicles.

If applicants are projecting such savings in their BCA, they should carefully demonstrate how the proposed project would generate such benefits. Applicants are encouraged to use local data on vehicle operating costs where available, appropriately documenting sources and assumptions. For analyses where such data is not available, this guidance provides standard national-level per-mile values for marginal vehicle operating costs from the American Automobile Association for light duty vehicles and from the American Transportation Research Institute for commercial trucks in Appendix A, Table A-5. These values include operating costs that vary with vehicle miles traveled such as fuel, maintenance and repair, tires, depreciation, and additionally, in the case of trucks, truck/trailer lease or purchase payments, insurance premiums, and permits and licenses. The values exclude other ownership costs that are generally fixed or that would be considered transfer payments, such as tolls, taxes, annual insurance, and registration fees. For commercial trucks, the values also exclude driver wages and benefits (which are already included in the value of travel time savings).

4.3. Safety Benefits

Transportation infrastructure improvements can also reduce the likelihood of fatalities, injuries, and property damage that result from crashes on the facility by reducing the number of such crashes and/or their severity. To claim safety benefits for a project, applicants should clearly demonstrate how a proposed project targets and improves safety outcomes. The applicant should include a discussion about various crash causation factors addressed by the project, and establish a clear link to how the proposed project mitigates these risk factors.

To estimate the safety benefits from a project that generates a reduction in crash risk or severity, the applicant should determine the type(s) of crash(es) the project is likely to affect, and the effectiveness of the project in reducing the frequency or severity of such crashes. The severity of prevented crashes is measured through the number of injuries and fatalities, and the extent of property damage. Various methods exist for projecting project effectiveness. Where possible, those measures should be tied to the specific type of improvement being implemented on the facility; broad assumptions about effectiveness (such as assuming safety improvements will result in a facility crash rate dropping to the statewide average crash rate) are generally discouraged.

For road-based improvements, estimating the change in the number of fatalities, injuries, and amount of property damage can be done using crash modification factors (CMFs), which relate different types of safety improvements to crash outcomes. CMFs are estimated by analyzing crash data and types, and relating outcomes to different safety infrastructure. Through extensive research by USDOT and other organizations, hundreds of CMF estimates are available and posted in the CMF Clearinghouse.[7] If using a

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[7] http://www.cmfclearinghouse.org/

CMF from the CMF Clearinghouse, USDOT encourages applicants to verify that the CMF they are using is applicable to the proposed project improvements. Applicants should ensure that the CMF is matched to the correct crash types, crash severity, and area type of the project. For an example, a CMF specifically associated with a reduction in fatal crashes in an urban setting is inappropriate to use in monetizing the safety benefits of a project for crash types in a rural area. An example calculation using CMFs is included in Appendix B.

To estimate safety outcomes from the project, the effectiveness rates of safety-related improvements must also be applied to baseline crash data. Such data are generally drawn from the recent crash history on the facility that is being improved, typically covering a period of 3-7 years. Applicants should carefully describe their baseline crash data, including the specific segments or geographic areas covered by that data; links to the source data are also often helpful, where they can be provided. The baseline data should be closely aligned with the expected impact area of the project improvements, rather than reflecting outcomes over a much larger corridor or region.[8]

Injury Severity Scales

USDOT recommended values for monetizing reductions in injuries are based on the Maximum Abbreviated Injury Scale (MAIS), which categorizes injuries along a six-point scale from Minor to Not Survivable. However, USDOT recognizes that accident data that are most readily available to applicants may not be reported as MAIS-based data. For example, law enforcement data may frequently be reported using the KABCO scale, which is a measure of the observed severity of the victim's functional injury at the crash scene. In some cases, the applicant may only have a single reported number of accidents in the area affected by a particular project, but have no injury and/or injury severity data for any of those accidents.

Table 1 on the following page provides a comparison of the KABCO and MAIS injury severity scales. Monetization factors for injuries reported on both the KABCO and MAIS injury severity scales are included in Appendix A, Table A-1, based on a conversion matrix provided by the National Highway Traffic Safety Administration (NHTSA), which allows KABCO-reported and generic accident data to be re-interpreted as MAIS data.[9]

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[8] The Fatality Analysis Reporting System (FARS) provides a useful, nationwide source for data on roadway fatalities. FARS data are available at https://www.nhtsa.gov/research-data/fatality-analysis-reporting-system-fars. Where an applicant is using local safety data that may not be consistent with FARS, it is helpful to explain any reasons for such discrepancies in the BCA narrative.

[9] National Highway Traffic Safety Administration, July 2011. The premise of the matrix is that an injury observed and reported at the crash site may end up being more/less severe than the KABCO scale indicates. Similarly, any accident can – statistically speaking – generate several different injuries for the parties involved. Each column of the conversion matrix represents a probability distribution of the different MAIS-level injuries that are statistically associated with a corresponding KABCO-scale injury or a generic accident.

Table 1. Comparison of Injury Severity Scales (KABCO vs MAIS vs Unknown)

Reported Accidents (KABCO or # Accidents Reported)	
O	No injury
C	Possible Injury
B	Non-incapacitating
A	Incapacitating
K	Killed
U	Injured (Severity Unknown)
# Accidents Reported	Unknown if Injured

Reported Accidents (MAIS)	
0	No injury
1	Minor
2	Moderate
3	Serious
4	Severe
5	Critical
Fatal	Not Survivable

Appendix A, Table A-1 provides guidance on the monetized values for reducing fatalities (the “value of a statistical life”, or VSL), injuries, and property damage in transportation safety incidents, with corresponding references for additional information. For an example calculation of safety benefits, please see Appendix B.

4.4. Emissions Reduction Benefits

Transportation activities can contribute significantly to localized air pollution, and some transportation projects offer the potential to reduce the transportation system’s impact on the environment by lowering emissions of air pollutants that result from production and combustion of transportation fuels. The economic damages caused by exposure to air pollution represent externalities because their impacts are borne by society as a whole, rather than by the travelers and operators whose activities generate those emissions. Transportation projects that reduce emissions may thus produce environmental benefits.

The most common local air pollutants generated by transportation activities are sulfur dioxide (SO_2), nitrogen oxides (NO_X), fine particulate matter (PM), and volatile organic compounds (VOC).[10] The recommended economic values for reducing emissions of various pollutants are shown in Appendix A, Table A-6.

Note that previous BCA guidance from USDOT has included a discussion of approaches to valuing reductions in carbon dioxide (CO_2) emissions and other greenhouse gases (GHGs) and provided recommended values. However, the guidance documents on which those estimates were based were

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[10] Some of these are chemical precursors to local (or “criteria”) pollutants that are synthesized during chemical reactions that occur in the earth’s lower atmosphere, rather than pollutants themselves.

subsequently rescinded.[11] As a result, USDOT does not currently have recommended unit values for reductions in these pollutants. Any such estimates provided in a BCA under the discretionary grant programs, however, should be discounted at the same rate as costs and other benefits quantified in the BCA, and should be based on the domestic damages of such emissions, rather than using global values.

If applicants wish to include monetized values for additional categories of environmental benefits (or disbenefits) in their BCA, then they should also provide documentation of sources and details of those calculations. Similarly, applicants using different values from the categories presented in Appendix A, Table A-6 should provide sources, calculations, and the applicant's rationale for diverging from those recommended values. For an example calculation of emission reduction benefits, please see Appendix B.

4.5. Other Issues in Benefits Estimation

Benefits to Existing and Additional Users

The primary benefits from a proposed project will typically arise in the "market" for the transportation facility or service that the project would improve, and would be experienced directly by its users. These include travelers or shippers who would utilize the unimproved facility or service under the baseline alternative, as well as any additional users attracted to the facility due to the proposed improvement.[12]

Benefits to existing users for any given year in the analysis period would be calculated as the change in average user costs multiplied by the number of users projected in that year under the no-build baseline. For additional users, standard practice in BCA is to calculate the value of the benefits they receive at one-half the product of the reduction in average user costs and the difference in volumes between the build and no-build cases, reflecting the fact that additional users attracted by the improvement are each willing to pay less for trips or shipments using the improved facility or service than were original users, as evidenced by the fact that they were unwilling to incur the higher cost to use it in its unimproved condition. See Appendix B for a sample calculation of benefits to new and existing users.

If some new users are expected to be drawn from facilities or services that compete with or substitute for the improved facility or service, remaining users of those alternatives or the economy as a whole can experience additional benefits. However, any such secondary or indirect benefits should be small relative to those experienced by users of the improved facility, and the analysis should focus on the proposed project's benefits to continuing and new users.

Modal Diversion

Improvements to transportation infrastructure or services may draw additional users from alternative routes or competing modes or services. Properly capturing the impacts of such diversion within BCA can be challenging and must be examined carefully to ensure that such benefits are truly additive within the analysis.

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[11] See Executive Order 13783, Promoting Energy Independence and Economic Growth, March 28, 2017.

[12] The number of "additional users" would be calculated as the difference in usage of the facility at any given point in the analysis period. Note that this is different from volume growth over time that would be expected to occur even under the no-build baseline.

First, it is important to note that any savings in costs or travel time experienced by travelers or shippers who switch to an improved facility or service are not an accurate measure of the benefits they receive from doing so, and do not represent benefits in addition to the benefits received by additional users of the improved alternative. The generalized costs for using the competing alternatives from which an improved facility draws additional users are already incorporated in the demand curve for the improved facility or service.[13] Applicants should thus avoid such approaches as comparing operating costs for truck and rail when estimating the benefits of a rail improvement that could result in some cargo movements being diverted from highways in their BCAs.

Reductions in external costs from the use of competing alternatives, however, may represent a source of potential benefits beyond those experienced directly by users of an improved facility or service. Operating both passenger and freight vehicles can cause negative impacts such as delays to occupants of other vehicles during congested travel conditions, emissions of air pollutants, and potential damage to pavements or other road surfaces. These impacts impose external costs on occupants of other vehicles and on the society at large that are not part of the generalized costs drivers and freight carriers bear, so they are unlikely to consider these costs when deciding where and when to travel.

A commonly cited source of external benefits from rail or port improvements is the resulting reduction in truck travel. Many factors influence trucks' impacts on public agencies' costs for pavement and bridge maintenance, such as their loaded weight, number and spacing of axles, pavement thickness and type, bridge type and span length, volume of truck traffic, and volume of passenger traffic. Consequently, estimating savings in pavement and bridge maintenance costs that result from projects to improve rail or water service is likely to be difficult and would ideally require detailed, locally specific input data. Where this has not been available, some applicants have used broad national estimates of the value of pavement damage caused by trucks from the 1997 *Federal Highway Cost Allocation Study*[14] in their BCAs in previous rounds of USDOT discretionary grant programs. If applicants choose to use estimates from that study, they should take care to use the values for different vehicles and roadway types (e.g., urban/rural) that most closely correspond to the routes over which the diversion is expected to occur. Applicants should also net out any user fees paid by trucks (such as fuel taxes) that vary with the use of the highway system from the estimates of reduced pavement damage.

Similarly, estimating reductions in congestion externalities caused by diversion of passenger and freight traffic from highway vehicles to improved rail or transit services is empirically challenging, usually requiring elaborate regional travel models and detailed, geographically-specific inputs, and should only be incorporated where such modeling results are available. Applicants should not use any broad, national level data to estimate such benefits. Estimates of net air pollutant emission reductions resulting from

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[13] This follows from the usual textbook description of the demand curve for a good or service: it shows the quantity that will be purchased at each price, while holding prices for substitute goods constant.

[14] *FHWA, Addendum to the 1997 Federal Highway Cost Allocation Study Final Report, 2000.* Available at https://www.fhwa.dot.gov/policy/hcas/addendum.cfm. As the estimates found in that report are stated in 1994 dollars, they should be inflated to the recommended 2017 base year dollars using a factor of 1.537 to reflect changes in the level of the GDP deflator over that period of time.

diverted or reduced truck travel may also be incorporated into using standard methodologies for doing so, as described in Section 4.4 above.

Work Zone Impacts

An example of "disbenefits" commonly associated with transportation projects is the impact of work zones on current users during construction or maintenance activities, such as traffic delays and increased safety and vehicle operating costs. These costs can be particularly significant for projects that involve the reconstruction of existing infrastructure, which may require temporary closures of all or a portion of the facility. Work zones may also be significant in the out years under a no-build base case, under which an aging facility might require more frequent and extensive maintenance to keep it operational. Work zone impacts should be monetized consistent with the values and methodologies provided in this guidance, and assigned to the years in which they would be expected to occur.

Resilience

Some projects are aimed at improving the ability of transportation infrastructure to withstand adverse events such as severe weather, seismic activity, and other threats and vulnerabilities that can severely damage or destroy transportation facilities. Incorporating resilience benefits into a BCA requires an understanding of both the expected frequency with which different levels of each stressor are expected to be experienced in the future, and the economic damages that different stressor levels are likely to inflict on specific infrastructure assets. This includes the anticipated frequencies of events such as extreme precipitation, seismic events, or coastal storm surges, as well as the range of potential severity of each event and the estimated cost of the resulting damages to specific assets, expressed as dollar figures.

Benefits for increasing resilience may be difficult to calculate due to the unpredictable occurrence of disruptive events, some of which could occur many decades in the future. Applicants may draw on previous experiences with facility outages to calculate the value of reduced infrastructure and service outages, such as costs incurred by travelers and facility operators when bridges are closed, and include those potential impacts in their estimates of the user benefits associated with the project.[15] The expected probability of the disruptive event(s) occurring within a given year should also be factored into the projected benefit stream of the improvement.

Noise Pollution

Noise pollution occurs from environmental sound that is generally considered likely to annoy, distract or even harm people and animals. Where relevant, applicants should consider whether a proposed project will significantly lower levels of noise generated by current transportation activity, as well as the extent to which more frequent service (e.g. in the case of freight or commuter rail, for instance) will increase cumulative noise levels. An applicant would have to determine the change in noise level (often measured in decibels adjusted or dBA), and whether the change is expected to occur during the daytime or

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[15] The National Oceanic and Atmospheric Administration (NOAA) database on storm surges and floor risks is one possible tool that applicants could use to estimate flood risk potential. See http://www.nhc.noaa.gov/surge/inundation/

nighttime, as nighttime includes sleep disturbance, which typically has a higher value associated with it. Projects that reduce the need to sound train whistles, for instance, can generate noise reduction benefits.

USDOT does not currently have a reliable means of estimating the public value of noise reductions for transportation projects in the U.S., and thus recommends that they be dealt with qualitatively in BCA until more definitive guidance on this issue is developed. Where quantified estimates are included in an applicant's BCA, the underlying methodology and values used should be carefully explained and documented.

Loss of Emergency Services

Transportation projects that reduce the likelihood of delays to emergency services, such as ambulance and fire services, can create benefits by reducing the damages resulting from those emergencies. For example, highway-rail grade separation projects can reduce or eliminate delays where emergency vehicles must seek alternative routes when crossing gates are down.

The Federal Emergency Management Agency (FEMA) has developed a methodology to aid in the monetization of such benefits.[16] That methodology is based on the observation that delays to fire services can cause a generalizable increase in property damage when fires burn longer; likewise, delays to ambulance services have a relatively predictable impact on survival rates for victims of cardiac arrest (one of the most common medical emergencies where time is a critical factor). The FEMA methodology is based on the complete loss of a fire station or hospital, but can be adapted for use in delays to emergency vehicles. However, applicants applying this methodology should take care not to assume unreasonably excessive delays to emergency services in the baseline scenario, as this will lead to an overestimate of project benefits. For example, assuming an ambulance will wait the entire time for a passing train at crossing gates when another grade-separated crossing is available nearby will lead to overestimating the emergency service delay reduction. Furthermore, applicants should carefully consider the size of the population assumed to be affected by such lapses in emergency services, as well as thoroughly justify and document such assumptions.

Quality of Life

Transportation projects can provide benefits that cannot easily be monetized but nevertheless may improve the quality of life of local or regional residents and visitors. Applicants should attempt to monetize these types of benefits to the extent possible; where doing so is not feasible, they should provide as much quantifiable data on those impacts as possible, focusing on changes expected to be brought about by the transportation improvement project itself.

Property Value Increases

Transportation projects can also increase the accessibility or otherwise improve the attractiveness of nearby land parcels, resulting in increased property values. However, such increases would generally largely result from reductions in travel times or other user benefits described elsewhere in this guidance. Such benefits should be calculated and monetized directly, rather than being factored into an assumed

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[16] https://www.hudexchange.info/course-content/ndrc-nofa-benefit-cost-analysis-data-resources-and-expert-tips-webinar/FEMA-BCAR-Resource.pdf

property value increase benefit; any claimed, monetized benefits based on property values should only capture otherwise unquantified benefits, such as those described elsewhere in this section. Such projections should also only count the on-time net increase in land value as the benefit, and should consider the net effect of both increases in land values induced by the project in some areas and any potential reductions in land values in other areas.

Additionally, some transportation projects may free up currently-occupied land for other, non-transportation uses, or may also include the creation of new spaces that are valued by the public (such as a park on top of a freeway cap project). If the applicant can reliably estimate the value of such land, based projected sales values or local values of land with similar uses, then that value could be included as an additional benefit within the BCA, or be described qualitatively when such benefits cannot be easily or reliably monetized.[17]

5. Costs

Project costs consist of the economic resources (in the form of the inputs of capital, land, labor, and materials) needed to develop and maintain a new or improved transportation facility over its lifecycle. In a BCA, these costs are usually measured by their market values, as those costs are directly incurred by developers and owners of transportation assets (as opposed to categories of benefits such as travel time savings that are not directly transacted in the market).

Cost data used in the BCA should reflect the full cost of the project(s) necessary to achieve the benefits described in the BCA. Applicants should include all costs regardless of who bears the burden of specific cost item (including costs paid for by State, local, and private partners or the Federal government). Cost data should include all funded and unfunded portions of the project, even if Federal funding is a relatively small portion of the total cost of the project with independent utility that is to be analyzed in the BCA.

5.1. Capital Expenditures

The capital cost of a project is the sum of the monetary resources needed to build the project (or program of projects). Capital costs generally include the cost of land, labor, material and equipment rentals used in the project's construction. In addition to direct construction costs, capital costs may include costs for project planning and design, environmental reviews, land acquisition, utility relocation, or transaction costs for securing financing. For large programs that involve multiple discrete projects that are related to one another and are each integral to accomplishing overall program objectives, applicants should estimate and report the costs of the various component projects of the program as well as summing those projects into a total cost.[18]

Project capital costs may be incurred across multiple years. All costs of the project (or that sub-component requesting funding if the project is a sub-component of a larger project and has independent utility)

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[17] Applicants should ensure, however, that any expected revenues from land sales have not already been netted out of the project's cost estimate, to avoid double-counting them.

[18] It is generally incorrect to lump unrelated projects into a single BCA. Where projects are unrelated to each other and do not impact each other's individual benefit streams, they should be analyzed using separate BCAs.

should be included, including costs already expended.[19] Costs should be recorded in the year in which they are expected to be incurred, regardless of when payment is made for those expenses (such as repayments of any principal and interest associated with financing the project). Applications for USDOT discretionary grant programs and their accompanying BCAs will typically provide capital cost information in three distinct forms:

1) Nominal dollars. The cost estimates provided in the project financial plan included in the application narrative will typically be stated in nominal or year-of-expenditure dollars, reflecting the actual costs that have previously been or are expected to be incurred in the future.
2) Real dollars. As noted above in Section 3.3, all costs and benefits used in the BCA should be stated in real or constant dollars using a common base year. Cost elements that were expended in prior years should thus be updated to the recommended base year (2017).[20] Costs incurred in future years should be adjusted to base year based on the future inflation assumptions that were used to derive them.
3) Discounted Real dollars. Any future year constant dollar costs should also be appropriately discounted to the baseline analysis year to allow for comparisons with other BCA elements (see Section 3.4).

5.2. Operating and Maintenance Expenditures

Operating and maintenance (O&M) costs cover a wide array of costs required on a continuing basis to support core transportation functions. The ongoing O&M costs of the project throughout the entire analysis period should be included in the BCA, and should be directly related to the proposed service plans for the project.

O&M costs should be projected for both the no-build baseline and with proposed improvement project. For projects involving the construction of new infrastructure, total O&M costs will generally be positive, reflecting the ongoing expenditures needed to maintain the new asset over its lifecycle. For projects intended to replace, reconstruct, or rehabilitate existing infrastructure, however, the net change in O&M costs under the proposed project will often be negative, as newer infrastructure requires less frequent and less costly maintenance to keep it in service than would an aging, deteriorating asset. Note also that more frequent maintenance under the baseline could also involve work zone impacts that could be reflected in projected user cost savings associated with the project.

Applicants should describe how O&M costs were estimated. Note that the relevant O&M costs are only those required to provide the service levels used in the BCA benefits calculations. For example, the BCA for a project that expands service frequency on an existing ferry route from three ferries per day to five ferries per day may look only at the benefits of the additional two new daily trips. In that case, the O&M

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[19] While economic decision-making often ignores such costs, treating them "sunk costs" that cannot be recovered, the purpose of including a BCA as part of the grant application for the USDOT discretionary grant programs is to determine whether the cost of project for which funding is being sought is justified by its benefits in its entirety, not whether future expenditures on the project or portion of the project funded by the grant are justified by total benefits of the whole project.

[20] Appendix A, Table A-7 provides a list of inflation adjustment factors for such costs going back to 2001

analysis would assess only the costs of providing those two additional daily departures, and not the cost of all five daily trips.

Maintenance costs are often somewhat "lumpy" over the course of an asset's lifecycle, with more extensive preservation activities being scheduled at regular intervals in addition to ongoing routine maintenance. Applicants should make reasonable assumptions about the timing and cost of such activities in accordance with standard agency or industry practices.

If the estimated O&M costs are provided in year of expenditure dollars, they should be adjusted to base year dollars prior to being included in the BCA.

While the net O&M costs associated with a project may be logically grouped with other project development costs, they should be included in the numerator along with other project benefits when calculating a benefit-cost ratio for a project proposed for funding under the discretionary grant programs (see Section 6 below).

5.3. Residual Value and Remaining Service Life

As noted above, the analysis period used in the BCA should be tied to the expected useful life of the infrastructure asset constructed or improved by the project. However, many transportation assets are designed for very long-term use, such as major structures (e.g., tunnels or bridges), and thus have an expected life that would exceed any reasonable analysis period (see Section 3.5 above). A project may also include capital asset components with an expected useful life that is shorter than those of the overall project, but which do not have independent utility themselves. These differences must be carefully considered when accounting for them in BCA.

Where some or all project assets have several years of useful service life remaining at the end of the analysis period, a "residual value" may be calculated for the project at that point in time. This could apply to both assets with expected service lives longer than the analysis period, and shorter-lived assets that might be assumed to have been replaced within the analysis period.[21] Applicants should carefully document the useful life assumptions that are applied when estimating a residual value in their BCA.

A simple approach to estimating the residual value of an asset is to assume that its original value depreciates in a linear manner over its service life.[22] An asset with an expected useful life of 60 years would thus retain half of its value after 30 years in service, while an asset with a 45-year life would retain one third of its value at that point in time.[23] Those residual values would then be discounted to their

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[21] For example, a component might be assumed to require replacement every 20 years. If the analysis period covers 30 years post construction, the BCA would have assumed the cost of replacing the asset at year 20, and would have 10 years of remaining service life at year 30.

[22] Other approaches may also be applied, so long as the methodology used is adequately described and justified in the BCA.

[23] In this example, if the construction period is five years, then the overall analysis period would be 35 years (5 years construction plus 30 years of operations).

present value using the discount rate applied elsewhere in the analysis. An example calculation of residual value is included in Appendix B.

While the projected residual value of a project may be logically grouped with other project development costs, it should be added to the numerator when calculating a benefit-cost ratio for a project proposed for funding under the discretionary grant programs (see Section 6 below).

6. Comparing Benefits to Costs

There are several summary measures that can be used to compare benefits to costs in BCA. The two most widely used measures are net present value and the benefit-cost ratio:

Net present value (NPV) is perhaps the most straightforward BCA measure. All benefits and costs over an alternative's life cycle are discounted to the present, and the costs are subtracted from the benefits to yield a NPV. If benefits exceed costs, the NPV is positive and the project may be considered to be economically justified.

The benefit-cost ratio (BCR) is frequently used in project evaluation when funding restrictions apply. In this measure, the present value of benefits (including negative benefits) is placed in the numerator of the ratio and the present value of costs is placed in the denominator. The ratio is usually expressed as a quotient (e.g., $2.2 million/$1.1 million = 2.0). For any given budget, the projects with the highest BCRs can be selected to form a package of projects that yields the greatest multiple of benefits to costs.

Deciding which elements to include in the numerator of the BCR and which to include in the denominator depends on the nature of the BCA and the purposes for which it is being used.[24] Where an agency is using BCA to help evaluate potential projects to implement under a constrained budget, the denominator should only include the upfront costs of implementing the project (i.e., capital expenditures). Since project funding decisions under the discretionary grant programs are being made under similar circumstances, this is the approach that should be used to calculate the BCR for BCAs developed pursuant to this guidance. Note that under this treatment, net O&M costs and the residual value would be added to or subtracted from the numerator when calculating the BCR, rather than the denominator.

While applicants are welcome to present estimates of a project's NPV or BCR in their BCA, USDOT analysts should be able to make such calculations independently based on the other information on benefits and costs provided in the BCA. What is most important is that applicants clearly present their estimates for each category of benefits and costs in a consistent manner (see Section 8 on Submission Guidelines below).

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[24] Note that this is not a concern for the calculation of net present value, since the results will be the same regardless of which elements are categorized as benefits or costs in that calculation.

7. Other Issues in BCA

7.1. Benefit-Cost Analysis vs. Economic Impact Analysis

A common mistake when developing a BCA occurs when applicants conflate economic *impacts* with economic *benefits*. A BCA measures the value of a project's benefits and costs to society, while an economic impact analysis measures the impact of increased economic activity within a region. Common metrics for measuring economic impacts include retail spending, business activity, tax revenues, jobs, and property values. Economic impact analyses often take a strictly positive view, (i.e., increased jobs, spending) and do not examine how the resources used for a project might have benefitted alternative societal uses of the resources (i.e., they do not assess the net effect on society).

For example, an economic impact analysis views the initial investment in infrastructure as a stimulus to the local economy, rather than as a cost to the local government. In addition, economic impact analyses typically use a regional perspective, while BCA uses an economy-wide or "societal" perspective. Positive impacts in one region may be accompanied by offsetting losses in a neighboring region, reflecting a transfer of spending or jobs that may be a net neutral summation. Similarly, increases in jobs in one industry could reflect a decrease in jobs in a different industry. By contrast, BCAs estimate first order net benefits that result from transportation projects by accounting for losses, costs, cost savings, benefits, and transfers of transportation time savings, investment costs, improved safety, reduced infrastructure maintenance costs, etc. BCA does not quantify second and third order impacts such as jobs or sales that may be generated in part by the first order net benefits. Moreover, second and third order economic impacts typically do not add to the value of first order net benefits measured by BCA, but instead represent impacts into which these first order net benefits are translated as they are transmitted through a complex economy.

Understanding and addressing economic impacts can be important to understand how a project may affect a particular region, but this analysis should be done as an independent follow-on exercise after assessing the benefits and costs of a project through a BCA. BCA is the main tool to determine whether a project generates sufficient value to society, measured as positive net benefits, and used to justify spending on a specific program or project. A project with negative net benefits could generate positive regional economic impacts simply by increasing spending or employment within a specific geographic area even if, from a national standpoint, its overall economic effects would likely be negative.

7.2. Transfers

Analyses should distinguish between benefits and transfer payments. Benefits reflect reductions in real resource usage and overall net benefits to society, while transfers represent changes in how those benefits and costs are distributed among various groups with a stake in the project. As such, they do not represent a net increase in societal benefits and thus are not legitimate benefits to be included in a benefit-cost analysis. Examples could include increases in local wages and property tax revenues. While these are benefits for local workers and local governments, they also represent costs paid by local property owners, respectively, with no net change in societal welfare.

Projected changes in revenues from fares, tolls, or port fees attributed to a proposed improvement project would also typically be considered as transfer payments, since they reflect both a cost to users and a revenue source to the facility operator. However, in some cases, reductions in fee rates may reflect reductions in operating costs that are passed onto users, and thus may serve as a proxy for such changes where detailed information on operating costs may not be available. If reductions in fees are treated this way, care should be taken to clearly show that these changes are actual benefits resulting from increased efficiency and not simply a transfer payment between the various parties involved, and to avoid double counting any operating cost and fee or fare reductions.

7.3. Avoided Costs

Transportation improvements are sometimes justified by describing the costs of an alternative, more costly improvement (often on another mode of transportation) that would accomplish roughly the same goal, such as reducing congestion or moving larger volumes of freight. However, applicants should not include the "avoided cost" of such alternative capital improvement projects when estimating benefits the BCA. For example, if a metropolitan area found that the cost of expanding an existing commuter rail line to accommodate future growth in travel demand was less than a corresponding investment in a new freeway facility, the applicant could not include the "savings" of these avoided costs between the two projects in the BCA. The goal of BCA is to examine whether the proposed project is justified given its expected benefits; as noted in Section 3.2 above, simply comparing one capital investment project to another does not indicate whether either project would be cost-beneficial in its own right. Note, however, that reductions in ongoing operating and maintenance costs of a transportation facility would be a valid impact to quantify in a BCA (see Section 5.2).

8. Submission Guidelines

The BCA submitted by the applicant should include both a narrative (such as a technical memo) and the detailed calculations used in the analysis. For the BCA narrative, each section should detail all the assumptions, calculations, and results of the BCA. The narrative should provide enough information so that a qualified third party can reproduce the results. The applicant should document and describe all data sources in addition to information on how each source feeds into the analysis.

Applicants should clearly describe the current baseline and how the proposed project would alter the baseline. This description should also include a summary of the estimated impacts (both positive and negative) of the proposed project. This description can be presented in a table or within the text, but it should make clear to the reviewer what the current situation is and how the proposed project will change the baseline. As noted above, if an application contains multiple, distinct projects that are linked together in a common objective, each of which has independent utility, the applicant should provide a separate description and analysis for each project.

The BCA should include a high-level summary of the key components of the BCA, including the benefits, costs, and major assumptions, with accompanying discussion. Costs should include the full cost of the project, including Federal, State, local, and private funding, as well as expected operations and maintenance costs, and not simply the requested grant amount or the local amount. Table 2 provides an example of a matrix format that could be used to help summarize this information.

Table 2: Example of an Executive Summary Matrix

Current Status/Baseline and Problem to be Addressed	Change to Baseline or Alternatives	Types of Impacts
Stop light at lightly used (non-peak) rural intersection with excess waiting time and safety hazard	Replace with roundabout /signal phasing improvement	Reduce wait times for vehicles (non-peak) & reduce accidents (peak)

8.1. Transparency and Reproducibility

As OMB Circular A-4 emphasizes, benefit-cost analyses should be sufficiently transparent so that a qualified third party can understand all its assumptions, reproduce the analysis with the same results, and would be likely to reach the same conclusions. USDOT recommends that applicants provide the detailed calculations of the analysis in the form of an unlocked Excel workbook to allow for a detailed review and sensitivity testing of key parameters by USDOT analysts. The workbook should also include tabs showing key inputs to the analysis as well as a summary of the final results for each cost and benefit category. The analysis should also identify any assumptions that heavily influence the results and could change the outcomes if varied, as well as the source documentation (with links as appropriate) for assumptions made in the analysis. Simply providing summary output tables or unlinked data tables (such as pdf files or hard-coded spreadsheets) does not provide the level of detail needed for a thorough review, and could result in delays in the review as USDOT reaches back to the applicant for more information.

Note that if an applicant uses a “pre-packaged” economic model to calculate net benefits, the applicant is still responsible for providing sufficient information so that a USDOT reviewer can follow the general logic of the estimates and reproduce them. The Department is particularly looking for key underlying assumptions of the model and annual benefit and cost by benefit and cost types. Where BCAs may have been developed using database-based models or other proprietary tools, applicants should consult with USDOT to help determine a mutually acceptable method of providing the needed detailed information.

8.2. Uncertainty and Sensitivity Analysis

BCAs will be subject to varying levels of uncertainty attributable to the use of preliminary cost estimates, difficulty of modeling future traffic levels, or use of other imperfect data and incompletely understood parameters. When describing the assumptions employed, BCAs should identify those that are subject to especially large uncertainty and emphasize which of these has the greatest potential influence on the outcome of the BCA.

Sensitivity analysis can be used to help illustrate how the results of a BCA would change if it employed alternative values for key data elements that are subject to uncertainty. A simple sensitivity analysis will take one variable and assume multiple valuations of that variable. For example, if the benefits of a project rely on an uncertain crash risk reduction, a sensitivity analysis should be done to estimate the benefits under different crash reduction assumptions. Submission of an unprotected Excel spreadsheet with embedded calculations will also allow USDOT reviewers to conduct sensitivity analyses, as necessary. The applicant may also wish to provide suggested alternative values for key parameters that could be used for such sensitivity testing, or provide the results of a broader uncertainty analysis using such methods as Monte Carlo simulation, where this has been conducted.

Appendix A: Recommended Monetized Values

Each project generates unique impacts in its respective community, and the grant evaluation process respects these differences, particularly within the context of benefit-cost analysis. While the impacts may differ from place to place, USDOT does recognize certain monetized values (and monetizing methodologies) as standard, which allows various projects from across the country to be evaluated and compared on a more equivalent "apples-to-apples" basis. The following tables summarize key values for various types of benefits and costs that the Department recommends that applicants use in their benefit-cost analyses. However, acceptable benefits and costs for BCAs submitted to USDOT are not limited only to these tables. The applicant should provide documentation of sources and detailed calculations for monetized values of additional categories of benefits and costs. Similarly, applicants using different values for the benefit and cost categories presented below should provide sources, calculations, and their rationale for divergence from recommended values.

The values provided in the tables on the following pages are stated in 2017 dollars, the base year recommended for use in applications submitted pursuant to NOFOs for discretionary grant programs issued in 2018.

Table A-1: Value of Reduced Fatalities and Injuries

<table>
<tr><th>Recommended Monetized Value(s)</th><th>References and Notes</th></tr>
<tr><td>
<table>
<tr><th>MAIS Level</th><th>Severity</th><th>Fraction of VSL</th><th>Unit value ($2017)</th></tr>
<tr><td>MAIS 1</td><td>Minor</td><td>0.003</td><td>$28,800</td></tr>
<tr><td>MAIS 2</td><td>Moderate</td><td>0.047</td><td>$451,200</td></tr>
<tr><td>MAIS 3</td><td>Serious</td><td>0.105</td><td>$1,008,000</td></tr>
<tr><td>MAIS 4</td><td>Severe</td><td>0.266</td><td>$2,553,600</td></tr>
<tr><td>MAIS 5</td><td>Critical</td><td>0.593</td><td>$5,692,800</td></tr>
<tr><td>Fatal</td><td>Not Survivable</td><td>1.000</td><td>$9,600,000</td></tr>
</table>
<table>
<tr><th>KABCO Level</th><th>Monetized Value</th></tr>
<tr><td>O – No Injury</td><td>$3,200</td></tr>
<tr><td>C – Possible Injury</td><td>$63,900</td></tr>
<tr><td>B – Non-incapacitating</td><td>$125,000</td></tr>
<tr><td>A – Incapacitating</td><td>$459,100</td></tr>
<tr><td>K – Killed</td><td>$9,600,000</td></tr>
<tr><td>U – Injured (Severity Unknown)</td><td>$174,000</td></tr>
<tr><td># Accidents Reported (Unknown if Injured)</td><td>$132,200</td></tr>
</table>
</td><td>
<i>Guidance on Treatment of the Economic Value of a Statistical Life in U.S. Department of Transportation Analyses (2016)</i> https://www.transportation.gov/office-policy/transportation-policy/revised-departmental-guidance-on-valuation-of-a-statistical-life-in-economic-analysis
Note:
The KABCO level values shown result from multiplying the KABCO-level accident's associated MAIS-level probabilities by the recommended unit Value of Injuries given in the MAIS level table, and then summing the products. Accident data may not be presented on an annual basis when it is provided to applicants (i.e. an available report requested in Fall 2011 may record total accidents from 2005-2010). For the purposes of the BCA, is important to annualize data when possible.
</td></tr>
</table>

Table A-2: Property Damage Only (PDO) Crashes

Recommended Monetized Value(s)	Reference and Notes
$4,327 per vehicle ($2017)	*The Economic and Societal Impact of Motor Vehicle Crashes, 2010 (revised May 2015), Page 12, Table 1-2, Summary of Unit Costs, 2000".* Inflated to 2017 dollars using the GDP Deflator.

Table A-3: Value of Travel Time Savings

<table>
<tr><th>Recommended Monetized Value(s)</th><th>References and Notes</th></tr>
<tr>
<td>
<table>
<tr><th colspan="2">Recommended Hourly Values of Travel Time Savings (2017 U.S. $ per person-hour)</th></tr>
<tr><th>Category</th><th>Hourly Value</th></tr>
<tr><td>In-Vehicle Travel[1]</td><td></td></tr>
<tr><td>Personal[2]</td><td>$14.20</td></tr>
<tr><td>Business[3]</td><td>$26.50</td></tr>
<tr><td>All Purposes[4]</td><td>$14.80</td></tr>
<tr><td>Commercial Vehicle Operators[5]</td><td></td></tr>
<tr><td>Truck Drivers</td><td>$28.60</td></tr>
<tr><td>Bus Drivers</td><td>$30.00</td></tr>
<tr><td>Transit Rail Operators</td><td>$48.90</td></tr>
<tr><td>Locomotive Engineers</td><td>$44.90</td></tr>
<tr><td colspan="2">1\ Values apply to all combinations of in-vehicle and other transit time on surface transportation modes. Walk access, waiting, and transfer time should be valued at $28.40 per hour for personal travel when actions affect only those elements of travel time.

2\ Values for personal travel based on local travel values as described in USDOT's Value of Travel Time guidance. Where applicants also have specific information on the mix of local versus long-distance intercity travel (i.e., trips over 50 miles in length) on a facility, then the local travel values of time may be blended with the long-distance intercity personal travel value of $19.90 per hour.

3\ Note that business travel <u>does not</u> include commuting travel, which should be valued at the personal travel rate. Travel on high-speed rail service that would be competitive with air travel should be valued at $37.80 per hour for personal travel and $66.00 for business travel.

4\ Weighted average based on a typical distribution of local travel by surface modes (95.4% personal, 4.6% business). Applicants should apply their own distribution of business versus personal travel where such information is available.

5\ Includes only the value of time for the operator, not passengers or freight.</td></tr>
</table>
</td>
<td><i>Revised Departmental Guidance on Valuation of Travel Time in Economic Analysis</i>

https://www.transportation.gov/office-policy/transportation-policy/revised-departmental-guidance-valuation-travel-time-economic</td>
</tr>
</table>

Table A-4: Average Vehicle Occupancy

<table>
<tr><th>Recommended Monetized Value(s)</th><th>References and Notes</th></tr>
<tr><td>
<table>
<tr><th>Vehicle Type</th><th>Occupancy</th></tr>
<tr><td>Passenger vehicles</td><td>1.39</td></tr>
<tr><td>Trucks</td><td>1.00</td></tr>
</table>
</td><td>Federal Highway Administration Highway Statistics 2016, Table VM1</td></tr>
</table>

Table A-5: Vehicle Operating Costs

<table>
<tr><th>Recommended Monetized Value(s)</th><th>References and Notes</th></tr>
<tr><td>
<table>
<tr><th>Vehicle Type</th><th>Recommended Value per Mile ($2017)</th></tr>
<tr><td>Light Duty Vehicles[1]</td><td>$0.39</td></tr>
<tr><td>Commercial Trucks[2]</td><td>$0.90</td></tr>
</table>
<p>1\ Based on an average light duty vehicle and includes operating costs such as gasoline, maintenance, tires, and depreciation (assuming an average of 15,000 miles driven per year). The value omits other ownership costs that are mostly fixed or transfers (insurance, license, registration, taxes, and financing charges).</p>
<p>2\ Value includes fuel costs, truck/trailer lease or purchase payments, repair and maintenance, truck insurance premiums, permits and licenses, and tires. The value omits tolls (transfers) and driver wages and benefits (already included in value of travel time savings) and is inflated to 2017 dollars using the GDP deflator.</p>
</td><td>
<p>American Automobile Association, Your Driving Costs – 2017 Edition (2017)
https://exchange.aaa.com/automotive/driving-costs/#.Wt9eRojwa72</p>
<p>American Transportation Research Institute, An Analysis of the Operational Costs of Trucking: 2017 Update (2017)
http://atri-online.org/wp-content/uploads/2017/10/ATRI-Operational-Costs-of-Trucking-2017-10-2017.pdf</p>
</td></tr>
</table>

Table A-6: Damage Costs for Pollutant Emissions

<table>
<tr><th>Recommended Monetized Value(s)</th><th>References and Notes</th></tr>
<tr><td>
<table>
<tr><th>Emission Type</th><th>$ / short ton*
($2017)</th></tr>
<tr><td>Carbon dioxide (CO_2)</td><td>**</td></tr>
<tr><td>Volatile Organic Compounds (VOCs)</td><td>$1,905</td></tr>
<tr><td>Nitrogen oxides (NOx)</td><td>$7,508</td></tr>
<tr><td>Particulate matter (PM)</td><td>$343,442</td></tr>
<tr><td>Sulfur dioxide (SO_2)</td><td>$44,373</td></tr>
</table>
<p>*Applicants should carefully note whether their emissions data is reported in short tons or metric tons. A metric ton is equal to 1.1015 short tons.</p>
<p>**USDOT does not currently have a recommended value for the damage costs of CO_2 emissions. See Section 4.4 for more guidance on how such a value might be included in a BCA.</p>
</td><td>
<p><i>Corporate Average Fuel Economy for MY2017-MY2025 Passenger Cars and Light Trucks (August 2012), page 922, Table VIII-16, “Economic Values Used for Benefits Computations (2010 dollars)”</i>
http://www.nhtsa.gov/staticfiles/rulemaking/pdf/cafe/FRIA_2017-2025.pdf</p>
<p>Values are inflated from 2010 dollars to 2017 dollars using the GDP deflator.</p>
</td></tr>
</table>

Table A-7: Inflation Adjustment Values

<table>
<tr><th>Recommended Monetized Value(s)</th><th>References and Notes</th></tr>
<tr><td>
<table>
<tr><th>Base Year of Nominal Dollar</th><th>Multiplier to Adjust to Real $2017</th></tr>
<tr><td>2001</td><td>1.3542</td></tr>
<tr><td>2002</td><td>1.3338</td></tr>
<tr><td>2003</td><td>1.3077</td></tr>
<tr><td>2004</td><td>1.2727</td></tr>
<tr><td>2005</td><td>1.2330</td></tr>
<tr><td>2006</td><td>1.1962</td></tr>
<tr><td>2007</td><td>1.1652</td></tr>
<tr><td>2008</td><td>1.1428</td></tr>
<tr><td>2009</td><td>1.1342</td></tr>
<tr><td>2010</td><td>1.1205</td></tr>
<tr><td>2011</td><td>1.0979</td></tr>
<tr><td>2012</td><td>1.0780</td></tr>
<tr><td>2013</td><td>1.0609</td></tr>
<tr><td>2014</td><td>1.0422</td></tr>
<tr><td>2015</td><td>1.0310</td></tr>
<tr><td>2016</td><td>1.0180</td></tr>
<tr><td>2017</td><td>1.0000</td></tr>
</table>
</td><td>
Bureau of Economic Analysis, National Income and Product Accounts, Table 1.1.9, “Implicit Price Deflators for Gross Domestic Product” (March 2018)

https://www.bea.gov/iTable/iTable.cfm?reqid=19&step=2#reqid=19&step=2&isuri=1&1921=survey&1903=13
</td></tr>
</table>

Appendix B: Sample Calculations

Example Inflation Adjustment Calculation

Adjusting for inflation requires a value with a known base year and the multiplier to adjust to the desired year dollars. For example, the real value in 2017 of $1,000,000 in expenses incurred in 2001, using the Implicit GDP Deflator multipliers given in Table A-7, would be as follows:

$$\begin{aligned}(2017\ Real\ Value\ of\ \$1{,}000{,}000\ in\ 2001) &= \$1{,}000{,}000\ x\ 1.3542\\ &= \$1{,}354{,}200\end{aligned}$$

Example Discounting Calculation

The following formula should be used to discount future benefits and costs:

$$PV = \frac{FV}{(1+i)^t}$$

Where PV = Present discounted value of a future payment from year *t*

FV = Future value of payment in real dollars (i.e., dollars that have the same purchasing power as in the base year of the analysis, see the next section for further discussion on this topic) in year *t*

i = Real discount rate applied

t = Years in the future for payment (where base year of analysis is t = 0)

For example, the present value in 2017 of $5,200 real dollars (i.e., dollars with the same purchasing power as in the 2016 base year) to be received in 2023 would be $3,465 if the real discount rate (i.e., the time value of money) is seven percent per annum:

$$\begin{aligned}PV &= \frac{\$5{,}200.00}{(1+0.07)^6}\\ &= \$3{,}464.98\end{aligned}$$

If the discount rate is estimated correctly, a person given the option of either receiving $5,200 in 2023 or $3,465 in 2017 would be indifferent as to which he or she might select. If the real discount rate were three percent, the present value of the $5,200 sum would be $4,355. It should be clear from the formula above that as the discount rate increases, the present values of future benefits or costs will decline significantly.

Applicants should discount each category of benefits and costs separately for each year in the analysis period during which they accrue. Table B-1 provides a simplified example of how this could be done for one category of benefits and one category of costs. Further reading and examples on discounting may be found in OMB Circulator A-94 and OMB Circular A-4.

Table B-1. Example of Discounting

Calendar Year	Project Year	Value of Travel Time Savings ($2017)	Discounted Travel Time Savings at 7%	Construction Costs ($2017)	Discounted Construction Costs at 7%	NPV at 7%
2018	1	$0	$0	$38,500,000	$38,500,000	-$38,500,000
2019	2	$0	$0	$15,500,000	$14,485,981	-$14,485,981
2020	3	$23,341,500	$20,387,370	$0	$0	$20,387,370
2021	4	$24,570,000	$20,056,439	$0	$0	$20,056,439
2022	5	$25,061,400	$19,119,222	$0	$0	$19,119,222
2023	6	$26,781,300	$19,094,697	$0	$0	$19,094,697
Total			**$78,657,728**		**$52,985,981**	**$25,671,746**

Example Calculation of Benefits to Existing and Additional Users

Estimating the benefits to existing and additional users requires estimates of the reduction in average costs to users resulting from an improvement as well as forecasts of traffic volumes in a given year both with and without the improvement.

For an illustrative example, assume that the current cost of travel and volume of riders is $75 per trip (reflecting the combined value of travel time costs, vehicle operating costs, safety costs, and other user costs) and that there are 200,000 riders projected in that year. The improvement is projected to reduce that generalized cost of travel is to $65 per trip and result in 250,000 riders in that year. First estimate the benefits for the existing users:

$$\begin{aligned} Existing\ User\ Benefits &= Volume\ of\ Existing\ Users\ x\ Change\ in\ Cost \\ &= V1\ x\ (P1 - P2) \\ &= 200{,}000\ x\ (\$75 - \$65) \\ &= 200{,}000\ x\ \$10 \\ &= \$2{,}000{,}000 \end{aligned}$$

Next, estimate the benefits for the additional users using the rule of half:

$$\begin{aligned} Benefits\ to\ Additional\ Users &= \frac{1}{2} x\ Volume\ of\ Additional\ Users\ x\ Change\ in\ Cost \\ &= \frac{1}{2} x\ (V2 - V1) x\ (P2 - P1) \\ &= \frac{1}{2}\ x\ (\$75 - \$65)\ x\ (250{,}000 - 200{,}000) \\ &= \frac{1}{2}\ x\ \$10\ x\ 50{,}000 \\ &= \$250{,}000 \end{aligned}$$

Summing the two types of consumer benefits, this hypothetical example would generate $2,250,000 in benefits in that year.

Example Value of Time Savings Calculation

A transit line is being improved to allow for a time savings of 12 minutes between a particular origin and destination pair. Current transit line demand between the two stations is 100,000 trips per year for all trip purposes, and the applicant estimates that demand will increase to a total of 110,000 trips per year after the project is implemented.

Existing passengers experience the full 12 minutes (0.2 hours) of travel time savings, as follows:

$$\begin{aligned} VTTS(existing) &= Value\ of\ time\ x\ Change\ in\ trip\ time\ x\ Affected\ trips \\ &= \frac{\$14.80}{hr} x\ 0.2\ hr\ x\ 100{,}000\ trips/year \\ &= \$296{,}000/year \end{aligned}$$

Applicants should repeat this calculation for each of the relevant trip markets along the corridor. The sum of the trip time savings across all origin and destination pairs provides the total trip savings to existing passengers.

In some cases, trip time savings (and/or reductions in fares) would be expected to attract new passengers or shippers using transit services. New passengers (or shippers) will generally not experience a comparable value of trip time savings on a per passenger basis, since they only start using the transit service once the shorter trip time is available. Thus, some portion of the trip time savings was necessary to attract that passenger to the transit mode from another mode, or to encourage the passenger to make a new trip they previously would not have made. A straightforward assumption is that new passengers were attracted equally by each additional increment of trip time savings, with the first additional passenger realizing almost the full value of benefits as pre-existing passengers, and the last new passengers switching to rail realizing only a small share of the overall benefits of the pre-existing passengers. That is, an equal number of new passengers were attracted by the first minute of savings as by the twelfth, with each new increment experiencing a diminishing share of net benefits. In this case, new passengers will on average value the time savings resulting from the service improvement at one-half of its value to existing passengers.

$$\begin{aligned} VTTS(new) &= Value\ of\ time\ x\ \frac{1}{2}\ x\ Change\ in\ trip\ time\ x\ Affected\ trips \\ &= \frac{\$14.80}{hr} x\ \frac{1}{2}\ x\ 0.2\ hr\ x\ 10{,}000\ trips/year \\ &= \$14{,}800/year \end{aligned}$$

Applicants should also repeat this calculation for each of the relevant trip markets along the corridor. The sum of the trip time savings across all origin and destination pairs provides the total trip savings to new passengers. Total VTTS is then the sum of the $\text{VTTS}_{\text{(existing)}}$ and $\text{VTTS}_{\text{(new)}}$, or \$310,800 annually in the simplified example above.

Example of Crash Modification Factor Calculation

To use a CMF, an applicant will first need the most recent year estimates of fatalities and injuries along an existing facility, as well as a CMF that correctly corresponds to the safety improvement being implemented. Once these have been collected, the estimated lives saved and injuries prevents are as follows:

$$\begin{aligned} Estimated\ Annual\ Lives\ Saved &= Current\ Annual\ Fatality\ Estimate\ x\ [1 - CMF] \\ Estimated\ Annual\ Injuries\ Prevented &= Current\ Annual\ Injury\ Estimate\ x\ [1 - CMF] \end{aligned}$$

Assume a project includes implementing rumble strips on a 2-lane rural road. The stretch of road in question is particularly dangerous and has had an annual average of 16 fatalities and 20 non-fatal injuries. For this example, assume a rumple strip has a hypothetical CMF of 0.84 for both fatalities and injuries. Estimating the prevented fatalities and non-fatal injuries would be as follows:

$$\begin{aligned} Estimated\ Annual\ Lives\ Saved &= Current\ Annual\ Fatality\ Estimate\ x\ [1 - CMF] \\ &= 16\ x\ [1 - 0.84] \\ &= 2.56/year \\ Estimated\ Annual\ Injuries\ Prevented &= Current\ Annual\ Injury\ Estimate\ x\ [1 - CMF] \\ &= 20\ x\ [1 - 0.84] \\ &= 3.20/year \end{aligned}$$

Thus, the rumble strip project would be expected to save approximately 2.6 lives per year and reduce injuries by 3.2 annually. These estimates can then be monetized as discussed in Section 4.3 and shown in the following example.

Example Safety Benefits Calculation

To demonstrate how to calculate safety benefits, consider a hypothetical grade crossing project that would grade separate the crossing. For this example, the project would eliminate 100 percent of the risk associated with rail-auto crashes (as well as provide other ancillary benefits with regard to surface congestion). To determine the safety benefit, the applicant should estimate a baseline crash risk (the existing conditions risk) to measure the risk reduction of the project.

Depending on the project site and the frequency of crashes, this can be done in several ways. One strategy is to determine the historical crash rate and assume that it would remain constant in the absence of the proposed project; however, this strategy may not be realistic if the historical crash rate has been changing, and is not effective for high consequence/low probability events or in regions with very few events. The applicant may also need to adjust the calculation to consider changes in the frequency of rail service and expected growth in automobile traffic, among other factors.

For example, if there are 10 crashes per year but the train flow is expected to increase by 10 percent over the next 5 years or automobile traffic is projected to increase, the baseline crash risk may also increase over the next 5 years. The most reliable approach to estimating the baseline risk and its reduction because of improving a crossing will depend on the location of the project, the objective of the project, and the data available. The applicant should document all assumptions on baseline crash risk and risk reduction, and how factors (e.g., population growth, expected changes in service, freight growth) impact the risk under the baseline and with the improvements resulting from a proposed project.

There are three main components to estimating the safety benefits: baseline risk; the reduction in risk expected to result from a project that improves a grade crossing; and the expected consequences posed by those risks. For this example, USDOT will assume that without the project (the baseline risk), the site would experience three collisions between trains and automobiles annually, resulting in an average consequence of one fatality and one minor injury per incident.[25] These fatalities and injuries represent the expected consequences of the baseline collision risk. Because the project removes the grade crossing and thereby eliminates all risk of auto-rail collisions, it also eliminates the expected consequences of that risk. Thus, its expected safety benefits include eliminating three fatalities and three minor injuries annually.

The following calculation illustrates the estimated annual safety benefits from removing the grade crossing:

$$\begin{aligned} Safety\ Benefits &= Baseline\ Risk\ x\ Risk\ Reduction\ x\ Expected\ Consequences \\ &= 3\ crashes/year\ x\ 100\%\ risk\ reduction\ x\ [1\ x\ \$9{,}600{,}000 + 1\ x\ \$28{,}800] \\ &= \$28{,}886{,}400/year \end{aligned}$$

When estimating the benefits, it is important to ensure that units align. For example, if risk reduction is defined on an annual basis, baseline risk should also be expressed on an annual basis. If expected consequences are expressed on an annual rather than a per crash basis, the number of crashes should be omitted from the equation.

Example Emissions Benefits Calculation

Benefits from reducing emissions of criteria pollutants should be estimated using the standard benefit calculation; that is, by multiplying the quantity of reduced emissions of each pollutant in various future years by the dollar value of avoiding each ton of emissions of that pollutant. For the example calculation, assume that the project will lower PM2.5 by 10 short tons annually; using the value from Table A-6 above, this reduction would result in \$3.4 million in benefits annually over its lifetime. Other emissions should be calculated similarly with their respective monetized value.

$$\begin{aligned} PM\ Reduction\ Benefit &= Quanity\ Reduced\ x\ Monetized\ Value \\ &= 10\ short\ tons\ x\ \$343{,}442/short\ ton \\ &= \$3{,}434{,}420/year \end{aligned}$$

The economic value of reduced emissions during each year of the project's lifetime would then be discounted to its present value for use in the overall BCA evaluation.

Example Residual Value Calculation

Residual value should be estimated using the total value of asset, the remaining service life at the end of the analysis period, and the cost of any major rehabilitation expected to occur in the remaining service life but outside the analysis period. For the example calculation, assume the analysis period is 30 years of

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[25] For simplicity in this example, USDOT assumes population growth, rail traffic, and highway traffic will remain constant.

operation but the project has a useful service life of 40 years. The total project cost, in real dollars, is $40 million. The residual value of the project would thus be:

$$
\begin{aligned}
RV &= \left(\frac{U-Y}{U}\right) x\ Project\ Cost \\
&= \left(\frac{40-30}{40}\right) x\ \$40{,}000{,}000 \\
&= \$10{,}000{,}000
\end{aligned}
$$

Where RV = Residual Value

U = Useful Service Life of Project

Y = Years of Analysis Period Project Operation

It’s important to note that this $10,000,000 in residual value benefits would occur in the final year of the analysis and should be discounted the same as other project benefits and costs in the BCA.

Appendix D

BCA

Hinsdale, NH - Brattleboro, VT Bridge Project
Benefit Cost Analysis (BCA) - Proposed Bridge Compared to Continued Existing Bridge Maintenance

	Benefits (Avoided Cost Associated with New Bridge)				Total Costs and Disbenefits (New Bridge and Bridge Repurposing)	Benefit Cost Ratios
Present Value	PM & NOx Emissions Costs	User Cost (Travel Time Savings and Avoided Train Delay)	Existing Bridge Rehabilitation and O&M Costs	**Total Benefits**		
At 3 Percent	$939,925	$98,605,118	$16,337,570	**$115,882,613**	**$45,982,951**	**2.52**
At 7 Percent	$570,847	$82,628,788	$13,991,994	**$97,191,630**	**$49,412,276**	**1.97**

Hinsdale, NH - Brattleboro, VT Bridge Project

Benefit Cost Analysis (BCA) - Proposed Bridge Compared to Continued Maintenance of Existing Anna Hunt Marsh Bridge and Charles Dana Bridge

Conforming to U.S. Department of Transportation "Benefit-Cost Analysis Guidance for Discretionary Grant Programs" June 2018

Project Description: Construction of New NH Route 119 Bridge over the Connecticut River

Estimated Project Timing: 2018 - Existing Year / 2020 - Construction Start / 2022 - Construction Finished (opening year) / 2049 - 30 Year Forecast.

Estimated Bridge Posting to 20 Tons at a Service Life = 117 years (2037)

		Benefits (Avoided Cost Associated with Continued Train Conflict and Operations and Maintenance of Existing Bridges)					Total Benefits		Costs and Disbenefits				Total Costs	
Calendar Year	**Analysis Year**	**Nox & PM Emissions Costs[1]**	**User Cost (Travel Time Savings / Avoided Delay)[2]**	**User Cost (Train Conflict Avoided Delay)[2]**	**Operation & Maintenance Costs ($) [3]**	**Total Annual Benefits**	**Discounted Benefits - Present Value @ 3%**	**Discounted Benefits - Present Value @ 7%**	**Capital Expenditures ($)[4]**	**Proposed Bridge Operation & Maintenance Disbenefit ($)[5]**	**Existing Trusses Operation & Maintenance Disbenefit ($)[6]**	**Total Annual Costs**	**Discounted Costs - Present Value @ 3%**	**Discounted Costs - Present Value @ 7%**
2016									$271,250				$271,250	$271,250
2017									$271,250				$271,250	$271,250
2018									$271,250				$271,250	$271,250
2019									$8,621,250				$8,621,250	$8,621,250
2020	1	$117,416	$38,980,855	$0	$6,950,000	***$46,048,272***	***$44,707,060***	***$43,035,768***	$14,000,000	$0	$0	$14,000,000	*$13,592,233*	*$13,084,112*
2021	2	$118,591	$39,370,664	$0	$6,950,000	***$46,439,254***	***$43,773,451***	***$40,561,843***	$14,000,000	$0	$0	$14,000,000	*$13,196,343*	*$12,228,142*
2022	3	$19,018	$384,210	$259,296	$30,000	***$692,524***	***$633,757***	***$565,306***	$14,000,000	$0	$0	$14,000,000	*$12,811,983*	*$11,428,170*
2023	4	$19,208	$279,174	$259,296	$30,000	***$587,678***	***$522,144***	***$448,337***	$8,000,000	$8,851	$0	$8,008,851	*$7,115,760*	*$6,109,914*
2024	5	$19,227	$279,453	$259,296	$30,000	***$587,977***	***$507,194***	***$419,219***		$8,851	$30,000	$38,851	*$33,513*	*$27,700*
2025	6	$19,247	$279,733	$259,296	$30,000	***$588,275***	***$492,671***	***$391,993***		$8,851	$0	$8,851	*$7,412*	*$5,897*
2026	7	$20,120	$674,031	$259,296	$75,000	***$1,028,446***	***$836,221***	***$640,465***		$8,851	$30,000	$38,851	*$31,589*	*$24,194*
2027	8	$19,630	$439,476	$259,296	$31,500	***$749,902***	***$591,979***	***$436,450***		$8,851	$0	$8,851	*$6,987*	*$5,151*
2028	9	$19,304	$280,573	$259,296	$30,000	***$589,173***	***$451,552***	***$320,471***		$14,751	$31,000	$45,751	*$35,064*	*$24,885*
2029	10	$19,324	$280,853	$259,296	$30,000	***$589,473***	***$438,623***	***$299,658***		$8,851	$0	$8,851	*$6,586*	*$4,499*
2030	11	$20,231	$691,151	$259,296	$75,000	***$1,045,678***	***$755,420***	***$496,794***		$8,851	$30,000	$38,851	*$28,066*	*$18,458*
2031	12	$19,575	$284,499	$259,296	$30,000	***$593,370***	***$416,178***	***$263,463***		$8,851	$0	$8,851	*$6,208*	*$3,930*
2032	13	$20,832	$145,773	$256,454	$319,500	***$742,559***	***$505,647***	***$308,136***		$8,851	$30,000	$38,851	*$26,455*	*$16,122*
2033	14	$19,401	$281,978	$259,296	$30,000	***$590,675***	***$390,506***	***$229,074***		$150,459	$51,000	$201,459	*$133,188*	*$78,129*
2034	15	$19,421	$282,260	$259,296	$75,000	***$635,977***	***$408,209***	***$230,507***		$8,851	$30,000	$38,851	*$24,937*	*$14,081*
2035	16	$19,440	$282,543	$259,296	$30,000	***$591,279***	***$368,465***	***$200,287***		$8,851	$0	$8,851	*$5,515*	*$2,998*
2036	17	$19,459	$282,825	$259,296	$30,000	***$591,581***	***$357,916***	***$187,279***		$8,851	$30,000	$38,851	*$23,505*	*$12,299*
2037	18	$71,035	$1,202,728	$259,296	$31,500	***$1,564,559***	***$919,013***	***$462,897***		$8,851	$0	$8,851	*$5,199*	*$2,619*
2038	19	$72,322	$1,481,149	$259,296	$75,000	***$1,887,767***	***$1,076,567***	***$521,983***		$14,751	$31,000	$45,751	*$26,091*	*$12,650*
2039	20	$72,074	$1,047,531	$259,296	$30,000	***$1,408,901***	***$780,074***	***$364,087***		$8,851	$0	$8,851	*$4,900*	*$2,287*
2040	21	$72,795	$1,058,007	$259,296	$30,000	***$1,420,097***	***$763,372***	***$342,972***		*$8,851*	*$30,000*	$38,851	*$20,884*	*$9,383*
2041	22	$73,523	$1,068,587	$259,296	$30,000	***$1,431,405***	***$747,040***	***$323,087***		$8,851	$0	$8,851	*$4,619*	*$1,998*
2042	23	$97,697	$15,989,390	$171,206	$4,302,000	***$20,560,294***	***$10,417,731***	***$4,337,130***		$8,851	$30,000	$38,851	*$19,685*	*$8,195*
2043	24	$75,000	$1,090,065	$259,296	$30,000	***$1,454,362***	***$715,450***	***$286,722***		$4,434,101	$1,397,000	$5,831,101	*$2,868,515*	*$1,149,582*
2044	25	$75,750	$1,100,966	$259,296	$30,000	***$1,466,012***	***$700,176***	***$270,112***		$8,851	$30,000	$38,851	*$18,555*	*$7,158*
2045	26	$76,508	$1,111,975	$259,296	$30,000	***$1,477,779***	***$685,239***	***$254,467***		$8,851	$0	$8,851	*$4,104*	*$1,524*
2046	27	$78,315	$1,603,872	$259,296	$75,000	***$2,016,483***	***$907,799***	***$324,513***		$8,851	$30,000	$38,851	*$17,490*	*$6,252*
2047	28	$78,467	$1,328,560	$259,296	$31,500	***$1,697,823***	***$742,079***	***$255,356***		$8,851	$0	$8,851	*$3,868*	*$1,331*

Hinsdale, NH - Brattleboro, VT Bridge Project

Benefit Cost Analysis (BCA) - Proposed Bridge Compared to Continued Maintenance of Existing Anna Hunt Marsh Bridge and Charles Dana Bridge

Conforming to U.S. Department of Transportation "Benefit-Cost Analysis Guidance for Discretionary Grant Programs" June 2018

Project Description: Construction of New NH Route 119 Bridge over the Connecticut River

Estimated Project Timing: 2018 - Existing Year / 2020 - Construction Start / 2022 - Construction Finished (opening year) / 2049 - 30 Year Forecast.

Estimated Bridge Posting to 20 Tons at a Service Life = 117 years (2037)

		Benefits (Avoided Cost Associated with Continued Train Conflict and Operations and Maintenance of Existing Bridges)					Total Benefits		Costs and Disbenefits				Total Costs	
Calendar Year	Analysis Year	Nox & PM Emissions Costs[1]	User Cost (Travel Time Savings / Avoided Delay)[2]	User Cost (Train Conflict Avoided Delay)[2]	Operation & Maintenance Costs ($)[3]	Total Annual Benefits	Discounted Benefits - Present Value @ 3%	Discounted Benefits - Present Value @ 7%	Capital Expenditures ($)[4]	Proposed Bridge Operation & Maintenance Disbenefit ($)[5]	Existing Trusses Operation & Maintenance Disbenefit ($)[6]	Total Annual Costs	Discounted Costs - Present Value @ 3%	Discounted Costs - Present Value @ 7%
2048	29	$78,826	$1,145,669	$259,296	$30,000	*$1,513,792*	*$642,372*	*$212,783*		$14,751	$31,000	$45,751	*$19,414*	*$6,431*
2049	30	$79,614	$1,157,126	$259,296	$30,000	*$1,526,037*	*$628,707*	*$200,471*		($32,891,150)	$0	($32,891,150)	*($13,550,718)*	*($4,320,815)*

Present Value @ 3%	**$939,925**	**$94,065,527**	**$4,539,592**	**$16,337,570**
Present Value @ 7%	**$570,847**	**$79,899,746**	**$2,729,041**	**$13,991,994**

Present Value Benefits	
@ 3%	**@ 7%**
$115,882,613	**$97,191,630**

Present Value Costs	
@ 3%	**@ 7%**
$45,982,951	**$49,412,276**

Benefit Cost Ratios	
@ 3%	**@ 7%**
2.52	**1.97**

Net Present Value	
@ 3%	**@ 7%**
$69,899,662	**$47,779,353**

Assumptions:

Discount Rates: 3% & 7%

1. See supporting spreadsheet - "Truss O&M VMT & Emissions.xlxs" in Appendix E2 for calculations and assumptions made.

2. See supporting spreadsheet "Posting & Train Conflict VHT.xlxs" in Appendix E2 for calculations and assumptions made.

3. Historic and projected maintenance costs used to estimate O&M. See spreadsheet "Baseline O&M Costs.xlsx" in Appendix E6.

4. See spreadsheet "Proposed Project Capital Expenditures.xlsx" in Appendix E7 for a description of all capital expenditures as well as a break down of year of expenditure.

5. O&M Costs provided by NHDOT, see spreadsheet "Proposed Bridge O&M Costs.xlsx" in Appendix E9. This column also includes the residual value of the proposed bridge in year 2039, see spreadsheet "Proposed Project Residual Value Calculations.xlsx" in Appendix E10.

6. Historic and projected maintenance costs used to estimate repurposed truss O&M. See spreadsheet "Repurposed Truss Bridge O&M Costs.xlsx" in Appendix E11.

XX - Input value from supporting spreadsheets.

Appendix E

BCA Worksheets

Appendix E1

Average Emissions Factors

EMFAC2014 (v1.0.7) Emission Rates
Region Type: Statewide
Region: California
Calendar Year: 2015
Season: Annual
Vehicle Classification: EMFAC2011 Categories
Units: miles/day for VMT, g/mile for RUNEX, PMBW and PMTW

Averaged Emissions Rates and % of VMT

			VMT miles/day		**NOx_RUNEX**	**Weighted** g/mile	**PM10_RUNEX**	**Weighted** g/mile
Heavy Duty	**DIESEL[1]**	**VMT Weighted Values**	**92502**	**0.8643**	7.5163	**6.4961**	0.0315	**0.0272**
Heavy Duty	**GAS[2]**	**VMT Weighted Values**	**14528**	**0.1357**	1.3765	**0.1869**	0.0003	**0.0000**
	Fuel Averages		**107031**	**1.00**				
					4.4464		0.0159	
						6.6829		**0.0273**

VMT	Diesel	Gasoline	SUM
TOTAL VMT =	199902	6576116.59	6776019
Vehicles > 40,000# GVW	92502	14528	107031

% Qualifying Vehicles[3]	**1.6%**

NOTES

[1] See supporting spreadsheet "Diesel.xlxs" for EMFAC2011 data and calculations.

[2] See supporting spreadsheet "Gasoline.xlxs" for EMFAC2011 data and calculations.

[3] Percentage VMT by vehicles with GVW > 40,000 to all VMT.

[4] See supporting spreadsheet "Veh. Class.xlxs" for listing of all vehicle class descriptions in EMFAC data.

EMFAC2014 (v1.0.7) Emission Rates
Region Type: Statewide
Region: California
Calendar Year: 2015
Season: Annual
Vehicle Classification: EMFAC2011 Categories
Units: miles/day for VMT, g/mile for RUNEX, PMBW and PMTW

			VMT miles/day		NOx_RUNEX	Weighted	PM10_RUNEX	Weighted
All Vehicles	**DIESEL[1]**	**VMT Weighted Values**	**199902**	**2.950%**	**4.7788**	**0.1410**	**0.0236**	**0.0007**
All Vehicles	**GAS[2]**	**VMT Weighted Values**	**6576117**	**97.050%**	**0.0571**	**0.0554**	**0.0005**	**0.0005**
		TOTALS	**6776019**	**100.0%**				
		Averages			**2.4179**		**0.0120**	
		Weighted Averages				**0.1964**		**0.0012**

NOTES

[1] See supporting spreadsheet "Diesel.xlxs" for EMFAC2011 data and calculations.

[2] See supporting spreadsheet "Gasoline.xlxs" for EMFAC2011 data and calculations.

EMFAC2014 (v1.0.7) Emission Rates
Region Type: Statewide
Region: California
Calendar Year: 2015
Season: Annual
Vehicle Classification: EMFAC2011 Categories
Units: miles/day for VMT, g/mile for RUNEX, PMBW and PMTW

Region	CalYr	VehClass	MdlYr	Speed	Fuel	VMT		ROG_RUNEX	TOG_RUNEX	CO_RUNEX	NOx_RUNEX	Weighted	CO2_RUNEX	Weighted	PM10_RUNEX	Weighted	PM2_5_RUNEX		
Statewide	2015	All Other Buses	2010	30	DSL	1851.55075	0.926%	0.160117932	0.182282078	0.415872299	4.685116131	0.043394915	1322.021586	12.2449503	0.020385763	0.000188819	0.019503884		1
Statewide	2015	LDA	2010	30	DSL	41541.30124	20.781%	0.013268408	0.0151052	0.24289157	0.033905876	0.007045924	345.0000989	71.69389504	0.004560672	0.000947746	0.004363379		2
Statewide	2015	LDT1	2010	30	DSL	60.97628724	0.031%	0.016670814	0.018978613	0.161113046	0.034574766	1.05464E-05	401.6856851	0.122526546	0.004640027	1.41535E-06	0.004439301		3
Statewide	2015	LDT2	2010	30	DSL	219.7136813	0.110%	0.016670814	0.018978613	0.161113046	0.034456943	3.78719E-05	469.1218195	0.51561506	0.004640027	5.09989E-06	0.004439301		4
Statewide	2015	LHD1	2010	30	DSL	20802.55861	10.406%	0.046640675	0.053097308	0.191952424	0.164756214	0.017145155	491.5265205	51.1501097	0.012551606	0.001306168	0.012008629		5
Statewide	2015	LHD2	2010	30	DSL	7694.086359	3.849%	0.046640675	0.053097308	0.191952424	0.164727032	0.006340227	557.830587	21.47050405	0.012551606	0.000483102	0.012008629		6
Statewide	2015	MDV	2010	30	DSL	10559.0609	5.282%	0.013721253	0.015620735	0.255189323	0.034409387	0.001817545	602.0396625	31.80044946	0.005028512	0.000265612	0.004557696		7
Statewide	2015	MH	2010	30	DSL	393.0647062	0.197%	0.042485605	0.048367036	0.119941959	2.337820286	0.004596826	1110.115909	2.182806489	0.015350796	3.01841E-05	0.014686727		8
Statewide	2015	Motor Coach	2010	30	DSL	1039.04565	0.520%	0.344316239	0.391977828	1.003209295	8.115987472	0.042185078	2013.787867	10.46721653	0.033746268	0.000175406	0.032286419		9
Statewide	2015	SBUS	2010	30	DSL	1202.760177	0.602%	0.130690564	0.148781259	0.339440964	4.058356885	0.024418115	1322.021586	7.95427216	0.015687819	9.43897E-05	0.015009171		10
Statewide	2015	T6 Ag	2010	30	DSL	61.28732851	0.031%	0.152937553	0.174107762	0.397222789	4.549071658	0.001394686	1322.021586	0.405314459	0.019239449	5.89856E-06	0.018407159		11
Statewide	2015	T6 CAIRP small	2010	30	DSL	305.9593853	0.153%	0.154324453	0.175686642	0.400824967	4.571151115	0.006996361	1322.021586	2.023416029	0.019460861	2.97858E-05	0.018618993		12
Statewide	2015	T6 instate construction heavy	2010	30	DSL	1439.848748	0.720%	0.154324453	0.175686642	0.400824967	4.560362167	0.032847254	1322.021586	9.522221496	0.019460861	0.000140172	0.018618993		13
Statewide	2015	T6 instate construction small	2010	30	DSL	4653.056988	2.328%	0.154324453	0.175686642	0.400824967	4.559579193	0.106131914	1322.021586	30.77228725	0.019460861	0.000452984	0.018618993		14
Statewide	2015	T6 instate small	2010	30	DSL	13930.55983	6.969%	0.154324453	0.175686642	0.400824967	4.555450229	0.317455412	1322.021586	92.12764635	0.015892401	0.001107493	0.018618993		15
Statewide	2015	T6 OOS small	2010	30	DSL	175.3032294	0.088%	0.154324453	0.175686642	0.400824967	4.571151115	0.004008652	1322.021586	1.159341342	0.019460861	1.70661E-05	0.018618993		16
Statewide	2015	T6 Public	2010	30	DSL	593.1736036	0.297%	0.113660256	0.12939355	0.295208359	3.675660464	0.010906868	1322.021586	3.922863736	0.012969009	3.84832E-05	0.012407975		17
Statewide	2015	T6 utility	2010	30	DSL	193.0644691	0.097%	0.112551825	0.128131685	0.292329445	3.647185851	0.003522436	1322.021586	1.276802609	0.012792053	1.23545E-05	0.012238674		18
Statewide	2015	UBUS	2010	30	DSL	683.5726801	0.342%	0.007836033	0.255809892	1.54521861	0.753508681	0.002576652	1773.367479	6.064099198	0.004797736	1.6406E-05	0.004590188		19
Statewide	2015	T6 CAIRP heavy	2010	30	DSL	108.5637317	0.054%	0.154324453	0.175686642	0.400824967	4.57130122	0.002482604	1301.927529	0.707057011	0.019460861	1.05689E-05	0.018618993	1	21
Statewide	2015	T6 instate heavy	2010	30	DSL	3888.325916	1.945%	0.154324453	0.175686642	0.400824967	4.555438626	0.088608568	1301.927529	25.32400147	0.019460861	0.000378536	0.018618993	2	22
Statewide	2015	T6 OOS heavy	2010	30	DSL	57.50730907	0.029%		0.175686642	0.400824967	4.571340711	0.001315072	1301.927529	0.374535265	0.019460861	5.59845E-06	0.018618993	3	23
Statewide	2015	T7 Ag	2010	30	DSL	38.07046919	0.019%	0.322886999	0.367582269	0.940772468	7.791876005	0.001483929	2013.787867	0.383517167	0.031125202	5.92766E-06	0.029778739	4	24
Statewide	2015	T7 CAIRP	2010	30	DSL	21364.05301	10.687%	0.435754118	0.496072893	1.269625221	9.77292807	1.044458549	1983.179313	211.9475937	0.044930274	0.004801817	0.04298661	5	25
Statewide	2015	T7 CAIRP construction	2010	30	DSL	1609.862106	0.805%	0.435754118	0.496072893	1.269625221	9.747719312	0.078500885	491.5265205	3.9583892	0.012551606	0.000101081	0.04298661	6	26
Statewide	2015	T7 NNOOS	2010	30	DSL	16920.31711	8.464%	0.435754118	0.496072893	1.269625221	9.772625234	0.827184909	1983.179313	167.8623665	0.044930274	0.003803036	0.04298661	7	27
Statewide	2015	T7 NOOS	2010	30	DSL	7983.890727	3.994%	0.435754118	0.496072893	1.269625221	9.773007467	0.390324377	1983.179313	79.20624553	0.044930274	0.001794471	0.04298661	8	28
Statewide	2015	T7 other port	2010	30	DSL	1357.716711	0.679%	0.397937185	0.453021193	1.159440761	9.09380317	0.061764307	2013.787867	13.67746913	0.040304786	0.000273747	0.038561219	9	29
Statewide	2015	T7 POAK	2010	30	DSL	2252.873848	1.127%	0.397937185	0.453021193	1.159440761	9.103886674	0.102599815	2013.787867	22.69517069	0.040304786	0.000454231	0.038561219	10	30
Statewide	2015	T7 POLA	2010	30	DSL	12841.51117	6.424%	0.397937185	0.453021193	1.159440761	9.069665144	0.582626517	2013.787867	129.3637849	0.040304786	0.00258914	0.038561219	11	31
Statewide	2015	T7 Public	2010	30	DSL	855.965901	0.428%	0.224905725	0.256038048	0.655291527	6.024198698	0.025795183	2013.787867	8.62289393	0.019140856	8.19598E-05	0.018312832	12	32
Statewide	2015	T7 Single	2010	30	DSL	1114.041807	0.557%	0.288694175	0.328656343	0.841147315	7.152783098	0.039862029	2013.787867	11.22271848	0.026942988	0.000150152	0.025777447	13	33
Statewide	2015	T7 single construction	2010	30	DSL	2204.944787	1.103%	0.288694175	0.328656343	0.841147315	7.147165735	0.078834158	2013.787867	22.2123393	0.026942988	0.000297185	0.025777447	14	34
Statewide	2015	T7 SWCV	2010	30	DSL	2729.707844	1.366%	0.047607648	1.562671623	5.616624317	2.979422711	0.040684703	3680.394759	50.25663786	0.004720537	6.446E-05	0.004516328	15	35
Statewide	2015	T7 tractor	2010	30	DSL	15694.91829	7.851%	0.397937185	0.453021193	1.159440761	9.093356721	0.713947286	1983.179313	155.7054817	0.040304786	0.003164452	0.038561219	16	36
Statewide	2015	T7 tractor construction	2010	30	DSL	1366.707025	0.684%	0.397937185	0.453021193	1.159440761	9.078978664	0.062071935	2013.787867	13.76803643	0.040304786	0.000275559	0.038561219	17	37
Statewide	2015	T7 utility	2010	30	DSL	113.0780364	0.057%	0.223628948	0.254584534	0.651571472	5.994584576	0.003390941	2013.787867	1.139134062	0.01898469	1.0739E-05	0.018163421	18	38
					TOTAL VMT	**199902**	1.000												
					Weighted														
		> 40,000 GVW Vehicles	DIESEL	Average Values				0.302098276	0.437480368	1.201374111	7.51633788		1896.361773		0.029728122		0.030163096		
						VMT		ROG_RUNEX	TOG_RUNEX	CO_RUNEX	NOx_RUNEX		CO2_RUNEX		PM10_RUNEX		PM2_5_RUNEX		
					Qualifying VMT	92502.0558	**46.274%**												
				VMT Weighted Average Values								**8.959593883**		**1984.77177**		**0.039466608**			
		All vehicles	DIESEL	Average Values				0.195463155	0.273337071	0.769513537	5.010560876		1450.505353		0.021257458		0.021236259		
				VMT Weighted Average Values								**4.778768203**		**1275.30371**		**0.023581245**			

EMFAC2014 (v1.0.7) Emission Rates
Region Type: Statewide
Region: California
Calendar Year: 2015
Season: Annual
Vehicle Classification: EMFAC2011 Categories
Units: miles/day for VMT, g/mile for RUNEX, PMBW and PMTW

Region	CalYr	VehClass	MdlYr	Speed	Fuel	VMT		ROG_RUNEX	TOG_RUNEX	CO_RUNEX	NOx_RUNEX	Weighted	CO2_RUNEX	Weighted	PM10_RUNEX	Weighted	PM2_5_RUNEX	
Statewide	2015	LDA	2011	30	GAS	3820879	0.581023627	0.010142591	0.014800046	0.514033488	0.048313605	0.028071346	359.1560107	208.6781281	0.000503158	0.000292347	0.000462635	1
Statewide	2015	LDT1	2011	30	GAS	141457.1	0.021510737	0.010198509	0.014881641	0.519949807	0.048936081	0.001052651	417.5905521	8.982680492	0.000503158	1.08233E-05	0.000462635	2
Statewide	2015	LDT2	2011	30	GAS	1735256	0.263872394	0.01176317	0.01716479	0.573579191	0.055751178	0.014711197	487.9178751	128.7480575	0.000503158	0.00013277	0.000462635	3
Statewide	2015	LHD1	2011	30	GAS	22685.83	0.00344973	0.006375572	0.00930322	0.129753303	0.052782043	0.000182084	694.6471525	2.396345198	0.000257864	8.89561E-07	0.000237096	4
Statewide	2015	LHD2	2011	30	GAS	12375.46	0.00188188	0.006961867	0.010158739	0.129871423	0.094108977	0.000177102	783.7699114	1.474960794	0.000257864	4.85269E-07	0.000237096	5
Statewide	2015	MCY	2011	30	GAS	30014.68	0.004564195	2.366394393	3.006122733	17.18129772	1.128674844	0.005151492	185.199508	0.845286637	0.000515951	2.3549E-06	0.000480683	6
Statewide	2015	MDV	2011	30	GAS	790475.5	0.120204004	0.012362547	0.018039399	0.6250259	0.056940128	0.006844431	627.3213974	75.40654374	0.000370248	4.45053E-05	0.000462635	7
Statewide	2015	MH	2011	30	GAS	1967.798	0.000299234	0.009879527	0.014416182	0.183772775	0.085743345	2.56573E-05	1314.77742	0.393426208	0.000257864	7.71617E-08	0.000237096	8
Statewide	2015	OBUS	2011	30	GAS	4335.848	0.000659333	0.009872301	0.014405638	0.200337572	0.080534935	5.30993E-05	1314.77742	0.866875595	0.000257864	1.70018E-07	0.000237096	9
Statewide	2015	SBUS	2011	30	GAS	1590.346	0.000241837	0.009844908	0.014365666	0.189596608	0.079611812	1.92531E-05	621.7637148	0.150365258	0.000257864	6.2361E-08	0.000237096	10
Statewide	2015	UBUS	2011	30	GAS	550.7398	8.37485E-05	0.012494213	0.018231526	0.302380259	0.220402013	1.84583E-05	1314.77742	0.110110616	0.000257864	2.15957E-08	0.000237096	11
Statewide	2015	T6TS	2011	30	GAS	12985.88	0.001974703	0.009873488	0.014407371	0.202200576	0.080704909	0.000159368	1314.77742	2.596294712	0.000257864	5.09205E-07	0.000237096	12
Statewide	2015	T7IS	2011	30	GAS	1542.619	0.000234579	0.302345511	0.44118186	30.98814214	2.672339018	0.000626875	1965.047554	0.460958836	0.000257864	6.04895E-08	0.000237096	13
					TOTAL VMT =	**6576117**	**1.000**											
		> 40,000 GVW Vehicles			Averages			0.1561095	0.227794616	15.59517136	1.376521964		1639.912487		0.000257864		0.000237096	
				TOTAL Qualifying MD & HD VMT		14528.49	0.221%											
					VMT Weighted Averages							**0.000786243**		**3.057253549**		**5.69694E-07**		
		all vehicles	GAS		Averages			0.213731431	0.27749837	3.979995443	0.361910991		877.0402582		0.000342968		0.00032523	
					VMT Weighted Averages							**0.057093014**		**431.1100337**		**0.000485075**		

EMFAC2011 Veh & Tech	EMFAC2011 Vehicle	Description	Source	EMFAC2007 Vehicle	EMFAC2007 Vehicle Code	Truck / Non-Truck Category	Truck 1 / Truck 2 / Non-Truck Category
LDA - DSL	LDA	Passenger Cars	EMFAC2011-LDV	LDA	PC	Non-Trucks	Non-Trucks
LDA - GAS			EMFAC2011-LDV			Non-Trucks	Non-Trucks
LDT1 - DSL	LDT1	Light-Duty Trucks (GVWR <6000 lbs. and ETW <= 3750 lbs)	EMFAC2011-LDV	LDT1	T1	Non-Trucks	Non-Trucks
LDT1 - GAS			EMFAC2011-LDV			Non-Trucks	Non-Trucks
LDT2 - DSL	LDT2	Light-Duty Trucks (GVWR <6000 lbs. and ETW 3751-5750 lbs)	EMFAC2011-LDV	LDT2	T2	Non-Trucks	Non-Trucks
LDT2 - GAS			EMFAC2011-LDV			Non-Trucks	Non-Trucks
LHD1 - DSL	LHD1	Light-Heavy-Duty Trucks (GVWR 8501-10000 lbs)	EMFAC2011-LDV	LHDT1	T4	Trucks	Truck 1
LHD1 - GAS			EMFAC2011-LDV			Trucks	Truck 1
LHD2 - DSL	LHD2	Light-Heavy-Duty Trucks (GVWR 10001-14000 lbs)	EMFAC2011-LDV	LHDT2	T5	Trucks	Truck 1
LHD2 - GAS			EMFAC2011-LDV			Trucks	Truck 1
MCY - GAS	MCY	Motorcycles	EMFAC2011-LDV	MCY	MC	Non-Trucks	Non-Trucks
MDV - DSL	MDV	Medium-Duty Trucks (GVWR 6000-8500 lbs)	EMFAC2011-LDV	MDV	T3	Non-Trucks	Non-Trucks
MDV - GAS			EMFAC2011-LDV			Non-Trucks	Non-Trucks
MH - DSL	MH	Motor Homes	EMFAC2011-LDV	MH	MH	Non-Trucks	Non-Trucks
MH - GAS			EMFAC2011-LDV			Non-Trucks	Non-Trucks
T6 Ag - DSL	T6 Ag	Medium-Heavy Duty Diesel Agriculture Truck	EMFAC2011-HD	MHDT	T6	Trucks	Truck 2
T6 CAIRP heavy - DSL	T6 CAIRP heavy	Medium-Heavy Duty Diesel CA International Registration Plan Truck with GVWR>26000 lbs	EMFAC2011-HD			Trucks	Truck 2
T6 CAIRP small - DSL	T6 CAIRP small	Medium-Heavy Duty Diesel CA International Registration Plan Truck with GVWR<=26000 lbs	EMFAC2011-HD			Trucks	Truck 2
T6 instate construction heavy - DSL	T6 instate construction heavy	Medium-Heavy Duty Diesel instate construction Truck with GVWR>26000 lbs	EMFAC2011-HD			Trucks	Truck 2
T6 instate construction small - DSL	T6 instate construction small	Medium-Heavy Duty Diesel instate construction Truck with GVWR<=26000 lbs	EMFAC2011-HD			Trucks	Truck 2
T6 instate heavy - DSL	T6 instate heavy	Medium-Heavy Duty Diesel instate Truck with GVWR>26000 lbs	EMFAC2011-HD			Trucks	Truck 2
T6 instate small - DSL	T6 instate small	Medium-Heavy Duty Diesel instate Truck with GVWR<=26000 lbs	EMFAC2011-HD			Trucks	Truck 2
T6 OOS heavy - DSL	T6 OOS heavy	Medium-Heavy Duty Diesel Out-of-state Truck with GVWR>26000 lbs	EMFAC2011-HD			Trucks	Truck 2
T6 OOS small - DSL	T6 OOS small	Medium-Heavy Duty Diesel Out-of-state Truck with GVWR<=26000 lbs	EMFAC2011-HD			Trucks	Truck 2
T6 Public - DSL	T6 Public	Medium-Heavy Duty Diesel Public Fleet Truck	EMFAC2011-HD			Trucks	Truck 2
T6 utility - DSL	T6 utility	Medium-Heavy Duty Diesel Utility Fleet Truck	EMFAC2011-HD			Trucks	Truck 2
T6TS - GAS	T6TS	Medium-Heavy Duty Gasoline Truck	EMFAC2011-LDV			Trucks	Truck 2
T7 Ag - DSL	T7 Ag	Heavy-Heavy Duty Diesel Agriculture Truck	EMFAC2011-HD	HHDT	T7	Trucks	Truck 2
T7 CAIRP - DSL	T7 CAIRP	Heavy-Heavy Duty Diesel CA International Registration Plan Truck	EMFAC2011-HD			Trucks	Truck 2
T7 CAIRP construction - DSL	T7 CAIRP construction	Heavy-Heavy Duty Diesel CA International Registration Plan Construction Truck	EMFAC2011-HD			Trucks	Truck 2
T7 NNOOS - DSL	T7 NNOOS	Heavy-Heavy Duty Diesel Non-Neighboring Out-of-state Truck	EMFAC2011-HD			Trucks	
T7 NOOS - DSL	T7 NOOS	Heavy-Heavy Duty Diesel Neighboring Out-of-state Truck	EMFAC2011-HD			Trucks	Truck 2
T7 other port - DSL	T7 other port	Heavy-Heavy Duty Diesel Drayage Truck at Other Facilities	EMFAC2011-HD			Trucks	Truck 2
T7 POAK - DSL	T7 POAK	Heavy-Heavy Duty Diesel Drayage Truck in Bay Area	EMFAC2011-HD			Trucks	Truck 2
T7 POLA - DSL	T7 POLA	Heavy-Heavy Duty Diesel Drayage Truck near South Coast	EMFAC2011-HD			Trucks	Truck 2
T7 Public - DSL	T7 Public	Heavy-Heavy Duty Diesel Public Fleet Truck	EMFAC2011-HD			Trucks	Truck 2
T7 Single - DSL	T7 Single	Heavy-Heavy Duty Diesel Single Unit Truck	EMFAC2011-HD			Trucks	Truck 2
T7 single construction - DSL	T7 single construction	Heavy-Heavy Duty Diesel Single Unit Construction Truck	EMFAC2011-HD			Trucks	Truck 2
T7 SWCV - DSL	T7 SWCV	Heavy-Heavy Duty Diesel Solid Waste Collection Truck	EMFAC2011-HD			Trucks	Truck 2
T7 tractor - DSL	T7 tractor	Heavy-Heavy Duty Diesel Tractor Truck	EMFAC2011-HD			Trucks	Truck 2
T7 tractor construction - DSL	T7 tractor construction	Heavy-Heavy Duty Diesel Tractor Construction Truck	EMFAC2011-HD			Trucks	Truck 2
T7 utility - DSL	T7 utility	Heavy-Heavy Duty Diesel Utility Fleet Truck	EMFAC2011-HD			Trucks	Truck 2
T7IS - GAS	T7IS	Heavy-Heavy Duty Gasoline Truck	EMFAC2011-LDV			Trucks	Truck 2
PTO - DSL	PTO	Power Take Off	EMFAC2011-HD			Trucks	Truck 2
SBUS - DSL	SBUS	School Buses	EMFAC2011-HD	SBUS	SB	Non-Trucks	Non-Trucks
SBUS - GAS			EMFAC2011-LDV			Non-Trucks	Non-Trucks
UBUS - DSL	UBUS	Urban Buses	EMFAC2011-LDV	UBUS	UB	Non-Trucks	Non-Trucks
UBUS - GAS			EMFAC2011-LDV			Non-Trucks	Non-Trucks
Motor Coach - DSL	Motor Coach	Motor Coach	EMFAC2011-HD	OBUS	OB	Non-Trucks	Non-Trucks
OBUS - GAS	OBUS	Other Buses	EMFAC2011-LDV			Non-Trucks	Non-Trucks
All Other Buses - DSL	All Other Buses	All Other Buses	EMFAC2011-HD			Non-Trucks	Non-Trucks

Appendix E2

Emissions Reduction & VHT Worksheets

Calc By: JCR Date: 6/2018
Chckd By: MJL Date: 7/2018

Increase in Emissions Cost During Rehabilitation and Maintenance of Bridges

	Year	Bridges Posting	Existing BridgesTraffic Implications	Annual VMT With Growth[1]	Posting VMT[2]	O & M Contributing Annual VMT[3]	Analysis VMT Used for Emissions	Emission Factors (g/mile) [4,6]		Emissions Increase (Metric Tons / Year)		Emissions Value ($ /Metric Ton)[5]		PM & Nox Emissions Cost ($ / Year)
			Full Closure					PM	NOx	PM	NOx	PM	NOx	PM &Nox
			Phased											
1	2020	E2	1 year	56848750		56848750	56848750	0.0012	0.196	0.06631	11.164	$ 378,301	$ 8,270	$ 117,416
2	2021	E2	1 year	57417238		57417238	57417238	0.0012	0.196	0.06697	11.276	$ 378,301	$ 8,270	$ 118,591
3	2022	E2		57991410	289957	0	289957	0.0273	6.683	0.00791	1.938	$ 378,301	$ 8,270	$ 19,018
4	2023	E2		58571324	292857	0	292857	0.0273	6.683	0.00799	1.957	$ 378,301	$ 8,270	$ 19,208
5	2024	E2		59157037	293149	0	293149	0.0273	6.683	0.00800	1.959	$ 378,301	$ 8,270	$ 19,227
6	2025	E2		59748608	293443	0	293443	0.0273	6.683	0.00801	1.961	$ 378,301	$ 8,270	$ 19,247
7	2026	E2	5 days	60346094	293736	413329	707065	0.0120	2.891	0.00850	2.044	$ 378,301	$ 8,270	$ 20,120
8	2027	E2	2 days	60949555	294030	166985	461015	0.0178	4.333	0.00822	1.998	$ 378,301	$ 8,270	$ 19,630
9	2028	E2		61559050	294324	0	294324	0.0273	6.683	0.00803	1.967	$ 378,301	$ 8,270	$ 19,304
10	2029	E2		62174641	294618	0	294618	0.0273	6.683	0.00804	1.969	$ 378,301	$ 8,270	$ 19,324
11	2030	E2	5 days	62796387	294913	430112	725025	0.0118	2.835	0.00855	2.055	$ 378,301	$ 8,270	$ 20,231
12	2031	E2		63424351	295208	3235	298443	0.0273	6.683	0.00814	1.994	$ 378,301	$ 8,270	$ 19,575
13	2032	E2	4 days	64058594	295503	702012	295503	0.0301	7.149	0.00888	2.113	$ 378,301	$ 8,270	$ 20,832
14	2033	E2		64699180	295798	0	295798	0.0273	6.683	0.00807	1.977	$ 378,301	$ 8,270	$ 19,401
15	2034	E2		65346172	296094	0	296094	0.0273	6.683	0.00808	1.979	$ 378,301	$ 8,270	$ 19,421
16	2035	E2		65999634	296390	0	296390	0.0273	6.683	0.00809	1.981	$ 378,301	$ 8,270	$ 19,440
17	2036	E2		66659630	296687	0	296687	0.0273	6.683	0.00809	1.983	$ 378,301	$ 8,270	$ 19,459
18	2037	20 Tons	2 days	67326227	1077220	184455	1261675	0.0235	5.735	0.02960	7.235	$ 378,301	$ 8,270	$ 71,035
19	2038	20 Tons	5 days	67999489	1087992	465750	1553742	0.0195	4.739	0.03023	7.362	$ 378,301	$ 8,270	$ 72,322
20	2039	20 Tons		68679484	1098872	0	1098872	0.0273	6.683	0.02998	7.344	$ 378,301	$ 8,270	$ 72,074
21	2040	20 Tons		69366279	1109860	0	1109860	0.0273	6.683	0.03028	7.417	$ 378,301	$ 8,270	$ 72,795
22	2041	20 Tons		70059941	1120959	0	1120959	0.0273	6.683	0.03058	7.491	$ 378,301	$ 8,270	$ 73,523
23	2042	20 Tons	4 months	70760541	763051	23069875	23832926	0.0020	0.404	0.04773	9.630	$ 378,301	$ 8,270	$ 97,697
24	2043	20 Tons		71468146	1143490	0	1143490	0.0273	6.683	0.03120	7.642	$ 378,301	$ 8,270	$ 75,000
25	2044	20 Tons		72182828	1154925	0	1154925	0.0273	6.683	0.03151	7.718	$ 378,301	$ 8,270	$ 75,750
26	2045	20 Tons		72904656	1166474	0	1166474	0.0273	6.683	0.03182	7.795	$ 378,301	$ 8,270	$ 76,508
27	2046	20 Tons	5 days	73633702	1178139	504340	1682480	0.0195	4.739	0.03273	7.972	$ 378,301	$ 8,270	$ 78,315
28	2047	20 Tons	2 days	74370039	1189921	203754	1393674	0.0235	5.735	0.03270	7.992	$ 378,301	$ 8,270	$ 78,467
29	2048	20 Tons		75113740	1201820	0	1201820	0.0273	6.683	0.03279	8.032	$ 378,301	$ 8,270	$ 78,826
30	2049	20 Tons		75864877	1213838	0	1213838	0.0273	6.683	0.03312	8.112	$ 378,301	$ 8,270	$ 79,614

TOTAL Metric Tons 0.680 154.058

NOTES

[1] Based on calculation of miles for all vehicles See Detour calculations below.

Annual VMT Calculation

NH Route 119 2020 AADT = 8,900 VPD

365 days per year

Shortest route (freight and vehicular) crossing the Connecticut River detours vehicles is16.9 miles to the North and 18.7 miles to the south. USE 17.5 miles.

Traffic Growth Factor is 1.0% annually. Past AADT volume was higher at the state line. The 2010 level was 9,700 vpd.

2020 VMT = 8,900 x 365 x 17.5

[2] Posting VMT assumes 0.5% of vehicles divert to the detour route. Assumptions based on E-2 posting and maintenance personnel observations that the existing narrow structures force large trucks to occupy both lanes to avoid portal collisions. The 20 ton posting VMT assumed 1.6% of total traffic volume qualifies based on the EMFAC data.

[3] O & M VMT values calculated based on the traffic pattern during construction activity proposed. Full closure reroutes all traffic. Phased traffic reroutes and delays traffic. Analysis for phased operations assumes duration is half of the actual time to estimate contributing annual VMT.

[4] Emission factors from Air Resources Board - California - EMFAC Web Database 2015 (criteria = 2011 model year for all vehicle classifications, gas and diesel engine traveling 30mph computed a weighted average based on VMT & fuel type). See Supporting Spreadsheets "Weighted Average E Rates All.xlsx"and "Weighted Average E Rates-20 ton.xlxs" in Appendix E1.

[5] Taken from Table A-6: Damage Costs for Criteria Pollutant Emissions, pg 32, *Benefit-Cost Analysis Guidance for Discretionary Grant Programs, Office of the Secretary U.S. Department of Transportation, June 2018*

[6] Weighted Emission Rates calculated based on anticipated O&M, E 2 and 20 Ton postings traffic vehicle classifications.

XX - Input value from supporting spreadsheets.

Calc By: JCR Date: 6/2018
Chckd By: MJL Date: 7/2018

Increase in VHT Traveling Alternate Route and Avoided VHT Train Conflict

	Year	Posting	Existing BridgesTraffic Implications	Analysis VMT Used for Emissions[1]	Alternate Route Traffic	Posting Annual VHT[3]	Avoided Train Conflict Annual VHT[4,5,6]	User Cost (Posting Annual Travel Time)[7]	User Cost (Avoided Train Delay)[7]
			Full Closure		# of Trips / Year	(Hours / Year)	(Hours / Year)	$14.80	
			Phased		17.5 miles / trip[1]	0.5833 hours / trip[2]		$28.60	
1	2020		1 year	56848750	3248500	2633842	0	$ 38,980,855	$ -
2	2021		1 year	57417238	3280985	2660180	0	$ 39,370,664	$ -
3	2022	E2		289957	16569	13434	17520	$ 384,210	$ 259,296
4	2023	E2		292857	16735	9761	17520	$ 279,174	$ 259,296
5	2024	E2		293149	16751	9771	17520	$ 279,453	$ 259,296
6	2025	E2		293443	16768	9781	17520	$ 279,733	$ 259,296
7	2026	E2	5 days	707065	40404	23568	17520	$ 674,031	$ 259,296
8	2027	E2	2 days	461015	26344	15366	17520	$ 439,476	$ 259,296
9	2028	E2		294324	16819	9810	17520	$ 280,573	$ 259,296
10	2029	E2		294618	16835	9820	17520	$ 280,853	$ 259,296
11	2030	E2	5 days	725025	41430	24166	17520	$ 691,151	$ 259,296
12	2031	E2		298443	17054	9948	17520	$ 284,499	$ 259,296
13	2032	E2	4 days	295503	16886	9850	17328	$ 145,773	$ 256,454
14	2033	E2		295798	16903	9859	17520	$ 281,978	$ 259,296
15	2034	E2		296094	16920	9869	17520	$ 282,260	$ 259,296
16	2035	E2		296390	16937	9879	17520	$ 282,543	$ 259,296
17	2036	E2		296687	16954	9889	17520	$ 282,825	$ 259,296
18	2037	20 Tons	2 days	1261675	72096	42053	17520	$ 1,202,728	$ 259,296
19	2038	20 Tons	5 days	1553742	88785	51788	17520	$ 1,481,149	$ 259,296
20	2039	20 Tons		1098872	62793	36627	17520	$ 1,047,531	$ 259,296
21	2040	20 Tons		1109860	63421	36993	17520	$ 1,058,007	$ 259,296
22	2041	20 Tons		1120959	64055	37363	17520	$ 1,068,587	$ 259,296
23	2042	20 Tons	4 months	23832926	1361881	1080364	11568	$ 15,989,390	$ 171,206
24	2043	20 Tons		1143490	65342	38114	17520	$ 1,090,065	$ 259,296
25	2044	20 Tons		1154925	65996	38495	17520	$ 1,100,966	$ 259,296
26	2045	20 Tons		1166474	66656	38880	17520	$ 1,111,975	$ 259,296
27	2046	20 Tons	5 days	1682480	96142	56079	17520	$ 1,603,872	$ 259,296
28	2047	20 Tons	2 days	1393674	79639	46453	17520	$ 1,328,560	$ 259,296
29	2048	20 Tons		1201820	68675	40058	17520	$ 1,145,669	$ 259,296
30	2049	20 Tons		1213838	69362	40459	17520	$ 1,157,126	$ 259,296

NOTES

[1] Based on Annual VMT calculation of considered miles as determined on "Truss O&M VMT & Emissions.xlxs" spreadsheet.

[2] Detour = 17.5 miles x 1/30 mph = 0.5833 hours per trip

Recommended Hourly Values of Travel Time Savings(2017 U.S. $ per person-hour. Reference Benefit-Cost Analysis Guidance for Discretionary Grant Programs, pg 30 & 31 for Surface Modes - Local Travel weighted average value = $28.60 / hour for Truck Drivers and = $14.80 for All Purposes.

[3] A 1.39 person occupancy multiplier is used during detour operations. Reference Benefit-Cost Analysis Guidance for Discretionay Grant Programs, June 2018, pg 31 Table A-4: Average Vehicle Occupancy. During Posting operations a multiplier of 1.0 is used.

[4] Genesee Wyoming who is the parent company of the NECR (New England central railroad) provided "at-grade" railroad crossing data. Gate down time exceeds 30 minutes. With pre-emption, Brattleboro Yard and Amtrak station stop, it is a busy location. In addition to NECR and Amtrak trains, Pan Am Southern also operates trains on this route. Rail traffic depending on switching moves is 8+ trains per day including 2 Amtrak trains stopping on the highway crossing daily.

[5] To estimate the time it takes to clear the traffic queues for a 3.75 minute gate down situation in VT along Route 119, a basic Syncro traffic model was created. Using the hourly recorded traffic data from NHDOT offers a highly representative distribution of hourly volumes to enable prediction of the traffic delay at the crossing due to trains passing thought the area. With the proximity of the RR crossing to the eastern limit of the 5 way intersection queues longer that xxx feet can gridlock xx of the xx total movements for the xxx 2020 AADT volume. More sufficisticated modeling was not completed or any dely included within this BCA analysis for this situation.

[6] Train conflict avoided VHT = 6 hours per occurrence * 8 occurrences per day * 7 days per week * 365 days per year= 17,520 hours per year. Delay determined from a comparision of existing traffic model to the model with an inserted intersection for trains. Train input provided by Genesee Wyoming safety data with an AADT = 11,100 vpd in 2016 over the tracks.

[7] Recommended Hourly Values of Travel Time Savings(2017 U.S. $ per person-hour. Reference Benefit-Cost Analysis Guidance for Discretionary Grant Programs, pg 30 & 31 for Surface Modes - Local Travel weighted average value = $28.60 / hour for Truck Drivers and = $14.80 for All Purposes.

XX - Input value from supporting spreadsheets.

Appendix E3

Baseline Rehabilitation Costs

Bridge Rehabilitation

Notes and Assumptions:

1. A major rehabilitation will be required in order to keep the existing Anna Hunt Marsh Bridge (NHDOT Bridge No. 041/040) and Charles Dana Bridge (NHDOT Bridge No. 042/044) in service based on their existing condition. Assume a 2 year construction duration from 2020 through 2021.
2. Anticipated work items include, complete lower chord replacement, deck replacement, floor system replacement, lateral bracing replacement, replacement of rocker bearings, joint replacement, bridge rail replacement, miscellaneous steel repair and complete bridge painting.
3. A detailed cost estimate was completed for a similar structure, the US Route 2 Bridge over the Connecticut River in Lancaster, NH. Therefore, this estimate will be modified to provide an approximate "square foot cost" for the truss rehabilitation. All costs will include a 15% contingency.
4. A detailed cost estimate to paint the existing bridges was provided by NHDOT. Additionally, the US Route 2 Bridge included a temporary bridge. The use of a temporary bridge is impractical for the existing bridges. Therefore, the bridge painting cost and temporary bridge will be removed from the US Route 2 "square foot cost".
5. The Charles Dana Bridge (NHDOT Bridge No. 042/044) contains approach spans as well as the main truss span. Therefore, the rehabilitation cost for the approach spans will be based on provided NHDOT girder bridge rehabilitation costs of $287/SF for deck replacement and floor system repairs.
6. Centerline bearing to centerline bearing and curb to curb width is used to calculate all bridge areas.
7. US Route 2 had a condition rating of 4 for the superstructure and substructure. 041/040 and 042/044 have better ratings of 5 and 6 and 5 and 5 for these elements, respectively. Therefore, use 95% of the US Route 2 square foot cost to account for the slightly better condition. The US Route 2 costs do not include mobilization. A 10% mobilization will be added at the end of the calculation.

US Route 2 Bridge:

Estimated Construction Total:	$ 11,391,925.00
Item 501.1 - Temporary Bridge	$ (2,800,000.00)
Item 556.101 - Painting Existing Structural Steel	$ (740,000.00)
Item 556.201 - Containment and Environmental Protection	$ (230,000.00)
Item 556.301 - Worker Protection	$ (37,000.00)
Item 556.401 - Waste Management	$ (19,000.00)
Total Applicable Costs:	$ 7,565,925.00
Total Applicable Costs with 15% Contingency:	$ 8,700,813.75
Bridge Length (ft):	398
Curb to Curb Width (ft):	28
Area (SF):	11,144
Truss Rehabilitation Cost Per Square Foot:	$ 780.76
95% of Truss Rehabilitation Cost Per Square Foot:	$ 740.00

Bridge Rehabilitation (Cont.)

Existing Trusses:

Bridge No. 041/040	
Truss Length (ft):	330
Curb to Curb Width (ft):	20.3
Truss Area (SF):	6699
Approach Span Length (ft):	0
Approach Span Deck Width (ft):	0
Approach Span Area (SF):	0

Bridge No. 042/044	
Truss Length (ft):	200
Curb to Curb Width (ft):	20.3
Truss Area (SF):	4060
Approach Span Length (ft):	94
Approach Span Deck Width (ft):	20.3
Approach Span Area (SF):	1908.2

Approach Span Rehabilitation Cost Per Square Foot:	$	287.00
Truss Rehabilitation Cost Per Square Foot:	$	740.00
Truss and Approach Span Paint Cost:	$	4,037,000.00

Total Bridge Rehabilitation Cost:	$	12,546,000.00

Additional Reconstruction Costs

Notes And Assumptions:

1. In order to rehabilitate the existing trusses, traffic must be maintained through a detour route and other traffic control items.
2. A conceptual value of $50,000 is used for maintenance of traffic based on similar NHDOT projects as well the length of detour, AADT and duration of construction.
3. The NHDOT Item 618 calculation sheet is used to estimate flagger and uniformed officer costs.
4. Use 10% of all items for miscellaneous TCP items including barriers, portable message boards, etc.
5. Include a 15% contingency.
6. Minor roadway reconstruction along the bridge approaches is conservatively ignored.

Maintenance of Traffic and Traffic Control Costs:

Maintenance of Traffic:	$	50,000
Flaggers and Officers:	$	21,410
Miscellaneous TCP Items:	$	7,141
Subtotal:	$	78,551
15% Contingency:	$	11,783

Maintenance of Traffic/TCP Total:	$	90,300

Total Baseline Project Costs:

Total Bridge Rehabilitation Cost:	$	12,546,000
Maintenance of Traffic/TCP Total:	$	90,300
Mobilization (Use 10% of All Items):	$	1,263,630

Total Baseline Project Costs:	$	13,900,000

Year	Baseline Costs	
2020	$	6,950,000
2021	$	6,950,000

New Hampshire DOT
Department of Transportation

HIGHWAY DESIGN
CALCULATION SHEET

PROJECT **Hinsdale, NH - Brattleboro, VT**
PROJECT NO. **12210C** ROUTE **NH 119**
CALCULATED BY **JCR** DATE **06/18/18**
CHECKED BY MJL DATE 7/2018
SUBJECT **Baseline Rehabilitation Costs** SHEET **1** OF **2**

SECTION 618 - UNIFORMED OFFICERS ($) AND FLAGGERS (HR)

			Est. Cost/HR		w/ 5% Markup	
ITEM	618.6	- UNIFORMED OFFICERS ($)	$64.00	=	$67.20	(See Note #2)
ITEM	618.61	- UNIFORMED OFFICERS WITH VEHICLE ($)	$74.00	=	$77.70	(See Note #2)
ITEM	618.7	- FLAGGERS (HR)	$25.00	=	$25.00	

ASSUMPTIONS:

1. Duration of Construction: 24 months
2. Cost for Officers "…will be paid for at the invoice value plus a 5% mark-up" Specification 618.5.1.
3. Use the Guidance Checklist to determine Possible Traffic Control Operations (TCO), Possible Presence Operations (PO), and Possible Enforcement Operations (EO)
4. Estimated work hours per day = 8 hours
5. Estimated work days per week Varies Days

TCO (Traffic Control Operations):

Location	TCP	Description	#	Item #	Duration (WKs)	HRs/ WK	Total HRs	Total Cost
Varies		Installation of detour signs	2	618.7	1.0	20	40	$ 1,000
Bridge		Close Bridge - 2 officers (1 on each end)	2	618.61	1.0	8	16	$ 1,243
Bridge		Close Bridge - 4 flaggers (2 on each end)	4	618.7	1.0	8	32	$ 800
Bridge		Traffic control for hauling/delivering materials - 1 officer on Brattleboro Side	1	618.61	3.0	40	120	$ 9,324
Bridge		Traffic control for hauling/delivering materials - 2 flaggers on Brattleboro Side	2	618.7	3.0	40	240	$ 6,000
Bridge		Open Bridge - 2 officers (1 on each end)	2	618.61	1.0	8	16	$ 1,243
Bridge		Open Bridge - 4 flaggers (2 on each end)	4	618.7	1.0	8	32	$ 800
Varies		Remove detour signs	2	618.7	1.0	20	40	$ 1,000
		Total Costs						**$ 21,410**

Sheet 1 totals

ITEM	618.6	=	$ -	
ITEM	618.61	=	$ 11,810.40	
ITEM	618.7	=	384	HR

Appendix E4

US Route 2 Bridge Rehabilitation Estimate

This appendix is a detailed cost estimate for the US Route 2 bridge in Lancaster, NH. This project included a rehabilitation of a similar truss in a similar condition to the existing Anna Hunt Marsh and Charles Dana Bridges and is intended to provide justification for the "square foot" costs used in baseline rehabilitation effort.

Hoyle, Tanner & Associates, Inc.
Hoyle, Tanner & Associates, Inc.
150 Dow Street
Manchester, NH 03101 (603) 669-

Calc. By:	EGW	Date:	1/2/2013
Chck. By:	EGW	Date:	9/5/2013
Chck. By:		Date:	
Chck. By:		Date:	

US Route 2 (Rogers' Rangers) Bridge over the Connecticut River, NHDOT Br. No. 111/129
Engineers Estimate of Probable Construction Costs
Hoyle, Tanner Project No. 092558/NHDOT Project No. 16155

Bridge Rehabiltation

ITEM NO	ITEM DESCRIPTION	Quantity		Cost	
		Unit	Amount	Unit	Total
209.201	GRANULAR BACKFILL (BRIDGE) (F)	CY	85	$50.00	$4,250
500.02	ACCESS FOR BRIDGE CONSTRUCTION	U	1	$200,000.00	$200,000
500.022	ACCESS FOR TEMPORARY BRIDGE CONSTRUCTION	U	1	$200,000.00	$200,000
501.1	TEMPORARY BRIDGE	U	1	$2,800,000.00	$2,800,000
502	REMOVAL OF EXISTING BRIDGE STRUCTURE	U	1	$1,300,000.00	$1,300,000
503.201	COFFERDAMS	U	1	$100,000.00	$100,000
504.1	COMMON BRIDGE EXCAVATION (F)	CY	210	$50.00	$10,500
512.0101	PREPARATION FOR CONCRETE REPAIRS, CLASS I	SY	25	$500.00	$12,500
520.01	CONCRETE CLASS AA	CY	10	$1,200.00	$12,000
520.12	CONCRETE CLASS A, ABOVE FOOTINGS (F)	CY	320	$750.00	$240,000
520.21	CONCRETE CLASS B, FOOTINGS (F)	CY	120	$350.00	$42,000
520.7001	LIGHTWEIGHT CONCRETE BRIDGE DECK (F)	CY	270	$900.00	$243,000
534.3	WATER REPELLENT (SILANE/ SILOXANE)	GAL	120	$75.00	$9,000
538.2	BARRIER MEMBRANE, PEEL AND STICK - VERTICAL SURFACES (F)	SY	25	$45.00	$1,125
541.5	PVC WATERSTOPS, NH TYPE 5 (F)	LF	35	$10.00	$350
544	REINFORCING STEEL (F)	LB	9000	$4.00	$36,000
544.2	REINFORCING STEEL, EPOXY COATED (F)	LB	90000	$2.00	$180,000
547	SHEAR CONNECTORS (F)	EA	5400	$5.00	$27,000
550.11	STRUCTURAL STEEL - BOTTOM CHORD (F)	LB	101000	$10.00	$1,010,000
550.12	STRUCTURAL STEEL - VERTICALS (F)	LB	12000	$12.00	$144,000
550.13	STRUCTURAL STEEL - DIAGONALS (F)	LB	1500	$12.00	$18,000
550.14	STRUCTURAL STEEL - END DIAGONALS (F)	LB	15500	$15.00	$232,500
550.15	STRUCTURAL STEEL - GUSSET PLATES (F)	LB	1000	$8.00	$8,000
550.16	STRUCTURAL STEEL - REHABILITATED GUSSET PLATES (F)	EA	19	$10,000.00	$190,000
550.17	STRUCTURAL STEEL - FLOOR FRAMING (F)	LB	354000	$5.00	$1,770,000
550.18	STRUCTURAL STEEL - UPPER BRACING (F)	LB	4500	$5.00	$22,500
550.189	STRUCTURAL STEEL - PORTAL AND SWAY BRACING (F)	LB	30500	$8.00	$244,000
550.19	TEMPORARY TRUSS SUPPORT SYSTEM	U	1	$375,000.00	$375,000
550.2	BRIDGE SHOES (F)	EA	4	$2,500.00	$10,000
552.1	REHABILITATION OF FIXED BRIDGE SHOES	EA	4	$2,000.00	$8,000
552.61	REPLACEMENT OF TRUSS BEARING PINS	EA	8	$2,000.00	$16,000
555.301	EXODERMIC STEEL BRIDGE DECK (F)	SF	13200	$40.00	$528,000
556.101	PAINTING EXISTING STRUCTURAL STEEL	U	1	$740,000.00	$740,000
556.201	CONTAINMENT AND ENVIRONMENTAL PROTECTION	U	1	$230,000.00	$230,000
556.301	WORKER PROTECTION	U	1	$37,000.00	$37,000
556.401	WASTE MANAGEMENT	U	1	$19,000.00	$19,000
561.11	PREFABRICATED EXPANSION JOINT, TYPE A (F)	LF	110	$520.00	$57,200
563.24	BRIDGE RAIL T4 (F)	LF	800	$200.00	$160,000
565.242	BRIDGE APPROACH RAIL T4 (STEEL POSTS)	U	4	$6,000.00	$24,000
568	STRUCTURAL TIMBER (F)	MBM	17	$6,000.00	$102,000
585.1	STONE FILL, CLASS A	CY	100	$40.00	$4,000
1002.1	REPAIRS OR REPLACEMENTS AS NEEDED - BRIDGE STRUCTURES	$	1	25,000	$25,000

	CONSTRUCTION (CON)
CONSTRUCTION SUBTOTAL	$11,391,925.00
CONTINGENCY (15%)	$1,708,788.75
CONSTRUCTION (CON) TOTAL FOR NHDOT FY PLANNING	**$13,200,000.00**

K:\092558\16155\Design\Estimates\[EstOfCost-Bridge Rehab.xls]Rehab

This Engineers Estimate of Probable Construction Costs is based on the anticipated scope of work, as well as HTA's experience with similar projects and understanding of current industry trends. The estimate has not been based on a final design for this project, and as such, it is intended to be preliminary in nature. It should be noted that changes in material or labor costs in the construction industry could impact the project cost in either direction.

Hoyle, Tanner & Associates, Inc.
Hoyle, Tanner & Associates, Inc.
150 Dow Street
Manchester, NH 03101 (603) 669-5

Calc. By:	EGW	Date:	9/5/2013
Chck. By:		Date:	
Chck. By:		Date:	
Chck. By:		Date:	

US Route 2 (Rogers' Rangers) Bridge over the Connecticut River, NHDOT Br. No. 111/129

Engineers Estimate of Probable Construction Costs

Hoyle, Tanner Project No. 092558/NHDOT Project No. 16155

Bridge Bypass - Existing Bridge Rehabiltation

ITEM NO	ITEM DESCRIPTION	Quantity		Cost	
		Unit	Amount	Unit	Total
209.201	GRANULAR BACKFILL (BRIDGE) (F)	CY	85	$50.00	$4,250
500.02	ACCESS FOR BRIDGE CONSTRUCTION	U	1	$200,000.00	$200,000
502	REMOVAL OF EXISTING BRIDGE STRUCTURE	U	1	$1,200,000.00	$1,200,000
503.201	COFFERDAMS	U	1	$100,000.00	$100,000
504.1	COMMON BRIDGE EXCAVATION (F)	CY	210	$50.00	$10,500
512.0101	PREPARATION FOR CONCRETE REPAIRS, CLASS I	SY	25	$500.00	$12,500
520.01	CONCRETE CLASS AA	CY	10	$1,100.00	$11,000
520.12	CONCRETE CLASS A, ABOVE FOOTINGS (F)	CY	320	$750.00	$240,000
520.21	CONCRETE CLASS B, FOOTINGS (F)	CY	120	$350.00	$42,000
520.7001	LIGHTWEIGHT CONCRETE BRIDGE DECK (F)	CY	270	$900.00	$243,000
534.3	WATER REPELLENT (SILANE/ SILOXANE)	GAL	120	$75.00	$9,000
538.2	BARRIER MEMBRANE, PEEL AND STICK - VERTICAL SURFACES (F)	SY	25	$45.00	$1,125
541.5	PVC WATERSTOPS, NH TYPE 5 (F)	LF	35	$10.00	$350
544	REINFORCING STEEL (F)	LB	9000	$4.00	$36,000
544.2	REINFORCING STEEL, EPOXY COATED (F)	LB	90000	$2.00	$180,000
547	SHEAR CONNECTORS (F)	EA	5400	$5.00	$27,000
550.11	STRUCTURAL STEEL - BOTTOM CHORD (F)	LB	101000	$10.00	$1,010,000
550.12	STRUCTURAL STEEL - VERTICALS (F)	LB	12000	$12.00	$144,000
550.13	STRUCTURAL STEEL - DIAGONALS (F)	LB	1500	$12.00	$18,000
550.14	STRUCTURAL STEEL - END DIAGONALS (F)	LB	15500	$15.00	$232,500
550.15	STRUCTURAL STEEL - GUSSET PLATES (F)	LB	1000	$8.00	$8,000
550.16	STRUCTURAL STEEL - REHABILITATED GUSSET PLATES (F)	EA	19	$10,000.00	$190,000
550.17	STRUCTURAL STEEL - FLOOR FRAMING (F)	LB	354000	$5.00	$1,770,000
550.18	STRUCTURAL STEEL - UPPER BRACING (F)	LB	4500	$5.00	$22,500
550.189	STRUCTURAL STEEL - PORTAL AND SWAY BRACING (F)	LB	10000	$8.00	$80,000
550.19	TEMPORARY TRUSS SUPPORT SYSTEM	U	1	$375,000.00	$375,000
550.2	BRIDGE SHOES (F)	EA	4	$2,500.00	$10,000
552.1	REHABILITATION OF FIXED BRIDGE SHOES	EA	4	$2,000.00	$8,000
552.61	REPLACEMENT OF TRUSS BEARING PINS	EA	8	$2,000.00	$16,000
555.301	EXODERMIC STEEL BRIDGE DECK (F)	SF	13200	$40.00	$528,000
556.101	PAINTING EXISTING STRUCTURAL STEEL	U	1	$850,000.00	$850,000
556.201	CONTAINMENT AND ENVIRONMENTAL PROTECTION	U	1	$265,000.00	$265,000
556.301	WORKER PROTECTION	U	1	$43,000.00	$43,000
556.401	WASTE MANAGEMENT	U	1	$22,000.00	$22,000
561.11	PREFABRICATED EXPANSION JOINT, TYPE A (F)	LF	110	$520.00	$57,200
563.81	REHABILITATION OF BRIDGE RAIL (F)	LF	800	$175.00	$140,000
585.1	STONE FILL, CLASS A	CY	100	$40.00	$4,000
1002.1	REPAIRS OR REPLACEMENTS AS NEEDED - BRIDGE STRUCTURES	$	1	25,000	$25,000

	CONSTRUCTION (CON)
CONSTRUCTION SUBTOTAL	$8,134,925.00
CONTINGENCY (15%)	$1,220,238.75
CONSTRUCTION (CON) TOTAL FOR NHDOT FY PLANNING	**$9,400,000.00**

K:\092558\16155\Design\Estimates\[EstOfCost-Bridge Rehab.xls]Bypass

This Engineers Estimate of Probable Construction Costs is based on the anticipated scope of work, as well as HTA's experience with similar projects and understanding of current industry trends. The estimate has not been based on a final design for this project, and as such, it is intended to be preliminary in nature. It should be noted that changes in material or labor costs in the construction industry could impact the project cost in either direction.

ITEM 209.201 GRANULAR BACKFILL (BRIDGE) (F) (CY)

- Existing backwalls are assumed to be removed in order to replace existing bridge bearings. Assume width of excavation is 4 ft behind the backwall.

Easterly Abutment:

$W_{fill} := 4ft$	Backfill Width Behind Abutment
$Elev_{FG\_abutB} := 857.65ft$	Finished Grade Elevation
$Elev_{BOE\_abutB} := 851.53ft - 1ft$	Bottom of Backfill
$L_{fill\_1} := 51ft + 2ft = 53\,ft$	Backfill Length Behind Abutment
$t_{road\_matl} := 1.67ft$	Roadway Select Materials Thickness
$t_{road\_pav} := 4in$	Roadway Pavement Thickness
$Vol_{abutB} := \left(W_{fill} \cdot L_{fill\_1}\right) \cdot \begin{pmatrix} Elev_{FG\_abutB} - t_{road\_matl} \cdots \\ + -t_{road\_pav} - Elev_{BOE\_abutB} \end{pmatrix}$	Backfill Volume Behind Abutment

$Vol_{abutB} = 40.175 \cdot cy$

Westerly Abutment:

$W_{fill} = 4\,ft$	Backfill Width Behind Abutments
$Elev_{FG\_abutA} := 857.65ft$	Finished Grade Elevation
$Elev_{BOE\_abutA} := 851.53ft - 1ft$	Bottom of Backfill
$L_{fill\_1} = 53\,ft$	Backfill Length Behind Abutment
$t_{road\_matl} = 1.67\,ft$	Roadway Select Materials Thickness
$t_{road\_pav} = 4 \cdot in$	Roadway Pavement Thickness
$Vol_{abutA} := \left(W_{fill} \cdot L_{fill\_1}\right) \cdot \begin{pmatrix} Elev_{FG\_abutA} - t_{road\_matl} \cdots \\ + -t_{road\_pav} - Elev_{BOE\_abutA} \end{pmatrix}$	Backfill Volume Behind Abutment

$Vol_{abutA} = 40.175 \cdot cy$

ITEM 209.201 GRANULAR BACKFILL (BRIDGE) (F) (CY) (CONT.)

Estimated Total Granular Backfill Volume:

$$V_{209.201} := Vol_{abutA} + Vol_{abutB}$$

$$V_{209.201} = 80.4 \cdot CY$$

Use Item 209.201 Quantity = 85 CY

ITEM 500.02 ACCESS FOR BRIDGE CONSTRUCTION (U)

- Access required for pier replacement and installation of temproary truss support system.

Use Item 500.02 Cost = $200,000

ITEM 500.022 ACCESS FOR TEMPORARY BRIDGE CONSTRUCTION (U)

- Cost based on bids for US Route 4 over the Connecticut River in Lebanon, NH and Hartford, VT.

Use Item 500.022 Cost = ~~$275,000~~ Use $200,000 See Next page (Item 501.1) For additional information.

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US Route 2 over the Connecticut River
NHDOT Bridge No. 111/129
Alternative No.1 -Rehab Existing Bridge
Engineering Study Quantity Calculations

Project No.: 092558
Sheet: ______ of: ______
Calc By: JAB Date: 12/26/12
Chck By: EGW Date: 1/3/13
Rev. By: EGW 9/5/13

ITEM 501.1 TEMPORARY BRIDGE (U)

4 Month Rental at $352,2000: $\text{Cost}_{4\_months} :=$ ~~4~~ $\cdot(\$\cdot 352200) =$ ~~1408800 $~~ $ 352,200

16 Month Rental at $71,975 $\text{Cost}_{16\_months} := 16\cdot(\$\cdot 71975) = 1151600\,\$$

Rental Cost: $\text{Cost}_{rental} := \text{Cost}_{4\_months} + \text{Cost}_{16\_months} =$ ~~2560400 $~~ $ 1503800

Installation, Say 20 days at $8,000/day: $\text{Cost}_{installation} := 20\cdot(\$\cdot 8000) = 160000\,\$$

Temp. Bridge Representative, Say 20 days at $1000/day: $\text{Cost}_{rep} := 20\cdot(\$\cdot 1000) = 20000\,\$$

Bridge Removal, Say 20 days at $8000/day: $\text{Cost}_{removal} := 20\cdot(\$\cdot 8000) = 160000\,\$$

Subtotal: $\text{Cost}_{subtotal} := \text{Cost}_{rental} + \text{Cost}_{installation} + \text{Cost}_{rep} + \text{Cost}_{removal} =$ ~~2900400 $~~ $ 1,843,800

Add 10% For Substructure Construction: $\text{Cost}_{substructure} := 10\%\cdot\text{Cost}_{subtotal} =$ ~~290040~~ $ $ 184,380

$\text{Item}_{501.1} := \text{Cost}_{subtotal} + \text{Cost}_{substructure} = 3190440\,\$$

Use Item 501.1 Cost = ~~$3,200,000~~ 2,800,000

Call Bridge Superstructure Total = $ 2,000,000
Call Bridge Substructure Total = $ 200,000
Total Temporary Bridge Cost = $ 2,200,000

Per Information from NHDOT total cost of Temporary bridge including access for construction is estimated to be $ 3,000,000

∴ Use Temp. Bridge Cost = $ 2,800,000

ITEM 502 REMOVAL OF EXISTING BRIDGE STRUCTURE (U)

- Ramsdell Road Bridge project (908603) had a very similar scope of work as this project. US Route 2 Bridge has more steel replacement than Ramsdell Road but for the most part the superstructure work is very similar. Use the bid prices received for Ramsdell Road project as the basis to estimate Item 502 for superstructure work. The bid price would be converted in per SF basis in order to determine the appropriate cost for the longer and wider bridge.
- Bid prices ranged from \$100K to \$230K. Since US Route 2 has more steel replacement, assume \$200K for superstructure removal.
- The existing pier will also be removed; use \$150/cy as a removal cost estimate. See sheet 10 of 24 of the 1946 existing plans for pier volume

$$\text{Cost}_{SF} := \frac{\$\cdot 200000}{21.5\text{ft}\cdot 108\text{ft}} = 86.133\cdot\frac{\$}{\text{ft}^2}$$

$$\text{Area}_{USRT2} := (398\text{ft})\cdot(35\text{ft} + 5.5\text{in}) = 14112.417\,\text{ft}^2$$

$$\text{Cost}_{super} := \text{Cost}_{SF}\cdot\text{Area}_{USRT2} = 1215539.765\,\$$$

Pier Removal

$$V_{total\_pier} := 433.2\text{cy}$$

$$\text{Cost}_{sub} := V_{total\_pier}\cdot\frac{(\$\cdot 150)}{\text{CY}} = 64980\,\$$$

$$\text{Item}_{502} := \text{Cost}_{super} + \text{Cost}_{sub} = 1280519.765\,\$$$

Use Item 502 Cost = \$1,300,000

ITEM 503.201 COFFERDAMS (U)

Use Item 503.201 Cost = $100,000

ITEM 504.1 COMMON BRIDGE EXCAVATION (F) (CY)

Easterly Abutment:

$W_{exc} := 4\text{ft}$	Excavation Width Behind Abutment
$Elev_{FG\_abutB} = 857.65\text{ ft}$	Finished Grade Elevation
$Elev_{BOE\_abutB} = 850.53\text{ ft}$	Bottom of Excavation
$L_{fill\_1} = 53\text{ ft}$	Excavation Length Behind Abutment
$t_{road\_matl} = 1.67\text{ ft}$	Roadway Select Materials Thickness
$t_{road\_pav} = 4\cdot\text{in}$	Roadway Pavement Thickness
$Vol_{abutB\_504.1} := \left(W_{fill}\cdot L_{fill\_1}\right)\cdot\begin{pmatrix} Elev_{FG\_abutB} - t_{road\_matl} \cdots \\ + -t_{road\_pav} - Elev_{BOE\_abutB} \end{pmatrix}$	Excavation Volume Behind Abutment

$Vol_{abutB\_504.1} = 40.175\cdot\text{cy}$

Westerly Abutment:

$W_{fill} = 4\text{ ft}$	Excavation Width Behind Abutments
$Elev_{FG\_abutA} = 857.65\text{ ft}$	Finished Grade Elevation
$Elev_{BOE\_abutA} = 850.53\text{ ft}$	Bottom of Excavation
$L_{fill\_1} = 53\text{ ft}$	Excavation Length Behind Abutment
$t_{road\_matl} = 1.67\text{ ft}$	Roadway Select Materials Thickness
$t_{road\_pav} = 4\cdot\text{in}$	Roadway Pavement Thickness
$Vol_{abutA\_504.1} := \left(W_{fill}\cdot L_{fill\_1}\right)\cdot\begin{pmatrix} Elev_{FG\_abutA} - t_{road\_matl} \cdots \\ + -t_{road\_pav} - Elev_{BOE\_abutA} \end{pmatrix}$	Excavation Volume Behind Abutment

$Vol_{abutA\_504.1} = 40.175\cdot\text{cy}$

ITEM 504.1 COMMON BRIDGE EXCAVATION (F) (CY) (CONT.)

Estimated Total Granular Backfill Volume:

$$V_{504.1} := Vol_{abutA\_504.1} + Vol_{abutB\_504.1}$$

$$V_{504.1} = 80.4 \cdot CY$$

Use Item 504.1 Quantity = 210 CY

ITEM 512.0101 PREPARATION FOR CONCRETE REPAIRS, CLASS I (CY)

- For preliminary analysis, assume 20% of the substructure surface area.

East Abutment:

$A_{abut\_512.0101} := 530.1ft^2$ See quantity calculation for Item 534.3

$A_{tot} := 20\%\cdot\left(2\cdot A_{abut\_512.0101}\right) = 23.56\cdot SY$

Use Item 512.0101 Quantity = 25 SY

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Chck By: JLK Date: 12/19/12

ITEM 520.01 CONCRETE CLASS AA (CY)

- This item is used for the backwall concrete.
- Assume top 1ft of backwall will be replaced except at bearing seat locations where entire depth of backwall will be replaced to facilitate bearing pin and expansion joint removal and replacement.

Abutment Backwall Concrete:

$H_{backwall} := 1ft$

$H_{backwall\_brg} := 858.11ft - 851.53ft + 1in = 6.663\,ft$

$W_{bearing\_seat} := 9ft$

$W_{abut} := 51ft$

$V_{backwall} := H_{backwall} \cdot \left(W_{abut} - 2 \cdot W_{bearing\_seat}\right) \cdot 1.25ft + H_{backwall\_brg} \cdot W_{bearing\_seat} \cdot 1.25ft$

$V_{backwall} = 4.3 \cdot CY$

$V_{520.01} := 2V_{backwall}$

$V_{520.01} = 8.6 \cdot CY$

Use Item 520.01 Quantity = 10 CY

ITEM 520.12 CONCRETE CLASS A, ABOVE FOOTINGS (CY)

- This item is used for the pier replacement.
- Assume replace in kind; see sheet 10 of 24 of the 1946 existing plans. Existing concrete class A volume includes concrete for footing. Concrete for footing is paid under Item 520.21 Concrete Class B, Footings.

$V_{total\_pier} = 433.2 \cdot cy$

$V_{pier\_footing} := (10ft + 7in) \cdot (58ft + 7in) \cdot (5ft)$

$V_{pier\_footing} = 3100\,ft^3$

$V_{520.12} := V_{total\_pier} - V_{pier\_footing}$

$V_{520.12} = 318.384 \cdot cy$

Use Item 520.12 Quantity = 320 CY

ITEM 520.21 CONCRETE CLASS B, FOOTINGS (CY)

- This item is used for the pier footing.
- Assume replace in kind; see sheet 10 of 24 of the 1946 existing plans.

$V_{pier\_footing} = 3100.035\,ft^3$

$V_{520.21} := V_{pier\_footing}$

$V_{520.21} = 114.816 \cdot cy$

Use Item 520.21 Quantity = 120 CY

ITEM 520.7001 LIGHTWEIGHT CONCRETE BRIDGE DECK (F) (CY) ✓

Deck:

Deck Thickness: $t_{deck} := 5in$ ✓

Deck. Width: $W_{deck} := 33ft$ ✓

Bridge Deck Length: $L_{bridge} := 398ft$ ✓

Deck Volume: $V_{deck} := t_{deck} \cdot W_{deck} \cdot L_{bridge}$

$V_{deck} = 202.7 \cdot CY$ ✓

Floorbeam Haunches:

Average Haunch Depth: $t_{haunch} := 2.91in$ ~ SAY OK FOR PRELIM.

Haunch Width: $W_{haunch\_fb} := 12 \cdot in$ ✓

Number of Beams: $N_{b\_fb} := 20$ ✓

Haunch Volume: $V_{haunch\_fb} := \overset{✓}{t_{haunch}} \cdot \overset{✓}{W_{haunch\_fb}} \cdot \overset{✓}{W_{deck}} \cdot \overset{✓}{N_{b\_fb}}$

$V_{haunch\_fb} = 5.9 \cdot CY$ ✓

Stringer Haunches:

Average Haunch Depth: $t_{haunch} = 2.91 \cdot in$ ~ SAY OK FOR PRELIM

Average Haunch Width: $W_{haunch\_str} := 7.78 \cdot in$

Number of Beams: $N_{b\_str} := 9$ ✓

Haunch Volume: $V_{haunch\_str} := t_{haunch} \cdot W_{haunch\_str} \cdot N_{b\_str} \cdot L_{bridge}$

$V_{haunch\_str} = 20.9 \cdot CY$ ✓

ITEM 520.7001 LIGHTWEIGHT CONCRETE BRIDGE DECK (F) (CONT.)

Brush Curb:

Brush Cub Width: $W_{curb} := 24in$ ✓

Curb Height: $Curb_{height} := 7in$ ✓

Brush Curb Volume: $V_{curb} := W_{curb} \cdot Curb_{height} \cdot L_{bridge} \cdot 2$

$V_{curb} = 34.4 \cdot CY$ ✓

$V_{520.7001} := \overset{✓}{V_{deck}} + \overset{✓}{V_{haunch\_fb}} + \overset{✓}{V_{haunch\_str}} + \overset{✓}{V_{curb}}$

$V_{520.7001} = 263.9 \cdot CY$

Use Item 520.7001 Quantity = 270 CY

ITEM 534.3 WATER REPELLENT (SILANE/SILOXANE) (GAL)

- Silane Siloxane is applied to both abutments and all wingwalls.
- Elevations and dimensions taken from existing 1946 plans.

Abutments:

Bearing Seat:

$D_{bearing} := 851.53ft - 1in - 849.5ft$ $\quad D_{bearing} = 1.947\,ft$

$W_{bearing} := 4.5ft + D_{bearing} \cdot \frac{4}{12}$ $\quad W_{bearing} = 5.149\,ft$

$A_{bearing} := 2\left[\overset{✓}{(4.5ft)}\cdot(9ft) + \left(D_{bearing}\right)\cdot\left[2\cdot\left[0.5\cdot\left(4.5ft + W_{bearing}\right)\right] + 9ft\right]\right]$ $\quad A_{bearing} = 153.6\,ft^2$ ✓

Backwall:

$H_{backwall\_rdwy} := (1ft + 8.125in) + \sqrt{(1.25ft)^2 + (7.5in)^2} + (3.75ft) - 8.875in$ $\quad H_{backwall\_rdwy} = 6.085\,ft$

$H_{backwall\_curb} := (1ft + 8.125in) + \sqrt{(1.25ft)^2 + (7.5in)^2} + (3.75ft)$ $\quad H_{backwall\_curb} = 6.825\,ft$

$A_{backwall} := (28ft)\cdot H_{backwall\_rdwy} + 2(2ft + 10in)\cdot H_{backwall\_curb}$ $\quad A_{backwall} = 209.054\,ft^2$

Abutment Face:

$A_{abut\_face} := D_{bearing}\cdot(1.25ft + 26.5ft + 1.25ft)$ $\quad A_{abut\_face} = 56.5\,ft^2$

Wingwalls:

$H_{wingwall\_max} := (1ft + 8.125in) + 1.25ft + (3.75ft)$ $\quad H_{wingwall\_max} = 6.677\,ft$

$H_{wingwall\_min} := H_{wingwall\_max} - (4ft + 4in)$ $\quad H_{wingwall\_min} = 2.344\,ft$

$$A_{wingwall} := 2\left[\begin{array}{l}(2ft + 2in)\cdot H_{wingwall\_max} + 0.5\cdot(6.5ft)\cdot\left(H_{wingwall\_max} + H_{wingwall\_min}\right) \ldots \\ + D_{bearing}\cdot(3.25ft) + \left(H_{wingwall\_min} + D_{bearing}\right)\cdot(1.25ft)\end{array}\right] \qquad A_{wingwall} = 110.9\,ft^2$$

Total Abutment Area:

$A_{abut} := A_{bearing} + A_{backwall} + A_{abut\_face} + A_{wingwall}$ $\quad A_{abut} = 530.1\,ft^2$

ITEM 534.3 WATER REPELLENT (SILANE/SILOXANE) (GAL) (CONT.)

Pier:

Sides: $A_{sides} := 2\cdot[0.5(852.85\text{ft} - 825.00\text{ft})[39.5\text{ft} + (43\text{ft} + 9.625\text{in})]]$ $A_{sides} = 2319.963\,\text{ft}^2$

Ends: $A_{ends} := 4\cdot[0.5\cdot(852.85\text{ft} - 825.00\text{ft})[(7\text{ft} + 3.75\text{in}) + (5\text{ft} + 8.5\text{in})]]$ $A_{ends} = 725.26\,\text{ft}^2$

Top: $A_{top} := 4\left(6.35\text{ft}^2\right) + (39.5\text{ft})(4\text{ft} + 5\text{in})$ $A_{top} = 199.858\,\text{ft}^2$

Total Pier Area:

$A_{pier} := A_{sides} + A_{ends} + A_{top}$ $A_{pier} = 3245.082\,\text{ft}^2$

Bridge Deck

Bridge Deck Length: $L_{bridge} = 398\,\text{ft}$

Brush Curb Height: $Curb_{height} = 7\cdot\text{in}$

Curb Width: $W_{curb} = 2\,\text{ft}$

Width $W_{tw} := W_{deck} - 2\cdot W_{curb}$ $W_{tw} = 29\,\text{ft}$

Deck and Curb Area:

$Area_{deck} := L_{bridge}\cdot\left(Curb_{height}\cdot 2 + W_{curb}\cdot 2\right) + L_{bridge}\cdot W_{tw}$

$Area_{deck} = 13598\,\text{ft}^2$

Total Area:

$Tot_{area} := 2A_{abut} + A_{pier} + Area_{deck} = 17903.54\,\text{ft}^2$

Silane-Siloxane Application Rate: $Rate := 150\,\dfrac{\text{ft}^2}{\text{gal}}$

Total Estimated Quantity: $V_{534.3} := \dfrac{Tot_{area}}{Rate}$

$V_{534.3} = 119.4\cdot\text{gal}$

Use Item 534.3 Quantity = 120 GAL

ITEM 538.2 BARRIER MEMBRANE, VERTICAL SURFACES (F) (SY)

- This item is applied to the horizontal joint at the base of the backwall.

Width: $W_{538.2} := 2ft$

Length $L_{abut} := 51ft$

$A_{538.2} := W_{538.2} \cdot L_{abut} \cdot 2 = 22.667 \cdot yd^2$

Use Item 538.2 Quantity = 25 SY

ITEM 541.5 PVC WATERSTOPS, NH TYPE 5 (F) (LF)

- Use at fixed emd deck backwall joint.

$\text{Quantity}_{541.5} := W_{deck}$

$\text{Quantity}_{541.5} = 33\ \text{ft}$

Use Item 541.5 Quantity = 35 LF

ITEM 544 REINFORCING STEEL (LB)

- This reinforcing is used at the pier footings; estimate 75 lbs per CY.

$Conc_{vol\_ftng} := 120CY$

Total Volume of CLASS B Concrete - See above calculations

$$Footing := Conc_{vol\_ftng} \cdot 75 \frac{lb}{CY} = 9000\,lb$$

Use Item 544 Quantity = 9,000 lbs

ITEM 544.2 REINFORCING STEEL, EPOXY COATED (LB)

- This reinforcing is used at the abutment backwalls, new pier and bridge deck.

Backwall and Pier:

- Estimate 75 lbs per CY of concrete for abutment backwall and pier reinforcing.

$\text{Conc}_{\text{vol}} := 10\text{CY} + 320\text{CY} \quad \text{Conc}_{\text{vol}} = 330\cdot\text{CY}$

Total Volume of CLASS AA Concrete and CLASS A Concrete- See above calculations

$$\text{Backwall} := \text{Conc}_{\text{vol}}\cdot 75\,\frac{\text{lb}}{\text{CY}} = 24750\,\text{lb}$$

Bridge Deck and Brush Curbs:

- This bridge would have an exodermic deck similar to the one used in Ramsdell Road Bridge project. On Ramsdell Road Bridge 10400 lbs of steel were used for 45 CY of concrete for the deck or 230 lbs/CY of concrete. Use this as the basis for estimating the weight of epoxy coated reinforcing steel.

$\text{Conc}_{\text{vol\_deck}} := 270\text{CY}$

Total Volume of deck concrete - See above calculations

$$\text{Deck} := \text{Conc}_{\text{vol\_deck}}\cdot 230\,\frac{\text{lb}}{\text{CY}} = 62100\,\text{lb}$$

Total Weight:

$$\text{Weight}_{\text{deck\_tot}} := \text{Backwall} + \text{Deck} = 86850\,\text{lb}$$

Use Item 544.2 Quantity =90,000 lbs

ITEM 547 SHEAR CONNECTORS (F) (EA)

- Ramsdell Road Bridge used 2 studs @ 9" at the floorbeams and 1 stud at 12" at the stringers. Use the same spacing for the basis of estimating the shear connector on US Route 2 Bridge.

Number of Floorbeams: $N_{b\_fb} = 20$

Number of studs per each Floorbeam: $N_{studs\_fb} := \mathrm{ceil}\left(\dfrac{W_{deck}}{9in} + 1\right) \cdot 2 = 90$

Number of Stingers: $N_{b\_str} = 9$

Number of studs per each Stinger $N_{studs\_str} := \mathrm{ceil}\left(\dfrac{L_{bridge}}{12in} + 1\right) = 399$

$\mathrm{Quantity}_{547} := N_{b\_fb} \cdot N_{studs\_fb} + N_{b\_str} \cdot N_{studs\_str}$

$\mathrm{Quantity}_{547} = 5391$

Use Item 547 Quantity = 5400 EA

ITEM 550.11 STRUCTURAL STEEL - BOTTOM CHORD (F) (LB)

- Dead load of existing members were calculated as part of as-built load rating. Dead loads shown below are taken from the "Truss Analysis - Dead Load Calculations"
- Entire bottom chord and splice plates are proposed to be replaced.

$DL_{bott\_chord} := 20792lb$

$DL_{bott\_tie\_PL} := 2\cdot(326lb) + 2\cdot(326lb) + 2\cdot(402lb) + 2\cdot(295lb) + 464lb = 3162\,lb$

$DL_{bott\_splice\_PL\_L2L7} := 2(27.9lb + 65.1lb) = 186\,lb$

$DL_{bott\_splice\_PL\_L3L6} := 2(130.3lb) = 260.6\,lb$

$DL_{bott\_splice\_PL\_L4L5} := 2(79.8lb + 150.7lb + 93.0lb + 65.1lb) = 777.2\,lb$

$DL_{bott\_splice\_PL} := DL_{bott\_splice\_PL\_L2L7} + DL_{bott\_splice\_PL\_L3L6} + DL_{bott\_splice\_PL\_L4L5} = 1223.8\,lb$

Total Weight of Structural Steel:

$Item_{550.11} := \left(DL_{bott\_chord} + DL_{bott\_tie\_PL} + DL_{bott\_splice\_PL}\right)\cdot 4 = 100711.2\,lb$

Use Item 550.11 Quantity = 101,000 lbs

ITEM 550.12 - STRUCTURAL STEEL - VERTICALS (F) (LB)

- Dead load of existing members were calculated as part of as-built load rating. Dead loads shown below taken from the "Truss Analysis - Dead Load Calculations"
- The following verticals are proposed to be replaced:
    - Span 1 south truss member L2-U2 ✓
    - Span 1 south truss member L3-U3 ✓
    - Span 1 north truss member L4-U4 ✓
    - Span 2 north truss member L3-U3 ✓
    - Span 2 south truss member L3-U3 ✓
    - Span 2 north truss member L4-U4 ✓
    - Span 2 south truss member L4-U4 ✓
    - Span 2 south truss member L5-U5 ✓

$DL_{L2U2} := 1966lb$ ✓

$DL_{L3U3} := 1350lb$ ✓

$DL_{L4U4} := 1420lb$ ✓

$DL_{L5U5} := 1420lb$ ✓

$DL_{vert} := 1 \cdot DL_{L2U2} + 3 \cdot DL_{L3U3} + 3 \cdot DL_{L4U4} + 1DL_{L5U5}$ $DL_{vert} = 11696\,lb$ ✓

Total Weight of Structural Steel:

$Item_{550.12} := DL_{vert} = 11696\,lb$

Use Item 550.12 Quantity = 12,000 lbs ✓

ITEM 550.13 - STRUCTURAL STEEL - DIAGONALS (F) (LB)

- Dead load of existing members were calculated as part of as-built load rating. Dead loads shown below taken from the "Truss Analysis - Dead Load Calculations"
- The following diagonals are proposed to be replaced:
    - Span 1 south truss member U5-L4

$DL_{U5L4} := 1290lb$

Total Weight of Structural Steel:

$Item_{550.13} := DL_{U5L4} = 1290\,lb$ ✓

Use Item 550.13 Quantity = 1,500 lbs ✓

ITEM 550.14 STRUCTURAL STEEL - END DIAGONALS (F) (LB)

- Dead load of existing members were calculated as part of as-built load rating. Dead loads shown below taken from the "Truss Analysis - Dead Load Calculations"
- The following diagonals are proposed to be replaced:
  - Span 1 south truss member L0-U1 both channels and top plate
  - Span 1 north truss member L0-U1 north channel
  - Span 1 north truss member U8-L9 south channel
  - Span 2 south truss member U8-L9 both channels
  - Span 2 north truss member L0-U1 both channels
- Also all end diagonal member lacing bars from mid-height to bearing will be replaced

$$DL_{L0U1\_total} := 4510lb$$

$$DL_{L0U1\_channel} := 33.3ft\cdot(50plf) \qquad DL_{L0U1\_channel} = 1665\,lb$$

$$DL_{L0U1\_2\_channels} := 2[33.3ft\cdot(50plf)] \qquad DL_{L0U1\_2\_channels} = 3330\,lb$$

$$DL_{U8L9\_channel} := DL_{L0U1\_channel} \qquad DL_{U8L9\_channel} = 1665\,lb$$

$$DL_{U8L9\_2\_channel} := DL_{L0U1\_2\_channels} \qquad DL_{U8L9\_2\_channel} = 3330\,lb$$

$$DL_{diag\_lacing} := 217lb$$

$$DL_{dia} := DL_{L0U1\_total} + DL_{L0U1\_channel} + DL_{U8L9\_channel} + DL_{U8L9\_2\_channel} + DL_{L0U1\_2\_channels} + \frac{8DL_{diag\_lacing}}{2} = 15368\,lb$$

Total Weight of Structural Steel:

$$Item_{550.14} := DL_{dia} = 15368\,lb$$

Use Item 550.14 Quantity = 15,500 lbs

ITEM 550.15 STRUCTURAL STEEL - GUSSET PLATES (F) (LB)

- Dead load of existing members were calculated as part of as-built load rating. Dead loads shown below taken from the "Truss Analysis - Dead Load Calculations"
- The following gusset plates are proposed to be replaced:
  - Span 1 south truss L7 north plate
  - Span 1 north truss L1 south plate
  - Span 2 north truss U4 north plate
- All lower panel point gusset plates at all bearings are proposed to be replaced.

$$DL_{L7} := \frac{(389.8\text{lb})}{2} = 194.9\,\text{lb}$$

$$DL_{L1} := 39.9\text{lb}$$

$$DL_{U4} := 0.5(226.5\text{lb}) = 113.25\,\text{lb}$$

$$DL_{L0L8} := 8\cdot(1183\text{lb}) = 9464\,\text{lb}$$

$$DL_{gusset} := \left(DL_{L7} + DL_{L1} + DL_{U4} + DL_{L0L8}\right) = 9812.05\,\text{lb}$$

Total Weight of Structural Steel:

$$Item_{550.15} := DL_{gusset} = 9812.05\,\text{lb}$$

Use Item 550.15 Quantity = 1000 lbs

ITEM 550.16 STRUCTURAL STEEL - REHABILITATED GUSSET PLATES (F) (EA)

- Dead load of existing members were calculated as part of as-built load rating. Dead loads shown below are taken from the "Truss Analysis - Dead Load Calculations"
- Gusset plate rehabilitation includes removing gusset plate, cleaning pack rus and scale, and reinstalling gusset plate.
- The following gusset plates are proposed to be rehabilitated:
  - Span 1 south truss L1, L2, L4, M45
  - Span 1 north truss L2, M3, M4, L4, M45, M5, L7
  - Span 2 south truss L4, L7
  - Span 2 north truss, L2, L3, M34, M45, M56, L7

$L1 := 1$

$L2 := 3$

$L3 := 1$

$L4 := 3$

$L7 := 3$

$M3 := 1$

$M34 := 1$

$M4 := 1$

$M45 := 3$

$M5 := 1$

$M56 := 1$

$N_{gussets} := L1 + L2 + L3 + L4 + L7 + M3 + M34 + M4 + M45 + M5 + M56 = 19$

Total Quantity of Gusset Plate Rehabilitation:

$Item_{550.16} := N_{gussets} = 19$

Use Item 550.16 Quantity = 19 EA

ITEM 550.17 STRUCTURAL STEEL - FLOOR FRAMING (F) (LB)

- Dead load of existing members were calculated as part of as-built load rating. Dead loads shown below taken from the "Truss Analysis - Dead Load Calculations"
- All floorbeams, stringers and lower bracing are proposed to be replaced.
- Proposed stringers are:
    - (1) W12x40
    - (3) W21x62
    - (5) W18x50
- The proposed intermediate floorbeams are W36x194 and end floorbeams are W36x160.
- New lower bracing would match existing.

Stringers:

$DL_{stringer} := L_{bridge} \cdot (40plf + 3 \cdot 62plf + 5 \cdot 50plf) = 189448\,lb$ Dead Load of stringers

$DL_{stringer\_conn} := 2 \cdot [8(2 \cdot 167lb) + 2(2 \cdot 84lb)] = 6016\,lb$

Floorbeams:

$DL_{fb} := (34.375ft) \cdot (4 \cdot 160plf + 16 \cdot 194plf) = 128700\,lb$ Dead Load of floorbeams

$DL_{fb\_conn} := 4 \cdot (2 \cdot 531lb + 3 \cdot 506lb) = 10320\,lb$ Dead Load of connection angles

Bracing:

$DL_{bracing} := 2 \cdot [2 \cdot (2 \cdot 270lb) + 8 \cdot (2 \cdot 541lb)] = 19472\,lb$ Dead Load of Lower Bracing

Total Weight of Structural Steel:

$Item_{550.17} := DL_{stringer} + DL_{stringer\_conn} + DL_{fb} + DL_{fb\_conn} + DL_{bracing} = 353956\,lb$

Use Item 550.17 Quantity = 354,000 lbs

ITEM 550.18 STRUCTURAL STEEL - UPPER BRACING (F) (LB)

- Dead load of existing members were calculated as part of as-built load rating. Dead loads shown below taken from the "Truss Analysis - Dead Load Calculations"
- The following upper bracing members are proposed to be replaced:
  - Span 1 members U6S-U5N and U5N-U4S
  - Span 2 members U5S-U4N and U4S-U4N

$DL_{diag\_bracing\_angles} := 551\,lb$

$DL_{diag\_bracing\_lacing} := 209\,lb$

$DL_{diag\_bracing\_connection\_PL} := 2\cdot\frac{144\,lb}{6} = 48\,lb$

$DL_{diag\_bracing} := DL_{diag\_bracing\_angles} + DL_{diag\_bracing\_lacing} + DL_{diag\_bracing\_connection\_PL} = 808\,lb$

$DL_{strut} := 1502\,lb + 119\,lb$

$DL_{upper\_bracing} := 3DL_{diag\_bracing} + DL_{strut} = 4045\,lb$

Total Weight of Structural Steel:

$Item_{550.18} := DL_{upper\_bracing} = 4045\,lb$

Use Item 550.18 Quantity = 4,500 lbs

ITEM 550.189 STRUCTURAL STEEL - PORTAL AND SWAY FRAMES (F) (LB)

- Dead load of existing members were calculated as part of as-built load rating. Dead loads shown below taken from the "Truss Analysis - Dead Load Calculations"
- All portal frame members are proposed to be replaced.
- All sway bracing lower struts, diagonals, verticals and connection plates are proposed to be replaced.

$DL_{portal} := 2\cdot(2233lb) = 4466\,lb$

$DL_{sway.U2U2\_U7U7} := 2\cdot(71lb + 277lb + 440lb + 202lb) = 1980\,lb$

$DL_{sway.U3U3\_U3U3} := 2\cdot(101lb + 305lb + 440lb + 179lb) = 2050\,lb$

$DL_{sway.U4U4} := (116lb + 321lb + 486lb + 182lb) = 1105\,lb$

$DL_{sway.U5U5} := (116lb + 321lb + 440lb + 182lb) = 1059\,lb$

$DL_{sway} := DL_{sway.U2U2\_U7U7} + DL_{sway.U3U3\_U3U3} + DL_{sway.U4U4} + DL_{sway.U5U5} = 6194\,lb$

Total Weight of Structural Steel:

$Item_{550.189} := 4DL_{portal} + 2DL_{sway} = 30252\,lb$

Use Item 550.189 Quantity = 30,500 lbs

ITEM 550.19 TEMPORARY TRUSS SUPPORT SYSTEM (U)

- Ramsdell Road Bridge project (908603) had a very similar scope of work as this project. US Route 2 Bridge has more steel replacement that Ramsdell Road but for the most part the work is very similar. Use the bid prices received for Ramsdell Road project as the basis to estimate Item 550.19. The bid price would be converted in per SF basis in order to determine the appropriate cost for the longer and wider bridge.
- Bid prices ranged from \$3K to \$75K. Since US Route 2 has more steel replacement, use \$60K for Ramsdell Road Bridge project.

$$\mathrm{Cost}_{SF.550.19} := \frac{\$\cdot 60000}{21.5\mathrm{ft}\cdot 108\mathrm{ft}} = 25.84\cdot\frac{\$}{\mathrm{ft}^2}$$

$$\mathrm{Area}_{USRoute2} := L_{bridge}\cdot(35\mathrm{ft} + 5.5\mathrm{in}) = 14112.417\,\mathrm{ft}^2$$

$$\mathrm{Item}_{550.19} := \mathrm{Cost}_{SF.550.19}\cdot\mathrm{Area}_{USRoute2} = 364661.929\,\$$$

Use Item 550.19 Cost = \$375,000

ITEM 550.2 BRIDGE SHOES ~~(U)~~ EA

- All expansion bearings will be replaced.

Quantity - 4 EA

ITEM 552.1 REHABILITATION OF FIXED BRIDGE SHOES ~~(U)~~ EA

Quantity - 4 EA

ITEM 552.61 REPLACEMENT OF TRUSS BEARING PINS (~~U~~) EA

Quantity - 8 EA

ITEM 555.301 EXODERMIC STEEL BRIDGE DECK (F) (U)

Deck. Width: $W_{deck} = 33\ \text{ft}$

Bridge Deck Length: $L_{bridge} = 398\ \text{ft}$

$A_{deck} := W_{deck} \cdot L_{bridge} = 13134\ \text{ft}^2$ ✓

Use Item 555.301 Quantity = 13,200 SF ✓

ITEM 556.101 PAINTING EXISTING STRUCTURAL STEEL(U)

- Ramsdell Road Bridge project (908603) had a very similar scope of work as this project. US Route 2 Bridge has more steel replacement that Ramsdell Road but for the most part the work is very similar. Use the bid prices received for Ramsdell Road project as the basis to estimate Item 556.101. The bid price would be converted in per lf basis in order to determine the appropriate cost for the longer bridge.
- Bid prices ranged from \$175K to \$227K. Since US Route 2 has more steel replacement, use \$200K for Ramsdell Road Bridge project.

$$\text{Cost}_{\text{SF\_556.101}} := \frac{\$\cdot 200000}{108\,\text{ft}} = 1851.852\cdot\frac{\$}{\text{ft}}$$

$$L_{\text{USRoute2}} := L_{\text{bridge}} = 398\ \text{ft}$$

$$\text{Item}_{556.101} := \text{Cost}_{\text{SF\_556.101}}\cdot L_{\text{USRoute2}} = 737037.037\,\$$$

Use Item 556.101 Cost = \$740,000

ITEM 556.201 CONTAINMENT AND ENVIRONMENTAL PROTECTION (U)

- Ramsdell Road Bridge project (908603) had a very similar scope of work as this project. US Route 2 Bridge has more steel replacement that Ramsdell Road but for the most part the work is very similar. Use the bid prices received for Ramsdell Road project as the basis to estimate Item 556.201. The bid price would be converted in per lf basis in order to determine the appropriate cost for the longer bridge.
- Bid prices ranged from \$50K to \$125K. Since US Route 2 has more steel replacement, use \$60K for Ramsdell Road Bridge project. Only one bid had the price of \$125K. All others were around \$50K.

$$\text{Cost}_{SF\_556.201} := \frac{\$\cdot 60000}{108\text{ft}} = 555.556\cdot\frac{\$}{\text{ft}}$$

$$L_{USRoute2} = 398\text{ ft}$$

$$\text{Item}_{556.201} := \text{Cost}_{SF\_556.201}\cdot L_{USRoute2} = 221111.111\,\$$$

Use Item 556.201 Cost = \$230,000

ITEM 556.301 WORKER PROTECTION (U)

- Ramsdell Road Bridge project (908603) had a very similar scope of work as this project. US Route 2 Bridge has more steel replacement that Ramsdell Road but for the most part the work is very similar. Use the bid prices received for Ramsdell Road project as the basis to estimate Item 556.301. The bid price would be converted in per lf basis in order to determine the appropriate cost for the longer bridge.
- Bid prices ranged from $9K to $50K. Since US Route 2 has more steel replacement, use $10K for Ramsdell Road Bridge project. Only one bid had the price of $50K. All others were around $9K.

$$\mathrm{Cost}_{SF\_556.301} := \frac{\$\cdot 10000}{108\mathrm{ft}} = 92.593\cdot\frac{\$}{\mathrm{ft}}$$

$$L_{USRoute2} = 398\ \mathrm{ft}$$

$$\mathrm{Item}_{556.301} := \mathrm{Cost}_{SF\_556.301}\cdot L_{USRoute2} = 36851.852\ \$$$

Use Item 556.301 Cost = $37,000

ITEM 556.401 WASTE MANAGMENT (U)

- Ramsdell Road Bridge project (908603) had a very similar scope of work as this project. US Route 2 Bridge has more steel replacement that Ramsdell Road but for the most part the work is very similar. Use the bid prices received for Ramsdell Road project as the basis to estimate Item 556.301. The bid price would be converted in per lf basis in order to determine the appropriate cost for the longer bridge.
- Bid prices ranged from \$5K to \$7.5K. Since US Route 2 has more steel replacement, use \$5K for Ramsdell Road Bridge project. Only one bid had the price of \$7.5K. All others were around \$5K.

$$\mathrm{Cost}_{SF\_556.401} := \frac{\$\cdot 5000}{108\mathrm{ft}} = 46.296\cdot\frac{\$}{\mathrm{ft}}$$

$$L_{USRoute2} = 398\ \mathrm{ft}$$

$$\mathrm{Item}_{556.401} := \mathrm{Cost}_{SF\_556.401}\cdot L_{USRoute2} = 18425.926\ \$$$

Use Item 556.401 Cost = \$19,000

ITEM 561.110 PREFABRICATED EXPANSION JOINT, TYPE A (LF)

- Proposed to replace expansion end dams with prefabricated expansion joints.

Estimated Quantity: $\mathrm{Quantity}_{561.110} := (35\mathrm{ft} + 5.5\mathrm{in})\cdot 3$

$\mathrm{Quantity}_{561.110} = 106.4\,\mathrm{ft}$

Use Item 561.110 Quantity = 110 LF

ITEM 563.24 BRIDGE RAIL T4 (F) (LF)

- All bridge rail is recommended to be replaced with a T4 Steel Bridge Rail.

$L_{rail} := 2 \cdot (L_{bridge}) = 796\ \text{ft}$

Total Weight of Structural Steel:

$Item_{563.24} := L_{rail} = 796\ \text{ft}$

Use Item 563.24 Quantity = 800 LF

ITEM 565.242 BRIDGE APPROACH RAIL T4 (U)

Estimated Quantity: $\text{Quantity}_{565.24} := 4$

Use Item 565.242 Quantity = 4 U

ITEM 568 STRUCTURAL TIMBER (F) (MBM)

BF = 1in · 1in · 1Ft

- Existing timber deck is proposed to be replaced in kind:
  - Deck is 2x4 timber and is nail laminated
  - Wearing course is 1" timber plank
  - Curb is 6x8 timber
  - Rails are 2x6 timber

$A_{timber\_deck} := (5.25ft + 2 \cdot 2in)(4in) = 1.861\,ft^2$ ✓

$A_{timber\_wc} := (5.25ft + 2 \cdot 2in - 2 \cdot 8in)(1in) = 0.354\,ft^2$ ✓

$A_{timber\_curb} := (6in)(8in) \cdot 2 = 0.667\,ft^2$ ✓

$A_{timber\_rail} := (2in)(6in) \cdot 6 = 0.5\,ft^2$ ✓

$Vol := L_{bridge} \cdot (A_{timber\_deck} + A_{timber\_wc} + A_{timber\_curb} + A_{timber\_rail}) = 16152.167 \cdot BF$ ✓

Estimated Quantity: 16.5MBM ✓

Use Item 568 Quantity = 16.5 MBM

Use 17 for Estimate ECW 12/21/12.

ITEM 585.1, STONE FILL CLASS A (CY)

Say 100 CY to place some additional stone around the existing pier and abutments

Use Item 585.1 Quantity = 100 CY

ITEM 1002.1 - REPAIRS OR REPLACEMENTS AS NEEDED - BRIDGE STRUCTURES (~~U~~) $

Allow $25,000

Use Item 1002.1 Quantity = $25,000

Appendix E5

Existing Truss Painting Cost Estimate

STATE OF NEW HAMPSHIRE

INTER-DEPARTMENT COMMUNICATION

DATE September 13, 2017

From Jerry S. Zoller, P.E.
Project Engineer

Office Bureau of Bridge Design
Tel. 603-271-2731, Fax -2759

Subject **Hinsdale, NH- Brattleboro, VT 12210-C**
Br. No. 041/040 (west) NH 119 / Connecticut R
Br. No. 042/044 (east) NH 119 / Connecticut R

To David L. Scott, P.E.
Chief of Design, Bridge Design Bureau

Re: Item 556 Preliminary Bridge Painting Estimate

I was requested on September 6, 2017 to provide a preliminary estimate to repaint the two steel camel-back through truss bridges referenced above. The westerly bridge is one-span and 339-ft. long. The easterly bridge is three-spans with a truss center span and a total length of 297 ft. I visited the bridges and generally observed the existing coating conditions from the shoreline, sidewalk, and easterly bridge seat area. Please consider the following comments, recommendations, and preliminary estimate for Item 556, Painting Existing Structural Steel.

(a) Assessment of Bridge Coating (ABC report):

The 1920 bridges have a concrete deck in the roadway and a timber sidewalk cantilevered on the upstream side. The truss structures have built-up riveted members.

The bridge members have not been painted for many years and have suffered considerable deterioration and corrosion. Crevice corrosion and rusting is evident in built-up members particularly within the splash zone near and above the bridge rail, and extensively below the deck in flooring members and bottom chord members. The upper truss coatings are in better condition but exhibit coating delamination and peeling in areas. The easterly (NH-side) truss is in poorer condition than the westerly (VT-side).

It is evident that some steel repair work will be required as well due to the effects of corrosion, with section loss to rivet heads, rust pack and deterioration of members, and rust pack in crevices.

The original coating is an alkyd paint lead (orange primer) containing lead components (lead-bearing paint LBP) and mill scale is present under the coatings. The existing coatings need to be replaced entirely.

(b) Recommendations:

I recommend that the existing structural steel be totally repainted, i.e. the existing coating be removed by abrasive blasting to an SP10 Near White finish within Class 1A negative-pressure containment, and repainted with a high-performance system.

All of the work must conform to stringent NHDES requirements for environmental protection, industrial requirements for coating application, and OSHA regulations governing worker health and safety. The NHDOT Standard Specifications require that the work be performed by a qualified contractor (i.e. meeting SSPC QP1 & QP2), and the work be overseen by a qualified coatings inspector.

The recommended coating system is a four-coat moisture-cured polyurethane system including a penetrating sealer applied over the zinc primer to seep into crevices and provide additional protection. The Department has successfully used this and similar coating systems on a number of bridges and trusses over the years.

(c) Preliminary estimate:

The estimated cost to repaint the bridge as described above is as follows:

Hinsdale 041/040 - repaint steel (westerly) truss bridge;

Description	Quantity	Rate	Cost
Item 556 Structural Steel	7,831 sf deck	$250.00/sf	$ 1,958,000
Field Painting Inspection	16 weeks	$6,500/wk	$ 104,000
Total Bridge Painting Costs			**$2,062,000**

Hinsdale 042/044 - repaint steel (easterly) truss bridge;

Description	Quantity	Rate	Cost
Item 556 Structural Steel	6,237 sf deck	$300.00/sf	$ 1,871,000
Field Painting Inspection	16 weeks	$6,500/wk	$ 104,000
Total Bridge Painting Costs			**$1,975,000**

TOTAL - repaint steel (both) truss bridges;

Description	Quantity	Rate	Cost
Item 556 Structural Steel (westerly truss)	14,068 sf deck	$250-300	$ 3,829,000
Field Painting Inspection (westerly truss)	32 weeks	$6,500/wk	$ 208,000
Total Bridge Painting Costs			**$4,037,000**

The two most comparable projects are the (2000) Orford-Fairley arch bridge and the (2016) Stewartstown arch bridge, both similarly large bridges with similar deteriorated paint condition and accelerated corrosion. The Appendix lists a number of truss bridges painted in recent years with information contributing to the estimate.

The Orford project costs are sixteen years old but in the Appendix table represent the high end of costs for Item 556, Painting Existing Structural Steel.

For this preliminary estimate I used the higher end of the 2016 Stewartstown project bid results as shown, and selected the three-bid average as a target cost. The additional considerations described below also suggest using the higher end of the Item 556 cost range.

To establish a "worst-case" cost to represent the high end of the estimate range for comparison, I note the Portsmouth Memorial bridge bid of 2008 which yielded the highest cost at $410/sf deck.

Project (bid year)	Deck Area	Unit cost/sf	Item 556 Cost
Orford-Fairley 12898 (2000)	14,068 sf	$102	$ 1,435,000
Orford-Fairley 12898 (adjusted for inflation)	14,068 sf	$ 142	$ 1,998,000
Stewartstown 15838 A-Bid	14,068 sf	$ 163	$ 2,293,000
Stewartstown 15838 B-Bid	14,068 sf	$ 153	$ 2,153,000
Stewartstown 15838 C-Bid	14,068 sf	$ 350	$ 4,924,000
Stewartstown 15838 Average-Bid	14,068 sf	$ 222	$ 3,123,000
Selected to use	14,068 sf	$ 250-300	$ 3,829,000
Portsmouth Memorial Br 13678	14,068 sf	$ 410	$ 5,768,000

(d) Additional considerations:

Factors influencing the repainting effort and preliminary estimate:

- The easterly bridge is three spans, the same work for the truss but additional for the beam spans.
- The considerable number of crevice corrosion locations will add to the surface preparation, sealing, caulking, and painting operations;
- The bridges will be closed enabling the Contractor to access the bridge unhindered, a favorable factor, however, painting a truss is always more expensive because of the ration of containment required versus area of steel to be painted;
- The large length and height of the trusses and the site over the river will require that the containment area be smaller perhaps than normal to reduce the effects of "sail" area and wind loads on the containment support structure and on the bridge itself;
- The proximity of the westerly bridge to the city, and particularly to the restaurant (Whetstone Station) on the northwest corner only ten feet away will be an added difficulty of risk to consider;
- The nature of the rehabilitation project, including considerable steel replacement and repair, will require the painting Contractor to mobilize to the site twice: (1) early to blast and prime the steel to de-lead the bridge for structural work and to inspect the steel for repair determinations; and (2) to repaint the entire bridge at the end of the job;
- The site location over the Connecticut River will add challenges, including winds, colder conditions, fog and condensation, altogether a shorter paint-friendly weather season;

APPENDIX - Project & Price Comparisons

Since 1993 the Department has contracted several painting projects for truss bridges. The comparison of bridge features and bid data below contributed to this preliminary cost estimate.

Yr	Town	Proj #	L	W	**Steel** area, sf	A-Bid, $	A-Bid **unit** $/sf	B-Bid unit $/sf	C-Bid unit $/sf	**Deck** area, sf	A-Bid $/sf **deck**
16	Stewartstown	15838	232	30.5	---	1,150,000	---	---	---	7,076	$163
08	Ports Mem'l	13678	600	29.0	402,600	7,134,000	$17.72	---	---	17,400	$410
08	Ashland-bw	14272	800	29.0	101,500	1,860,000	$18.33	17.70	19.50	23,200	$ 80
06	Monroe	14095	308	22.2	34,600	668,000	$19.31	18.06	20.12	6,838	$ 98
03	Effingham	13647	140	19.0	6,400	133,000	$20.78	28.27	31.48	7,429	$ 50
01	Haverhill	12363	259	31.4	30,000	740,000	$24.67	29.17	20.00	8,133	$ 91
00	Orford	12898	432	34.0	124,000	1,500,000	$12.10	15.53	---	14,688	$102
99	Ports I-95	12514	1344	105	818,000	8,610,000	$10.53	10.76	11.25	140,448	$ 62
99	Plymouth	12811	172	25.6	24,000	266,000	$11.08	10.98	13.13	4,403	$ 60
98	Bethlehem	12808	124	24.0	12,500	160,000	$12.80	11.32	16.99	2,976	$ 54
93	Piermont	S-4277	352	24.3	---	623,500	---	---	---	8,554	$ 73

Stewartstown Arch (2016)

Stewartstown Arch (2016)

Stewartstown Arch (2016)

Portsmouth Memorial (2008)

Ashland-Bridgewater (2008)

Monroe (2006)

Effingham (2003)

Haverhill (2001)

Orford (2000)

Portsmouth I-95 (1999)

Plymouth (1999)

Piermont (1993)

Appendix E6

Baseline O&M Cost

Hoyle, Tanner & Associates, Inc.
150 Dow Street
Manchester, New Hampshire 03101

HTA PROJECT NO. 092590 **SHEET** **OF**
PROJECT DESCRIPTION NHDOT Hinsdale, NH - Brattleboro, VT
TASK Long Term Operation/Maintenance Costs
CALCULATED BY: EGW **DATE:** 09/29/2017
CHECKED BY: JCR **DATE:** 09/29/2017

K:\092590_13\4-Design\Reports\BCA\BCA Appendices\[Appendix E6_Baseline O&M Cost.xlsx]BCA Input Data

BRIDGE REHABILITATION/REPLACEMENT COST BENEFIT ANALYSIS

Baseline Long-Term Operation and Maintenance Cost

Notes and Assumptions:

1. Maintenance costs are based on a 40 year analysis period.	N=	40	years
2. NHDOT Roadway Tier Multiplier:	M=	1.5	(Tier 3)
3. Costs are in 2017 dollars.	I=	0%	
4. Bridge curb-to-curb width	TW=	20.3	ft
5. Br. No. 041/040 (West) Length	L=	339	ft
6. Br. No. 042/044 (East) Length	L=	297	ft
7. Sidewalk width	SW=	5.25	ft

8. The duration of the major rehabilitation of the trusses is 2 years 2020-2021. Therefore, the O&M tasks will being in 2022.

Truss Bridge Maintenance and Preservation

Item	Frequency (years)	Item Cost	Lane Closure Duration	Notes:
Wash Trusses & Deck, General Maintenance & Oil	1	$30,000	2 days	Cost information provided by NHDOT is $15000 per bridge.
In-depth/FCM Bridge Inspection performed by Consultant	4	$45,000	5 days	Based on recent similar project scopes
Crack Sealing	5	$1,000	2 days	1 day operation per lane. Use $0.07/SF cost from NHDOT
Pave	10	$21,000	2 day complete closure	1 day operation to mill, 1 day to pave. Use $1.60/SF cost from NHDOT
Sidewalk Timber Deck Replacement	10	$167,000	None	Use $50 per SF based on similar project rehabilitation estimate.
Expansion joint strip seal replacement & modular joint repairs	10	$5,000	2 day complete closure	Assumes strip seal can be replaced in one day while modular joint repairs would be on a second day. Costs are $2500 per day for crew time and materials
Structural steel repairs, paint touch up, concrete deck repairs, membrane, expansion joint replacement	20	$2,600,000	4 months complete closure	Estimate 4 month duration to perform this work. Use $200/SF based on prevoius truss project experience.
Substructure Repairs	20	$25,000	Included in superstructure duration	Estimate 5 one day closures for equipment and access to perform repair work. Costs are $5000 per day for crew time and materials.
Deck Replacement	50	$0		Deck replacement would occur in a year beyond the analysis period.

Truss Bridge Maintenance and Preservation (with Tier Multiplier)

Item	Frequency (years)	Item Cost	Lane Closure Duration	Notes:
Wash Trusses & Deck, General Maintenance & Oil[1]	1	$30,000	2 days	Cost information provided by NHDOT is $15000 per bridge.
In-depth/FCM Bridge Inspection performed by Consultant[1]	4	$45,000	5 days	Based on recent similar project scopes
Crack Sealing	5	$1,500	2 days	1 day operation per lane. Use $0.07/SF cost from NHDOT
Pave	10	$31,500	2 day complete closure	1 day operation to mill, 1 day to pave. Use $1.60/SF cost from NHDOT
Sidewalk Timber Deck Replacement	10	$250,500	None	Use $50 per SF based on similar project rehabilitation estimate.
Expansion joint strip seal replacement & modular joint repairs	10	$7,500	2 day complete closure	Assumes strip seal can be replaced in one day while modular joint repairs would be on a second day. Costs are $2500 per day for crew time and materials
Structural steel repairs, paint touch up, concrete deck repairs, membrane, expansion joint replacement	20	$3,900,000	4 months complete closure	Estimate 4 month duration to perform this work. Use $200/SF based on prevoius truss project experience.
Substructure Repairs	20	$37,500	Included in superstructure duration	Estimate 5 one day closures for equipment and access to perform repair work. Costs are $5000 per day for crew time and materials.
Deck Replacement	50	$0	$0	Deck replacement would occur in a year beyond the analysis period.

Notes:

1. These costs do not include the tier multiplier.

Appendix E7

Proposed Project Capital Expenditures

Hoyle, Tanner & Associates, Inc.

150 Dow Street
Manchester, NH 03101

Hoyle, Tanner Project No. 092590.13
Hinsdale, NH - Brattleboro, VT
NH Route 119 Over the Connecticut River
NHDOT Project No. 12210C
Capital Expenditure Costs

Sheet: ________ Of: ________
Calc By: JCR Date: 6/2018
Chck By: MJL Date: 7/2018
Rev By: ________ Date: ________
Chck By: ________ Date: ________

Notes and Assumptions:

1. Proposed project capital expenditures have been provided by NHDOT. These include engineering, right-of-way acquisitions, and construction costs.
2. All costs are in real dollars.
3. For ease of calculation, the costs that occur in multiple years are equally distributed in those years.

Expenditure	Amount	Year(s) of Expenditure
Engineering	$ 1,085,000.00	2016-2019
New Hampshire Right-of-way	$ 270,000.00	2019
Vermont Right-of-way	$ 8,080,000.00	2019
Proposed Bridge Construction	$ 42,000,000.00	2020-2022
Existing Truss Rehabilitation for Pedestrian Use	$ 8,000,000.00	2023

Total Expenditure	$ 59,435,000.00

Year	Capital Expenditures ($)
2016	$ 271,250.00
2017	$ 271,250.00
2018	$ 271,250.00
2019	$ 8,621,250.00
2020	$ 14,000,000.00
2021	$ 14,000,000.00
2022	$ 14,000,000.00
2023	$ 8,000,000.00

Appendix E8

Proposed Project
Preliminary Cost Estimate

New Hampshire DOT
Department of Transportation

PROJECT: **HINSDALE / BRATTLEBORO**
SUBJECT: **NH 119 OVER CONNECTICUT RIVER**
TITLE: **BUILD ESTIMATE**

Project: **12210C**
Designer & User: **WPS**
date: **7/2/2018**
Checker: **CKN**

	Ttl. Items: 52 **Item No.**	**Item Description**	**Quantity**	**Unit**	**Unit Cost**	**Total Cost** **$ 44,600,000.00**
1	207.1	Common Channel Excavation	438	CY	**$ 25.00**	$ 10,950.00
2	209.201	Granular Backfill Bridge (F)	2100	CY	**$ 45.00**	$ 94,500.00
3	403.11	Hot Bituminous Pavement, Machine Method	675	Ton	**$ 75.00**	$ 50,625.00
4	403.61	Pavement Joint Adhesive (Bridge Base)	9012	LF	**$ 1.50**	$ 13,518.00
5	403.911	Hot Bituminous Bridge Pavement, 1" Base Course (F)	456	Ton	**$ 160.00**	$ 72,960.00
6	500.02	Access for Bridge Construction	1	U	**$ 6,000,000.00**	$ 6,000,000.00
7	503.201	Cofferdams	1	U	**$ 600,000.00**	$ 600,000.00
8	504.1	Common Bridge Excavation (F)	3385	CY	**$ 35.00**	$ 118,475.00
9	508.	Structural Fill	195	CY	**$ 75.00**	$ 14,625.00
10	510.1	Pile Driving Equipment	1	U	**$ 50,000.00**	$ 50,000.00
11	510.61	Furnishing & Driving Steel Bearing Piles	2076228	LB	**$ 0.50**	$ 1,038,114.00
12	510.65	Driving-Points for Steel Bearing Piles	231	EA	**$ 180.00**	$ 41,580.00
13	510.9	Pile Splices	462	EA	**$ 50.00**	$ 23,100.00
14	520.0302	Concrete Class AA, Approach Slabs (QC/QA) (F)	77	CY	**$ 570.00**	$ 43,890.00
15	520.12	Concrete Class A, Above Footing (F)	2703	CY	**$ 1,000.00**	$ 2,703,000.00
16	520.213	Concrete Class B, Footings (On Soil) (F)	986	CY	**$ 600.00**	$ 591,600.00
17	520.351	Form Liner for Concrete (F)	473	SY	**$ 10.00**	$ 4,730.00
18	520.6	Concrete Class T, Foundation Seal	3861	CY	**$ 350.00**	$ 1,351,350.00
19	520.70026	Concrete Bridge Deck (QC/QA) (Panel Option) (F)	3512	CY	**$ 850.00**	$ 2,985,200.00
20	534.3	Water Repellent (Silane-Siloxane)	433	GAL	**$ 150.00**	$ 64,950.00
21	538.2	Barrier Membrane, Peel and Stick, Vertical Surfaces (F	45	SY	**$ 150.00**	$ 6,750.00
22	538.6	Barrier Membrane, Heat Welded, Machine Method (F)	8121	SY	**$ 25.00**	$ 203,025.00
23	541.1	PVC Waterstops, NH Type 1 (F)	81	LF	**$ 10.00**	$ 810.00
24	541.2	PVC Waterstops, NH Type 2 (F)	82	LF	**$ 10.00**	$ 820.00
25	541.4	PVC Waterstops, NH Type 4 (F)	93	LF	**$ 10.00**	$ 930.00
26	544.	Reinforcing Steel (F)	482000	LB	**$ 1.25**	$ 602,500.00
27	544.51	Reinforcing Steel - Stainless Steel (F)	1053000	LB	**$ 2.75**	$ 2,895,060.48
28	544.7	Synthetic Fiber Reinforcement	539	LB	**$ 8.25**	$ 4,446.75
29	547.	Shear Connector (F)	25250	EA	**$ 5.25**	$ 132,562.50
30	548.21	Elastomeric Bearing Assemblies (F)	25	EA	**$ 1,200.00**	$ 30,000.00
31	550.1	Structural Steel (F)	6336900	LB	**$ 1.75**	$ 11,089,575.00
32	550.2101	Bridge Shoes - HLMR	20	EA	**$ 2,500.00**	$ 50,000.00
33	561.20	Prefabricated Modular Bridge Joint System (F)	102	LF	**$ 1,750.00**	$ 178,500.00
34	562.1	Silocon Joint Sealant (F)	120	LF	**$ 15.00**	$ 1,800.00
35	563.23	Bridge Rail T3 (F)	1532	LF	**$ 135.00**	$ 206,820.00
36	563.231	Bridge Rail T3 With Protective Screening (F)	48	LF	**$ 180.00**	$ 8,640.00
37	563.233	Bridge Rail T3 With Snow Screening (F)	192	LF	**$ 180.00**	$ 34,560.00
38	563.24	Bridge Rail T4 (F)	1566	LF	**$ 141.00**	$ 220,806.00
39	563.241	Bridge Rail T4 With Protective Screening (F)	48	LF	**$ 205.00**	$ 9,840.00
40	563.243	Bridge Rail T4 With Snow Screening (F)	192	LF	**$ 205.00**	$ 39,360.00
41	564.1	Bridge Lighting System	1	U	**$ 50,000.00**	$ 50,000.00
42	565.232	Bridge Approach Rail T3 (Steel Posts) (F)	2	U	**$ 5,500.00**	$ 11,000.00
43	565.242	Bridge Approach Rail T4 (Steel Posts) (F)	2	U	**$ 6,000.00**	$ 12,000.00
44	585.2	Stone Fill, Class B	67	CY	**$ 27.00**	$ 1,809.00
45	609.01	Straight Granite Curb	65	LF	**$ 22.00**	$ 1,430.00
46	609.02	Curved Granite Curb	65	LF	**$ 32.00**	$ 2,080.00
47	692.	Mobilization	1	U	**$ 1,218,321.25**	$ 1,218,321.25
48	1010.41	Quality Control / Quality Assurance (QC/QA) for Concre	1	$	**$ 537,583.90**	$ 537,583.90
49	1020.02	Inspection - Paint	1	$	**$ 10,000.00**	$ 10,000.00
50	1020.03	Inspection - Steel	1	$	**$ 120,000.00**	$ 120,000.00
51	1030.	Construction Engineering	1	$	**$ 3,045,803.13**	$ 3,045,803.13
52						$ -
53		Rehabilitation of Existing Truss Bridges				$ 8,000,000.00
54						$ -
55						$ -
56						$ -

PRELIMINARY
DESIGN
SECTION

STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION

PROJECT NO. A004(152)
STATE NO. 12210C

PRELIMINARY ESTIMATE (TOTAL)

CITY/TOWN: **HINSDALE-BRATTLEBORO**
COUNTY: **CHESHIRE**
ROAD: **NH 119/VT 142**
TYPE: **BRIDGE REPLACEMENT**

DATE: **10/10/2017**
LENGTH: **0.81** MI
PAVEMENT: **24-36** FT WIDE
SHOULDERS: **3-8** FT WIDE

COST SHARE	VT	NH
BRIDGE	17%	83%
CONSTRUCTION	40%	60%

ITEM NO.	ITEM	UNIT	QUANTITY	PRICE	AMOUNT
203.1	COMMON EXCAVATION	CY	9,700	$8.00	$77,600
203.2	ROCK EXCAVATION	CY	131	$35.00	$4,585
203.6	EMBANKMENT-IN-PLACE	CY	20,300	$6.00	$121,800
209.1	GRANULAR BACKFILL	CY	240	$45.00	$10,800
214	FINE GRADING	U	1	$14,800.00	$14,800
304.1	SAND	CY	5,175	$20.00	$103,500
304.2	GRAVEL	CY	6,150	$24.00	$147,600
304.3	CRUSHED GRAVEL	CY	5,775	$29.00	$167,475
304.35	CRUSHED GRAVEL FOR DRIVES	CY	65	$30.00	$1,950
403.11	HOT BITUMINOUS PAVEMENT, MACHINE METHOD	TON	5,800	$90.00	$522,000
403.12	HOT BITUMINOUS PAVEMENT, HAND METHOD	TON	70	$119.00	$8,330
563.23	BRIDGE RAIL T3	LF	70	$160.00	$11,200
563.24	BRIDGE RAIL T4	LF	115	$158.00	$18,170
565.232	BRIDGE APPROACH RAIL T3 (STEEL POSTS)	U	2	$5,300.00	$10,600
565.242	BRIDGE APPROACH RAIL T4 (STEEL POSTS)	U	2	$10,000.00	$20,000
585.3	STONE FILL, CLASS C	CY	100	$41.00	$4,100
606.18001	31" W-BEAM GUARDRAIL WITH 8" OFFSET BLOCK (STEEL POST)	LF	1,450	$16.50	$23,925
606.1254	BEAM GUARDRAIL (TERMINAL UNIT TYPE EAGRT, TL 3)	U	1	$1,950.00	$1,950
606.1255	BEAM GUARDRAIL (TERMINAL UNIT TYPE EAGRT, TL 2)	U	2	$1,925.00	$3,850
608.12	2" BITUMINOUS SIDEWALK	SY	1,620	$16.00	$25,920
609.01	STRAIGHT GRANITE CURB	LF	2,190	$21.75	$47,633
609.811	BITUMINOUS CURB, TYPE B (4" REVEAL)	LF	2,065	$6.50	$13,423
618.610	UNIFORMED OFFICERS WITH VEHICLE[1]	$	1	$30,000.00	$30,000
618.700	FLAGGERS[1]	HR	4,000	$25.00	$100,000
619.1	MAINTENANCE OF TRAFFIC[1]	U	1	$80,000.00	$80,000
619.2	CONSTRUCTION SIGNS AND WARNING DEVICES[1]	U	1	$35,000.00	$35,000
619.25	PORTABLE CHANGEABLE MESSAGE SIGNS	U	4	$3,400.00	$13,600
	RETAINING WALL	U	1	$125,000.00	$125,000
	SIGNALS	U	1	$175,000.00	$175,000
					$1,919,810
	MISCELLANEOUS ITEMS (20%)				$383,962
	LIMITED RE-USE SOILS (NH ONLY)				$200,000
	ITS - RWIS WEATHER STATION (NH ONLY)				$80,000
	WATER TREATMENT (VT ONLY)				$300,000
					$2,883,772
	DRAINAGE (11%)				$304,691
					$3,188,463
	WATER POLLUTION CONTROL (20%)[1]				$637,693
	MOBILIZATION (10%)[2]				$318,846
	CONTINGENCY (20%)[2]				$637,693
			ROADWAY SUB-TOTAL		**$4,782,695**
	CONSTRUCTION ENGINEERING (10%)[2]				$478,269
698.12	FIELD OFFICE TYPE C[1]	MON	30	$1,800.00	$54,000
698.2	PHYSICAL TESTING LABORATORY[1]	MON	30	$1,000.00	$30,000
			ROADWAY TOTAL		**$5,344,964**
	BRIDGE[2,3]	U	1	$44,600,000	$44,600,000
			BRIDGE TOTAL		**$44,600,000**
			CONSTRUCTION TOTAL		**$49,944,964**
			ROUNDED TOTAL		**$50,000,000**

[1] ITEMS SHARED BY EACH STATE (ROADWAY SPLIT)

[2] ITEMS SHARED BY EACH STATE (BRIDGE SPLIT)

[3] INCLUDES MOBILIZATION AND CONSTRUCTION ENGINEERING

COMP. BY: T. Zanes

CHECKED BY: J. Hebert

Appendix E9

Proposed Bridge O&M Costs

Proposed Bridge Preservation/Rehabilitation Schedule

Proposed Bridge Area: 88,505 sf
Roadway Tier Multiplier: 1 (H-B)

Notes and Assumptions:
1. All efforts, occurrence years, square foot costs and tier multipliers have been provided by NHDOT.
2. All monetary values are in real dollars.
3. The bridge is assumed to be opened at the start of 2023. Therefore, all O&M tasks will begin in year 2023.

			Costs per SF without Tier Multiplier			Total Costs with Tier Multiplier			
Operation Year	Analysis Period Year	Effort	Preservation Tasks	Rehabilitation Tasks	Maintenance Tasks	Preservation Tasks	Rehabilitation Tasks	Maintenance Tasks	
Every Year	2023-2059	Wash and Oil[1]	$ -	$ -	$ 0.10	$ -	$ -	$ 8,851	Data to be entered Into BCA Spreadsheet
5	2028	Crack Seal	$ -	$ -	$ 0.07	$ -	$ -	$ 5,900	
10	2033	Pave	$ -	$ -	$ 1.60	$ -	$ -	$ 141,608	
15	2038	Crack Seal	$ -	$ -	$ 0.07	$ -	$ -	$ 5,900	
20	2043	Patch, Membrane and Joints	$ 50.00	$ -	$ -	$ 4,425,250	$ -	$ -	
25	2048	Crack Seal	$ -	$ -	$ 0.07	$ -	$ -	$ 5,900	
	2049		End of BCA Analysis Period						
Every Year	2050-2143	Wash and Oil[2]	$ -	$ -	$ 0.10	$ -	$ -	$ 823,097	Proposed Bridge Preservation/Rehabilitation After End of BCA Analysis Period
30	2053	Pave	$ -	$ -	$ 1.60	$ -	$ -	$ 141,608	
35	2058	Crack Seal	$ -	$ -	$ 0.07	$ -	$ -	$ 5,900	
40	2063	Patch, Membrane and Joints	$ 50.00	$ -	$ -	$ 4,425,250	$ -	$ -	
45	2068	Crack Seal	$ -	$ -	$ 0.07	$ -	$ -	$ 5,900	
50	2073	Pave	$ -	$ -	$ 1.60	$ -	$ -	$ 141,608	
55	2078	Crack Seal	$ -	$ -	$ 0.07	$ -	$ -	$ 5,900	
60	2083	New deck	$ -	$ 100.00	$ -	$ -	$ 8,850,500	$ -	
65	2088	Crack Seal	$ -	$ -	$ 0.07	$ -	$ -	$ 5,900	
70	2093	Pave	$ -	$ -	$ 1.60	$ -	$ -	$ 141,608	
75	2098	Crack Seal	$ -	$ -	$ 0.07	$ -	$ -	$ 5,900	
80	2103	Patch, Membrane and Joints	$ 50.00	$ -	$ -	$ 4,425,250	$ -	$ -	
85	2108	Crack Seal	$ -	$ -	$ 0.07	$ -	$ -	$ 5,900	
90	2113	Pave	$ -	$ -	$ 1.60	$ -	$ -	$ 141,608	
95	2118	Crack Seal	$ -	$ -	$ 0.07	$ -	$ -	$ 5,900	
100	2123	Patch, Membrane and Joints	$ 50.00	$ -	$ -	$ 4,425,250	$ -	$ -	
105	2128	Crack Seal	$ -	$ -	$ 0.07	$ -	$ -	$ 5,900	
110	2133	Pave	$ -	$ -	$ 1.60	$ -	$ -	$ 141,608	
115	2138	Crack Seal	$ -	$ -	$ 0.07	$ -	$ -	$ 5,900	
120	2143	Replace Bridge	$ -	$ -	$ -	$ -	$ -	$ -	

Notes:
1. Data to be entered in each year for BCA.
2. Cost per year times summation of residual value years.

Analysis Year	Calendar Year	Preservation Tasks	Rehabilitation Tasks	Maintenance Tasks	Annual Maintenance	Yearly Summation (BCA Input)[1]
1	2020					$ -
2	2021					$ -
3	2022					$ -
4	2023				$ 8,851	$ (8,851)
5	2024				$ 8,851	$ (8,851)
6	2025				$ 8,851	$ (8,851)
7	2026				$ 8,851	$ (8,851)
8	2027				$ 8,851	$ (8,851)
9	2028			$ 5,900	$ 8,851	$ (14,751)
10	2029				$ 8,851	$ (8,851)
11	2030				$ 8,851	$ (8,851)
12	2031				$ 8,851	$ (8,851)
13	2032				$ 8,851	$ (8,851)
14	2033			$ 141,608	$ 8,851	$ (150,459)
15	2034				$ 8,851	$ (8,851)
16	2035				$ 8,851	$ (8,851)
17	2036				$ 8,851	$ (8,851)
18	2037				$ 8,851	$ (8,851)
19	2038			$ 5,900	$ 8,851	$ (14,751)
20	2039				$ 8,851	$ (8,851)
21	2040				$ 8,851	$ (8,851)
22	2041				$ 8,851	$ (8,851)
23	2042				$ 8,851	$ (8,851)
24	2043	$ 4,425,250			$ 8,851	$ (4,434,101)
25	2044				$ 8,851	$ (8,851)
26	2045				$ 8,851	$ (8,851)
27	2046				$ 8,851	$ (8,851)
28	2047				$ 8,851	$ (8,851)
29	2048			$ 5,900	$ 8,851	$ (14,751)
30	2049				$ 8,851	$ (8,851)

Notes:

1. These values are negative since these are disbenefits for the proposed project.

$ (4,510,805) 0

Appendix E10

Proposed Project Residual Value Calculations

Hoyle, Tanner & Associates, Inc.
150 Dow Street
Manchester, NH 03101

Hoyle, Tanner Project No. 092590.13
Hinsdale, NH - Brattleboro, VT
NH Route 119 Over the Connecticut River
NHDOT Project No. 12210C
Residual Value Calculations

Sheet: ________ Of: ________
Calc By: JCR Date: 6/2018
Chck By: MJL Date: 7/2018
Rev By: ________ Date: ________
Chck By: ________ Date: ________

$$RV = \left(\frac{U - Y}{U}\right) x\ Project\ Cost$$

$$= \left(\frac{40 - 30}{40}\right) x\ \$40{,}000{,}000$$

$$= \$10{,}000{,}000$$

Where RV = Residual Value
U = Useful Service Life of Project
Y = Years of Analysis Period Project Operation

Useful Service Life (U):	120 years
Begin Analysis Year:	2020
End Analysis Year:	2049
Bridge Opening Year:	2023
Bridge Age At End of Analysis (Y):	26 years
Project Cost[1]:	$ 42,000,000
Residual Value[2]:	$ 32,900,000

Notes:

1. Only includes construction cost of the proposed bridge and roadway. The rehabilitated trusses used for pedestrian/bicycle use in the proposed project are assumed to have no residual value.
2. At the end of BCA analysis (2049). Discounting is applied in the BCA spreadsheet.
4. All monetary values are in real dollars.

Appendix E11

Repurposed Truss Bridge O&M Costs

Hoyle, Tanner & Associates, Inc.

150 Dow Street
Manchester, New Hampshire 03101

HTA PROJECT NO. 092590 **SHEET** **OF**
PROJECT DESCRIPTION NHDOT Hinsdale, NH - Brattleboro, VT
TASK Long Term Operation/Maintenance Costs
CALCULATED BY: JCR **DATE:** 06/18/2018
CHECKED BY: MJL **DATE:** 7/2018

K:\092590_13\4-Design\Reports\BCA\BCA Appendices\[Appendix E11_Repurposed Truss Bridge O&M Costs.xlsx]O&M Schedule

BRIDGE REHABILITATION/REPLACEMENT COST BENEFIT ANALYSIS

Repurposed Trusses for Use as Pedestrian Bridges Long-Term Operation and Maintenance Cost

Notes and Assumptions:

1. Maintenance costs are based on a 30 year analysis period.	N=	30	years
2. NHDOT Roadway Tier Multiplier:	M=	1	(Not Used for Pedestrian Bridge)
3. Costs are in 2017 dollars.	I=	0%	
4. Bridge curb-to-curb width	TW=	20.3	ft
5. Br. No. 041/040 (West) Length	L=	339	ft
6. Br. No. 042/044 (East) Length	L=	297	ft
7. Sidewalk width	SW=	0	(Not Used for Pedestrian Bridge)

8. The maintenance activities are the same as the baseline truss O&M from the "Baseline O&M Costs.xlsx" file. Some item intervals are increased or item costs are decreased due to an anticipated slower rate of deterioration.

9. Truss rehabilitation is assumed to take place in 2023. Therefore, long term maintenance will begin in 2024.

Truss Bridge Maintenance and Preservation

Item	Frequency (years)	Item Cost	Lane Closure Duration	Notes:
Wash Trusses & Deck, General Maintenance & Oil	2	$30,000	NA	Cost information provided by NHDOT is $15000 per bridge.
In-depth/FCM Bridge Inspection performed by Consultant	10	$45,000	NA	Based on recent similar project scopes
Crack Sealing	5	$1,000	NA	1 day operation per lane. Use $0.07/SF cost from NHDOT
Pave	20	$21,000	NA	1 day operation to mill, 1 day to pave. Use $1.60/SF cost from NHDOT
Sidewalk Timber Deck Replacement	NA	$0	NA	Sidewalk will not be used.
Expansion joint strip seal replacement & modular joint repairs	10	$5,000	NA	Assumes strip seal can be replaced in one day while modular joint repairs would be on a second day. Costs are $2500 per day for crew time and materials
Structural steel repairs, paint touch up, concrete deck repairs, membrane, expansion joint replacement	20	$1,300,000	NA	Estimate 4 month duration to perform this work. Use $100/SF. $200 was used for the baseline O&M.
Substructure Repairs	20	$25,000	NA	Assume a 5 day work period. Costs are $5000 per day for crew time and materials.
Deck Replacement	50	$0	NA	Deck replacement would occur in a year beyond the analysis period.

Analysis Year	Calendar Year	Preservation Tasks	Rehabilitation Tasks[2]	Maintenance Tasks	Biennial Maintenance	Yearly Summation (BCA Input)[1]
1	2020					$ -
2	2021					$ -
3	2022					$ -
4	2023					$ -
5	2024				$ 30,000	$ 30,000
6	2025					$ -
7	2026				$ 30,000	$ 30,000
8	2027					$ -
9	2028			$ 1,000	$ 30,000	$ 31,000
10	2029					$ -
11	2030				$ 30,000	$ 30,000
12	2031					$ -
13	2032				$ 30,000	$ 30,000
14	2033	$ 5,000		$ 46,000		$ 51,000
15	2034				$ 30,000	$ 30,000
16	2035					$ -
17	2036				$ 30,000	$ 30,000
18	2037					$ -
19	2038			$ 1,000	$ 30,000	$ 31,000
20	2039					$ -
21	2040				$ 30,000	$ 30,000
22	2041					$ -
23	2042				$ 30,000	$ 30,000
24	2043	$ 1,330,000		$ 67,000		$ 1,397,000
25	2044				$ 30,000	$ 30,000
26	2045					$ -
27	2046				$ 30,000	$ 30,000
28	2047					$ -
29	2048			$ 1,000	$ 30,000	$ 31,000
30	2049					$ -

Notes:

1. These values are disbenefits for the proposed project.
2. These costs are included in the Capital Expenditures. Reference "Proposed Project Capital Expenditures.xlsx" in Appendix E7.

Appendix F

Bridge Inspection Reports

New Hampshire Department of Transportation

Bridge Inspection Report

☑ NBI ☑ Element ☑ FC ☐ U/W ☐ Special

Existing Bridge Section
Bureau of Bridge Design
Hinsdale 041/040

Date of Inspection: 06/21/2016
Date Report Sent: 9/15/2016
☑ Picture taken during inspection
Owner: NHDOT
Bridge also in: Brattleboro , Vermont

NH119
Over
CONNECTICUT RIVER
Anna Hunt Marsh Bridge

Recommended Postings:

Weight: E2

Width: Not Required
Narrow bridge sign @ NH end only.

Primary Height Sign Recommendation: **11`-04"**
Optional Centerline Height Sign Rec: **15`-00"**

Clearances: (Feet) Over: 11.55
Under: 0.00
Route: 15.26

☑ Weight Sign OK
☑ Width Sign OK
☑ Height Signs OK

Condition: Not on the Redlist
Deck: 7 Good
Superstructure: 5 Fair
Substructure: 6 Satisfactory
Culvert: N N/A (NBI)

Structure Type and Materials:

Number of Spans Main Unit: 1
Number of Approach Spans: 0

Main Span Material and Design Type
Steel Through Truss

Sufficiency Rating: 43.8%
NBI Status: Functionally Obsolete

Bridge Rail: Substandard
Rail Transition: Substandard
Bridge Approach Rail: Meets Standards
Approach Rail Ends: Substandard

NH Bridge Type: High Truss
Deck Type: Concrete Precast Panel
Wearing Surface: None
Membrane: None
Deck Protection: None
Pavement thickness: Not Applicable
Curb Reveal: Not Applicable
Plan Location: A-56;1-3-3-3

Bridge Dimensions:

Length Maximum Span: 324.0 ft
Left Curb/Sidewalk Width: 6.0 ft
Width Curb to Curb: 20.3 ft
Approach Roadway Width (W/ Shoulders): 34.0 ft

Total Bridge Length: 339.0 ft
Right Curb/Sidewalk Width: 0.0 ft
Total Bridge Width: 23.1 ft
Median: No median
Bridge Skew: 0.00 °

Bridge Service:

Type of Service on Bridge: Highway and Pedestrian
Type of Service under: Waterway
Lanes on bridge: 2
Lanes Under: NA

Year Built: 1920
Year Rebuilt: 1988
Detour Length: 15.0 mi

AADT: 8100
Future AADT: 11988
Percent Trucks: 4 %
Year of AADT: 2013
Year of Future AADT: 2035

Federal or State Definition Bridge: Fed. Definition Bridge
Roadway Functional Class: Urban Collector
New Hampshire Highway System and Class: Secondary-DOT Maintained
Eligibility for the National Register of Historic Places: Eligible (Historic)
Traffic Direction: Two-way traffic

National Bridge Inventory (NBI) Appraisal Ratings:

Deck Geometry: Intolerable, Replacement
Underclearances: Not Applicable (NBI)
Approach Alignment: Minimum Tolerable
Structural Evaluation: Above Min. Tolerable
Channel/Channel Protection: Minor Damage
Waterway Adequacy: Equal Desirable Criteria
Bridge Scour Critical Status: Stable for extreme flood
Riprap Condition: Fair Condition
Debris Present: No Debris Present

MINOR SCOUR. SAND, SILT, AND COBBLE BOTTOM.

Date of Underwater Inspection: Jul. 2015

AASHTO CoRe Element Condition State Data:

No.	Description	Env.	Material Notes and Condition Notes
52	Concrete Slab - Protected with Coated Bars	Severe	*PRECAST CONC. SLABS WITH GROUTED SHEAR KEYS. 3.75" AT EDGES TO 5.75" AT MID. 5KSI CONC. W/ 80KSI EPOXY COATED W.W.F.* *SEVERAL FINE CRACKS IN WEARING SURFACE. FINE CRACKS ON SOFFIT.*
107	Painted Steel Beam or Girder (Open Web)	Moderate	*W18x35 STRINGERS COMPOSITE WITH PRECAST DECK PANELS.* *RUSTED WITH AREAS OF MINOR SECTION LOSS. EXTERIOR STRINGERS HAVE MODERATE RUST AND SCALE. TOP AND BOTTOM FLANGES RUSTED WITH UP TO 1/8" SECTION LOSS AT EXTERIORS. DRILLED HOLES IN TOP FLANGES. SOME FLAME GOUGES*
121	Painted Steel Bottom Chord (Thru Truss)	Severe	*AREAS OF HEAVY RUST WITH LIGHT SECTION LOSS. PACK RUST BETWEEN PLATES AND ANGLES IN MANY AREAS. CROSS BRACE ANGLES HOLED IN AREAS. LOWER LATERAL BRACING WELDS BROKEN AT MIDDLE OF SECOND BAY FROM EAST. SMALL HOLES IN ANGLE LATERAL BRACING AT MIDSPAN.*
126	Painted Steel Thru Truss (Exclude Bottom Chord)	Moderate	*LATTICE RUSTED AND HOLED AT NORTHWEST. MINOR DAMAGE TO DIAGONALS.*
152	Painted Steel Floor Beam	Moderate	*RUSTED AT TOP AND BOTTOM FLANGES UNDER LEAKAGE. RUST AND SCALE AT EXTERIOR ENDS. CROSS BRACING MOUNTING PLATE HEAVILY RUSTED, SCALING AND SECTION LOSS. SEVERAL HOLED.*

No.	Description	Env.	Material Notes and Condition Notes
217	Other Material Abutment	Moderate	*SUBMERGED PORTION OF THE ABUTMENTS (CONCRETE & MASONRY) ARE IN GENERALLY SATISFACTORY CONDITION. MINOR DEFECTS INCLUDE 1/4" CRACKS WITH RUST STAINING ON THE EAST ABUTMENT AND ISOLATED AREAS OF MORTAR LOSS IN THE WEST ABUTMENT. SHEET PILE EXPOSED IN FRONT OF THE EAST ABUTMENT. SPALLED AT SOUTH EAST CORNER, NO REBAR EXPOSED. BACKWALL SPALLED AT NORTHEAST.*
300	Strip Seal Expansion Joint	Severe	*STRIP SEAL AT EAST ABUTMENT EXPANSION JOINT WITH STEEL ARMOR PROTECTION.*
301	Pourable Joint Seal (Includes Asphaltic Plug)	Severe	*2" POURABLE SILICONE JOINT SEAL AT WEST ABUTMENT.* *JOINT HOLED AT WEST, PATCHED.*
311	Moveable Bearing (roller, sliding, etc.)	Severe	*NESTED ROLLER BEARINGS WITH TRUSS PIN AT EAST ABUTMENT* *BOTTOM PLATES HOLED AT NORTHEAST ROLLER BEARING, REPAIRED AND PAINTED. PLATES BETWEEN ROLLER BEARING PIN AND TOP CHORD END DIAGONAL RUSTED WITH HEAVY SECTION LOSS AT NORTHEAST, CLEANED AND PAINTED. MODERATE RUST AT BEARINGS.*
313	Fixed Bearing	Moderate	*FIXED PIN BEARINGS AT WEST ABUTMENT* *MODERATE RUST AND SCALE AT INTERIORS.*
334	Coated Metal Bridge Railing	Low	*** W-Beam on Box ** GALVANIZED* *RAIL TRANSITION DAMAGE AT SOUTHWEST, SOUTHEAST, NORTHEAST AND APPROACH RAIL DAMAGE AT NORTHEAST AND SOUTHWEST. TOP PIPE HAND RAIL BROKEN AT MIDSPAN.*
357	Pack Rust Condition Warning Flag	Moderate	*LOWER CHORD AND LATERAL BRACING CONNECTION PLATES AFFECTED.*
363	Section Loss Condition Warning Flag	Moderate	*Element record added 2014-08-14.* *EXTERIOR STRINGERS HAVE UP TO 30% LOSS AT BOTTOM FLANGES. LATERAL CROSS BRACING CONNECTION PLATES HEAVILY RUSTED, KNIFE EDGED AND SEVERAL HOLED. ANCHOR BOLT NUTS RUSTED OFF AT WEST BEARING INTERIORS.*

No.	Description	Env.	Quantity	Units	State 1	State 2	State 3	State 4	State 5
52	Concrete Slab - Protected with Coated	Severe	7,115	(SF)	100 %	0 %	0 %	0 %	0 %
107	Painted Steel Beam or Girder (Open W	Moderate	3,730	(LF)	20 %	50 %	20 %	10 %	0 %
121	Painted Steel Bottom Chord (Thru Truss	Severe	660	(LF)	0 %	70 %	27 %	3 %	0 %
126	Painted Steel Thru Truss (Exclude Botto	Moderate	660	(LF)	0 %	89 %	10 %	1 %	0 %
152	Painted Steel Floor Beam	Moderate	358	(LF)	0 %	80 %	20 %	0 %	0 %
217	Other Material Abutment	Moderate	43	(LF)	0 %	100 %	0 %	0 %	
300	Strip Seal Expansion Joint	Severe	21	(LF)	50 %	50 %	0 %		
301	Pourable Joint Seal (Includes Asphaltic	Severe	21	(LF)	100 %	0 %	0 %		
311	Moveable Bearing (roller, sliding, etc.)	Severe	2	(EA)	0 %	50 %	50 %		
313	Fixed Bearing	Moderate	2	(EA)	0 %	100 %	0 %		
334	Coated Metal Bridge Railing	Low	2,228	(LF)	0 %	100 %	0 %	0 %	0 %
357	Pack Rust Condition Warning Flag	Moderate	1	(EA)	0 %	100 %	0 %	0 %	
363	Section Loss Condition Warning Flag	Moderate	1	(EA)	0 %	100 %	0 %	0 %	

New Hampshire Department of Transportation

Bridge Inspection Report

☑ NBI ☑ Element ☑ FC ☐ U/W ☐ Special

Existing Bridge Section
Bureau of Bridge Design

Hinsdale 041/040

Bridge Notes:

Anna Hunt Marsh Bridge.
STATE OF NEW HAMPSHIRE
In the Year of Our Lord Two Thousand Ten
AN ACT naming a bridge across the Connecticut River from Hinsdale, New Hampshire to Brattleboro, Vermont, informally known as the Hinsdale Bridge, the Anna Hunt Marsh Bridge.
Be it Enacted by the Senate and House of Representatives in General Court convened:
281:1 Town of Hinsdale; Bridge Named. Pursuant to RSA 4:43, the larger or western Pennsylvania truss bridge built in 1920, informally known as the Hinsdale Bridge, that spans the Connecticut River from Hinsdale, New Hampshire to Brattleboro, Vermont on Route 119, bridge number 041/040, shall be named the Anna Hunt Marsh Bridge.
281:2 Signage. The cost of design, construction, maintenance, and installation of any signage, replacement signage, or other markers required under section 1 of this act shall not be a charge to the state. However, the design, construction, and installation of any signage or other markers required under this act shall be approved by the department of transportation.
281:3 Effective Date. This act shall take effect 60 days after its passage.
Approved: July 8, 2010
Effective Date: September 6, 2010

SPIDER STAGING USED THESE DATES 11/27/01, 11/22/04, April 9,10,11,14,15/2008, 03/25/13, 8/14/14.
UNDERWATER INSPECTION 7/19/2010, 7/29/2015.

Inspection Notes: 06/21/2016
MTC inspection comments -
SPIDER INSPECTION DONE 6/21/2016.
SIDEWALK RAIL BROKEN AT MIDSPAN.
DECK: PRECAST CONCRETE SLABS WITH GROUTED SHEAR KEY JOINTS- SEVERAL FINE CRACKS. FINE CRACKS AT SOFFIT.
SUPERSTRUCTURE- PAINT CURLING, CHIPPING AND LIGHT SURFACE RUST THROUGHOUT. STRINGERS; TOP AND BOTTOM FLANGES RUSTED WITH UP TO 1/8" SECTION LOSS ON EXTERIOR STRINGERS. DRILLED HOLES IN TOP FLANGES. SOME FLAME GOUGES. BOTTOM CHORDS- AREAS OF HEAVY RUST WITH LIGHT SECTION LOSS. PACK RUST BETWEEN PLATES AND ANGLES IN MANY AREAS. LOWER LATERAL BRACING ANGLES HOLED IN AREAS. CONNECTION PLATES HEAVILY RUSTED, SEVERAL HOLED. SOUTHWEST ROLLER BEARING HEAVY RUST
SUBSTRUCTURE- MEDIUM SPALL AT SOUTHEAST BRIDGESEAT. SPALL UNDER STRINGER ONE AT SOUTHWEST, ANCHOR BOLT EXPOSED. MINOR SPALLS AT BACKWALL NORTHEAST.

PICTURES: B561 27 THRU 34, SEE PIC LIST FOR DESCRIPTIONS.

Approach and Roadway Notes: *W-BEAM AND POST DAMAGED AT BOTH ENDS. WORN IN WHEEL PATHS ALONG APPROACHES.*

Inspection History:

Inspection Date	Inspector	Major Element Condition Ratings
06/21/2016	MTC	**Deck:** 7 **Super:** 5 **Substr:** 6 **Culvert:** N
07/29/2015	JEL	**Deck:** 7 **Super:** 5 **Substr:** 6 **Culvert:** N
08/14/2014	MHC	**Deck:** 7 **Super:** 5 **Substr:** 6 **Culvert:** N
03/25/2013	MTC	**Deck:** 7 **Super:** 5 **Substr:** 6 **Culvert:** N
06/19/2012	MTC	**Deck:** 7 **Super:** 6 **Substr:** 6 **Culvert:** N
09/09/2011	MTC	**Deck:** 7 **Super:** 6 **Substr:** 6 **Culvert:** N
12/01/2010	DEP	**Deck:** 7 **Super:** 6 **Substr:** 6 **Culvert:** N
07/19/2010	DMB	**Deck:** 7 **Super:** 6 **Substr:** 6 **Culvert:** N
06/30/2010	MTC	**Deck:** 7 **Super:** 6 **Substr:** 6 **Culvert:** N
04/16/2008	JEL	**Deck:** 7 **Super:** 6 **Substr:** 6 **Culvert:** N
10/16/2006	JEL	**Deck:** 8 **Super:** 6 **Substr:** 6 **Culvert:** N
11/22/2004	JEL	**Deck:** 8 **Super:** 6 **Substr:** 6 **Culvert:** N
11/27/2001	FNM	**Deck:** 5 **Super:** 6 **Substr:** 7 **Culvert:** N
04/21/1999	RLM	**Deck:** 5 **Super:** 6 **Substr:** 7 **Culvert:** N

Inspection History:

Inspection Date	Inspector	Major Element Condition Ratings
11/05/1998	RLM	**Deck:** 5 **Super:** 6 **Substr:** 7 **Culvert:** N
07/01/1997	Not Available	**Deck:** 6 **Super:** 6 **Substr:** 7 **Culvert:** N
09/01/1995	Not Available	**Deck:** 6 **Super:** 6 **Substr:** 7 **Culvert:** N
11/01/1993	Not Available	**Deck:** 6 **Super:** 6 **Substr:** 7 **Culvert:** N
07/01/1992	Not Available	**Deck:** 6 **Super:** 7 **Substr:** 7 **Culvert:** N

Copy Distribution:

- ☐ (2) Bureau of Municipal Hghways
- ☐ (3) Bureau of Municipal Hghways
- ☐ Bureau of Turnpikes
- ☑ Border State
- ☐ Bureau of Rail and Transit
- ☐ Army Corps Of Engineers
- ☐ Railroad
- ☐ Dept. of Res. and Econ. Dev.
- ☐ Dept. of Environmental Services
- ☐ USDA Forest Service
- ☐ Bureau of Traffic

New Hampshire Department of Transportation

Bridge Inspection Report

☑ NBI ☑ Element ☑ FC ☐ U/W ☐ Special

Existing Bridge Section
Bureau of Bridge Design

Hinsdale 042/044

Date of Inspection: 09/27/2016
Date Report Sent: 11/14/2016
☑ Picture taken during inspection
Owner: NHDOT

NH119
Over
CONNECTICUT RIVER
Charles Dana Bridge

Recommended Postings:

Weight: E2

☑ Weight Sign OK

Width: Not Required
NARROW BRIDGE SIGNS IN PLACE

☑ Width Sign OK

Primary Height Sign Recommendation: **11`-10"**
Optional Centerline Height Sign Rec: **14`-10"**

Clearances: (Feet)
Over: 12.14
Under: 0.00
Route: 15.09

☑ Height Signs OK

Condition: Not on the Redlist
Deck: 7 Good
Superstructure: 5 Fair
Substructure: 5 Fair
Culvert: N N/A (NBI)

Sufficiency Rating: 47%
NBI Status: Functionally Obsolete

Bridge Rail: Meets Standards
Rail Transition: Substandard
Bridge Approach Rail: Meets Standards
Approach Rail Ends: Substandard

Structure Type and Materials:
Number of Spans Main Unit: 1
Number of Approach Spans: 2

Main Span Material and Design Type
Steel Through Truss

Approach Span Material and Design Type
Steel Girder and Floorbeam

NH Bridge Type: High Truss
Deck Type: Concrete Precast Panel
Wearing Surface: None
Membrane: None
Deck Protection: Unknown
Pavement thickness: Not Applicable
Curb Reveal: Not Applicable
Plan Location: 1-3-3-3

Bridge Dimensions:
Length Maximum Span: 200.0 ft
Left Curb/Sidewalk Width: 7.2 ft
Width Curb to Curb: 20.3 ft
Approach Roadway Width (W/ Shoulders): 34.0 ft

Total Bridge Length: 297.0 ft
Right Curb/Sidewalk Width: 0.0 ft
Total Bridge Width: 21.0 ft
Median: No median
Bridge Skew: 0.00 °

Bridge Service:
Type of Service on Bridge: Highway
Type of Service under: Waterway
Lanes on bridge: 2
Lanes Under: NA

Year Built: 1920
Year Rebuilt: 1988
Detour Length: 16.0 mi

AADT: 8100
Percent Trucks: 4 %
Year of AADT: 2013
Future AADT: 11988
Year of Future AADT: 2035

Federal or State Definition Bridge: Fed. Definition Bridge
Roadway Functional Class: Urban Collector
New Hampshire Highway System and Class: Secondary-DOT Maintained
Eligibility for the National Register of Historic Places: Possibly eligible
Traffic Direction: Two-way traffic

National Bridge Inventory (NBI) Appraisal Ratings:

Deck Geometry: Intolerable, Replacement
Underclearances: Not Applicable (NBI)
Approach Alignment: Equal Minimum Criteria
Structural Evaluation: Above Min. Tolerable
Channel/Channel Protection: Bank Slumping
Waterway Adequacy: Equal Desirable Criteria
Bridge Scour Critical Status: Countermeasures in place
Riprap Condition: Good Condition
Debris Present: No Debris Present

TIMBER CRIB EXPOSED UNDER P#2. PART OF P#1 CONCRETE FOOTING EXPOSED ALSO. SAND & COBBLE BOTTOM.

Date of Underwater Inspection: Jul. 2015

AASHTO CoRe Element Condition State Data:

No.	Description	Env.	Material Notes and Condition Notes
31	Timber Deck - Bare	Severe	*SIDEWALK, TIMBER PLANKS.* *SIDEWALK- FEW SCREWS LIFTED, FEW LOOSE PLANKS.*
52	Concrete Slab - Protected with Coated Bars	Severe	*PRECAST CONCRETE SLABS WITH NON-SHRINK GROUTED JOINTS - SEVERAL FINE CRACKS, FEW GASKETS PROTRUDING. WEARING SURFACE POTHOLED AT EAST END OF EASTBOUND LANE.*
107	Painted Steel Beam or Girder (Open Web)	Severe	*EXTERIOR BEAM TOP AND BOTTOM FLANGES HAVE HEAVY RUST, LIGHT SECTION LOSS IN AREAS. PAINT PEELING IN AREAS.*
121	Painted Steel Bottom Chord (Thru Truss)	Severe	*HEAVY PACK RUST IN LOWER INTERIOR CHORD PLATES. LIGHT SECTION LOSS OVERALL. HEAVY SECTION LOSS ON BATTEN PLATES IN MIDDLE TWO THIRDS OF BRIDGE. LIGHT SECTION LOSS ON SEVERAL RIVET HEADS. SPLICE COVER PLATE HAS HOLED AT FLOORBEAM # 6. FEW WITH HEAVY LOSS. SMALL HOLE IN GUSSET PLATE AT BEARING # 1, PIER #2 AND BEARING # 2 PIER # 1.*
126	Painted Steel Thru Truss (Exclude Bottom Chord)	Severe	*LATTICE WORK RUSTED OFF AT NORTHWEST AND SOUTHEAST. MINOR IMPACT DAMAGE. PAINT PEELING, AREAS OF LIGHT SURFACE RUST.*

No.	Description	Env.	Material Notes and Condition Notes
152	Painted Steel Floor Beam	Severe	*RUSTED AT ENDS WITH AREAS OF MODERATE SCALE AND LIGHT SECTION LOSS UNDER LEAKAGE. MINOR RUST AND SCALE AT TOP AND BOTTOM FLANGES. PAINT PEELING IN AREAS. HEAVY RUST AND SECTION LOSS AT SEVERAL CROSS BRACING CONNECTION PLATES MOUNTED AT FLOORBEAMS.*
210	Reinforced Concrete Pier Wall	Severe	*TWO CONCRETE PIERS.* *THE SUBMERGED PORTIONS OF THE PIERS ARE IN POOR CONDITION WITH SPALLS, EXPOSED REBAR, AND EROSION OF THE CONCRETE. TIMBER CRIBBING UNDER PIER # 2 EXPOSED. MINOR SPALL AT EAST SIDE PIER # 2. LARGE SPALL WITH REBAR EXPOSED, WEST SIDE OF COLUMN #1, PIER #2. SPALL AT WATERLINE OF PIER # 1, WEST SIDE. SPALLS UNDER BEARING #1, PIER #1.*
215	Reinforced Concrete Abutment	Severe	*LIGHT SPALL AT SOUTHWEST BRIDGE SEAT AT BEARING. LIGHT CRACKS, MINOR SPALLS OVERALL.*
303	Modular Joint and Seal Assembly	Severe	*DEBRIS FILLED, SEAL FAILING AT JOINT # 3. SEAL HOLED AT JOINT # 4 AT SOUTH.*
311	Moveable Bearing (roller, sliding, etc.)	Severe	*HEAVY RUST BUILD-UP AT PIER BEARINGS. SMALL HOLE IN GUSSET PLATE AT BEARING # 2, PIER # 1 AND BEARING # 1, PIER # 2. BEARING SPACING PLATE HOLED AT BEARING # 1, PIER # 2. BEARING BOLTS EXPOSED AND RUSTED WITH SECTION LOSS AT BEARING #1, PIER #1.*
313	Fixed Bearing	Severe	*RUSTED UNDER LEAKAGE.*
334	Coated Metal Bridge Railing	Low	*** W-Beam *** *MINOR DAMAGE, LIGHT SURFACE RUST IN AREAS.*
357	Pack Rust Condition Warning Flag	Severe	*Element record added 2013-04-30.* *PACK RUST IN LOWER CHORD HAS CAUSED MINOR DISTORTION OF THE BUILT-UP COMPONENTS.*
363	Section Loss Condition Warning Flag	Severe	*AREAS OF MINOR TO MODERATE LOSS, UP TO 1/8", AT STRINGERS, FLOORBEAMS AND LOWER CHORDS. 5/8" REMAINING AT BOTTOM FLANGES OF SEVERAL FLOORBEAMS. SMALL HOLE IN GUSSET PLATE AND BEARING SPACER PLATE AT BEARING # 1, PIER # 2. AREAS OF MODERATE, 1/8", LOSS IN LOWER LATERAL BRACING AND CONNECTOR PLATES. CONNECTOR PLATE AND LOWER LATERAL BRACE AT SOUTH END OF FLOORBEAM # 5 HOLED.*

No.	Description	Env.	Quantity	Units	State 1	State 2	State 3	State 4	State 5
31	Timber Deck - Bare	Severe	2,142	(SF)	100 %	0 %	0 %	0 %	
52	Concrete Slab - Protected with Coated E	Severe	6,232	(SF)	0 %	100 %	0 %	0 %	0 %
107	Painted Steel Beam or Girder (Open We	Severe	1,066	(LF)	0 %	43 %	30 %	27 %	0 %
121	Painted Steel Bottom Chord (Thru Truss	Severe	299	(LF)	0 %	55 %	15 %	30 %	0 %
126	Painted Steel Thru Truss (Exclude Botto	Severe	299	(LF)	30 %	50 %	15 %	5 %	0 %
152	Painted Steel Floor Beam	Severe	230	(LF)	0 %	55 %	30 %	15 %	0 %
210	Reinforced Concrete Pier Wall	Severe	171	(LF)	0 %	80 %	20 %	0 %	
215	Reinforced Concrete Abutment	Severe	69	(LF)	0 %	100 %	0 %	0 %	
303	Modular Joint and Seal Assembly	Severe	43	(LF)	40 %	60 %	0 %		

No.	Description	Env.	Quantity	Units	State 1	State 2	State 3	State 4	State 5
311	Moveable Bearing (roller, sliding, etc.)	Severe	24	(EA)	74 %	25 %	1 %		
313	Fixed Bearing	Severe	24	(EA)	40 %	40 %	20 %		
334	Coated Metal Bridge Railing	Low	594	(LF)	77 %	23 %	0 %	0 %	0 %
357	Pack Rust Condition Warning Flag	Severe	1	(EA)	0 %	100 %	0 %	0 %	
363	Section Loss Condition Warning Flag	Severe	1	(EA)	0 %	100 %	0 %	0 %	

Bridge Notes:
STATE OF NEW HAMPSHIRE
Charles Dana Bridge
In the Year of Our Lord Two Thousand Ten
AN ACT naming a bridge across the Connecticut River from Hinsdale, New Hampshire to Brattleboro, Vermont the Charles Dana Bridge and correcting the naming of a bridge across the Connecticut River in the town of Chesterfield, New Hampshire from the Judge Harlan Fiske Stone Bridge to the Justice Harlan Fiske Stone Bridge.
Be it Enacted by the Senate and House of Representatives in General Court convened:
280:1 Town of Hinsdale; Bridge Named. Pursuant to RSA 4:43, the smaller or eastern Parker truss bridge that spans the Connecticut River from Hinsdale, New Hampshire to Brattleboro, Vermont on Route 119, bridge number 042/044, shall be named the Charles Dana Bridge.
280:2 Town of Chesterfield; Bridge Named. Amend 2009, 108:1 to read as follows:
108:1 Town of Chesterfield; [Judge] Justice Harlan Fiske Stone Bridge. Pursuant to RSA 4:43, the old 1937 arch bridge over the Connecticut River, in the town of Chesterfield, New Hampshire, is hereby named the [Judge] Justice Harlan Stone Bridge.
280:3 Signage. The cost of design, construction, maintenance, and installation of any signage, replacement signage, or other markers required under sections 1 and 2 of this act shall not be a charge to the state. However, the design, construction, and installation of any signage or other markers required under this act shall be approved by the department of transportation.
280:4 Effective Date. This act shall take effect upon its passage.
Approved: July 8, 2010
Effective Date: July 8, 2010

SPIDER STAGING INSPECTION 4/17,18 /08; 4/30/2013; 8/18/2014, 9/27/2016 MONTH LATE BECAUSE OF EQUIPMENT AVAILABILITY.
UNDERWATER INSPECTION 7/19/2010, 7/29/2015.

Inspection Notes: 09/27/2016
MHC - inspection comments -
BRIDGE RAIL: AREAS OF DAMAGE AND LIGHT RUST.
DECK: WEARING SURFACE POTHOLED IN AREAS. JOINT SEALS DEBRIS FILLED AND DAMAGED. FINE CRACKS AT SOFFIT, FEW GASKETS PROTRUDING. TIMBER SIDEWALK HAS FEW LOOSE PLANKS.
SUPERSTRUCTURE: PAINT PEELING AT ALL STEEL COMPONENTS. RUST, PACK RUST, AND MINOR SECTION LOSS AT BOTTOM CHORDS. LIGHT TO MODERATE RUST WITH LIGHT SCALE AND AREAS OF MINOR SECTION LOSS AT FLOORBEAMS, STRINGERS, AND SECONDARY MEMBERS. PAINT PEELING AND LIGHT SURFACE RUST AT UPPER TRUSS MEMBERS. LATTICE WORK RUSTED OFF AT NORTHWEST AND SOUTHEAST. OLD OVERHEAD IMPACT DAMAGE. BEARINGS RUSTED, MODERATE TO HEAVY AT EXTERIORS WITH MINOR SECTION LOSS. SMALL HOLES IN GUSSET PLATES.
SUBSTRUCTURE: LIGHT CRACKS, MINOR SPALLS IN ABUTMENTS. SPALL UNDER BEARING AT PIER #1. LARGE SPALL WITH REBAR EXPOSED AT PIER #2.

PICTURES: B568
52. BOTTOM EDGE OF GUSSET PLATE AT FLOORBEAM # 2, SOUTH, RUSTED AND HOLED.
53. LATERAL BRACING CONNECTION PLATE HOLED AT SOUTH END OF FLOORBEAM # 5.
54. COVER PLATE HOLED AT LOWER CORD SPLICE, SOUTH END OF FLOORBEAM # 6.
55. GUSSET PLATE AND BEARING SPACER PLATE HOLED, BEARING # 1, PIER # 2.
56. PAINT PEELING, LIGHT SURFACE RUST AT UPPER CORD.
57. WEARING SURFACE POTHOLED AT EAST END OF EASTBOUND LANE.

Approach and Roadway Notes: *ASPHALT- FEW CRACKS.*
MINOR DAMAGE TO RAIL, FEW POST DAMAGED AND BROKEN.

Inspection History:

Inspection Date	Inspector	Major Element Condition Ratings
09/27/2016	MHC	Deck: 7 Super: 5 Substr: 5 Culvert: N

Inspection History:

Inspection Date	Inspector	Major Element Condition Ratings
07/29/2015	NBG	Deck: 7 Super: 5 Substr: 5 Culvert: N
08/18/2014	MTC	Deck: 7 Super: 5 Substr: 6 Culvert: N
04/30/2013	MHC	Deck: 7 Super: 5 Substr: 6 Culvert: N
03/25/2013	MTC	Deck: 7 Super: 5 Substr: 6 Culvert: N
06/19/2012	MHC	Deck: 7 Super: 5 Substr: 6 Culvert: N
12/01/2010	DEP	Deck: 7 Super: 5 Substr: 6 Culvert: N
07/19/2010	DMB	Deck: 7 Super: 5 Substr: 6 Culvert: N
06/30/2010	JEL	Deck: 7 Super: 5 Substr: 6 Culvert: N
04/18/2008	FNM	Deck: 7 Super: 5 Substr: 6 Culvert: N
10/16/2006	JEL	Deck: 8 Super: 6 Substr: 6 Culvert: N
11/23/2004	FNM	Deck: 8 Super: 6 Substr: 6 Culvert: N
11/26/2003	JEL	Deck: 8 Super: 6 Substr: 6 Culvert: N
11/26/2001	JEL	Deck: 5 Super: 6 Substr: 6 Culvert: N
04/20/1999	JEL	Deck: 5 Super: 6 Substr: 6 Culvert: N
07/01/1997	Not Available	Deck: 6 Super: 6 Substr: 6 Culvert: N
06/01/1995	Not Available	Deck: 6 Super: 7 Substr: 6 Culvert: N
11/01/1993	Not Available	Deck: 6 Super: 7 Substr: 6 Culvert: N
07/01/1992	Not Available	Deck: 6 Super: 7 Substr: 6 Culvert: N

Copy Distribution:

- ☐ (2) Bureau of Municipal Hghways
- ☐ (3) Bureau of Municipal Hghways
- ☐ Bureau of Turnpikes
- ☐ Border State
- ☐ Bureau of Rail and Transit
- ☐ Army Corps Of Engineers
- ☐ Railroad
- ☐ Dept. of Res. and Econ. Dev.
- ☐ Dept. of Environmental Services
- ☐ USDA Forest Service
- ☐ Bureau of Traffic