Best Practices and Lessons Learned on the Preservation and Rehabilitation of Historic Bridges

Prepared for:
American Association of State Highway
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Executive Summary

Building upon previous National Cooperative Highway Research Program (NCHRP) studies, the American Association of State Highway and Transportation Officials (AASHTO) requested that the current report, *Best Practices and Lessons Learned on the Preservation and Rehabilitation of Historic Bridges*, be written to offer insight into successful measures implemented by transportation agencies. State Department of Transportation (DOT) staff members routinely encounter historic bridge-related projects and make critical decisions that ultimately determine if these bridges will be preserved, restored, rehabilitated, or replaced. Input by State Historic Preservation Offices (SHPO) and other stakeholders contribute to these decisions. In some states, established processes result in informed decisions that all groups understand and can support, regardless of outcome. In other cases, where states lack good communications, systems, and protocols, these same groups with disparate goals are much less likely to reach consensus or compromise.

The best practices discussed in this report represent a broad variety of approaches developed to preserve and rehabilitate many historic bridge types. These approaches address all phases of work, including project planning, design and mitigation, as well as preemptive measures to preserve historic bridges before any project is even considered. All of the measures discussed require an increased awareness on behalf of transportation agencies, SHPOs, and preservation advocacy groups. This awareness can be manifested in many forms. Bridge inventory surveys, establishing relationships with stakeholders, and education and training are just a few of the efforts that should be undertaken prior to project initiation, when it may already be too late to preserve the structure in question. Identifying historic bridges, particularly those that are unique or rare, and their character-defining features can help agencies allocate funding and promote agency policies that are able to facilitate preservation, rehabilitation, and even replacement, in a manner that effectively preserves this visible part of our engineering heritage. Learning about possibilities and fostering a collaborative approach can be critical to project success when needs arise, and may prove particularly useful when fast-tracked or high-profile bridge projects emerge.

Involving cultural resources staff and considering potential adverse effects from the earliest stages of project planning also promotes more balanced decisions. While early planning does not always mean that bridge preservation will prevail, it can help all parties better understand each other, even if the ideal outcome cannot be reached. Financial implications are a factor in many projects and an issue that requires particular consideration given current transportation funding concerns nationwide. However, many best practices presented in this report are the result of identifying solid community values and a willingness to consider the full range of options before deciding that replacement of an historic bridge is the only viable project option. Likewise, commitments to productive compromise and respectful working relationships among stakeholders were found to be critical.

As the research team explored current practices and compared them to best practices, they found that successful initiatives need be neither complex nor expensive. The team also found that many practices could easily be implemented across other states and municipalities. In many instances, engineers,

cultural resources professionals, and preservation advocacy staff independently expressed a desire to abandon an "all or none" approach. Indeed, understanding character-defining features allows for appropriate compromises in preservation and rehabilitation. And, interviewees unilaterally agreed that supporting a sound rehabilitation project that respected a bridge's historic character was preferable to accepting replacement, even if a project could not support a meticulous restoration-in-kind. This willingness to integrate compromises into projects can ultimately result in fewer bridge replacements.

Common Areas of Practice

Based on the literature search and responses to the interview questions posed as a part of this study, the research team identified a number of common areas of practice that drive successful outcomes. These include 1) Program Management, 2) Project Management, 3) Dealing with Risk, 4) Partnering, 5) Education, and 6) Local Agency Assistance.

Program Management

Program management for historic bridges covers practices that apply to historic bridges as a group, including their inventory and evaluation, and the development of action plans. This includes their management as part of the highway system, as part of the bridge program, as part of the cultural resources program, or as a jointly managed set of special assets. These aspects are further broken down and individual program highlights flagged below:

Asset or Resource Management with Programmatic Agreements

This encompasses management of historic bridges through an asset management program, or through a resource management program, including formal programs such as a Programmatic Agreement (PA). Ohio has a well-developed PA which includes an appendix of approved projects. Vermont DOT has been delegated responsibilities from its SHPO on the strength of its PA. Minnesota's PA features "premier" example bridges which are accorded a higher degree of preservation effort. Oregon uses a similar approach and Indiana categorizes historic bridges as "select" and "non-select". TxDOT also has a highly developed PA which includes funding for Texas Historical Commission work.

System-wide Historic Bridge Plans

Another highlighted approach is development of System wide historic bridge plans, covering the criteria, considerations, goals, concurrences, general context, and potentially acceptable treatments by bridge type, size, and location. Minnesota DOT's Plan includes guidance on roles and responsibilities, treatments, and maintenance practices. Oregon's plan is integrated with its bridge program and Virginia's plan has a list of specific considerations it uses in evaluating individual bridges. TxDOT plan is tied to its Historic Bridge Manual that also addresses treatment options.

Bridge-Specific Historic Bridge Plans

Alternatively, some states develop bridge-specific historic bridge plans within the context of the overall system including maintenance procedures, per the AASHTO Guidelines for Historic Bridge Rehabilitation and Replacement for historic bridge decision-making, or develop a similar program level process. Bridge-specific historic bridge plans form the basis for projects that will be context sensitive solutions. Ohio has some 50 plans for its most significant structures, and VTrans develops individual plans based on category type and Virginia has some 54.

Evaluation Process

The evaluation process involves selection of bridges for possible retention as is, for retention through repair, for widening, strengthening, conversion to pedestrian use, relocation or sale, or for replacement as a part of system management. Ideally this is integrated with programming as is done in Ohio, Vermont, and Oregon. Minnesota starts with load ratings.

Section 106 and Section 4(f) Processes

The process is used to decide whether to replace or rehabilitate when done as part of the management system development of candidate projects; and how the process meets the requirements specified in the consultation criteria for Section 106 of the National Historic Preservation Act and Section 4(f) of the Department of Transportation Act. VTrans has been delegated SHOP responsibility, and other states such as Minnesota have program level discussions with their SHPO. Oregon has agreements in place to make 106 findings for "in-kind" repairs.

Program Level Cost Data

The process of developing programming level cost estimates for deciding project level options is considered important in the development of viable candidate projects. All DOT's surveyed commonly refer to past projects in developing future cost estimates.

Treatment Criteria

Development of criteria for determining which treatments would be most beneficial in preserving the context of a bridge and protecting character-defining features of a bridge by type, in keeping with safety and cost factors, etc. Ohio has an award winning guide, MnDOT has theirs posted on the web, and Oregon has gone on to develop a "complete" approach.

Design Guidance

Development of design guidance for repairs, alterations and rehabilitation of historic bridges by type commonly uses general AASHTO guidance, with exceptions as needed for historic bridges. Vermont has developed its own guidance for bridge rehabilitation, as has Oregon, and VA.

System Data

Systematic acquisition and recording of bridge data, including condition, geometry, load capacity, traffic volume, recorded accidents, actual maintenance costs, and actual cost data from repairs, rehabilitations, and replacements support program decision-making. Compilation of such information is common practice.

Historic Inventory

Systematic acquisition and recording of historic context, character-defining features and determination of eligibility for listing on the National Register of Historic Places provides an up-to-date and relevant inventory of historic bridges in support of programmatic decision-making. Historic bridge inventories are common in Ohio, VT, MN, OR, AK, IN, and TX, all of which maintain historic inventories.

Maintenance Manuals

Development and refinement of maintenance instructions for historic bridges, or manuals that include specific guidance for particular historic bridge types, including detailed instructions on how and when to apply treatments that would be most beneficial to protect character-defining features of a bridge by type is also key. Ohio has well developed maintenance and preservation guidelines posted on its website and VTrans has detailed maintenance protocols on theirs.

Project Management

Project management for historic bridges covers practices that apply to historic bridges individually, including their condition, significance, cost, and treatment options as part of the highway system, as part of the bridge program, as part of the cultural resources program, and as a jointly managed set of special assets. These aspects of project management are further broken down as follows:

Multi-discipline

Practices that establish a multi-discipline development team for the project, including a cultural resource specialist, a public involvement specialist, and an environmental requirements specialist, all to ensure community, historic and environmental values, are considered from the beginning of the project through to final contract plans.

Define Scope

Practices that routinely define project scope as repair or replace, or permit the project team to consider options to replacement, are important during project development.

Determine Options

Project management also calls for a process to determine options for action, including repair, alteration, rehabilitation, relocation or replacement.

Evaluate and Communicate Historic Significance

Processes should also be in place for evaluation and communication of the historic significance of the bridge. Factors considered will include: setting in the environment and community, character-defining features, physical fabric and features that must be preserved, fabric and features that could be altered if needed, and restoration of damaged features that should be returned to as-original condition.

Bridge Condition, Traffic, and Design Exceptions

Process for detailed evaluation of bridge type, bridge condition data, load rating, seismic risk, geometry, traffic data, accident data and other systems information will determine the need for structural repairs, strengthening, retrofits, design exceptions, testing, revised load rating, and other actions that could permit continued use of the bridge.

Cost Comparisons

In addition, developing design level cost estimates using actual cost data for repairs, retrofits and rehabilitation to permit comparison of alternatives is part of individual project management. This includes seeking cost data from other agencies if insufficient data is available to the owner.

Public Communication and Involvement

Practices may establish public communication, such as websites and newsletters to inform the public about the project, its objectives, and progress, and to seek opinions from the public. Also, efforts are made to engage the public and solicit input, such as public meetings, workshops, surveys or other means.

Bridge Maintenance

Processes for developing historic bridge maintenance projects or work tasks together with cultural resource considerations are essential to ensure work does not adversely affect the historic significance of the bridge.

Capture Innovation

Ideally there will also be a process for capturing innovative techniques developed in the project for future use by other projects and other owners.

Risk Management and Tort Liability

A concern of owner agencies which continue to use functionally obsolete bridges is the potential for lawsuits resulting from accidents, where a claim may be made that damages resulted from the bridge not meeting current design standards. Community outreach and a documented decision-making process can reduce potential tort liability concerns. Other risks are related to project delay in the acquisition of environmental approvals.

Partnering

Successful historic bridge efforts appear to utilize a partnering approach among staff responsible for bridge management, project development, and bridge maintenance. For some agencies, this has been sufficiently long-standing to have become a cultural climate. For others, it is been a more recent realization that working together can be much less work and lead to a greater number of successful projects, where some of the successes are correctly determined replacements.

Partnering can be very formal, executed through legislation, programmatic agreements, and facilitated workshops. Or it can be very informal, identified almost solely by actions demonstrated on projects. The agencies interviewed represent a range of approaches to partnering. How, and when, they developed programmatic agreements help show this range.

Education

Workshops for bridge engineers can help them learn the historic side of bridges and the value the public sees in their historic bridges. Workshops can also make the engineers more aware of flexibility in design, or practical design initiatives, and thus make rehabilitation of bridges less challenging. Joint workshops for historians and bridge engineers can also help to educate both groups and foster partnering.

Presentations at conferences that demonstrate the practicality of historic bridge rehabilitation, describe the requirements, and explain the processes for historic bridge work can facilitate the learning process. Outreach to college and high school classes or other groups may help build public support for preserving historic bridges. Ideally, bridge inventory results, bridge-specific management plans and demonstration projects can be featured in these discussions.

Local Agency Assistance and Synergies

State DOTs typically have the expertise and capacity to manage historic bridges, and as such are in a position to help local agencies understand their role in preserving historic bridges; identify which bridges are truly historic; determine which bridges could reasonably be rehabilitated; develop historic bridge projects that would be competitive for funds; and set aside dedicated funds for historic bridges. Indeed, as historic bridge preservation systems, trust, and expertise grow out of best practices, agencies such as Ohio DOT, Oregon DOT, and Vermont Agency for Transportation (VTrans) have been able to benefit from increased regulatory flexibility in the form of expanded Categorical Exclusion determinations, more defensible National Environmental Policy Act (NEPA) determinations, and delegated Section 106 authority..

Next Steps

Education and training using case studies can inform practitioners and help support DOTs and SHPOs which are willing to work cooperatively to develop historic bridge preservation and rehabilitation procedures and policies. Training based on this report should focus on establishing a process that develops realistic cost estimates for a variety of alternatives, including partial repair, strengthening,

widening in-kind and rehabilitation, all in keeping with original designs while preserving character-defining bridge features. This approach allows a fair comparison with a replacement alternative and if cooperatively developed, allows all stakeholders to fully understand and appreciate the entire process.

Follow up Research

To determine whether this study results in an increase in the use of best practices as described here, the use of AASHTO Guidelines, or the use of any other references noted in the report, a survey of State DOTs and SHPOs should be implemented two years after publication of this work. A short survey would be useful to gauge the level of interest and types of education and training that could promote further acceptance of these practices to assist DOTs and SHPOs. This study, while a start toward a reference manual on bridge preservation practices, is by no means a comprehensive reference manual of physical preservation practices. As any bridge engineer can attest, the best way to preserve a bridge is through a well-directed, diligent maintenance program. A comprehensive reference manual which could provide practitioners with practical strategies for solving particular physical repair and maintenance issues to help keep historic bridges from need of replacement due to deterioration is much needed.

1. Introduction

1.1 Overview

The nation's inventory of historic bridges continues to decline at a steep pace, and the loss of bridges is often due to an inability to reconcile preservation or rehabilitation goals with engineering standards. Because there are no accepted standards for historic bridge rehabilitation which address engineering issues, rehabilitation of a historic bridge is sometimes determined to be infeasible or imprudent without resorting to alternatives or specialized treatments. For example, when design alterations are needed to make a bridge sufficiently safe for long-term use, compliance with historic preservation requirements can limit the ability to change the visual appearance or materials of the bridge even when rehabilitation might be a possibility. Alternatively, safety mandates and engineering standards can make in-kind restoration impractical at best. In instances such as these an "all or none" result can tend to lead to unnecessary replacement of historic structures.

Existing policies and practices that support preserving bridges are in place, and many of these practices are described in this report. The establishment of the Scenic Byways Program in 1991 and the National Highway System Designation Act of 1995 allows states in conjunction with the Federal Highway Administration (FHWA) to develop site-specific design criteria, to balance transportation needs with community values. Context Sensitive Solutions/Design tenets also support designs that preserve historic bridges.

In addition to policies and practices, practitioners need access to tools, guidance, and examples developed by other transportation managers, design engineers, cultural resources specialists, and historic preservationist specialists. Making this information widely available would help practitioners develop affordable approaches to preserving historically and architecturally significant bridges. For the purposes of this study, the hierarchy of bridge preservation goals is as follows:

- Preservation in place with a vehicular use;
- Preservation in place for other uses; and
- Removal to another site.

A primary goal for historic bridge preservation is to develop a set of solutions that allows bridges to remain in place and in use for vehicular traffic. If preserving the bridge's vehicular use is not an option, then preserving the bridge in place for other uses such as a hiker/biker trail, while a new bridge for vehicular traffic is constructed nearby may be a reasonable alternative. Removal of a historic bridge to a new location for another use can also be a viable option, albeit the least preferred.

Several recent and related efforts have focused on this issue, including the establishment of guidelines in NCHRP 25-25 Task 19, *Historic Bridge Rehabilitation/Replacement Decision Making*, adoption of these guidelines by the American Association of State Highway and Transportation Official (AASHTO) Bridge Engineers Subcommittee, and the establishment of the Community of Practice (CoP) for Historic Bridge Preservation by AASHTO's Center for Environmental Excellence. This issue was highlighted when

members of the Historic Bridge CoP identified the conflict between historic bridge preservation and engineering design guidelines as the top issue associated with historic bridges and transportation project delivery.

Interestingly, many best practices seem simple to incorporate, but have yet to be implemented across the nation. Involving agency cultural resources staff during early project phases and fostering trusting relationships with SHPO staff are well-established in some states, but rare in others. Similarly, many best practices that yield affordable options are not always used to realize project cost savings. The approaches presented in this study serve to support balanced decisions and equitable compromises which can result in increased consideration for historic bridges, and ultimately a decline in bridge removal and replacement

1.2 Purpose of the Research

The purpose of NCHRP 25-25, Task 66 is to identify, compile, and make available in an organized and useful format, the best practices and lessons learned regarding the preservation and rehabilitation of historic bridges. As a practical guide, this research will help transportation managers, design engineers, cultural resources specialists, historic preservationists, and the public:

- Identify existing resources (i.e., guidelines, standards and policies) that can be used to support historic bridge preservation and rehabilitation;
- Utilize best engineering practices that balance historic preservation with safety and utility, and minimize the loss of historic bridges; and
- Draw upon case studies of methods and practices being used to successfully preserve and rehabilitate historic bridges.

This effort builds upon the concepts and structure identified in NCHRP 25-25, Task 49, *Effective Practices for Considering Historic Preservation in Transportation Planning and Early Project Development,* and the guidelines outlined in NCHRP 25-25, Task 19, In many instances, the best practices of successful historic bridge preservation or rehabilitation relate the common threads of information exchange, negotiation, methods, materials that can foster innovations, and consensus among all parties.

1.3 Research Method

Recognizing that historic bridges encompass a wide range of types, materials, and sizes and are located in rural, suburban, and urban locations, the research team consulted the AASHTO CoP for Historic Bridge Preservation, the National Trust for Historic Preservation, the Historic American Engineering Record, several professional journals, corporate professional networks, and state DOT staff, as well as local agency project organizations to identify established practices and case studies for inclusion in this research.

1.3.1 Literature Review

The first step in this study was a literature search of standards, guidelines, practices, and processes relevant to the preservation or replacement of historic bridges. Sources investigated included the Secretary of the Interior's Standards for the Treatment of Historic Properties, AASHTO and Transportation Research Board (TRB) reports and guidance, state-specific approaches, and technical engineering publications. The team found from this review that many of the best practices involve coordination, compromise and early integration of preservation issues in the transportation project development process. Also examined as part of a review of international literature, was the European emphasis on conservation (as opposed to strict preservation) for roads and bridges in historic settings.

While not specific to the preservation and rehabilitation of historic bridges, other literature focused on resolving conflicts among parties with various perspectives, as well as on process and analysis methods to support improved decision-making. More recent reports that support using flexibility in decision-making were also reviewed and considered, including the Transportation Research Board (TRB) Special Report 214 *Designing Safer Roads, Practices for Resurfacing, Restoration and Rehabilitation*, AASHTO's risk-assessment based *Guidelines for Geometric Design of Very Low-Volume Local Roads (ADT<400),* and *A Guide for Achieving Flexibility in Highway Design*.

The key references identified during the literature search are listed and annotated in **Appendix A**, which also includes a brief summary of each document, publication and website.

1.3.2 Interviews

Following the literature review, the research team conducted a series of interviews to solicit detailed information on recurring issues, lessons learned, and best practices from individuals and organizations actively engaged in historic bridge preservation and rehabilitation. The research team developed an initial list of agency and organization staff, and other individuals, to be interviewed as part of this project. This list was based on the research team's knowledge and experience as well as the literature search and recommendations from the project's review panel. The list of practitioners to be interviewed included: local, state and federal transportation managers and agency staff, cultural resources managers, bridge engineers, cultural resources agency staff, legal staff, engineering, cultural resources consultants, and preservation organizations. A list of the individuals interviewed and their affiliations is available in **Appendix B**.

The research focused on States with known success in programs and in projects that have resulted in rehabilitated historic bridges. Contacts within the State or Local Agency Department with responsibility for bridge engineering and for cultural resources management were identified, as were contacts within the pertinent FHWA Division and State Historic Preservation Offices (SHPOs). The research team developed a specific set of questions for each discipline in order to explore the challenges, sources of conflict and to identify case studies that provide good examples of balancing historic preservation, engineering practices, and project requirements. With the exception of the legal staff who were treated separately the set of questions asked of each group had a common or core list of questions which was

paired with a list of individual questions tailored to the roles and responsibilities of each group. A list of the survey questions posed to each group is contained in **Appendix C**.

Many interviewees agreed to share their personal knowledge and their agencies' historic bridge practices. ,

The research team conducted the majority of interviews via the telephone, although in several instances a two-step process of making initial contact by telephone and then emailing the questions to the individual for a written reply was used when the interviewee preferred this method. In a few cases, members of the research team discussed issues beyond those presented in the initial question list, in order to gather details about specific areas or actions referenced by the interviewee. In some instances, the research team conducted follow-up interviews to ensure that information about a particular project or case study was correctly documented and so that the practice or lesson learned could be clearly understood and/or replicated. Responses from all of the interviews were uploaded to a central database for comparison and analysis.

2. Historic Bridge Preservation Practices Identified

2.1 Introduction

As outlined in **Section 1.0**, after the completion of the literature search, the project team conducted interviews with engineering, cultural resources, and legal staff within state DOTs, SHPOs, FHWA offices, citizens groups active in preservation, and several knowledgeable individuals who could provide information on practices that have been used successfully to preserve and rehabilitate historic bridges.

Practices are repeatable actions, organized, understood, and documented in some fashion, that are followed by agency personnel in their efforts to preserve historic bridges, while keeping their transportation system as functional as possible with funds available. The research obtained through the interview process and literature search has been organized as follows:

- Program Management
- Project Development
- Dealing with Risk
- Partnering
- Education
- Local Agency Assistance

This section of the study outlines each of these five areas as elements of success. Later chapters will present how agencies have successfully applied each.

2.2 Program Management

Program management for historic bridges covers practices that apply to historic bridges as a group encompassing inventory, evaluation and the development of action plans. It also includes their management as part of the highway system, as part of the bridge program, as part of the cultural resources program, and as a jointly managed set of special assets.

The following techniques were identified as program management practices for preserving historic bridges:

Asset or Resource Management with Programmatic Agreements

Management of historic bridges through an asset management program or through a resource management program, including formal programs such as Programmatic Agreement (PA).

System-wide Historic Bridge Plans

Development of System wide historic bridge plans, covering the criteria, considerations, goals, concurrences, general context, and potentially acceptable treatments by bridge type, size, and location.

Bridge-Specific Historic Bridge Plans

Development of bridge-specific historic bridge plans in the context of the overall system including maintenance procedures, per AASHTO Guidelines for Historic Bridge Rehabilitation and Replacement for historic bridge decision-making, or a similar program level process.

Evaluation Process

The selection of bridges for possible retention as is, retention through repair, widening, strengthening, conversion to pedestrian use, relocation or sale, and for replacement as part of system management.

Section 106 and Section 4(f) Processes

The decision process to replace or rehabilitate in accordance with Section 106 consultation procedures and Section 4(f) standards.

Program Level Cost Data

The process of developing programming level cost estimates for deciding project level options as considered in the development of viable candidate projects.

Treatment Criteria

Development of criteria for determining which treatments would be most beneficial to protect character-defining features of a bridge, by type, in keeping with safety and cost factors, etc.

Design Guidance

Development of design guidance for repairs, alterations and rehabilitation of historic bridges, by type.

System Data

Systematic acquisition and recording of bridge data, including condition, geometry, load capacity, traffic volume, recorded accidents, actual maintenance costs, and actual cost data from repairs, rehabilitations and replacements to support program decision-making.

Historic Inventory

Systematic acquisition and recording of historic context, character-defining features and determination of eligibility for listing on the National Register of Historic Places to provide an up-to-date and relevant inventory of historic bridges in support of programmatic decision-making.

Maintenance Manuals

Development and refinement of maintenance instructions for historic bridges, or manuals that include specific guidance for particular historic bridge types.

2.3 Project Development Practices

Project management for historic bridges covers practices that apply to historic bridges as individual structures, including their condition, significance, cost, and treatment options as part of the highway system, as part of the bridge program, as part of the cultural resources program, and as a jointly managed set of special assets. These practices and processes are further broken down as follows:

Multi-discipline

Practices that establish a multi-discipline development team for the project, including a cultural resource specialist, a public involvement specialist and an environmental requirements specialist, to ensure community, historic and environmental values are considered from the beginning of the project through final contract plans.

Define Scope

Practices that routinely define project scope as repair or replace, or permit the project team to consider options to replacement, during project development.

Determine Options

Processes to determine options for action, including repair, alteration, rehabilitation, relocation, or replacement.

Evaluate and Communicate Historic Significance

Process for evaluation of and communication of the historic significance of the bridge, its setting in the environment and community, its character-defining features, physical fabric and features which must be preserved, fabric and features which could be altered if needed, and restoration of damaged features which should be returned to original condition.

Bridge Condition, Traffic, Design Exceptions

Process for detailed evaluation of bridge type, condition data, load rating, seismic risk, geometry, traffic data, accident data and other systems information to determine the need for structural repairs, strengthening, retrofits, design exceptions, testing, revised load rating, and other actions which could permit continued use of the bridge.

Cost Comparisons

Process for developing design level cost estimates using actual cost data for repairs, retrofits, and rehabilitation to permit comparison of alternatives. This includes seeking cost data from other agencies if insufficient data is available to the owner.

Public Communication

Practices establishing public communication, such as websites and newsletters to inform the public of the project, its objectives, and its progress and opinions sought from the public.

Bridge Maintenance

Process for developing historic bridge maintenance projects or work tasks, taking into account cultural resource considerations to ensure that the work does not adversely affect the historic significance of the bridge.

Capture Innovation

Process for capturing innovative techniques developed in the project for future use by other projects and other owners.

2.4 Dealing with Risks (Tort Liability)

One concern for owner agencies as they continue to use functionally obsolete bridges is the potential for lawsuits claiming damages which may result from the bridge not meeting current new design standards. A broad cross-section of State DOT officials was interviewed to determine the extent of this concern and its effect on project decisions. In addition, official reports of the appellate and highest courts of the 50 states and all circuits of the federal courts were reviewed in this context.

2.5 Partnering

Successful historic bridge efforts appear to utilize a partnering approach to bridge management, project development, and bridge maintenance. For some this has been sufficiently long-standing to be a cultural climate. For others, it is been a more recent development. Partnering can be very formal, executed through legislation, programmatic agreements, and facilitated workshops. Or it can be very informal, identified almost solely by actions demonstrated on projects. The agencies interviewed represent a range of approaches to partnering. How and when they developed programmatic agreements help show this range.

2.6 Education

A number of the agencies interviewed suggested that education was either a significant part of their success or was clearly needed to reach their idea of success.

Practices in education include the following:

- Workshops for bridge engineers to make them more aware of flexibility in design or practical design initiatives which make rehabilitation of bridges less challenging;
- Workshops for bridge engineers that help them learn the historic side of bridges and the value the public places on historic bridges;
- Joint workshops for historians and bridge engineers which can both educate and foster partnering;
- Presentations at conferences that demonstrate the practicality of historic bridge rehabilitation;

- Presentations at conferences that describe the requirements for historic bridge preservation and the process for consultation on historic bridge work; and
- Presentations to community groups, such as college and high school classes, to introduce them to the values and techniques in preserving historic bridges.

2.7 Local Agency Assistance

Ownership (stewardship) of historic bridges is clearly not confined to State DOTs. State transportation agencies have responsibilities both in distribution of federal funding for Local Agency bridge projects, and in oversight of their planning and execution of the resulting projects. These responsibilities exist, and apply for a great number of historic bridges, especially the shorter span bridges. As with education, a number of agencies saw this as an area where they could provide a benefit to historic bridges.

Actions a State DOT could undertake with local agencies include helping them:

- Understand their respective roles in preserving historic bridges;
- Identify which bridges are truly historic;
- Determine which bridges could reasonably be rehabilitated;
- Identify and develop historic bridge projects that would be competitive for funds; and
- Set aside dedicated funds for historic bridges.

3. Best Practices and Case Studies

In an environment of increasing population and decreasing availability of public funds, historic bridge preservation and rehabilitation must be considered in the broader context of preserving and rehabilitating the overall transportation system. Practices that acknowledge this reality and are still able to preserve and rehabilitate historic bridges with high cultural resource value are of the most interest as "Best Practices."

Long-standing practices, with extensive rehabilitation already completed, offer compelling evidence of practicability. However, these practices must be studied to determine why, and how, they can be adopted by other agencies. A truly Best Practice is not limited to the location where it was developed.

Before examining best practices, it is helpful to define common terms and identify criteria for selection of Best Practices. The Best Practices are organized under the areas of:

- Program management
- Project development
- Partnering
- Education
- Local agency support

Definitions:

- *Program:* A methodical system of plans, objectives, criteria and processes used to optimize allocation of resources, monitor performance of processes and evaluate outcomes against established criteria.
- *Programmatic Agreement (PA):* A signed agreement or memorandum of understanding between an agency tasked with performing functions and one or more regulatory agencies tasked with overseeing such functions. The PA lays out the objectives of the program involved, the roles and responsibilities of the parties to the agreement, the plan or processes that are to be followed, restrictions on actions, standards to be adhered to, allowed exceptions or exemptions, and recourse options if parties do not live up to their commitments.
- *Plan:* A definition of an intended accomplishment of the program, with one or more objectives, the resources, assets or activities covered, the processes to be used to achieve objectives, standards, priorities, funding, and timelines involved.
- *Project:* An approved capital investment, which when developed through an appropriate process, will preserve, rehabilitate, enhance, or alter an existing resource or asset, or provide a new capital asset.

- *Process:* A written or understood set of tasks or steps, including decisions that, when initiated and followed, would result in a planned outcome.
- *Objective:* A desired outcome of a program, plan or process; a positive result providing a return on investment of time, personnel and public funds.
- *Practice:* An existing set of tasks or steps constituting a process or part of a process that is actively practiced and produces a planned, predictable, and repeatable outcome.
- *Inventory:* A listing of cultural resources or capital assets with the necessary properties of each, that is sufficiently current and accurate, to provide needed information for management of the resources or assets.
- *Historic significance:* Cultural significance of a resource or capital asset, resulting from a valuation process, such as determination of eligibility for listing on the National Register of Historic Places, opinion of a state or local landmarks commission, or from active public involvement, that must be considered in any public work which might affect it.
- *Bridge:* A structure, as defined by the National Bridge Inventory System (NBIS), with a length of at least 20 feet.
- *Public education and public involvement:* Getting the public involved in preserving historic resources, educating them on the historic significance so they understand what they have, and once educated, providing them a process to involve themselves in preservation of historic bridges.

Selection Criteria:

- Practice must actually be used;
- Practice must be demonstrated as repeatable;
- Practice must have provisions for review and for changes;
- Practice must have concurrence of regulators (SHPO, FHWA); and
- Practice must produce reasonable and useful outcomes.

In addition to the discussion in this chapter, **Appendix D** contains a list of tools, techniques, and examples related to historic bridge preservation practices.

3.1 Program Management Practices by State or Local Agency

This section discusses the program management practices that are used by or have been developed by specific state or local agencies.

3.1.1 Ohio

Ohio DOT manages its historic bridges through its Historic Bridge Program within the Office of Environmental Services. This is a mature, well-established resource management program with a formal Cultural Resources Manual that covers historic bridges.

Asset or Resource Management through Programmatic Agreements

Ohio DOT utilizes a Programmatic Agreement (PA) to assist in defining the roles and responsibilities regarding preservation, rehabilitation and replacement of historic bridges since developing the first PA, which was signed on July 23, 1993. According to Ohio DOT's Cultural Resource Section Environmental Specialist and Historic Bridge Program Manager, Tom Barrett, the DOT's current, and third, PA for Section 106 (executed November 29, 2011) now covers all federally funded or approved highway projects, and includes an appendix specifically for Federally funded or approved highway bridge projects, thus replacing its previous bridge-exclusive PA. He points out that the PA is "most helpful pre-NEPA, as a scoping tool." The PA includes language in its Appendix C, dealing with National Register of Historic Places (NRHP) listed or eligible bridges, stating "rehabilitation is preferred until proven unfeasible or not a prudent use of public funding." The appendix makes direct references to the AASHTO Historic Bridge Guidelines and to the State's own *Ohio Historic Bridge Maintenance and Preservation Guidance*.

Ohio DOT has streamlined the process for replacement of non- eligible bridges. Tom Barrett notes that the DOT's "extensive statewide inventory research and PAs have categorically excluded thousands of bridges from Section 106 coordination. Having an up-to-date inventory [which] SHPO, staff engineers and FHWA agree on, allows for streamlining of [the] process for non-NRHP bridge work; allowing [Ohio Cultural Resource staff] to focus on the stewardship and identification of historically significant bridges." FHWA Ohio Division Bridge Engineer Matt Shamis agrees: "Ohio's now retired historic bridge PA resulted in the better candidates of specific types of bridges being rehabilitated, while allowing the lesser examples to be replaced. Many bridge owners have bought into the idea and are supporters of the concept. The environmental decisions are made in advance of the projects. And project time can be streamlined."

This PA is a proven successful practice, as the parties have extended it from its original intent, to cover the full range of project work. Review of the latest Historic Bridge Inventory spreadsheet shows 31 of the 843 inventoried state-owned structures received some form of rehabilitation between 1991 and 2007.

System-wide Historic Bridge Plan

Ohio DOT has a commitment to System wide management of historic bridges contained within its PA where FHWA, Ohio DOT and Ohio SHPO shall "cooperate in meaningful, long term planning for the protection of historic properties. . . Identifying transportation-related

concerns threatening historic properties. . . [and providing] effective stewardship of historic bridges."

Ohio DOT funds two positions at the Ohio SHPO, as agreed to in its PA, to assist in this effort.

While Ohio DOT does not have what it would call a System wide plan, its first and second historic bridge inventories, published in 1983 and 1990, respectively, include four categories for bridges inventoried:

- National Register of Historic Places (NRHP) listed;
- Selected, that is, those that are clearly eligible for NRHP listing;
- Reserve, those that potentially could be determined eligible; and
- Non-Selected, those which are clearly not eligible.

Chapter 3 of the 1983 Historic Bridge Inventory is titled "Preservation Plan," as is Chapter 2 of the 1990 Inventory. These call for the DOT and SHPO to enter into a Preservation Plan which encompasses:

- Maintenance of Historic Bridge Inventory
- Rehabilitation of Historic Bridges
- Relocation of Historic Bridges
- Salvage of Historic Bridges
- Documentation of Historic Bridges
- Replacement of Historic Bridges

These chapters lay out the framework for the programmatic agreement that ensued in 1993, which in effect is a System wide preservation plan.

Bridge-Specific Historic Bridge Plans

Ohio DOT utilizes bridge-specific management plans for its highest priority historic bridges. According to their Cultural Resources Specialist, Tom Barrett, Ohio started with 12 management plans for individual historic bridges, and is now completing approximately 50 management plans for the most significant structures in the statewide inventory. He estimates that over 10 percent of Ohio's bridges will have a management plan completed by 2013. Appendix C of the 2011 PA now requires Ohio DOT to complete management plans for bridges that are endangered, are one-of-a-kind, or are associated with a regional or national context, engineering trend, or prolific designer.

Ohio DOT utilizes the AASHTO Historic Bridge Guidelines. Tom Barrett notes that the DOT's new (2011) PA emphasizes principles of both the AASHTO Guidelines and the Ohio DOT Historic Bridge Manual, along with stipulations that require public outreach which includes the historic significance of bridges to their owners/neighbors, and the marketing of historic bridges available for reuse. .

Evaluation Process

Ohio DOT performs the development of alternatives within its process for programming bridge projects.

Tom Barrett explains that at Ohio DOT, the Cultural Resources staff is "rapidly moving more into the preliminary scoping phase versus reacting to a predetermined scope of work. Because of publications like the AASHTO Guidelines, we are much more informed on the potential life that historic bridges can have." The Cultural Resources "staff recommends alternative considerations in the preliminary scoping process which are based on [Section] 4(f) Alternatives Analysis requirements. This approach is more successful in getting rehabilitation [rather than] requiring quantitative analysis of bridge options later, just to satisfy [Section] 4(f) for the Environmental Document."

Section 106 and Section 4(f) Processes

Ohio DOT makes the initial decision for rehabilitation or replacement within its process for programming bridge projects as well. The PA requires rehabilitation to be considered first.

According to Mike Loeffler, Manager of Bridge Operations and Maintenance, the Ohio DOT Office of Structural Engineering considers each bridge for work needed to remove structural and functional deficiencies. This is a well defined process, reviewing the NBIS data and load ratings to determine what deficiencies need to be corrected. As the work items add up, the natural comparison occurs between the repair workload and cost, to the workload and cost to do replacement. "If replacement appears warranted, the Office of Environmental Services checks to see if the bridge is historic. More careful consideration to potentially avoid replacement then takes place. When rehabilitation is decided, the focus becomes to preserve the historic features of the bridge."

Program Level Cost Data

Ohio DOT utilizes cost data from completed rehabilitation projects on its bridges to develop cost estimates for proposed future rehabilitation work. The FHWA Ohio Division carefully examines cost estimates for replacement versus rehabilitation projects. Division Bridge Engineer, Matt Shamis notes: "I have reviewed cost comparisons from competing replacement vs. rehabilitation projects. I used my knowledge of construction items and historic cost data from the DOT to assure the comparison was fair. I have discounted those comparisons that were biased and required re-submittals which sometimes changed the conclusion of the comparison."

Treatment Criteria

Ohio DOT has a written guide, *Ohio Historic Bridge Maintenance and Preservation Guidance* that provides guidance, by type of bridge, material and bridge element, from a historic perspective, for use by rehabilitation design engineers and maintenance staff. The guidance won an award in 2011 from the Ohio SHPO, which described it "as an outstanding contribution to historic preservation in Ohio."

Design Guidance

Ohio DOT Bridge Design Manual 2004 edition is retained in an active status as it is based on allowed stress design, more appropriate for use with older bridges, and has detailed guidance for rehabilitation and repair design, by bridge type, material and element. The current manual refers back to this edition's Section 400, for rehabilitation, but as with the 2004 edition, does not provide any specific guidance for dealing with historic bridges.

System Data

Ohio DOT inspects and records condition data as required by FHWA in accordance with the NBIS standards. The Ohio DOT has a comprehensive Manual of Bridge Inspection, which covers bridge types, elements, and condition assessment, with detailed guidance and photographs, somewhat similar to the FHWA PONTIS Bridge data management system. The name "Pontis" is derived from the Latin "pons," meaning bridge.

Historic Inventory

Ohio DOT maintains an up-to-date inventory of its historic bridges. According to the DOT's website, the first formal inventory was completed in 1983, followed by updates in 1990, 1994, 2004, and in 2010, its current inventory. In addition, updates for specific groups of bridges, such as arch and truss, have been performed to keep the inventory as accurate as possible.

According to Tom Barrett, the current inventory includes an "updated 2010 historic bridge inventory database with 484 identified NRHP listed or eligible bridges." During the project scoping phase, "new information [may be] presented or uncovered that determines a bridge is eligible for NRHP."

Historic bridge inventory information is available to the public through a unique Geographic Interface called "Buckeye Assets," accessed directly at (http://www.buckeyeassets.org/), or via links to it from various pages within the DOT site, including the Historic Bridge Page. Tom Barrett explained that "This is a new ODOT application that uses an interactive map, much like Buckeye Traffic, to deliver real-time information about Ohio's historic bridges. Users choose search criteria, update the map, and then right click on pinpoint images to see a listing of bridges within a 2-mile radius of where they clicked. Information, including pictures, is delivered via a window and downloadable as a PDF."

As noted earlier, Ohio DOT historic bridge inventories are more than an inventory, they provide required physical identification and historic context of the bridges to support determination of historic significance. They also provide a systematic evaluation and classification of historic significance, and a preservation plan by classification. The classification plan, worked out with SHPO in the first two, formed the basis for programmatic agreements which have guided historic bridge preservation and rehabilitation for nearly 30 years.

Maintenance Manual

As mentioned above, Ohio DOT has a written guide, *Ohio Historic Bridge Maintenance and Preservation Guidance*. The DOT also has an on-line Bridge Maintenance Manual, which provides preventive maintenance guidance and repair techniques, by bridge element, and for repairs, expected costs and repair life. While the guidance does not specifically address historic bridges, the techniques presented are applicable. The Ohio DOT maintenance and preservation guidelines are on ODOT's website and available for download at:

http://www.dot.state.oh.us/divisions/planning/environment/cultural_resources/historic_bridges/Pages/default.aspx.

3.1.2 Vermont

Asset or Resource Management through Programmatic Agreements

Vermont Agency for Transportation (VTrans) manages its historic bridges through a historic bridge program that was established through a PA with FHWA, Advisory Council for Historic Preservation, Vermont SHPO, Vermont Agency of Natural Resources, and Vermont Agency of Commerce and Community Development. This PA is available here:

http://www.aot.state.vt.us/progdev/sections/structures%20info/vermonthistoricbridgeprogram/HBP01Program%20Agreement.html

VTrans executed a second PA, covering Section 106 Consultation and providing a Manual of Standards and Guidelines to streamline the processing of projects involving historic properties. This PA is available here:

http://www.aot.state.vt.us/archaeology/documents/pa.pdf

VTrans Historic Preservation Officer and senior planner, Scott Newman describes VTrans management of historic bridges as having three main parts:

- VTrans has developed individual management plans for historic bridge categories: covered bridges, metal truss bridges, masonry arch bridges (draft), and concrete arch bridges (draft).
- Programmed projects involving historic bridges are governed by the agreements in the management plans.
- The 2000 PA with FHWA, ACHP, and VT-SHPO delegated the full responsibilities and authority of the Vermont SHPO to qualified individuals (Historic Preservation and Archaeology Officers) within VTrans.

The Vermont Historic Bridge Program is thoroughly described in Appendix A of its PA.

System wide Historic Bridge Plans

The VTrans Historic Bridge PA is more than an agreement on roles and responsibilities. It initially included a management plan for metal truss bridges, was updated to include a

management plan for covered bridges, and has draft management plans being readied for inclusion covering stone arch bridges and concrete bridges. With these bridge category management plans, along with the Historic Bridge Plan, it is a state-wide management plan, but has some features of bridge-specific plans.

VTrans Program Development Manager, Richard Tetreault states that his office considers work for historic bridges “within our regular State and Town Highway Bridge programs.” He further explains that historic bridge preservation projects are “triggered like our regular work using inspection information and project prioritizations," which establish “the bridge needs and are not roadway driven.”

Scott Newman provides some additional details:

- Generally, bridge projects are programmed using uniform criteria whether they are historic structures or not, based on need (i.e., condition, structural deficiencies, and geometric deficiencies).
- There are some limited exceptions, including dedicated federal funding, or transportation enhancement (TE) projects.
- Once programmed, the projects are subject to Section 106 and Section 4(f) reviews as defined in the statewide Section 106 Transportation Programmatic Agreement, and individual historic bridge management plans.

Bridge-Specific Historic Bridge Plans

According to Scott Newman, “VTrans has developed individual management plans for historic bridge categories: covered bridges, metal truss bridges, masonry arch bridges (draft), and concrete arch bridges (draft).” The VTrans management plans apply to both State-owned and Township-owned bridges, although the State only has authority over its own bridges.

Evaluation Process

With regard to the rehabilitate or replace decision process, Richard Tetreault notes that “the MOU [memorandum of understanding] lays out the plan.” The process balances safety and load capacity with historic value. “Historic truss bridge scopes [of work] are predetermined by a MOU with DHP [Vermont Department of Historic Preservation or VT-SHPO], FHWA, and AOT [VTrans]. They fall into categories that include: reinforce for full highway use, preserved for limited use, preserved and adapted for alternative use, relocated for limited use, and document and destroy. Covered bridges are keepers and we are currently working on preservation plans for concrete and masonry arches. Projects can seek an exception that would change their category.” This describes a strategy of preservation unless the need for an exception is demonstrated and accepted, as opposed to a strategy of replacement unless a prudent and feasible alternative is sought, which places preference in preservation, yet does not preclude replacement when needed.

Section 106 and Section 4(f) Processes

Vermont has a unique method of meeting Section 106 requirements. According to the VTrans Historic Preservation Officer Scott Newman, the 2000 PA delegated the Section 106 responsibilities and authority of the VT-SHPO to the VTrans Historic Preservation and Archaeology Officers such that "VTrans self-regulates for Section 106." This delegation of authority represents the highest level of trust an SHPO can have in the decision-making and project execution of an agency entrusted with historic resources.

Of greater significance than the PA itself, is the Manual of Standards and Guidelines, which it generated, providing a detailed description of the actions and expectations for all parties involved in developing projects with Section 106 potential. The manual is available here:

http://www.aot.state.vt.us/archaeology/documents/finalmanual.pdf

Program level Cost Data

Vermont has a track record of rehabilitating historic bridges and therefore has bid data on which to base realistic estimates for alternatives and construction estimates for projects. VTrans bridge design engineer, Wayne Symonds, notes that the engineers "use bid histories and engineering judgment for estimating both rehabilitation and new construction projects. Due to the number of projects that we have completed we have good histories although every bridge can have its own unique qualities to take into consideration when estimating." He adds: "VTrans has a standard approach to the construction items that we use. This allows for a good history and also the contracting community sees a consistent approach to the projects."

In Appendix B of the 2000 PA, VTrans provides its Metal Truss Preservation Plan, which includes its list of historic bridges that need work, with estimates for both rehabilitation and replacement, allowing direct cost comparison by the public.

Treatment Criteria

Vermont has developed treatments for its metal truss bridges and timber truss bridges. Its Historic Bridge Program, Appendix A of its PA, includes these treatments.

Design Guidance

Vermont does not use AASHTO standards for highways and bridges. Instead, according to Scott Newman, the agency has developed its own "State Design Standards to guide decision making for bridge rehabilitation and replacement projects, including for historic bridges. The state standards include design exception criteria to allow rehabilitation of historic bridges in some cases where bridge geometry does not meet the state minimums."

System Data

VTrans inspects its bridges to obtain condition data in accordance with the federal National Bridge Inventory System (NBIS) standards and acquires traffic and accident data similar to other states.

Historic Inventory

As part of the development of its PA, VTrans has inventoried and examined all of the historic bridges in the State. It has identified State-owned metal truss bridges and developed a plan for them. It has done similarly with its covered bridges. VTrans now has draft plans for concrete arch bridges and masonry arch bridges.

Maintenance

While the agency does not have a specific maintenance manual for historic bridges, VTrans has identified detailed maintenance requirements for historic bridges in its Historic Bridge Program, which originate from its PA. In the historic bridge plans for metal truss bridges and for covered bridges, projects are identified, with projected year and cost, to undertake repair work beyond routine maintenance.

3.1.3 Minnesota

Resource Management through Programmatic Agreement

Minnesota DOT manages its historic bridges through its historic bridge program. This is a mature, well-established program, which, in addition to bridges that are categorized as registered or eligible for registration, has a category for "premier" examples of historic bridges for which the DOT commits to providing a higher level of preservation effort. In addition Minnesota DOT has a Historic Bridge Committee that meets regularly to discuss preservation planning. The Committee includes cultural resource specialists, bridge engineers, and State Aid staff and has standing invitations for SHPO, FHWA and Department of Natural Resources staff.

The DOT utilizes a Programmatic Agreement to assist in defining the roles and responsibilities regarding preservation, rehabilitation and replacement of historic bridges. It does not fund any positions at the Minnesota SHPO.

The PA is available here:

http://www.dot.state.mn.us/historicbridges/pdfs/PROGRAMMATICAGREEMENT/FINALSIGNEDBRIDGEPA.pdf

In addition, the DOT has a long-standing Programmatic Categorical Exclusion Agreement, to streamline non-controversial project work. It specifically requires the work to have no involvement with historic properties requiring consultation. This PA is available here:

http://dotapp7.dot.state.mn.us/edms/download?docId=620464

System-wide Historic Bridge Plan

Minnesota DOT has a statewide plan, the *Minnesota Historic Bridge Management Plan* (Mead & Hunt, 2006), which provides guidance for DOT Districts and Local Public Agencies in roles and responsibilities, preparation of bridge-specific plans, and recommended preservation treatments and maintenance practices for historic bridges in the State. The Plan includes

examples of design exceptions and proper documentation. It also includes the nine guidelines from the Virginia Guidelines for Bridge Maintenance and Rehabilitation, the list of historic bridges as of the Plan's date, a sample bridge specific management plan and the 24 premier bridges that are to have bridge-specific plans.

The Minnesota DOT General Management Plan for Historic Bridges is available here:

http://www.dot.state.mn.us/historicbridges/pdfs/GENERALMANAGEMENTPLAN/GENERALMNHISTORICBRIDGEMGTPLAN.pdf

Minnesota DOT's Cultural Resource Specialist for Bridges, Kristen Zschomler, notes that "Currently, we are only involved in project level reviews. We are working to improve the project selection process through the following steps – making sure all bridge owners are aware of which bridges are historic, helping to create scoring criteria that gives more points to historic bridge rehab projects, and providing better guidance on how to get through the NEPA, Section 106, and 4(f) processes."

Bridge-Specific Historic Bridge Plans

Minnesota DOT's program utilizes bridge-specific management plans for its highest priority premier historic bridges. The Bridge Office has tasked a specific design team and its supervisor to develop core skills in rehabilitation and repair design and evaluation. Detailed management plans for Minnesota bridges, prepared by Mead & Hunt and HNTB, are available for the "premier" bridges, including the bridges noted below:

Bridge 4380 (Anoka-Champlin Mississippi River Bridge) completed in 1929 to carry U.S. Highway 52 (now US 169) over the Mississippi River. It has a length of 995 feet, with ten, reinforced-concrete, continuous-arch spans. A major rehabilitation and widening in 1996 included replacement of all superstructure elements above the arch ribs. The recommended future use of the bridge is rehabilitation for continued vehicular use on-site. The 60 page plan is available at:

http://www.dot.state.mn.us/historicbridges/pdfs/MANAGEMENTPLANS/4380FINALPLAN.pdf

Evaluation Process

State Bridge Engineer, Nancy Daubenberger explains that Minnesota DOT considers "safety our top priority, thus, it follows that the load capacity is a primary concern in any bridge rehabilitation project. We desire the rehabilitated bridge to be able to safely carry modern-day traffic loads, if it is an important link in the system for which load-posting would provide hardship. We use our standard design loading to analyze what repairs are needed. If that analysis shows that repairs could be extensive to the point of causing an adverse effect to the historic structure, we would consider reduced loadings [although] only if load posting the bridge is prudent given the individual situation."

In implementing its PA, the DOT starts with determining what the needs of the bridge are with respect to condition, load rating and traffic volume. Nancy Daubenberger notes that the DOT does "use 3-D modeling to analyze the load carrying capacity, which often times utilizes finite

element analysis. We have considered the use of materials testing but to date have not performed any for evaluating load carrying capacity of historic bridges." If repair, rehabilitation or alteration will not meet the purpose and need, replacement is then considered. Having in-house engineering staff or an on-call consultant engineer with the necessary knowledge and experience in evaluating older bridges and determining where test data or analysis will enable a bridge to safely continue in service is important in the evaluation process.

Section 106 and Section 4(f) Processes

The Minnesota DOT PA spells out in detail the roles and responsibilities for consultation, the determination of effect, and efforts to avoid an adverse effect. In Stipulation 2, the PA (2008) takes this consultation process a step farther: "The FHWA and MnSHPO recognize that long-range approaches to mitigation can be more efficient than project-by-project mitigation items, and will seek to develop such approaches as needs and resources permit." The current PA is much more detailed and supersedes a 2005 PA, which covered essentially the section 106 process.

Program Level Cost Data

According to Nancy Daubenberger, "After rehabilitation needs and rehabilitation recommendations are complete for rehabilitation of the historic structure, potential replacement structures are scoped (could be multiple types) both rehabilitation and replacements are estimated. Estimates are either prepared by bridge estimating unit (smaller to large non-iconic type) or by consultant (iconic type) with review by bridge estimating unit. The In-house estimating unit utilizes bid costs from recent projects of similar work and size if possible or by development of anticipated labor, material and equipment costs for unique work."

Kristen Zschomler points to the value of these realistic estimates: "Having a preservation and stabilization estimate has helped us greatly to secure funding to perform the needed work. Having these estimates shelf-ready, we have been able to rehab 5 of our selected 24 state-owned bridges in the last 5 years, and we are currently working on plans to rehab 8 of the remaining 24 in the next 5 years. Having these estimates was a key tool in allowing our Department to plan for and prioritize these projects."

Treatment Criteria

Minnesota DOT has developed criteria for treatments and included these in the bridge specific preservation plans. Each of the bridge specific management plans is easily accessed through the DOT website's Historic Bridges page, Preservation Tab: http://www.dot.state.mn.us/historicbridges/state-owned.html.

Design Guidance

Minnesota DOT uses its Bridge Preservation, Improvement and Replacement (PIR) Guidelines for guidance on criteria. Those guidelines reside on the Minnesota DOT's website found at:

http://www.dot.state.mn.us/bridge/documentsformslinks/construction/10b01.pdf. Although the Bride PIR Guidelines were to expire in 2010, this is still the current version.

According to Nancy Daubenberger, "We tend to look back at past preservation/rehabilitation projects for details that were successful which can be applied to historic bridges. Also, we recently drafted a document that encourages designers and project managers to consider the use of design exceptions for historic bridges. That document is still under review by our State Historic Preservation Office. Cost estimating would be done internally by bridge estimating staff similar to other rehabilitation projects except [that] many instances require multiple option estimates."

The Bridge PIR Guidelines above are referenced in another important design guide, *Design Standards and Exceptions.* While this does not have specific historic bridge citations as yet, design exceptions have been key elements in successful historic bridge rehabilitations.

This guide is available at: http://dotapp7.dot.state.mn.us/edms/download?docId=623068

In the Design Exceptions and Standards guide Minnesota cites 13 Critical Design Elements which, along with a few additional bridge elements on certain projects, require documentation and approval. Provision is made for some exemptions for both documentation and approval. The 13 Critical Design Elements are:

- Design Speed
- Lane Width
- Shoulder Width
- Bridge Shoulder Width
- Horizontal Clearance to Obstructions
- Bridge Structural Capacity
- Stopping Sight Distance
- Horizontal Alignment, Radius
- Grades, Percent
- Vertical Alignment, K value
- Normal Cross Slope
- Superelevation
- Vertical Clearance

System Data

Minnesota DOT acquires its bridge condition data through an inspection program meeting NBIS standards and includes the PONTIS element level condition codes. PONTIS is the Bridge Management System (BMS) software developed by AASHTO and used by over 45 state DOTs to record and evaluate bridge condition down to the element level, such as a steel girder or floor beam.

Historic Inventory

Minnesota DOT maintains an up-to-date inventory of it its historic bridges. The inventory is part of its general Historic Bridge Management Plan, and of its PA. An annual update is provided to Minnesota SHPO in accordance with the PA.

Minnesota DOT's Historic Bridge web page is both thorough and informative. For each of the 24 premier bridges, accessed by the Preservation Tab, the electronic inventory provides links to photographs, historic data, historic context and the bridge's management plan. There are 25 bridges listed on the page because one of the 24 premier bridges in the Historic Bridge Management Plan, despite the DOT's best efforts, could not be rehabilitated. Rather than cross off the premier bridge that could not be rehabilitated, the DOT used its historic inventory and condition information and selected a replacement bridge to elevate to premier status. This highlights the importance of having a thorough and up to date historic bridge inventory.

Maintenance Manual

Minnesota DOT has, in its PA, a requirement for training of maintenance personnel who will work on the 24 bridges identified for preservation in the PA's Appendix A. Each of the 24 premier bridges has a maintenance checklist in its individual bridge management plan which must be filled out and submitted annually to the DOT Cultural Resource Unit.

3.1.4 Oregon

Asset or Resource Management through Programmatic Agreements

Oregon DOT manages its historic bridges as high value assets within its Bridge Program, centrally managed by the Bridge Engineering Section. Bert Hartman, Bridge Program Unit Manager, which has responsibility for determining which bridges are programmed into the STIP, explains that "Oregon has a System Preservation Strategy Work Plan for bridges. The first strategy is to protect the high value coastal, historic, and major river crossings and border structures. Oregon has defined the population of "High Value" bridges, many of which are historic. Oregon also uses "Practical Design" to fund only basic bridge rehabilitation projects and rare replacements. The bridge program in Oregon is centrally managed, and there one of the units is the Bridge Preservation Unit. Individuals in this unit are primarily involved with the preservation of historic structures. There is close coordination between this unit and those who are managing the STIP."

Oregon DOT has a PA with the state SHPO. Oregon Dot funds 50 percent of each of two positions with Oregon SHPO, one for Cultural Resources and one for Archeology.

System-wide Historic Bridge Plan

Oregon DOT has developed a statewide Historic Bridge Plan in a cooperative effort between its Bridge Engineering and Cultural Resource staffs. Concurrently, Oregon DOT has made Historic Bridges an element of its Bridge Program, which enables access to funding for repair and rehabilitation funding, along with other bridges. Oregon DOT brings its cultural resource

specialists onto the decision team that determines which bridges need what work, and when that work will be programmed as part of the Bridge Program.

Bridge-Specific Historic Bridge Plans

Oregon DOT has not developed bridge-specific management plans, although Hartman reports that they "are currently developing long term plans for each of our 200 "Major" bridges, a good portion of which are historic." The DOT has determined a number of actions that it will undertake in rehabilitation projects, and has incorporated these actions, or treatments, in nearly 30 projects to date. These include necessary repairs, seismic retrofit (phase 1), strengthening as needed, rail retrofit with strengthened historic (stealth) rails, preservation of visual details, such as McCullough's Art Deco styling, deck overlay and for steel structures, recoating. Oregon DOT has made a Department level commitment to the Public that it will preserve their historic bridges.

Evaluation Process

Oregon DOT replaces bridges, but as a last resort, whether historic or not, in order to maximize the effectiveness of funds available. The decision to replace is usually a system level decision, after a detailed Section 4(f) analysis that failed to find a prudent and feasible alternative. This is handled as a cooperative effort by the bridge engineering staff and cultural resources staff to ensure that all reasonable efforts were invested in attempting to avoid replacement.

This is in effect a "Pre-Section 106 Consultation" done prior to placing the project in the STIP as a candidate replacement project. It does not replace the Section 106 and Section 4(f) processes within the project, but it does make those steps much easier.

Bert Hartman points out that "Oregon has several historic coastal bridges that are irreplaceable and will be maintained indefinitely. These bridges take the majority of the funds that are devoted to historic bridge preservation. While the funding varies depending on the project that is programmed, approximately $15 million to $20 million goes into historic bridge projects annually." The funds used are federal Highway Bridge Program (HBP), Surface Transportation Program (STP) and National Highway System (NHS) with state matching funds.

Bert Hartman continues, "We consider rehabilitation for each bridge project. Only when rehabilitation does not make sense from a structural or financial perspective is replacement chosen. There is a rule-of-thumb that when the rehabilitation cost for any bridge is greater than 50 percent of the replacement cost, serious consideration should be given to replacement. We will seek guidance from our historians on bridges that are designated as being historic and those that look like they may be historically significant but have no historic designation. We recently had an older bridge that was not on the historic bridge list that was to be rehabilitated. During the project development, the only parts of the bridge that could be saved were the steel girders and the substructure. Since these had no historic significance, the bridge will be replaced. We fully coordinated with our historians before making this decision."

Bert Hartman notes, "Building the [State Transportation Improvement Program] STIP is a cooperative effort between the bridge headquarters unit, and the regions. Replacements are rare due to the current financial situation. Bridges that have deteriorated timber elements, scour issues due to the bridge being too short for the site conditions, or are deteriorated to the point beyond which rehabilitation is financially sound, are typical of the bridges that are replaced. The bridge program in Oregon currently programs one or two state highway bridges per year for replacement. After the draft bridge program is made, it is presented to the Area Commissions on Transportation for their input. The final decision on the projects that are included in the STIP is made by the Oregon Transportation Commission."

Section 106 and Section 4(f) Processes

On major projects, including rehabilitation and cathodic protection, bridge rail strengthening or replacement, widening or other alteration, Oregon DOT Cultural Resources staff develops the Section 106 finding in accordance with SHPO requirements and SHPO concurs with their finding. Oregon DOT has updated its PA with Oregon SHPO such that the DOT may develop the Section 106 finding without needing SHPO concurrence when the work constitutes repair or replacement of bridge components with in-kind materials, bridge deck and bridge joint repairs or replacement, pavement preservation and guardrail repair or replacement with essentially in-kind materials.

Program Level Cost Data

Oregon DOT has a library of bid cost data on historic and non-historic bridge and tunnel rehabilitation. The Cultural Resources staff has access to the Bridge Preservation Engineering Team, so that if cost estimates for rehabilitation and replacement prepared by others raise questions, the estimates can be independently checked.

Treatment Criteria

Oregon DOT has developed an extensive suite of analysis procedures, repair, rehabilitation and in-kind alteration treatments for historic bridges, and specialized contracting methods to help ensure successful completion of historic bridge rehabilitation projects. This "complete" approach has taken significant effort to develop, but has been paying off with repeated successful projects for over two decades.

Design Guidance

The Oregon DOT Historic Bridge Plan has developed guidance for treatment of its historic bridges. The Plan states that "the preferred option for the treatment of historic bridges is rehabilitating the bridge for continued vehicular use at its current location." Other Plan treatments include: pair with another bridge; repair and maintain for adaptive use; stabilize and close; transfer ownership (off-site); document, dismantle and retain for DOT or adaptive use; and document and demolish.

System Data

Oregon DOT inspects its bridges in accordance with the NBIS standards and records both the NBIS data and the detailed PONTIS element condition data in a database for analysis of needed work. The DOT performs quality control (QC) check inspections and invites members of the Bridge Preservation Team, and others, to participate. This is done to both ensure that accurate and reasonable data is provided by bridge inspectors and to extend the understanding of the physical bridge condition as represented by the data.

Historic Inventory

Oregon DOT Cultural Resources staff prepared the original historic bridge inventory, published as *Historic Highway Bridges of Oregon* (Smith, Dykman and Norman, 1989). The 1989 inventory has been added to by research on specific bridges considered for inclusion in the State STIP and by a detailed inventory and context statement in *Beam, Slab and Girder Bridges in Oregon* (George Kramer, 2004). An update to the inventory has been in the works for the last several years.

Maintenance Manual

Oregon DOT does not have an historic bridge maintenance manual. Its Bridge Preservation Engineering Team works closely with District Bridge Crews to review problems and develop maintenance solutions for historic and movable bridges. The Maintenance Districts are aware of the value the communities place on their historic bridges, and of the investment being made to correctly rehabilitate the bridges and maintain their historic integrity. The maintenance crews seek guidance, through the Regional Environmental Coordinator or through the Bridge Preservation Engineering Team, from the Cultural Resource staff on how best to perform maintenance or minor repairs on historic bridges.

Oregon is one of the states selected under NCHRP Program 20-68A for Scan 07-05: *Best Practices in Bridge Management Decision-Making*, Chapter 11, available at: http://onlinepubs.trb.org/onlinepubs/nchrp/docs/NCHRP20-68A_07-05.pdf. The report, published in 2009, states that Oregon DOT considers bridge maintenance and bridge preservation as one program and that the Bridge Preservation Team has responsibilities to work with maintenance crews to provide engineering support for and inspection for special maintenance items for historic and movable bridges.

The report notes that Oregon DOT reserves 20 percent of its Bridge Program funding for historic, coastal, movable bridges and border bridges. It also shows that Oregon lists "Historic Bridges" as the 13th category for bridge needs, and has identified Historic Bridges as the third highest category of bridge funding needs in the State.

3.1.5 Virginia

Asset or Resource Management through Programmatic Agreements

Virginia DOT (VDOT) manages its Historic Bridges through a management plan. Malcolm Kerley, Virginia DOT Chief Engineer, notes the DOT "has identified historic bridges and their treatment issues in advance: all bridges under VDOT purview that are individually eligible for or listed on the National Register are covered under VDOT's *Management Plan for Historic Bridges in Virginia* (Miller, et. al., 2001)."

Virginia DOT Cultural Resources staff have been a part of the development of the management plan, which researched, recorded and, organized information on the historic characteristics and significance of each bridge in the management plan. Additional information is acquired through projects for bridges that were not deemed eligible at the time the plan was written but now require a determination of eligibility.

System wide Historic Bridge Plans

The Virginia DOT management plan for historic bridges is statewide in scope. It includes 11 possible actions that must be considered for each historic bridge, including rehabilitate and keep for vehicular use, upgrade to DOT standards, relocate, abandon and replace. It also provides a set of actions that may be relevant to a specific bridge, such as strengthening, maintaining or improving the waterway, dealing with lead paint, continuing as a vehicle bridge, upgrading approaches, consensus on initial cost estimates, consensus on extended cost estimates, tort risk if treatment performed, and whether a new structure would be needed if a treatment were performed.

The Plan also lays out nine considerations that need to be addressed in design exceptions to continue service at less than DOT standards:

1. Type of project;
2. Amount and character of traffic;
3. Accident history;
4. Degree to which a standard is being reduced;
5. Whether the exception will affect other standards;
6. Effect of the exception on the safety and operation of the facility and its compatibility with adjacent sections of roadway;
7. Cost of attaining full standards and any resultant environmental impacts;
8. Whether any additional features are being introduced that would mitigate the deviation; and
9. Whether future improvements are planned or programmed to correct the substandard design feature.

Bridge-Specific Historic Bridge Plans

Appendix B of the Virginia DOT management plan includes a general plan for each of the 54 bridges studied, whether state, local agency or privately (railroad) owned. These are grouped in four categories: non-arch concrete (7), metal truss (25), concrete or masonry arch (20) and covered (2). Each has a recommended treatment, with management options in order of preference.

Evaluation Process

Malcolm Kerley notes, "Decisions regarding the disposition of any historic bridge begin with an assessment of its suitability for continued service in the transportation system and its evaluation as a historic property. Two complementary resources that provide a basis for these decisions in Virginia are the Bridge Safety Inspection Reports, required by federal regulations to be completed by Virginia DOT and other bridge owners every two years (every year for fracture-critical structures), and the 2001 *Management Plan for Historic Bridges in Virginia* completed for every structure that is eligible for inclusion or is listed in the National Register of Historic Places and the Virginia Landmarks Register. Choices beyond leaving the structure "as is" include documentation and demolition of the bridge, preservation or restoration in place or at a more appropriate location, or rehabilitation to meet current system needs. The decision process that follows is complex, involving an interaction of many engineering, environmental, and historic factors, in combination with contractor expertise and the availability of funding."

The decision process for rehabilitation versus replacement has two key steps, the initial one with the District Structure and Bridge Engineer and the second through review and approval by the State Structure and Bridge Engineer. The Chief Engineer explains, "These decisions are made in accordance with the recommendations in VDOT's *Management Plan for Historic Bridges in Virginia*. In the case of catastrophic damage from a natural or man-made disaster, the decision will be based on a combination of the management plan recommendations and the physical condition of the bridge."

Section 106 and Section 4(f) Processes

Virginia DOT performs Section 106 consultations on projects for concurrence by the Virginia Department of Historic Resources (DHR and SHPO).

Program Level Cost Data

Virginia DOT has a long record of repair and rehabilitation projects for its bridges, so has extensive bid tabulation data to draw from for costs estimates. The management plan was developed with the help of a multidisciplinary task force that ensured cost estimating for repair and rehabilitation treatments was done correctly and had consensus. The resulting database has Initial Cost [Consensus] as a data element that can be examined and updated to reflect changes in cost and level of agreement.

Treatment Criteria

The Secretary of the Interior's Standards address issues concerning repair, rehabilitation, and replacement situations. The Secretary's Standards are considered as part of the management plan in general and also in the case of any emergency repairs to individual National Register-eligible historic bridges in Virginia. Virginia DOT cultural resource staff coordinates these actions with the SHPO. The Plan is based on a Memorandum of Understanding (MOU) between Virginia DOT and the Virginia DHR/SHPO and has an established procedure for this.

Design Guidance

The management plan states, "Significant structures may be eligible for funding based on the scope of the work and the funding category applied. The overall transportation needs must be balanced with cultural enhancement. Long-range forecasting must be applied to determine how a bridge will provide the adequate level of service for the roadway and the most culturally beneficial solution to save and preserve significant structures. The impact of expending funds that will not be available for other structures is also a consideration. The trade-off of minimal maintenance to preserve in-place or until the structure may be dismantled and preserved off-site, and the expenditure of larger sums to provide a suitable (or unsuitable) continuing in-service bridge, must be weighed. Typically, there are no dedicated funds for historic bridges."

Virginia DOT has its *Best Practices for the Rehabilitation and Moving of Historic Metal Truss Bridges*, 2006, for guidance on preservation of truss bridges.

Historic Inventory

Virginia DOT inspects its bridges and requires local agencies to inspect theirs, in accordance with the National Bridge Inventory requirements established by the FHWA.

Maintenance Manual

The management plan provides some information on maintenance, but is not a maintenance manual.

3.1.6 New York City

Asset or Resource Management

New York City (NYC) DOT manages 787 bridges, including the Brooklyn, Manhattan, Queensboro and Williamsburg bridges, plus 25 movable bridges and 5 tunnels. The DOT provides detailed annual management reports on bridge conditions, work accomplished and work planned. The City does not have a formal asset management or resource management plan for its historic bridges.

System wide Historic Bridge Plan

NYC DOT does not have a formal historic bridge management plan. According to New York City's Bridge Engineer, Henry Perahia, NYC's practice is to "program projects to address the structural deterioration of the bridges. When those bridges are historic, we commonly include

and restore the historic elements to the extent possible (such as the canopy lights and the Colonnade on the Manhattan Bridge, and the fountain at Macombs Dam Bridge). When current safety standards preclude strict compliance with the original design, we attempt to design the features to resemble and be consistent with the original design to the extent possible. Landmarked bridges are reconstructed in accordance with local laws."

Bridge Specific Plans

NYC DOT does not have specific management plans for its bridges although development of maintenance, preservation and rehabilitation projects is ongoing, as noted in the annual reports.

As to the decision on rehabilitation or replacement, Henry Perahia notes that "Several parties are involved in the decision-making process. The process starts with our engineering personnel." "Unless there is a major traffic and/or safety concern that can only be resolved by replacement (can only think of one such case offhand - the Willis Avenue Bridge), the default would be rehabilitation. In the case of reconstruction or rehabilitation, we would need and obtain the approval of the design from the NYC Landmarks Preservation Commission and the State Historic Preservation Officer."

Evaluation Process

Henry Perahia explains that the New York City DOT does "make a distinction between safety and load capacity. Safety does not get compromised. Our design criteria are based upon [the] latest codes and standards set by NYS [New York State] DOT, AASHTO, etc. All substandard features are identified. As an example for this, we had barriers on the Brooklyn Bridge that would not deflect current vehicles safely, and we redesigned those barriers to meet current standards and resemble as closely as possible the original features. Remediation of major traffic impacts as well as security concerns would also fall under this category.

However, if the only concern is complying with current standards (as opposed to safety as well), then those features will remain substandard. To illustrate, the Brooklyn Bridge's design does not meet current standards for geometry and weight capacity (i.e., it does not accommodate trucks), and as a result is considered by the federal government to be functionally obsolete. Since compliance with current standards would require replacement of the bridge, the bridge will remain functionally obsolete for the foreseeable future (including after the current $500 million rehabilitation)."

Program Level Cost Data

Cost estimating is not an issue. NYC DOT bridges are such that replacement is generally not an option and each has an extensive history of repairs and rehabilitation, so costs are well documented.

Treatment Criteria

Henry Perahia notes that "There are no formal policies, but repairs by their nature are generally reversible and minimally invasive. At times, the repairs are done in two phases. We

will do whatever is necessary to first make the bridge and roadway safe. If the emergency repair is not consistent with the original feature, particularly on a historic structure, we come back for a longer term repair. As an example, if a vehicle damages a rail to the point that it is not safe to allow the roadway to stay open, we may put a Jersey barrier in front to make it safe in the interim while we fabricate a replacement rail that is consistent with the appearance of the rail that was damaged."

Design Guidance

NYC DOT provides in-kind rehabilitation of its historic bridges. Henry Perahia notes, "the preference is to rehabilitate the historic bridge (which can mean replacing major components, but they would be replaced with components that matched, to the extent possible, the original component)."

He further notes that the rare, theoretical exception would be if the structure were unsafe in its current configuration and would need replacement to make it safe.

The more common example is when the certain original features do not meet current safety standards, at which time NYCDOT would rehabilitate the bridge with features that are compliant and consistent with the general historic nature of the bridge.

Historic Inventory

NYC DOT inspects its bridges in accordance with NBIS standards. No information was obtained on how historic data was acquired or utilized.

Maintenance Manual

According to Henry Perahia, "Maintenance, including repainting, is generally performed to repair the deficient feature in kind and as a result does not impact the historic features of the bridge. Maintenance and rehabilitation are separate efforts and while rehabilitation can have maintenance impacts, maintenance rarely directs construction (except, of course, that the lack of maintenance accelerates the need for rehabilitation or reconstruction)." He also noted that any rehabilitation that changes the appearance of the structure is first reviewed and approved by the NYC Landmarks Preservation Commission.

3.1.7 Arkansas

Asset or Resource Management through Programmatic Agreements

Arkansas Highway and Transportation Department (AHTD) has a historic bridge program managed by its Environmental Division, Cultural Resources Section, which is a resource management program. It is designed to balance historic preservation needs with the traffic and safety needs of the public. The purpose of the Historic Bridge Program is twofold: first, to produce a statewide inventory of bridges eligible for inclusion on the National Register of Historic Places; second, to document, rehabilitate or preserve historic bridges that are programmed for replacement by AHTD.

Robert Scoggin, AHTD Bridge Historian and manager of the Historic Bridge Program, notes, "We do not have [an] asset management plan for our historic bridges. Until evaluations for rehabilitation or replacement are being made at the programming level instead of the project review level, a plan would not work. There has to [be] buy in of the value of rehabilitation as a viable option from all levels for it to work. The AHTD needs to be convinced that rehabilitation can be more cost effective than replacement in some cases and that a process can be created that would effectively evaluate the rehab\replace options before programming. We are working toward this goal."

System-wide Historic Bridge Plans

Arkansas Highways does not have a System wide plan for preservation of historic bridges. Bridges become proposed for projects when conditions deteriorate sufficiently that work must be done or the bridge closed to traffic, or when a route carried by an historic bridge is in need of modernization and the existing bridge will not be able to accommodate this.

Bridge-Specific Historic Bridge Plans

AHTD does not have bridge-specific plans for its historic bridges.

Evaluation Process

The evaluation process for alternatives is carried out in project development. According to Robert Scoggin, "The group that programs work at AHTD does not use the AASHTO Guidelines. When the historic bridge process was originally set up, a Historic Bridge Analysis Committee was created that included the Division Heads of Environmental, Surveys, Roadway Design, Construction and Right of Way along with the Heavy Bridge Maintenance Engineer and the Historic Bridge person. This group would meet after a project was programmed to replace a historic bridge and determine if replacement was the only option for the project. This normally results in the bridge being replaced unless the marketing was successful. The way the process is set up, it unintentionally precludes rehabilitation unless an outside group (SHPO) forces rehabilitation."

Section 106 and Section 4(f) Processes

The decision for replacement or rehabilitation is made during project development. Robert Scoggin notes that historic bridge rehabilitation is one of the three major issues he faces. "We do not look at rehabilitation of bridges until the project has already been programmed. We need to determine if the project should be a replacement or rehabilitation before the project is programmed."

Program Level Cost Data

AHTD has not rehabilitated many historic bridges and does not have a well-established database for bridge rehabilitation costs. It does have cost data for new construction.

Treatment Criteria

AHTD does not have established criteria, other than the Secretary of the Interior's Standards.

Bridge Guidance

AHTD follows the AASHTO Design Specification for Bridges. It does not have any design guidance for historic bridge rehabilitation.

System wide Data

AHTD collects and records bridge condition data as required by the NBIS standards.

Historic Inventory

Historic context has been obtained through a series of inventories, on a five-year basis from 1987 through 2000. Henry Scoggin explains, "Every five years we evaluate a class of bridges (generally [a] time period i.e. 1955-1960) for eligibility to the NR. Recently we have reevaluated our original inventories for 1987 to 1992 along with certain classes of bridges (i.e. grade separation, [Works Progress Administration] WPA). Occasionally, a bridge will show up that is determined eligible that was not part of the inventories."

AHTD has an extraordinary set of methods to make their historic bridge inventory available to the public. Through their Environmental Division Historic Bridge Program website: http://www.arkansashighways.com/environmental/cultural_resources/historic_bridge_program.aspx

The public can use their GIS map to locate historic bridges, view their inventories, select groups of bridges by type with beautiful photographs, detailed GIS map and a thumbnail sketch of bridge features.

Also available are fly-through visualization graphics of laser scanned historic truss bridges.

Separately, there is an excellent video prepared by Arkansas Educational Television Network and AHTD available at http://www.arkansashighways.com/movies/historic_bridges_of_arkansas.aspx offering a very thought-provoking insight into the connection people have to historic bridges.

Maintenance Manual

AHTD does not have a manual for historic bridge maintenance. According to Robert Scoggin, "maintenance of historic bridges" is one of the three biggest issues AHTD faces in managing historic bridges. "We need to do a better job of maintaining the bridges while they are in use. We are slowly working with our heavy bridge maintenance engineer to create some guidelines for this that can be used by AHTD and hopefully the counties."

3.1.8 Indiana

Asset or Resource Management through Programmatic Agreements

Indiana DOT has a *Programmatic Agreement among the Federal Highway Administration, the Indiana Department of Transportation, the Indiana State Historic Preservation Officer, and the Advisory Council on Historic Preservation Regarding Management and Preservation of Indiana's Historic Bridges* (2006). The PA outlines project development procedures for historic

bridges based on their classification of Select (bridges most suitable for preservation and that are excellent examples of a given historic bridge type) or Non-Select (not considered excellent examples of a given type of historic bridge or are not suitable candidates for preservation). The PA provides a basic asset management plan for the Indiana DOT historic bridges.

System-wide Historic Bridge Plan

The PA has determined which bridges are "Select" and which are "Non-Select," so it is a System wide plan. According to DOT Architectural Historian, Mary Kennedy, "The programmatic agreement streamlines mitigation for replacement of Non-Select bridges because individual project memorandums of agreement (MOAs) are no longer needed if the only "adverse effect" is to the bridge itself (after a thorough alternatives analysis has justified replacement)."

Bridge Specific Historic Bridge Plans

The bridges determined to be Select have a specific plan to be preserved. The programmatic agreement specifies that FHWA-Indiana Division will not fund the demolition of a Select bridge. Mary Kennedy notes that it is "too early in our program implementation to have any aggregate data on resultant projects."

Evaluation Process

The rehabilitate or replace decision has been made up front in the Select/Non-Select process. Mary Kennedy points out that Cultural Resources staff does not make decisions about whether to rehabilitate or replace historic bridges. "We review documents related to the environmental process to ensure they comply with the programmatic agreement." The Select/Non-Select process therefore appears to not be a multidisciplinary approach.

Section 106 and Section 4(f) Processes

Mary Kennedy notes, "The Programmatic Agreement and supplementary Project Development Procedure (PDP) require a thorough Section 4(f) alternatives analysis, specifying the alternatives to be studied. We are too early in our program implementation to have any aggregate data on resultant projects."

Program Level Cost Data

As noted above, Indiana has little experience with this new process and so does not have recent cost data for rehabilitation work in Indiana DOT contracts.

Treatment Criteria

The PA provides the criteria for treatments. Select Bridges would have to be replaced wholly at the DOT's cost.

Design Guidance

There is no engineering design guidance in the PA. It does identify, in Appendix B, two standard treatments, Rehabilitation and Demolition. Rehabilitation must be used for Select

Bridges and may be used for Non-Select. Demolition may not be used for Select Bridges. Ms. Kennedy notes that the "Historic Bridge Project Development Process (PDP), which is based on stipulations within the above agreement" (PA), provides some guidance and the "Indiana Design Manual Section 72-7.0, Treatment of Historic Bridge on Low-Volume Local Road" offers some additional design guidance.

System Data

Indiana DOT inspects and records condition data in accordance with the NBIS standards. The DOT collects element level PONTIS data, which it has combined with other data in a system by a vendor selected by AASHTO for future PONTIS Bridge Management System versions.

Historic Inventory

The Select/Non-Select process could not be finalized, notes Mary Kennedy, until the "historic bridge inventory (which was called for through our historic bridges programmatic agreement) determined National Register eligibility of all publically-owned bridges built before 1965. The process was completed in February 2009." "Therefore, eligibility of these bridges is known before a project is even proposed."

Maintenance Manuals

For all Select Bridges, and when the selected alternative includes preservation of a Non-Select Bridge, the bridge owner must ensure that the bridge will be maintained for at least 25 years. No maintenance tasks are identified and only the Secretary of the Interior's Standards for Rehabilitation are referenced.

3.1.9 Texas

Asset or Resource Management through Programmatic Agreements

Texas established a Memorandum of Understanding (MOU) between Texas DOT (TxDOT) and Texas Historical Commission (THC/SHPO) in its Administrative Code, Title 43, Part 1, Chapter 2, Subchapter B, Rule 24. The MOU provides "a formal mechanism for THC review of TxDOT projects that have the potential to adversely affect cultural resources in order to assist TxDOT in making environmentally sound decisions." The MOU and a parallel programmatic agreement (between FHWA, THC and the Advisory Council on Historic Preservation) provide for streamlined review of TxDOT projects. Streamlining mechanisms embedded in these parallel agreements include in-house clearance by TxDOT staff of projects with no adverse effects on historic properties, specified consultation procedures and standardized procedures for historic bridge projects. TxDOT must provide monthly reports to FHWA and THC on such undertakings.

The agreements require TxDOT to provide funding for THC to implement measures to facilitate early coordination, expedited 20-day reviews of TxDOT's transportation projects and other streamlining mechanisms developed in cooperation between the agencies.

The agreements list a series of activities that do not have the potential to affect historic properties and therefore do not require individual project review by THC.

In the agreements, TxDOT commits to early identification of cultural resources within standardized areas of potential effects (APE) for proposed transportation projects. It further commits to initiating coordination with consulting parties including the SHPO during the early planning stages of these projects, when the widest range of alternatives is open for consideration.

System wide Historic Bridge Plan

TxDOT manages its historic bridges with a plan, detailed in its Historic Bridge Manual, available at: http://onlinemanuals.txdot.gov/txdotmanuals/his/working_with_historic_bridges_temp.htm. The Manual is a statewide management plan, identifying treatment options and requirements for proper purpose and need statements. TxDOT Bridge Division design engineers and historians are currently engaged in developing an updated historic bridge manual for implementation in FY13.

Bridge-Specific Historic Bridge Plan

TxDOT developed bridge-specific historic bridge management plans for on-system historic bridges in 2002 in conjunction with the THC. These plans outline the potential for preservation of bridges listed in the National Register of Historic Places, but maintenance is not currently addressed specifically for historic bridges. Localized decision-making is driven by the results of biennial inspection cycles for both on-system (by the district) and off-system bridges (by the local governmental owner) as issues arise.

Current efforts include development of bridge-specific management plans for a broader range of locally owned and on-system historic metal truss bridges for a broader scope of issues including standardized maintenance strategies. These plans also are intended to provide models for local governments to adapt in making decisions about maintaining their bridges sufficiently to keep them from needing major intervention drawing on federal bridge funding. Expected to be developed in FY13, these plans are intended primarily for use by TxDOT district staff, but should also serve as well as models for potential adoption by local governments owners of historic bridges.

Evaluation Process

The agreements specify that projects involving historic bridges-require TxDOT to evaluate the preservation options in the following order of preference: full vehicular use; reduced level of vehicular use; non-vehicular use at original site; relocation for vehicular use; relocation for non-vehicular use; or demolition. TxDOT documents the evaluation of each preservation

option including the identification of the preferred option with supportive alternatives analysis to be provided to consulting parties and the THC during the Section 106 coordination process.

Section 106 and Section 4(f) Process

If the chosen alternative poses an adverse effect to a historic bridge, the agreements require TxDOT to consult with THC in accordance with 36 CFR 800 (Section 106) for all federally funded bridge projects. The results of the Section 106 consultation are folded into the Section 4(f) alternatives analysis submitted to FHWA for a final determination of the outcome of the proposed project.

Program Level Cost Data

In conducting alternatives analysis, the TxDOT Bridge Division employs cost data based on contracted repairs and rehabilitation projects completed throughout the state. The Bridge Division employs a senior bridge design engineer specializing in repair and rehabilitation of historic bridges, as well as project managers with extensive experience with such projects.

Treatment Criteria

According to TxDOT senior bridge design engineer Charles Walker, historic bridge preservation projects consider three primary strategies:

- Rehabilitate for continued service,
- Adaptive reuse (convert to a pedestrian only structure), and
- Bypass.

These options consolidate the treatments identified in the agreements into the most pragmatic options that account for preservation, safety and fiscal goals.

Design Guidance

TxDOT engineers devised alternative minimum design standards to apply to historic bridges on low traffic volume roads. These standards provide guidance in designing safe repairs, retrofits and rehabilitation of historic bridges in cases where low traffic volume, nearby alternative routes and narrow travel lanes do not limit the application of appropriate preservation solutions.

System Data

TxDOT inspects its bridges and records the condition data in accordance with the federal NBIS standards. TxDOT follows a comprehensive and detailed inspection manual, which helps ensures the conditions are correctly evaluated and recorded in devising treatment strategies for both on-system and off-system bridges.

Historic Inventory

TxDOT maintains data on all functional on-system and off-system historic bridges to inform its planning efforts. Inventories completed to date include historic metal truss bridges, non-truss

bridges, Depression-era bridges and postwar bridges. Eligibility determinations are made at the statewide level of engineering significance, with provisions for the analysis of local historical significance. Further historical data is obtained through consultation with local historical commissions as projects are planned. Guidelines for the development of this data are outlined in *A Guide to the Research and Documentation of Historic Bridges in Texas* (Knight & Associates, 2004), available at: http://ftp.dot.state.tx.us/pub/txdot-info/env/bridges.pdf.

Maintenance Manual

TxDOT follows procedures outlined a bridge maintenance manual, but it currently provides no technical guidance specifically targeted to issues faced by historic bridges. This gap will be addressed by management plans for historic bridges being developed for release in FY13.

3.2 Project Development Practices by State or Local Agency:

3.2.1 Ohio

Multi-discipline

Ohio DOT, starting from a program level review of bridges, is well prepared for handling historic bridges when level of service, condition or other issues result in the need for a project. Ohio DOT provides cultural resource staffing to the project team for in-house design and requires equivalent staffing for consultant design. Tom Barrett notes that "as CRM [cultural resource management] folks study the mechanics of the bridge; focus on what elements should be preserved; become knowledgeable in engineering/safety concerns and material limitations; they are consulted earlier in the decision making" process.

Define Scope

Ohio DOT programs both rehabilitation and replacement projects. On replacement projects, rehabilitation is also considered. Tom Barrett notes that since 2010, one of the initial 12 management plan bridges has been re-scoped from a scheduled replacement to rehabilitation based on the management plan's recommendations.

Determine Options

Ohio DOT cultural resource staff recommends alternative considerations in the preliminary scoping process which are based on 4(f) Alternatives Analysis requirements. Tom Barrett states that this approach has proven "more successful in getting a rehabilitation" project established than the more conventional requirement for "quantitative analysis of bridge options later", which will only "satisfy 4(f) for the Environmental Document."

Evaluate and Communicate Historic Significance

According to Tom Barrett, whenever the cultural resource staff is consulted on the historic status of a structure and work is scoped for the bridge, a copy of the applicable section of the *Ohio Historic Bridge Maintenance and Preservation Guidelines* is sent via email and/or included

[in] the Section 106 finding as an environmental commitment for the project, to insure the proper treatment of the bridge.

Bridge Conditions, Traffic, Design Exceptions

For important historic bridges, the historic significance of the bridge, its contribution to a historic district, if present, and its character defining features that are most important to preserve are provided to the project team.

For bridges without a bridge-specific plan, the information required is contained in the Ohio Historic Bridge Inventory, which has been updated regularly, and is conveyed by the cultural resource staff assigned to the project. Cultural resource staff members provide historic evaluation and interpretation expertise to the project team to assist them in delivering a successful project.

Ohio DOT, as noted above, utilizes the 4(f) alternatives analysis approach to identify the problems that must be resolved for the bridge to continue to function in its role in the transportation system, and repair, strengthening and alteration actions, which would satisfactorily address the key issues. Ohio DOT has a long record of the structural engineers and cultural resource staff working together. Tom Barrett notes, "Ohio DOT structural engineers are very proactive in exploring rehabilitation options early on bridges where we have jurisdiction (US and State Routes). Locally sponsored projects that have a federal action that requires Alternatives Analysis for 4(f), receive a concurrent review by our Cultural Resources staff and Structural Engineers."

Cost Comparisons

Ohio DOT has both a large number of historic bridges (484 as of its 2010 inventory) and a large number of bridges that have been rehabilitated or repaired. As a result, Ohio DOT has a substantial amount of actual cost data, which it uses to reasonably price alternatives for comparison, as well as develop ultimate project construction estimates.

Public Communication and Involvement

Ohio DOT keeps the public both well informed and involved to ensure smooth, positive project delivery. The ODOT Division of Planning, Office of Environmental Services has a website for historic bridges, with links to resources such as Buckeye Assets and the updated historic bridge list (http://www.dot.state.oh.us/divisions/planning/environment/cultural_resources/historic_bridges/Pages/default.aspx).

Bridge Maintenance

Ohio DOT has both its written guide, *Ohio Historic Bridge Maintenance and Preservation Guidance*, which provides guidance, by type of bridge, material and bridge element, from a historic perspective, for use by rehabilitation design engineers and maintenance staff and its on-line Bridge Maintenance Manual, which provides preventive maintenance guidance and repair techniques, by bridge element, and for repairs, expected costs and repair life.

In addition, with respect to emergency repairs, Tom Barrett notes, "Our District environmental coordinator notifies us when a historical property is scheduled for emergency repairs. We have conducted photo-documentation, and construction monitoring on a few instances with negligible schedule interruptions for the highway repair. Scoping the data recovery work at the pre-bid emergency contract meeting greatly helps, when it is feasible."

Capture Innovation

Ohio DOT has an innovative method to enable the public to access information about its bridges. Buckeye Assets (www.buckeyeassets.org) enables finding bridges within an area on an electronic graphical interface system (GIS) map. One can look specifically for historic bridges and select one from the map and read through the information compiled on the bridge.

Ohio DOT and its partners have tasked themselves in their PA to work collaboratively to identify innovative ideas and special needs, record them in their annual reports, as a minimum. The focus within the PA is on cultural resource field and management issues, and does not address innovative design, analysis, materials, construction or contracting innovations. Innovative ideas in these areas are captured through technical presentations as conferences, such as the Ohio Transportation Engineering Conference (OTEC), and national conferences such as the Concrete Bridge Conference.

The American Society of Civil Engineers (ASCE) Central Ohio Section has hosted a number of Historic Bridge Conferences in Ohio, which have shared technical advances and preservation initiatives among engineers and cultural resource specialists.

Within the DOT, the engineers and cultural resources staff work closely together so that ideas are not lost, but there is not a special program for documenting innovative techniques.

3.2.2 Vermont

Multi-discipline

According to VTrans Historic Preservation Officer Scott Newman, the Historic Preservation and Archeology Officers are responsible for making final Section 106 determinations on behalf of the SHPO. He notes, "This has numerous advantages beyond eliminating a step in the review process. It allows the decision makers to be at the table in internal project meetings improving productivity, enables significant reductions in documentation and other paperwork, and increases ownership of the process with attendant improvements in historic resource consideration." This, in effect, puts SHPO on the design team.

Define Scope

Bridge design engineer, Wayne Symonds, explains: VTrans starts determining the project scope through evaluation of the bridge condition and its load rating. For VTrans, "Safety is job one. However, we do sometimes establish project specific design loading based on the location and use of the historic structure. Once established the structure is rehabilitated to meet that loading. The Vermont State Standards are used to determine whether the existing width is

adequate." "Vermont has developed and adopted its own state standards (Vermont State Standards) that provide flexibility on the geometrics of the highway. All historic bridges are designed and rated to the AASHTO Standard Specifications using the Allowable Stress Design. We have found with this approach we are not compromising." Vermont State Standards are practical design methodology, just not labeled as such, which permits tailoring the scope of work to meet the actual needs of the bridge.

Determine Options

VTrans, in its Project Development Manual, states: "The purpose of any transportation project is not to replace a bridge or replace a road. That decides the project outcome before the ink is dry on the [Purpose and Need] P&N statement. The entire idea behind writing a P&N is to state in general terms the goals for the facility. In some cases the purpose behind a project might be to improve safety, to enhance mobility, to enhance commercial development, to improve structural capacity, to enhance pedestrian and bicycle movement, etc. It can be a combination of these or just one. But in no case does the P&N state a solution."

Mr. Newman summarizes the process in these points:

- Treatments for metal truss bridges are stipulated in the management plan based on engineering and traffic analysis. Bridges in this plan are cleared for Section 106 because the document is formatted as a Section 106 PA. Each project is further evaluated for Section 106 and Section 4(f) when programmed given that conditions may have changed since the agreement was signed (1998).
- Treatments for concrete arch bridges are recommended in the management plan (draft). This document is not formatted as a Section 106 PA and recommendations are vetted through the Section 106 and Section 4(f) processes as projects are programmed.
- Recommended approaches to evaluating and rehabilitating masonry arch and covered bridges as a class are detailed in their respective management plans. The bridges are not assigned to different treatment categories based on the assumption that these bridges possess sufficiently high historic significance that every reasonable effort will be made to preserve every structure in every case. Final decisions about treatment are made within the Section 106 and Section 4(f) evaluations underpinned by the contents of the management plans.
- Adherence to the Sections 106 and 4(f) regulations, with adequate public input, ensures fair consideration of repair and replacement alternatives.

Evaluate and Communicate Historic Significance

VTrans has dedicated significant effort over several decades to establish its programmatic approach to historic bridges. These plans and draft plans communicate to the design team the historic significance and character defining features to preserve.

Bridge Condition, Traffic, Design Exceptions

The design team evaluates the bridge condition information, traffic data, the load rating, the appropriate plan or draft plan for the bridge type, the purpose and need statement and previous designs for similar bridges, to determine what solutions could be applied to the bridge at hand. Wayne Symonds notes that VTrans "developed a consistent approach to the metal truss and timber covered bridge rehabilitation projects. This consistent approach has allowed us to develop a good relationship with SHPO and to start the conversation closer to "Yes". It has taken 15 years to develop this shared understanding between the engineering and historic constraints. SHPO and engineers can now look back on the history of success and carry that forward." He adds: "Historic structures in Vermont are not really analyzed differently or use different materials or specifications. The lesson learned is how to use good engineering and material choices to meet the needs including historic concerns."

Cost Comparisons

As mentioned under Program Management, VTrans has good histories on bid data although every bridge can have its own unique qualities to take into consideration when estimating. Wayne Symonds notes that "Vermont has few of what would be considered larger iconic bridges and for the historic bridge projects we have found that the bid history is scalable to the size of the project. "

Public Communications and Involvement

VTrans provides for public communication, through its websites and advises the public of upcoming projects, progress of current projects and seeks opinions from the public.

Bridge Maintenance

VTrans has identified the maintenance actions required for continued safe use of metal truss and covered timber truss bridges. For Towns that enroll their bridge(s) in the Historic Bridge Program, VTrans requires that these listed maintenance actions be routinely performed in exchange for funding all further rehabilitation work as needed for the enrolled bridge(s).

3.2.3 Minnesota

Multi-discipline

Minnesota DOT does not have a requirement for multi-discipline design teams, but the cultural resource staff is actively involved. Kristen Zschomler notes: "Currently, we are only involved in project level reviews. We are working to improve the project selection process through the following steps – making sure all bridge owners are aware of which bridges are historic, helping to create scoring criteria that gives more points to historic bridge rehab projects, and providing better guidance on how to get through the NEPA, Section 106, and 4(f) processes.

3.2.4 Oregon

Multi-discipline

Oregon DOT utilizes a multi-discipline project team approach on all projects, and ensures bridge preservation engineers and cultural resource specialists are a part of any team working on a historic bridge project. A significant factor in this is the expectation of the public that historic bridges will be preserved to the extent possible. Each design team is aware of this and this awareness enhances the position of the cultural resource specialist, and of the bridge preservation engineer. This has developed steadily through a series of projects, primarily on the Oregon Coast Highway and the Historic Columbia River Highway.

Having hydraulics, environmental, traffic, roadway, bridge, cultural resources, public involvement, right of way, construction and maintenance representation at the table ensures all factors are looked at and prioritized. This helps keep things in perspective when the desired work is compared with the available funds. For the Coast Arch Bridges and Movable Bridges, the manager of the Bridge Preservation Engineering Team often joined the project design team to help guide the project to a successful rehabilitation. This included assisting with FHWA and SHPO discussions preliminary to providing documents for formal review and "marketing" the project to the construction contractors.

ODOT Bridge preservation provided another feature in historic bridge contracts that the contractors appreciated: joint designer/contractor/inspector training to both help develop the skills needed and to ensure all parties have an understanding of what is needed. This also enhances the concept of partnering for success, rather than specifying the minimum acceptable workmanship.

Working with the biologists, Bridge Preservation pioneered providing concept drawings of work bridges and enclosures to support the rehabilitation work. These were done early to support the Biological Assessment (BA) for working in critical endangered species habitat. The regulators, primarily Oregon Fish and Wildlife and National Marine Fisheries, greatly appreciated this, as the work bridges and enclosures they saw on site looked like the drawings in the BA. This confirmed the work proposed and the work accomplished were the same.

Define Scope

Oregon DOT programs historic bridge projects, with some exceptions, as repair or rehabilitation projects. On projects where replacement is the action identified, and modernization of the route to meet traffic demand is the driving force for the project, a thorough analysis of route alternatives and an analysis of alternatives utilizing the bridge in some capacity are studied. In one rare case, a McCullough-designed arch bridge, Cooks Chasm, was replaced because the ocean had eroded the rock outcroppings the bridge was founded upon to the point it was at risk. A replacement arch bridge was constructed farther in and with a longer arch to avoid a repeat action. The short piece of US-101 abandoned was turned into a scenic overlook for the ocean and the new arch bridge.

This started with three Coast Bridges, programmed for rehabilitation to prevent loss to corrosion damage as had happened to the Alsea Bay Bridge. The DOT did not have an idea of what could be done or what it would cost. The scope was essentially "fix the bridge", with no basis for costs. Two individuals in the Bridge Section knew of a technology and research in progress by the California DOT (Caltrans) that could halt the corrosion process. One bridge was turned into a test project. Its successful completion caused the creation of the Bridge Preservation Team and conversion of the other two projects into cathodic protection and rehabilitation projects.

The DOT, FHWA and SHPO all wanted these projects to succeed, but Oregon's share of Highway Bridge Program funds was modest. Control of scope emerged as a clear lesson learned to apply to historic bridge and other rehabilitation projects. Rehabilitation permits this.

As an example, in 2007 rehabilitation started on the Coos Bay (McCullough Memorial) Bridge southern arches. The northern arches were held out as a second phase, unprogrammed. The bid was favorable and change orders were minor, so the deck overlay was extended to the northern half. Additional funds were found to allow the rail replacement for the northern arches to be added. Recently funds have been identified to provide cathodic protection for the northern arches project. This will complete the approximately $80 million dollar rehabilitation and preservation effort around the time the bridge reaches 80 years in service.

Determine Options

Oregon DOT cultural resource specialists develop the Section 106 finding for each project, and with which the Oregon SHPO concurs. The Historic Bridge PA provides for Oregon DOT cultural resources staff to make the final determination without SHPO concurrence for specified work where it is deemed not to impact the historic nature of a bridge.

Because almost all projects involving historic bridges have a preliminary analysis that is agreed to by DOT cultural resources staff prior to programming, the options investigated by the design team involve the level of rehabilitation, techniques to be used, the constructability of techniques, impact to the public during construction, how to incorporate environmental protection, safety improvements and reduction in future maintenance needs. With Oregon DOT having completed nearly 30 historic bridge projects in the last two decades, the design teams have many proven techniques with their costs, to provide useful information when finalizing the scope of work and contract plans. Cost is always a concern, and some desired work items are not accomplished in a current project as a result. The design teams are constrained to stay within scope, but new information can result in a change in scope, and an increase in funding. The team is reminded, however, that the funds come from a reduction in scope of another project.

The determination of options, as noted below, starts with safety. A critical element is the load rating. If the bridge cannot carry at least the required legal load limits (no posting is required) after rehabilitation, keeping it under traffic will be difficult. Here, the options start with

identification of the elements that reduce the load rating below the legal loads and the desired annual permit loads. If the structure is an arch or a truss, a finite element model is usually developed and a proof load test is performed to validate the model.

Evaluate and Communicate Historic Significance

Oregon DOT consults informally with SHPO prior to proposing unusual techniques or projects involving alterations. Where replacement open railings have been used and the original 18-inch arched opening was retained, FHWA has required the DOT to meet the AASHTO 6-inch ball criteria. On the first such bridge, the DOT used the SHPO suggested stainless steel aircraft cable strung horizontally outboard of the openings with stainless steel fasteners and turnbuckles. Subsequent bridges have used a mutually agreed upon stainless steel bar, bent to follow the shape of the arch.

During project design, a cultural resource specialist is a permanent member of the design team. The cultural resources staff function is twofold:

- Educate the team on the history and significance of the specific bridge and how it fits into the roadway and locality, and its place in the collection of historic bridges; and
- Inform the team of which features must be preserved and to assist in negotiating minor alterations to features required when condition of the feature requires more than repair-in-kind.

Oregon DOT Bridge Section's view has become cultural resource specialists save scare rehabilitation dollars. They answer the engineers' questions and help identify what features need to be preserved and to what degree, along with features that can be modified or left as is, thus focusing funds where they are most needed. By not attempting to make all of the bridge as if brand new, another historic bridge will be preserved, as well.

This joint process is what is responsible for ODOT keeping the rehabilitation cost of its historic bridges down to about one third the cost of replacement and still ending up with award projects.

Bridge Conditions, Traffic, Design Exceptions

In evaluating bridges during the design process, the Bridge Preservation Engineering Team starts by examining the following:

- Original as constructed drawings;
- Existing as constructed photos;
- Load rating conditions to determine extent of strengthening repairs;
- Bridge inspection report and accident report data;
- Historic information provided by agency historian;

- The amount of funding available to do all or a portion of the work items based on the ODOT Practical design concept; and
- Region, District or Maintenance office requests for a particular work items.

The team starts with bridge safety. According to Ben Tang, the Team Supervisor, "The first issue is safety, determined by examining the accident data for the bridge. If no major vehicle accidents have been documented on the bridge and by visual inspection there are no apparent indications of vehicle damage to the bridge rail, then the findings would imply any major structural modifications to bridge rail unnecessary."

One issue with bridge safety is deck width. ODOT's Bridge Preservation Engineering Team considers multiple factors before recommending an historic bridge for widening. According to Ben Tang, "With respect to load capacity, if the bridge structural support members have the capacity to carry the additional widening of roadway and still maintain the architectural integrity of the structure, then the widening will result in increased traffic safety just by eliminating the issues associated with a deficient roadway width."

He elaborated that the DOT will "rehabilitate existing beams of historic bridge by FRP [fiber reinforced polymer] strengthening to either maintain or increase load rating capacity. In order to preserve the original appearance of the strengthened FRP beam, rather than cover the FRP surface with a painted coating, my technique consists of broad casting a sand mix to the last epoxy top coat and then cover the surface with a class 2 finish."

When replacement of the architectural pedestrian railing with a visually identical vehicle railing is desired, Ben Tang ensures he obtains a design exception for historic bridge railing, which is a "Stealth rail - providing a precast concrete exterior with a interior steel skeleton designed to carry AASHTO Standard Specification [for Highway Bridges] (17th edition) traffic rail loading."

His lesson learned in ensuring continued use of design flexibility is to "maintain proper documentation throughout the design phase. Obtain all design exceptions."

Cost Comparisons

Ben Tang explains, "Bridge estimated costs [are] determined from Bridge Section Cost data base, RS Means cost analysis books, and existing rehabilitation cost Bid Tabs. Generally small projects are higher in cost. Smaller projects require less quantity of material but the same amount of work or equipment to accomplish tasks. A deck overhang widening for example, whether the project is large or small, require the same type of equipment to do the job e.g. (handling equipment like forklift, crane)." Oregon DOT has nearly 30 historic bridge rehabilitation projects completed from which to draw bid costs for estimates. The cost for rehabilitation is always compared to the cost for replacement. For Yaquina Bay, rehabilitation of the concrete spans was $13 million as opposed to $54 million for replacement. However, $8 million for painting and $4 million for planned repairs for the steel arch spans need to be added, bringing the rehabilitation cost to $25 million, and the replacement cost needs to be

adjusted to a present value well in excess of the 1990 estimate, which will keep the bridge within the Oregon DOT experience of rehabilitation costing approximately 1/3 of replacement.

Perhaps the most interesting lesson learned here is that the Oregon DOT has adopted the Section 4(f) analysis to replacement and rehabilitation in general. With concern nationwide that the condition of infrastructure is worse than the available funds can handle, and that the economy cannot support additional taxes, Oregon has seen that carefully rehabilitating historic bridges requires significantly fewer funds than replacing them with new bridges meeting current standards and has chosen to careful rehabilitate non-historic bridges to achieve similar cost savings. This increases the number of critical bridge problems the State can resolve with the available funds.

Public Communication and Involvement

Oregon DOT provides extensive public involvement and public information prior to and during each project to ensure public knowledge and satisfaction with its stewardship of their historic bridge. Cultural resource staff members help with public meetings, which are mandatory for DOT projects, and with information for public affairs and public involvement staff. Ben Tang notes that these "allow community input by town hall meeting to determine perception of community toward structural widening or modifications to historic bridge."

In one case, the Rocky Creek (Ben Jones) 1927 arch bridge rehabilitation, at public meetings held in the community, the public persuaded the DOT to not pursue widening the 22 foot wide bridge by two feet as they were concerned that such an action could result in the SHPO removing the determination of eligibility for the bridge. In another case, the rehabilitation and widening of the 1923 Old Winchester arch bridge, the standing-room-only public meeting was resoundingly in favor of widening this 20 foot wide seven arch span bridge by 4 feet and adding sidewalks, even though only the sidewalks could only be 3 feet wide. The public further agreed to have the bridge closed for nine months to enable the Contractor to complete the project earlier. In both cases the community made it clear that this was their bridge, and they would work with the DOT just as they expected the DOT to work with them.

Each historic bridge project and each significant project has a website created, which provides background, current status and news about the bridge. Examples of these project websites are:

http://www.oregon.gov/odot/hwy/region1/pages/or43_willamette_river_br/index.aspx

http://www.oregon.gov/ODOT/HWY/region3/oldsiskiyou.shtml

http://www.odotmovingahead.com/article.php?current_month=Sep-2011&articleid=256&title=Bridge%20rehabilitation%20wraps%20up%20on%20Old%20Siskiyou%20Highway

http://www.oregon.gov/odot/hwy/region1/pages/stjohns/index.aspx

Bridge Maintenance

Oregon DOT has two levels of maintenance work for bridges. Maintenance Districts, within their own budget and staffing, perform normal maintenance, including pressure washing of bridges, minor spall repair, paint touch up, deck patching, removal of accumulated drift wood, cleaning of catch basins. A second level of maintenance, Major Bridge Maintenance, is funded by the Bridge Program. Projects are proposed by the Districts, reviewed and approved by the Bridge Operations and Bridge Program Units and either performed by the Districts or by contract. Cultural Resources staff are involved with these even though there may not be a formal project team established.

The Bridge Preservation Team provides maintenance engineering design for many maintenance projects. With its experience on historic bridge projects, it recognizes when Cultural Resources staff assistance is required and easily and informally adds them to the effort, if not already involved.

Capture Innovation

One of the methods Oregon DOT uses to capture innovative ideas is through presentations at its annual Bridge Design Conference, the Oregon and Northwest Region Bridge Maintenance Conferences and at the biennial Western Bridge Engineers Seminar. Another method, encouraged by FHWA and others is to provide presentations at national bridge and historic conferences, when out-of-state travel can be approved and funded, so that others are aware of the results this proactive approach of Oregon DOT engineers and historians working together to both keep people moving and keep their transportation history present.

While not a scientific method, one thing that ODOT is able to do, with the average of at least one historic rehabilitation project completed a year, is to factor new ideas and lessons learned from the last project into the current one. Design techniques and specifications improve with this “production line” approach. Doing a project every five years does not allow such an easy transfer of information and makes a more formal method very important.

3.2.5 Virginia

Multi-discipline

Virginia DOT developed a statewide historic bridge plan that has a specific recommended treatment plan for each bridge that the project design team must follow. The plan was developed under the oversight of the Historic Structures Task Group (HSTG), an interdisciplinary team, which includes Virginia DOT’s Cultural Resource Program Manager, an Architectural Historian from Virginia’s Department of Historic Resources, FHWA’s Virginia Division Bridge Engineer, a Virginia DOT structural engineering supervisor and experienced researchers from the Virginia Transportation Research Council. The group addresses the management of historic bridges in Virginia through combined expertise in bridge engineering, maintenance, and local history. Initially, the HSTG came together as part of an effort to inventory bridges throughout Virginia to evaluate the significance of the bridges surveyed and

their eligibility for the National Register of Historic Places. The group was also instrumental in developing a management plan for addressing the bridges determined to be significant. Through these efforts, there has been a substantial reduction in the time and cost traditionally needed to address these bridges on a project-by-project basis. Presently, the HSTG continues to function as an interdisciplinary group reviewing the significance of structures that have not been captured by the various inventories or are scheduled for replacement. The group's combined expertise allows them to promptly reach a consensus on the historic significance of a structure in a timely manner.

Define Scope

The scope of work for each bridge covered by the plan is essentially laid out. Changes in condition and funding availability will alter the final project scope.

Evaluate and Communicate Historic Significance

The treatments are called out in the plan, and the historic significance is covered in the plan. Virginia DOT cultural resource staff assists the designers in developing project statements and plans for historic bridge projects.

Bridge Condition, Traffic, Design Exceptions

Virginia DOT collects bridge condition data as required by the NBIS standards and has a detail Manual for the Condition Evaluation of Bridges. Virginia DOT uses the element level PONTIS bridge condition data to provide better input to its bridge management system.

Cost Comparisons

Virginia DOT has over 13,000 NBIS class bridges and 55 determined eligible for listing on the National Register. As a result, Virginia DOT has extensive cost data to utilize in developing cost estimates for bridge rehabilitation work, including historic bridges.

Public Communication and Involvement

Virginia DOT provides notification to the public and invites participation at public hearings on the design. Virginia DOT also provides project websites with additional information. All projects, as with other states, are contained in the Virginia Transportation Development Plan, which receives public review before being approved by the Commonwealth Transportation Board and FHWA.

3.2.6 Indiana

Multi-discipline

The Indiana DOT has a detailed step-by-step project development process document, available at: http://www.in.gov/indot/files/FINAL_Historic_Bridge_PA_PDP.pdf for design teams and cultural resource staff to follow, but it does not require that the team be multi-disciplinary. Indiana DOT Cultural Resource Specialist, Mary Kennedy notes that: "Cultural Resources staff does not make decisions about whether to rehabilitate or replace historic bridges. We review

documents related to the environmental process to ensure they comply with the programmatic agreement."

Define Scope

The project development document (PDP) provides guidance on defining the project scope: "Per the Historic Bridge PA, INDOT will classify and label all historic bridge projects as "Bridge Project – Scope Undetermined" until after FHWA has identified a preferred alternative for the project. This generic classification for bridge projects will ensure that federal aid applicants and the public do not have false expectations that the bridge will be replaced before the NEPA process is completed."

Determine Options

Mary Kennedy notes that "The programmatic agreement and supplementary PDP require a thorough Section 4(f) alternatives analysis, specifying the alternatives to be studied. We are too early in our program implementation to have any aggregate data on resultant projects." Specifically, it requires consideration of the following, in order, and stopping with the first that yields a prudent and feasible alternative:

- Rehabilitation for Continued Vehicular Use (two-way and one-way options)
- Bypass (non-vehicular use)
- Relocate (non-vehicular use)
- Replacement

Evaluate and Communicate Historic Significance

The PA conveys the historic significance of the bridges as either Select for preservation or Non-Select for preservation. The PDP allows for historic property reports, but does not clarify whether reconsideration of historic eligibility is available. The PDP refers to the DOT Cultural Resource Manual, so that an appropriate determination could be made if required.

Bridge Condition, Traffic, Design Exceptions

The Indiana PDP requires consideration of condition and traffic, and it allows for use of design exceptions to permit continued vehicular use of bridges below the Indiana Design Manual minimum standards for Select bridges.

Cost Comparisons

The Indiana PDP does not detail how costs estimates for options considered are to be made. This means that that the standard process called out in the Design Manual would be used. Until Indiana has executed a number of rehabilitations of Select bridges, the cost estimates may be less rigorous than where the repair or rehabilitation cost items are well established. The PDP does give guidelines for prudent decisions. A Select bridge must be rehabilitated, if technically feasible and the rehabilitation cost is no more than 80% of replacement cost. A Non-Select bridge may be rehabilitated if the rehabilitation cost is not more than 40% of

replacement cost. There are additional restrictions regarding bridge functionality for Non-Select bridges, as well.

Public Communication and Involvement

The PDP requires at the beginning of the process a coordination letter be sent out seeking consulting parties for the project. It also requires a Historic Properties Report (HPR) and seeks feedback on the purpose and need statement, the HPR and the area of Potential Effect. The PDP requires a public hearing once the preferred alternative has been identified.

Bridge Maintenance

Mary Kennedy was not aware of anything to guide maintenance measures.

Capture Innovation

Capture of innovative solutions in historic bridge preservation rests with the cultural resource specialists and design engineers.

3.2.7 Texas

Multi-discipline

The TxDOT Historic Bridge Manual requires that an interdisciplinary Historic Bridge Team (HBT) be established for any project involving a historic bridge. The Bridge Division project manager serves as the team leader. The HBT may include members from the district and area offices, the Bridge and Environmental Affairs divisions, FHWA, and local officials or others as appropriate. The Manual is primarily written to detail the procedures for analyzing decisions regarding the rehabilitation, removal or replacement of historic bridges.

The TxDOT Bridge Project Development Manual states, “Historic Bridges are also a priority for the Bridge Division. The division works with the Environmental Affairs Division and local entities to preserve this valuable heritage.” Under its Design Section, responsibilities listed include:

- Preparing designs and reviews for historic, railroad and unique structures, and structural applications.
- Preparing designs and sketches for widening, repairing and reconstructing bridges for detailing by the districts.

The TxDOT Bridge Railing Manual includes a section on historic bridge railings, with four reasonable approaches. The last approach correlates with the technique Oregon used for the decorative concrete railings on the large Coast Highway Bridges.

Define Scope

The TxDOT Historic Bridge Manual advises that a proper “purpose and need statement should not focus on a solution for the problem, but rather should identify the problem” to be solved. All historic bridge projects require alternatives analyses **that demonstrate whether** feasible

and prudent alternatives to taking the bridge may be successfully developed. The TxDOT Bridge Division maintains expertise in rehabilitating historic bridges, and as senior bridge design engineer Charles Walker relates, "Districts in Texas are now not asking *CAN* you preserve, but *WILL* you preserve. Public pressure provides a great incentive to preserve bridges. The internet has made the public aware of the possibilities of preserving historic bridges." As a consequence, successful historic bridge rehabilitation efforts resulted in continued vehicular service for both on-system and off-system bridges, as well as successful development of hike and bike facilities that reused historic bridges.

Determine Options

The historic bridge project development process focuses on developing the alternatives analysis specified by the Section 4(f) regulations, with options ranging from continued use for vehicles to removal given full consideration. Mr. Walker relates that rehabilitation does occur and that "Bridge railing upgrading is probably performed the most. Texas Transportation Institute (TTI) has developed retrofit railings for truss bridges (primarily early 20th century examples) and concrete bridges (typically 1920s and 1930s) that protect traffic while upgrading the strength. One lesson learned with the load rating of truss bridges is that the empirical equations for AASHTO's live load distribution factor, in the use of analyzing stringers and floor beams, are too conservative. A more accurate approach is to develop a finite element model and calibrate it with load testing." (This correlates with the finite element modeling and proof load testing done by the Oregon DOT Bridge Preservation Team.)

Evaluate and Communicate Historic Significance

The HBT formed for a project brings additional expertise to the design team. Specialized condition assessments are integrated into the process, as well as discussions regarding the character-defining elements of the bridge and their impact on preservation solutions. The District must prepare the Section 4(f) documentation to present to FHWA for a federal project, with assistance from the Environmental Division. The Environmental Affairs Division performs the Section 106 consultation process.

Bridge Condition, Traffic, Design Exceptions

TxDOT has a comprehensive on-line Bridge Inspection Manual specifying collection of bridge condition data in accordance with FHWA NBIS requirements. TxDOT does not have a formal Bridge Management System, but does record PONTIS element level condition data "for on-system bridges in anticipation that a BMS will be implemented in the near future."

Cost Comparisons

Cost estimates are prepared either by the Bridge Division or by districts, using cost data from bid tabs collected in accordance with FHWA cost data requirements. Mr. Walker and the bridge project managers maintain a database of cost information for repairs and rehabilitation of historic bridges.

Public Communication and Involvement

The Environmental Division is tasked with developing a Public Involvement Plan. The Historic Bridge Manual notes that "revised regulations require TxDOT to provide a higher level of public involvement" and that the Texas SHPO of the THC is "particularly concerned about historic bridges." For "bridges with an adverse effect (which includes bridges being moved and relocated for an alternative use as well as those proposed for demolition), there should be a notice of opportunity for a public meeting to discuss the historic bridge and project's impact upon it," in addition to the consulting party process carried out for the Section 106 process.

Bridge Maintenance

Maintenance of historic bridges resides with the districts, based on the outcome of the biennial inspection cycle. No technical guidance specifically targeted to issues faced by historic bridges is currently provided in the maintenance manual. This gap will be addressed by management plans for historic bridges being developed for release in FY13.

Capture Innovation

Capture of innovative solutions in historic bridge preservation rests with the cultural resource specialists and design engineers.

3.3 Risk Management (Tort Liability) Evaluation by State

While there are thousands of reported cases involving government tort liability arising out of alleged dangerous conditions on bridges in general, there are very few involving historic bridges.

The Federal Lands Highway Program administers roads and bridges on federal and Native American lands, including those in national parks and on reservations. While most federal decisions are reported, the inventory of bridges that might be the subject of a federal lawsuit is relatively small when compared to state and local jurisdictions. The inventory of historic bridges is even smaller. As a result, it is not surprising that only one federal case involving an historic bridge was found. Also only one reported state appellate tort case involving a historic bridge was found. These two cases are described below.

Carlton v. Cleburne County, Arkansas, 93 F.3d 505 (8th Cir.1996)

In this case, 40 people suffered serious injuries when they fell into the Little Red River upon the collapse of the allegedly deteriorating and poorly maintained 1912 "Swinging Bridge." The factual predicate for this case would have militated that it proceeds as a tort action in state court or under the Federal Tort Claims Act (FTCA) in federal court. Since the county-owned bridge was neither owned nor controlled by the federal government, plaintiffs had no cause of action under the FTCA. In order for federal jurisdiction to attach, plaintiffs needed to assert a violation of a Constitutional right. They asserted that the county had violated their purported constitutional right to safety and security under the due process clause of the 14th Amendment

to the U.S. Constitution. The federal court held that the Constitution provided no such right. The plaintiffs also sued the county in state court; however, that action was resolved without being reported. One can only speculate that the state action may have suffered from a procedural defect, was barred by sovereign immunity or the statute of limitation, was settled or preceded to judgment. In any event, the state action was not appealed and thus, the case was not recorded in the official reports. A factor that might have been determinative in the state court action was that a few years prior to its collapse, a bridge inspection determined that the bridge was sturdy and capable of supporting pedestrians for another 50 to 100 years, and the county had no notice otherwise.

Helton v. Knox County, Tenn., 922 S.W.2d 877 (1996).

Only one reported state appellate tort case involving a historic bridge was found. This is because of the relatively few number of cases that proceed through the costly, lengthy and uncertain state appellate process, as well as the general ground rules for screening the publication of appellate cases in the official reports. In this Tennessee case a surviving spouse sought wrongful death damages for the death of her husband, whose vehicle went off a single-lane, century-old, historic, county-owned bridge that lacked standard guardrails. The bridge was in a sparsely populated part of the county and little used. It was located at the bottom of a downgrade and preceded by two relatively sharp turns that required drivers to travel at a slow rate of speed. There was no history of accidents on the bridge. Leading up to the bridge was a sign reading "Warning – One Lane Bridge Ahead." There were also black and yellow vertical paddleboards – long narrow boards containing black and yellow hash marks - on the ends of the bridge. The bridge itself had no railings. The edge of pavement was delineated by a painted edge stripe and heavy curbstones 6 to 8 inches high. On three prior occasions, inspectors from the Tennessee Department of Transportation, charged with the inspection of county bridges, had advised the county that the bridge "was a serious deficiency" and needed approved approach guardrails, as well as approved bridge rails. Nevertheless, taking into account the costs of these improvements and its concern for preservation of this historic bridge, the county decided not to follow the inspectors' recommendations.

Notwithstanding expert testimony that approved bridge rails would have prevented the vehicle from going off the bridge, the trial court decided that, based upon all the factual evidence, the bridge was not "defective, unsafe, or dangerous." The appellate court disagreed and overturned the trial court decision. On appeal to the Tennessee Supreme Court, the court held that given the context of when the bridge was built, its low traffic volume, the warning sign and paddles, the two curves requiring a slow rate of speed, and the clearly delineated edge of pavement, it could not find that the bridge was "defective, unsafe, or dangerous to the ordinary prudent driver." Moreover, the court held that the county decision-making process that resulted in the decision not to follow the inspectors' recommendations was discretionary in nature and thus, immune under the discretionary function exception to Tennessee's Government Tort Liability Act.

In this case, the county engineers' decision to preserve this historic bridge was upheld by the highest court in the State of Tennessee. Yet, after the accident and prior to the trial court decision, the county installed approach guardrails and bridge rails at a cost of nearly $200,000. This highlights an important issue with regard to policy decisions. Policy makers need to carefully consider implementation of remedial measures in response to a lawsuit. In some states, that response can be viewed as an admission of agency wrongdoing. It also may not be the best use of limited safety funds that should be allocated to sites with higher traffic volumes and a higher frequency of crashes.

The paucity of reported state decisions on the issue of risk related to historic bridge preservation is not unexpected, given the reasons stated above. However, it is not determinative on the issue of whether or not potential tort liability is an impediment to preservation of historic bridges. Consequently, targeted legal contacts from a representative sample of states were developed to solicit claim and risk management information related to tort liability issues and decision-making. While the information is anecdotal, it is nevertheless important because of the dearth of reported cases. The states contacted were Washington, Pennsylvania, Wisconsin, California, Hawaii, Delaware, Oregon, Missouri, and Indiana. These states were not selected based upon geography or the federal circuits, but rather upon relevant criteria that they presented a representative mix of a range of legal frameworks relating to sovereign immunity, caps on damages, comparative negligence, and personal liability. The complete questions asked of these interviewees are contained in **Appendix C**.

The responses varied in the level of detail and responsiveness to the questions. However, it was clear that agencies with best practices do not find potential tort liability concerns to be an obstacle to the preservation of historic bridges. Through community outreach, they build a consensus on the value of preservation. They thoroughly document the decision-making process, setting forth the reasons, both engineering and otherwise, that support preservation. Alternatives are explored and considered. In some cases, robust traffic engineering and positive guidance can be used to provide a safe travel experience over a bridge that does not meet current design standards. When capacity and structural issues are insurmountable, they will preserve the bridge, but put it to other modal uses.

Conversely, there are still agencies that find replacement to be a more legally secure approach than preservation, notwithstanding the bridge's historic significance. Even in these states, tort liability is not the driving factor in these decisions; rather, it is the commitment to bringing all bridges with capacity and structural issues up to current design standards.

3.3.1 Oregon

Most legal issues regarding historic bridges in Oregon involve contract administration of bridge preservation projects, rather than potential tort liability. A local bridge that collapsed in Southern Oregon injured several people. Prior to its collapse, the bridge was the subject of an engineering study in which no deficiencies were found. The engineering firm was under contract with the Oregon DOT to perform bridge inspections. The ensuing litigation was focused on the engineering firm, rather than the public agencies.

3.3.2 Indiana

In Indiana, the locals had the federal-aid program for local bridges stopped because of actual and/or threat of lawsuits. These were not tort lawsuits, but rather lawsuits that sought the enforcement of National Historic Preservation Act provisions. As a result, both FHWA and INDOT saw the need to reconsider how they were approaching bridge preservation. The constant legal monitoring and ability to seek legal recourse has been critical in ensuring that FHWA and INDOT honor the spirit and intent of the law. The effective practice demonstrated here is using legal means to ensure full and fair application of existing state and federal laws.

3.3.3 Washington State

While most legal issues relating to historic bridges are environmental in nature, there have been tort lawsuits with allegations that a historic bridge not meeting current standards was the cause of injury. Based upon Washington DOT's trial court experience as reported by its enterprise risk manager, raising the historic nature of the bridge as a defense to the fact that the bridge is not up to current standards generally has not been effective. The decision to preserve, upgrade or replace a historic bridge is usually driven by its remaining useful life, capacity and ability to maintain traffic loads. When such bridges are upgraded, new bridge rails and barriers that are sensitive to the original design of the bridge can be incorporated. In some instances, such as the Tacoma Narrows Bridge, new bridge elements can be designed to be architecturally similar to the existing historic bridge, which can retained and remain in use.

3.3.4 Pennsylvania

From the early to mid 1900s, many classes of local roads were transferred to state jurisdiction; however, in many cases, it was unclear whether the transfer included the route's bridges. This resulted in a limited number of historic bridges that were "orphaned." Resolution of these ownership issues was often not resolved until a bridge was the subject of replacement or rehabilitation as part of a larger project. Where preservation of a historic bridge has strong local support, potential tort liability is less of an obstacle because of the department's "right-sizing" program that uses context sensitive design and solutions and "smart transportation" criteria. Where a bridge can no longer handle the necessary capacity or traffic loads, Pennsylvania DOT has a program that provides for the transfer and removal of the bridge to another location for reuse by another government or historic preservation group.

3.3.5 Wisconsin

Tort liability is not a driving factor in a decision to preserve, upgrade or replace a historic bridge because sovereign immunity is still strong in Wisconsin. The Wisconsin DOT strives to preserve functionally obsolete, structurally deficient, historic bridges for other uses (e.g., pedestrian and bicycle facilities) when replacing them for highway traffic.

3.3.6 California

Earthquake retrofitting has been a driving factor in California for upgrading and replacing historic bridges. While this is a safety concern, it is also a potential tort liability concern. Some historic bridges, such as those along State Route 1 in Monterey County, have been sensitively upgraded, preserving their historic character, while others with less aesthetic designs, such as the east span of the San Francisco-Oakland Bay Bridge, are being replaced. Suicide barriers/screening has been more a public safety issue than a potential tort liability issue. For example, the lack of a suicide barrier on the Golden Gate Bridge was held not to be a dangerous condition to persons exercising due care.

3.3.7 Hawaii

Hawaii DOT has faced a significant risk in tort liability, not just for the agency, but for its engineers as well. The risk has been removed with recent legislation, but the engineers remain concerned. FHWA is supportive of rehabilitation and retention of historic properties and Hawaii also has a strong historic preservation constituency. As a result, the public has resisted attempts to upgrade or replace historic one-lane bridges on the Hana Highway on Maui and the one-lane Hanalei Bridge on Kauai. The Hanalei Bridge has been rehabilitated and the Hawaii DOT is proceeding with road improvements, including end treatments for the bridge, implicitly acknowledging that the risk of retention is acceptable. Despite serious concerns over potential tort liability, the Hawaii DOT and Maui County Public Works Department have been limited, in many cases, to simply maintaining the bridges as best as possible. One such bridge, the Koukou'ai Bridge, shown in Appendix D, is typical of the load-limited one lane bridges that are common on the Hana Belt Road. Rehabilitation of the bridge is shown in the Hawaii Statewide Transportation Improvement Program (2011-2014) for Federal Fiscal Year 2013, but the project statement is written to replace or repair, so it remains to be seen if the change in the law, coupled with cost savings, will overcome engineering concerns.

3.3.8 Delaware

In Delaware, potential tort liability is not at the forefront of decision-making regarding the preservation, upgrade or replacement of historic bridges – a result of relatively strong sovereign immunity and a large constituency for historic bridge preservation. When improvements are necessary, a sensitive redesign with modern materials that preserves the bridge's character-defining features is the preferable option, if possible. If not, the DOT undertakes a replacement.

3.3.9 Missouri

In Missouri, the decision to preserve, upgrade or replace a historic bridge is driven primarily by economics and cost, the same factors for bridges that are not historic. Potential tort liability is a factor, but not the driving factor, in considerations. As a result, historic bridge preservation is relatively rare. When preservation is pursued, it is because local residents view themselves

as stakeholders in the decision; there is a source of funds for the preservation; and stakeholders are willing to sign an agreement that transfers bridge ownership with all attendant responsibility and liability.

As the foregoing responses demonstrate, potential tort liability does not appear to be the impediment to preservation of historic bridges that was originally anticipated. In many cases, other factors have a much greater impact on decision-making. Where it is a concern, well documented decisions, fully explaining all the considerations that were weighed and their associated implications, ameliorate obstacles raised by potential tort liability.

3.4 Partnering Practices by State or Local Agency

3.4.1 Ohio

Partnering developed within Ohio as a means to deal with the large number of historic bridges within the State. This led to the first Ohio DOT PA in 2001, between the DOT and FHWA for Applicability Determination and Programmatic Section 4(f). The AASHTO Center for Environmental Excellence, Programmatic Agreement Library (PAL) Database notes: "This agreement was the first delegation of approval from the Federal Highway Administration (FHWA) to determine that projects are incompliance with Section 4(f)." While not a signatory to this agreement, as this is delegation of FHWA authority, this would not have been possible without the concurrence of Ohio SHPO. This describes a high level or trust developed from successfully working together to address both preservation of historic bridges and replacement of those requiring replacement. Ohio now has its third generation PA in effect, which includes in its many actions, such partnering efforts as joint efforts between the DOT, FHWA and SHPO "to provide a public education and interpretation component in its undertakings whenever appropriate" and "to jointly conduct a Section 106/NRHP training class which includes a testing component for consultant prequalification. These classes are a requirement for all Ohio DOT cultural resource staff and Ohio DOT District environmental staff to successfully complete." Additional required training classes are jointly provided for staff and consultants, with a testing component.

3.4.2 Vermont

Partnering between VTrans, FHWA and the SHPO was established through a formal PA. This has been updated as the partners identified and agreed upon improvements.

In addition, VTrans has worked with Townships that owned their own historic bridges to provide funding for rehabilitation, providing the Township maintained the bridge to standards established for historic bridges.

Two items of note, showing how partnering works in Vermont have come up as a result of damage from Hurricane Irene:

- TWO RIVERS-OTTAUQUECHEE Regional Commission (TRORC) Irene Recovery Update – 10/7/11, included the following item:

Covered Bridges, Iron Bridges and Other Historic Transportation Infrastructure

For those communities with historic transportation infrastructure such as covered bridges, iron bridges, old stone culverts, etc; please contact Scott Newman (VTrans Historic Preservation Officer) and/or Nick Wark (VTrans Hydraulics Engineer). They will likely meet with you in conjunction with FEMA or FHWA Public Assistance personnel, where they will work with your community and the VT State Historic Preservation Officer to consult on any potential historic transportation infrastructure. See their contact information below:

Scott Newman - VTrans HP Officer
(802) 595 - 5119
scott.newman@state.vt.us

- WINDHAM Regional Commission Current Activities Regarding Irene - updated 10/25/2011, included the following:

NFIP Exemption Process for Historic Buildings: FEMA sent out a press release on September 29, 2011, reminding Vermonters that historic buildings may not need to undergo the same flood-proofing measures that may be required of newer buildings. For information that provides further detail on the Vermont-specific requirements that must be met to qualify for this historic building exemption, click here. A handout to help property owners and communities consider the pros and cons of repairing or demolishing historic buildings is here.

Many other examples can be found, but these illustrate that even in difficult times, there is partnership providing for historic bridges.

3.4.3 Minnesota

Minnesota DOT has established it Historic Bridge Committee to primarily partner internally to establish the necessary understanding of structural issues and Federal Highway Bridge Program restraints and of the public values and legal requirements driving the responsibility of owner agencies to preserve historic bridges. In keeping with its PA, Minnesota DOT has opened this committee up to SHPO and FHWA participation and to start the process of assisting Local Public Agencies, has included the State Aid Office. This regularly scheduled "partnering session" is gradually developing common understanding into common goals.

3.4.4 Oregon

Oregon DOT, like most, has done occasional bridge rehabilitation or bridge "twinning" to deal with bridge condition or increased traffic demand, but did not have a common view with FHWA or SHPO until the loss of one of the McCullough Arch Bridges to extensive corrosion damage in the late 1980s. This placed all of the remaining historic bridges on the Coast Highway, and many of the non-historic bridges, in jeopardy. A rapid search for potential rehabilitation techniques drew in FHWA and SHPO to help. FHWA became an immediate partner in developing projects for cathodic protection. SHPO readily agreed, but after loss of one of the crown jewels on the Coast Highway, was understandably less than confident in the DOT. After three successful projects, and five years of working out details, SHPO became a definite partner. As the number of projects completed topped a dozen, the relationship between SHPO and the DOT became less regulatory and far more supportive. The goal of projects became to make the bridges both closer to original construction condition and appearance, and safer for traffic. This defines the current state of partnership for State bridges, and for bridges belonging to a number of local agencies, as well.

Internal partnering has also become important. As the process of rehabilitating the Coast Bridges reached a mature level with known deterioration rates, known production rates, known costs, Region staff asked the Bridge Preservation Team to start taking a look at inland historic bridges. This resulted in adapting the process to look at all historic bridges and to partner the design effort with regional structural staff and consultants.

3.5 Historic Bridge Education Practices by State or Local Agency

3.5.1 Ohio

For Ohio DOT, Tom Barrett sees a major issue in managing historic bridges as "educating our customers and the public that "historic" does not have to mean increased costs and delay in order to keep the bridge in service; and that all parts of the structure are "hands off" for upgrading; or new elements will need to look antique."

He notes: "There is a statewide organization for county engineers. The plan is to periodically address this group to inform them on historic values, procedures, techniques (treatments) and other items, which could help them decide to rehabilitate rather than replace their historic bridges."

3.5.2 Vermont

Vermont has long recognized that education is key to keeping their historic bridges available to the public. As a result, Part 7 of their historic bridge PA is devoted to Education and Heritage Tourism. This requires "a viable educational effort devoted to increasing public awareness regarding the benefits of preserving historic bridges.

Accordingly, VTrans and VT SHPO will develop a schedule for meeting with town officials, public works engineers, and district transportation engineers, and will prepare a standard

educational presentation. Seminars and workshops will be coordinated through the regional planning commissions. The Historic Bridge Program will be explained at meetings conducted in each region, and Bridge Preservation Plans will be distributed to town representatives via regional commissions.

Educational efforts will also include promotion through Heritage Tourism, and a cooperative plan will be developed with the Department of Tourism and Marketing. A map showing the location of all bridges in the program will be prepared and made available for distribution via a variety of possible resources."

In one place, almost all groups for which education could have a positive impact on historic bridges, the public, engineers, planners, elected officials, and the tourist industry, have been identified and addressed.

Examples of practices include:

- News releases at Vermont.gov on opening ceremonies for historic bridge rehabilitations.
- News releases by towns, such as Richmond's richmondvt.com/bridgestreet.php, providing the status of painting of their bridge, owned by the State, but with the new color selected by the Town Select board, 11/09/11.
- Broadcasts on Vermont Public Radio, such as 11/26/07, by Scott Newman, which is still available and can be downloaded as an MP3 file.
- Bridge Preservation and Maintenance Conferences in conjunction with University of Vermont Transportation Research Center, Vermont Local Roads and FHWA.

3.5.3 Minnesota

The Historic Bridge PA Stipulation 2 includes requirements for education of and outreach to local groups and local agencies.

3.5.4 Oregon

Oregon DOT provides education through its state-wide environmental, bridge engineering design and bridge maintenance conference.

Oregon DOT Regional Public Involvement staff and Cultural Resources staff provide websites for historic bridge rehabilitation projects and offer presentations. A number of historic bridge projects have included public interpretive sites to educate the public on the historic significance of the bridge and the work done to rehabilitate and preserve the bridge.

The media have covered many historic bridge projects in detail, providing the public with information on the projects.

Oregon DOT has produced brochures, presentations and web pages for its Historic Columbia River Highway and its structures, the Oregon Coast Highway bridges, and the Covered Bridges to keep these and other historic bridges in the public's eye.

3.6 Local Agency Assistance Practices by State or Local Agency

3.6.1 Ohio

Ohio DOT has a PA for local agency funded work and 100% state funded work, which provides a streamlined process for work on non-historic bridges or where the work items are specifically listed in the agreement as they do not affect the historic nature of a bridge.

3.6.2 Vermont

VTrans, as other state transportation agencies, recognizes that the majority of historic bridges in the state are owned by local agencies, and that they are financially constrained.

To assist in the long-term preservation of these historic bridges, in Part 3 of VTrans' Historic Bridge Plan, towns are invited to participate in the Program, which covers all five points for Local Agency Assistance. By signature of their governing bodies to a document titled "Historic Bridge Participation Agreement", towns, cities, and villages enroll in the Historic Bridge Program. VTrans agrees to "pay all costs of future rehabilitation or restoration for bridges that have been enrolled in the Programs for continued highway use, subject to the requirements regarding maintenance described in Part 4, and will agree to undertake such work according to the Secretary of the Interior's Standards for Historic Preservation Projects."

"In return, towns will agree to preserve bridges that have been enrolled in the Program in perpetuity, subject to loss or damage by human catastrophe or by other circumstances beyond human control. Towns will signify their commitment to preserve the identified bridge(s) by granting a Historic Bridge Preservation Easement."

With this approach, VTrans closes the loop, first applying the Historic Bridge Plan requirements to Town-owned bridges and second, providing the funding to meet the requirements, as it has been doing for State-owned bridges.

An additional benefit for Towns in SHPO delegating its authority to VTrans Historic Preservation Officers is that "Municipal owners of historic bridges may ask to have individual determinations [of NR eligibility] made at any time by VTrans Officers."

3.6.3 Minnesota

Minnesota DOT has performed a detailed evaluation of potentially historic State-owned bridges and evaluated them for their potential to be rehabilitated. Kristen Zschomler notes that MNDOT's inventory of all historic bridges in the state benefited not just Minnesota DOT, but also Local Public Agencies, "in that 95 percent of their bridges were found to be not eligible, so most of their bridge projects get cleared without a lengthy Section 106 review." She adds, "The Minnesota DOT State Aid Office (that aids the local agencies in the development of transportation projects), the CRU, and Bridge Office are currently reaching out to local agencies to begin the dialog on potentially developing a similar approach [in evaluating historic bridges for their potential to be rehabilitated] for the local system as was developed and implemented on the state system." This will enable development of bridge specific

preservation plans for local bridges. The plan is to complete this work over the next several years.

3.6.4 Oregon

Oregon DOT works closely with counties that own historic covered bridges, and helps them apply for federal funds. For the period when federal funds were unavailable, the State created its own funding program, administered by the DOT Bridge Section. For other special bridges, such as movable bridges and fracture critical bridges, the DOT provides technical advice and regional bridge inspection contracts to assist bridge owners in ensuring the safety of their bridges. In one example, the City of Portland Bridge Engineer asked for help evaluating options for the 105-year old pin connected Thurman Street deck truss. After review by the Bridge Preservation Team, the DOT was able to find funds to replace the deteriorated wood deck with a light weight concrete deck.

4. Recommendations for Implementation and Distribution

Implementation of effective processes to preserve historic bridges and carry vehicular and pedestrian traffic can be complex. Despite the impediments, numerous state DOTs have successfully implemented practices that accomplish historic bridge preservation in a practical manner. The keys to success include a commitment to an open and cooperative approach to problem solving and the availability of models and examples that can be adapted to the local situation.

This document provides examples of practices and organizations that can aid state and local DOTs in the development of an effective bridge preservation process. The information contained in this document can also serve as a resource for FHWA Division Offices to support the state and local DOTs in successfully preserving and rehabilitating bridges. The practices and approaches outlined can also be used to by SHPOs as all work cooperatively to preserve bridges as functional structures while meeting the intent of the Secretary of the Interior's Standards for the Treatment of Historic Properties. Accordingly, State DOTs and FHWA Division Offices should be notified of this study's completion through normal channels (AASHTO, FHWA, and the Historic American Engineering Record). Beyond this notification, it is also suggested that efforts be undertaken to notify local governments, historic preservation organizations, and engineering, planning and cultural resource consultants by posting information about the study on websites visited and maintained by these agencies and organizations.

Webinars, presentations and handouts based on the executive summary of this report should be shared with interested agencies and stakeholders, or offered at regional conferences for engineers, historians, planners and transportation officials. Individuals who were interviewed for this study along with the report's authors should also be encouraged to present this information. Numerous professional listservs could provide information about the webinar.

Finally, many of the best practices and case studies could also serve as the basis for regional or national workshops targeted to transportation agencies, local government, and historic preservation groups. These workshops would be most effective if individuals who were interviewed for this study along with the report's authors could participate in developing and presenting the information.

5. Summary and Conclusions

The best practices discussed in this report represent a broad variety of approaches developed to preserve and rehabilitate many historic bridge types. These approaches include all phases of work, including project planning, implementation, and mitigation, as well as pre-emptive measures to preserve historic bridges before any project is even considered. However, all of the measures discussed require an increased awareness on behalf of transportation agencies, SHPOs, and preservation-advocacy groups. This awareness can be manifested in many forms. Bridge inventory surveys, establishing relationships with other stakeholders, and education and training are just a few of the efforts that should be undertaken prior to project initiation, when it may already be too late to preserve the structure in question. Identifying historic bridges, particularly those that are unique or rare, and their character-defining features can help agencies allocate funding and promote agency policies that can facilitate preservation, rehabilitation, and even replacement, in a manner that effectively preserves this visible part of our engineering heritage. Learning about possibilities and fostering a collaborative approach can be critical to project success when needs arise, and can prove particularly useful when fast-tracked or high profile bridge projects emerge.

Involving cultural resources staff and considering potential adverse effects in project planning from the earliest stages also promotes more balanced decisions. While early planning does not always mean that bridge preservation will prevail, it can help all parties better understand each other even if the ideal outcome cannot be achieved. Financial implications are a factor in many projects and an issue that requires particular consideration given current transportation funding concerns nationwide. However, many best practices presented in this report are the result of identifying solid community values, and a willingness to consider the full range of options before deciding that replacement of an historic bridge is the only viable project option. Likewise, commitments to productive compromise and respectful working relationships among stakeholders were found to be critical.

As the research team explored current practices and compared them to best practices, they found that successful initiatives need not be complex or expensive; and that many practices could easily be implemented in other states or municipalities. In many instances, engineers, cultural resources professionals, and preservation advocacy staff all independently expressed a desire to abandon an “all or none” approach. Indeed, understanding character-defining features allows for appropriate compromises in preservation and rehabilitation. Interviewees unanimously agreed that supporting a sound rehabilitation project that respected a bridge’s historic character was always preferable to accepting replacement even if a project could not support a meticulous restoration-in-kind. This willingness to integrate compromises into projects can ultimately result in fewer bridge replacements. Further, this kind of outreach and a documented decision-making process can reduce potential tort liability concerns

As the research team explored current practices and compared them to best practices, they found that successful initiatives need not be complex or expensive. The team also found that many practices could easily be implemented across other states and municipalities. In many instances, engineers, cultural

resources professionals, and preservation advocacy staff independently expressed a desire to abandon an "all or none" approach. Indeed, understanding character-defining features allows for appropriate compromises in preservation and rehabilitation. And, interviewees unilaterally agreed that supporting a sound rehabilitation project that respected a bridge's historic character was always preferable to accepting replacement even if a project could not support a meticulous restoration-in-kind. This willingness to integrate compromises into projects can ultimately result in fewer bridge replacements. Further this kind of outreach and a documented decision-making process can reduce potential tort liability concerns and permitting delays.

Education and training using case studies can inform practitioners and help support DOTs and SHPOs who are willing to work cooperatively to develop historic bridge preservation and rehabilitation procedures and policies. Training based on this report should focus on establishing a process that develops realistic cost estimates for a variety of alternatives, including partial repair, strengthening, widening in-kind and rehabilitation, all in keeping with the original design while preserving character-defining bridge features. This approach allows a fair comparison with a replacement alternative and if cooperatively developed, allows all stakeholders to fully understand and appreciate the entire process.

As DOTs develop their expertise and capacity to manage historic bridges, it puts them in a position to help local agencies: understand their responsibilities in preserving historic bridges, identify which bridges are truly historic, determine which bridges could reasonably be rehabilitated, develop historic bridge projects that would be competitive for funds, and set aside dedicated funds for historic bridges. Indeed, as historic bridge preservation systems and expertise and trust grow out of best practices, agencies are finding that they can take advantage of expanded regulatory flexibility.

To promote the adoption of these study results as well as the AASHTO Guidelines, and other references noted in the report, a survey of State DOTs, FHWA Offices, and SHPOs should be implemented in two years after publication of this work. A short survey should gauge the level of interest and types of education and training could promote further acceptance of these practices to assist DOTs, FHWA and SHPOs.

6. Future Research

This study, while a start toward a reference on bridge preservation practices, is by no means a comprehensive reference manual that addresses physical preservation practices. As any bridge engineer can attest, the best way to preserve a bridge is through a well-directed, diligent maintenance program. A comprehensive reference manual which could provide practitioners with practical strategies for solving particular physical repair and maintenance issues is essential to help keep historic bridges from needing to be replaced due to preventable deterioration.

Appendix A Literature Review

A.1 Guidelines, Standards and Policies

These documents cover primarily historic preservation and highway and bridge engineering standards.

A.1.1 U.S. Department of the Interior, National Park Service

Link: http://www.nps.gov/index.htm

Secretary of the Interior's Standards for Rehabilitation (36 CFR 67)

Available: http://www.nps.gov/history/hps/tps/tax/rhb/stand.htm

The Secretary of the Interior's Standards for Rehabilitation pertain to historic buildings of all materials, construction types, sizes, and occupancy and encompass the exterior and interior, related landscape features and the building's site and environment, as well as attached adjacent or related new construction. The Standards are to be applied to specific rehabilitation projects in a reasonable manner, taking into consideration economic and technical feasibility.

1. A property shall be used for its historic purpose or be placed in a new use that requires minimal change to the defining characteristics of the building and its site and environment.
2. The historic character of a property shall be retained and preserved. The removal of historic materials or alteration of features and spaces that characterize a property shall be avoided.
3. Each property shall be recognized as a physical record of its time, place, and use. Changes that create a false sense of historical development, such as adding conjectural features or architectural elements from other buildings, shall not be undertaken.
4. Most properties change over time; those changes that have acquired historic significance in their own right shall be retained and preserved.
5. Distinctive features, finishes, and construction techniques or examples of craftsmanship that characterize a property shall be preserved.
6. Deteriorated historic features shall be repaired rather than replaced. Where the severity of deterioration requires replacement of a distinctive feature, the new feature shall match the old in design, color, texture, and other visual qualities and, where possible, materials. Replacement of missing features shall be substantiated by documentary, physical, or pictorial evidence.
7. Chemical or physical treatments, such as sandblasting, that cause damage to historic materials shall not be used. The surface cleaning of structures, if appropriate, shall be undertaken using the gentlest means possible.

8. Significant archeological resources affected by a project shall be protected and preserved. If such resources must be disturbed, mitigation measures shall be undertaken.
9. New additions, exterior alterations, or related new construction shall not destroy historic materials that characterize the property. The new work shall be differentiated from the old and shall be compatible with the massing, size, scale, and architectural features to protect the historic integrity of the property and its environment.
10. New additions and adjacent or related new construction shall be undertaken in such a manner that if removed in the future, the essential form and integrity of the historic property and its environment would be unimpaired.

A.1.2 American Association of State Highway and Transportation Officials (AASHTO)

Link: http://www.transportation.org/

A Policy on Geometric Design of Highways and Streets, 5th edition (2004)

Available for purchase: https://bookstore.transportation.org/item_details.aspx?id=110

Commonly known as the Green Book, the policy defines the nationally applicable and replicable design criteria and guidance that underlies new and full reconstruction (rebuilt along the existing alignment with the complete replacement of the roadway) of roads and bridges. It is a common misconception that the Green Book is the one and only source of design criteria or guidelines for state and federally funded projects. Until 1995, Congress did require FHWA to use the Green Book guidance for federally funded projects, but The National Highway System Designation Act of 1995 removed that limitation and now allows states to develop their own design criteria/guidelines for all non-National Highway System highways (see Vermont Agency for Transportation, 1997). This is a significant policy shift that enables states to implement different design criteria/guidelines if they so desire. Many states, however, still use the AASHTO guidelines as their design criteria or standards, which makes Green Book guidance the commonly held standard for geometric design of bridges and highways. Congress mandates that the AASHTO guidelines be used as the design standards for National Highway System (NHS) highways, including interstate highways.

Green Book design criteria are not the criteria used to evaluate the adequacy of bridges to remain in place. The *Foreword* to the 2004 edition of the Green Book is very clear that its policy is not intended for projects where revisions to horizontal or vertical curvature are not necessary or practical. For projects where major realignment is not needed, existing design values may be retained. Additionally, the Green Book is not intended by AASHTO as the policy for the engineering definition of resurfacing, restoration, or rehabilitation (3R) projects. With approval from FHWA, states may develop 3R design criteria that can be specific to the needs of their jurisdiction for all types of highways, except NHS. These state-specific standards may have values lower than Green Book values and thus offer opportunities for keeping historic

bridges in service. Refer to Transportation Research Board. *Designing Safer Roads, Practices for Resurfacing, Restoration and Rehabilitation*, Special Report 214, Washington, D.C., 1987.

Streets and highways, including bridges, are complicated designs that reflect a balance of many operational, functional and safety considerations. To focus on the elements deemed most important, FHWA has identified 13 controlling design criteria as having substantial importance to the safety and operational performance of any highway, and the design process for new and full reconstruction projects requires meeting all 13 controlling criteria. The intent of the Green Book is to provide guidance to the designer by referencing a recommended range of values for those critical controlling criteria. Sufficient flexibility is permitted to encourage independent designs tailored to particular situations. Green Book guidance is not intended to be a detailed design manual that could supersede the need for the application of sound principles by the knowledgeable design professional. Minimum values are either given or implied by the lower value in a given range of values while larger range values will normally be used where the social, economic and environmental impacts are not critical. This is the source of minimum and desirable values for commonly used concepts. The value ranges are provided to accommodate consideration of other factors, especially environmental considerations, like historic bridges and bridges in and contributing to historic districts, with the intent that facility will be safe and efficient for users, acceptable to non-users, and in harmony with the environment.

Many features associated with the design of bridges and their approaches, e.g., roadside features, railings, signage, are not controlling design criteria. Selection of design elements beyond the 13 controlling criteria offer opportunities for flexibility based on engineering judgment with the exception of traffic control devices, which are governed by the *Manual of Uniform Traffic Control Devices (MUTCD).*

A Context for Common Historic Bridge Types (October 2005)

Available: www.trb.org/NotesDocs/25-25(15)_FR.pdf

This report was sponsored by AASHTO in cooperation with FHWA, and was conducted in the National Cooperative Highway Research Program (NCHRP) 25-25, Task 15. This study covers bridges built in the United States through 1955, up to the year of the passage of the Federal Aid Highway Act of 1956, which created the Interstate Highway System. It is intended to provide assistance to practitioners with assessing the historic significance of bridge types within the context of the United States, and can improve the significance evaluation process through providing a picture of the bridge types that are very common and those that are much less common, as well as providing an assessment of the technological and historical significance of the individual types. The study lays the foundation for evaluating whether a bridge to be removed requires additional documentation. (It is important to note that the study does not address one-of-a kind and other rare historic bridges.)

Guidelines for Historic Bridge Rehabilitation and Replacement (March 2007)

Available: http://onlinepubs.trb.org/onlinepubs/archive/NotesDocs/25-25(19)_FR.pdf

Initially prepared for AASHTO's Standing Committee on the Environment (SCOE) and endorsed and published by AASHTO in 2008, the guidance provides a nationally applicable model for balanced decision making within the larger NEPA format. The guidelines are intended as a protocol for defining when rehabilitation of a historic bridge is prudent and feasible and when it is not based on engineering and environmental data and judgments. Decision makers are lead through considerations that will support the right decision for the right reasons. Emphasis is placed on understanding what makes the bridge historic and then considering bridge-type specific alternatives to make it structurally and functionally adequate while balancing preserving its historic significance and other environmental considerations. The guidance recognizes that decisions are primarily driven by the ability to make the bridge adequate and uses engineering values as the threshold for rehabilitate or replace decisions. Common problems by bridge type and material are described as ways to address deficiencies, thus making the bridge adequate and keeping it in service. Emphasis is placed on understanding what is controlling condition code ratings and the level of effort needed to bring them up to at least a 5. Appropriate balanced treatments that meet *The Secretary of the Interior's Standards for Rehabilitation* are provided for common historic bridge types.

The guidelines are based on the protocol used and tested for the development of management plans for defining the long-term preservation potential for statewide populations of historic bridges in Georgia and Maine. Their great benefit is that they illustrate how much inherent flexibility exists within the current planning, project development and environmental review processes to develop solutions that balance sound engineering with historic preservation.

Guidelines for Geometric Design of Very Low-Volume Local Roads (ADT<400) (2001)

Available: https://bookstore.transportation.org/Item_details.aspx?id=157

Now AASHTO's applicable policy in lieu of the Green Book for very low volume local roads design criteria, the guidance within this document lays out an approach to design criteria based on the characteristics of very low-volume local roads and matches improvements to their cost benefit to improve safety rather than apply more costly full-design criteria values. The guidelines recommend an approach for both rehabilitation and new construction using safety risk assessment and cost benefit of safety improvements as the basis for decisions. The result is that decisions, from roadway geometry to bridge width, are matched to the current performance of the facility. If it is performing adequately and working safely, then there is no need to upgrade it. The AASHTO policy and guidance are founded, in part, on the 1994 NCHRP Report 362 that showed that less-stringent standards for existing roads could save money without compromising safety.

This study, which was promoted by county bridge engineers, is an important watershed in thinking about safety and design criteria. It has probably done more to promote flexibility in highway and bridge design and thinking about what really underlies design criteria than any other research to date. Its adoption as AASHTO policy speaks to the desire on the part of engineers to consider sound and supported approaches to design decisions and to

accommodate different values for different circumstances, like roads with very low traffic volume historic roads and the bridges on them.

For existing bridges on very low volume local roads (ADT <400), the guidance states that they may remain in place, unless there is a site-specific safety problem related to the width of the bridge. Since many historic bridges across the country are located on minor roads, application of this AASHTO policy can affect positive outcomes for preserving historic bridges.

Case Studies on the Rehabilitation of Historic Bridges. Prepared by the SRI Foundation. (July 2011)

Available: http://environment.transportation.org/environmental_issues/historic_cultural/docs_reports.aspx

The report was prepared by the SRI Foundation for the AASHTO Center for Environmental Excellence to address a dearth of historic bridge rehabilitation case studies and best practices that would provide detailed, technical, real-world examples that state Departments of Transportation (DOTs) and local transportation agencies could use in planning and executing rehabilitation projects. The 16 case studies included in this report were developed in partnership with state DOTs and local transportation agencies, and their historic bridge rehabilitation contractors. The case studies provide photographs, bridge descriptions and settings, rehabilitation information and costs, contacts and significant issues associated with the project.

Highway Safety Manual (2010)

Available for purchase: https://bookstore.transportation.org/collection_detail.aspx?ID=33

The Highway Safety Manual (HSM) is an advisory manual that brings science and statistical analysis to quantifying safety. It enables designers and all stakeholders to determine quantifiably what effect on safety the proposed change will make. The new manual is linked to FHWA's Interactive Highway Safety Design Model (IHSDM) because it uses the IHSDM crash prediction module as the protocol for analyzing and quantifying safety for non-freeway roadway types. This means that the cost and safety performance of a bridge can be quantified and supported.

Hypothetically, there could be a historic bridge that is operationally adequate but has documented safety problems. Several reasonable alternatives that would modify the existing geometry could be considered. After analyzing each alternative using the techniques within the HSM, the effects on safety could be shown to be identical for each of the alternatives. Knowing that the alternates meet the purpose and need, the decision maker could support selecting the alternative that most favors preservation of the historic bridge.

There are many benefits to now being able to quantify safety and define expected long-term safety performance of existing or changed highway geometric design, including moving beyond assumptions about the safety associated with nominal values and addressing what effect design exceptions will have of future safety. It also enables owners, managers and designers to calculate the cost to safety of keeping or modifying historically significant features

of roadways, like walls along roadways or intersections design. That information could potentially influence decisions in regard to cost-effectiveness and funding.

LRFD Design Specifications, Customary Units, 5th Edition (2010)

Available for purchase: https://bookstore.transportation.org/Item_details.aspx?id=1560

This is the latest version of the AASHTO Bridge Specification, which contains the standards that all new bridges must be designed and constructed to meet.

Manual for Bridge Evaluation, 2th Edition (2010)

Available for purchase: https://bookstore.transportation.org/collection_detail.aspx?ID=96

This manual has been developed to assist bridge owners by establishing inspection procedures and evaluation practices that meet the NBIS standards. The manual has been divided into eight Sections, with each Section representing a distinct phase of an overall bridge inspection and evaluation program. This manual replaces both the 1998 *AASHTO Manual for Condition Evaluation of Bridges* and the 2003 *AASHTO Guide Manual for Condition Evaluation and Load and Resistance Factor Rating (LRFR) of Highway Bridges*. It also supersedes the *Manual for Bridge Evaluation, 1st Edition with Interims*. It serves as a single standard for the evaluation of highway bridges of all types.

A.1.3 Transportation Research Board (TRB)

Link: http://www.trb.org/Main/Home.aspx

A.1.4 Federal Highway Administration

Interactive Highway Safety Design Module (2008)

Available for purchase: http://www.fhwa.dot.gov/research/tfhrc/projects/safety/comprehensive/ihsdm/index.cfm

FHWA's Interactive Highway Safety Design Module (IHSDM) is a suite of software analysis tools that can quantify the safety and operational effects of geometric design. It checks existing and proposed designs against relevant design policy values and provides expected safety (substantive safety) and operational performance. The data is intended to support decision making. There are six evaluation modules; design consistency (diagnoses safety concerns at horizontal curves); intersection review (typical safety concerns); policy review (compliance with relevant geometric design policies); traffic analysis (quality of service for existing and future traffic flows); driver/vehicle (weather conditions exist that could result in loss of vehicle control); and crash prediction. All modules except crash prediction are for two-lane rural roads. The crash prediction module, which addresses most roadway types except freeways, estimates the frequency of crashes expected on a roadway based on its geometric design and traffic characteristics. It also serves as the analytical tool that supports AASHTO's brand new Highway Safety Manual.

Because the IHSDM facilitates checking both current and proposed geometric design in regard to long-term safety performance, it enables safety to be quantified. Simply stated it means that changes to existing roads can be evaluated for their substantive safety rather than relying on assumptions about the safety of nominal values. This means that decision makers and stakeholders alike can evaluate the cost and benefit of improvements. Whether the analysis favors retaining historically significant features or not, the IHSDM should be used to support balanced decision making.

The crash prediction module makes it possible to project and quantify the average number of future crashes at existing sites with the existing geometry (e.g., number and width of lanes, horizontal curves), as well as to predict future crashes based on proposed changes, like adding a left turn lane, widening a horizontal curve or adding shoulders. The algorithm for calculating safety is composed of three basic components: (1) a calibration factor; (2) a safety performance function; and (3) crash modification factors.

Since each safety performance function has standard base conditions, it is very possible these base conditions will not match the base conditions at the site being analyzed. To convert the base conditions to the conditions at the user's site, crash modification factors that adjust the base model specific geometric element dimensions and traffic control features are used. Crash modification factors are multiplied by the safety performance function and the calibration factor to determine the number, type and severities of crashes. The number of crashes by type and severity for the segments and all the intersections within the limits of the study are added together to determine the overall crashes within the study limits.

IHSDM - HSM Predictive Method 2011 Release (version 7.0.0, September 29, 2011) is now available for free download http://www.ihsdm.org. User technical support is also available free-of-charge. An IHSDM Training Course is available through the FHWA's National Highway Institute. IHSDM development is coordinated with two related initiatives: the Highway Safety Manual developed by the Transportation Research Board and published by AASHTO; and the Safety Analyst (http://www.safetyanalyst.org/), developed by FHWA and now available as AASHTOWare.

A.2 Flexibility

Flexibility in applying standards and policies are divided into several topic areas, as shown below. These documents provide a basis to develop a logical, and repeatable, process or procedure for deciding upon rehabilitation or replacement of an historic bridge.

A.2.1 Management Guidance

Effective Practices for Considering Historic Preservation in Transportation Planning and Early Project Development (2008)

Available: http://onlinepubs.trb.org/onlinepubs/archive/NotesDocs/25-25(49)_FR.pdf

Prepared for AASHTO's Standing Committee on the Environment (SCOE), NCHRP Project 25-25, Task 49 is the first concerted effort to compile in one document descriptions of best practices for considering historic preservation factors during transportation systems planning and early project development. This project also examines how state departments of transportation (DOT) effectively engage historic preservation agencies and organizations, and federally recognized tribes, during planning and the initial stages of project development.

The study was conducted in three stages: 1) a literature search; 2) a nationwide on-line survey of state DOTs and local planning organizations; and 3) follow-up interviews with those agencies and organizations that noted in their survey responses that they did consider historic preservation factors during either planning or early project development. Transportation planners from 28 states participated in the on-line survey, as did cultural resource staff from 38 states. Eighteen states participated in the follow-up interviews. Based on the literature search, on-line survey, and follow-up interviews, the project team, in consultation with the study's panel members, identified a sample of states and local planning organizations for additional in-depth interviews. The purpose of these more in-depth interviews was to document the specifics of how these agencies developed and maintain their best practices.

The best practices documented in this study, though developed to address specific conditions and problems within each state and agency, can be grouped into five categories: computerized cultural resource inventories; archaeological predictive modeling; formal, interagency procedures; regularly scheduled consultation with State Historic Preservation Offices (SHPO), tribes, and other stakeholders; and Section 106 programmatic agreements

Guidelines for Historic Bridge Rehabilitation and Replacement (2008)

Available: http://onlinepubs.trb.org/onlinepubs/archive/NotesDocs/25-25(19)_FR.pdf

See description under Section A.1.2.2.

Chamberlin, W. P. Historic Bridges—Criteria for Decision Making. NCHRP Synthesis of Highway Practice No. 101. Transportation Research Board, National Research Council, Washington, DC. 1983.

Available: http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_syn_275.pdf

This pioneering synthesis examined state highway agencies' efforts to identify historic bridges and approaches to resolving inherent issues to preserve them. The conclusion of the 1983 study was that both identification and preservation of historic bridges varied greatly from state to state and few states had even considered a consistent approach for managing them.

DeLony, E. and T. H. Klein. "Historic Bridges: A Heritage at Risk. A Report on a Workshop on the Preservation and Management of Historic Bridges. Washington, DC, December 3-4, 2003." SRI Foundation, Preservation Conference Series 1. June 2004.

Available: http://www.srifoundation.org/pdf/bridge_report.pdf

The report is a summary of the issues, initiatives and recommendations identified by a national panel of practitioners who gathered at a two-day workshop to define the issues confronting historic bridges. The goal of the workshop was to consider possible solutions for preserving at-risk bridges. The group produced ten specific recommendations to "streamline and enhance historic bridge preservation and management nationwide," and those recommendations range from mandating states to do bridge-specific management plans to an NCHRP synthesis on rehabilitation verses replacement decision making. The report also includes synthesis of a 15-question survey sent to a variety of historic bridge stakeholders.

A.2.2 Context Sensitive Solutions

In many cases, new practices are initiated by design trends or paradigm changes that are supported by legislation. One such paradigm change is to provide designs that consider the context of the project, providing a Context Sensitive Solution (CSS). CSS has evolved over the past several decades, initially through grass roots events and publications and then through surface transportation legislation. Key legislation supporting the use of CSS includes:

The Intermodal Surface Transportation Efficiency Act of 1991

Available: http://thomas.loc.gov/cgi-bin/query/z?c102:H.R.2950.ENR:

The National Highway System Designation Act of 1995

Available: http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=104_cong_public_laws&docid=f:publ59.104

Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU)

Available: http://www.fhwa.dot.gov/safetealu/index.htm

Neuman, T. R., et al. A Guide to Best Practices for Achieving Context Sensitive Solutions. NCHRP Report 480, Transportation Research Board, Washington, DC. 2002

Available: http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_480.pdf

The guide explains how DOTs and other transportation agencies can incorporate context-sensitive designs (CSD) and CSS into project development. The methodologies are supported by case studies. The publication is an extremely well organized and practical approach to a logical and efficient process to arrive at the right answer for the right reasons and to incorporate stakeholder values into the project development process. The CSD/CSS methodology is based on a nonlinear, iterative process to capture all necessary interactions with stakeholders at the appropriate points in the project development process.

This is an important publication that articulates very well an inclusive, balanced and efficient process for developing and advancing projects, not just projects involving historic bridges. It has been demonstrated to efficiently produce solutions that address the human and cultural effects of transportation projects and to facilitate flexibility in thinking about how to solve the transportation problem in a way that does no harm and may enhance the human

environment. The guidance outlines how all projects, not just those involving historic properties, might better be advanced.

A.2.3 Flexibility in Design

Flexibility has always been a part of the AASHTO and FHWA design standards and guidance. The manner in which design standards are written, however, makes discerning this flexibility challenging. As a result, both FHWA and AASHTO commissioned guides to assist designers in identifying appropriate use of flexibility, following a sound engineering method and documenting the resulting design exceptions.

American Association of State Highway and Transportation Officials (AASHTO)

Link: http://www.transportation.org/

Task Force on Environmental Design. *Design Flexibility Case Study Report* (1997)

Limited availability at Northwestern University Transportation Library and Wisconsin Department of Transportation.

This report focuses on eight case studies demonstrating design criteria that were chosen to lessen environmental impacts and address mitigation.

A Guide for Achieving Flexibility in Highway Design (2004)

Available for purchase: https://bookstore.transportation.org/item_details.aspx?ID=103

A combination of the context-sensitive approach to design, the project development process, and using the inherent flexibility in current design criteria, the guidance is particularly useful in developing balanced solutions. The key is its linking of the project development process to achieve the flexibility needed for balanced decisions. The guidance acknowledges that properly defining the need and purpose in broad, not predetermined, terms is crucial, as is agreement among all parties that there is actually a need for the project. It also takes each of the controlling design criteria and describes alternative treatments for addressing a specific deficiency. The guidance demonstrates to practitioners who use AASHTO guidance how to understand when special consideration is appropriate and how to use flexibility in developing and advancing projects on non-NHS roads. Successful approaches for incorporating consideration of issues beyond engineering are outlined, as are useful examples of flexibility in specific design criteria, as well as mitigation for design exceptions.

Federal Highway Administration (FHWA)

Link: http://www.fhwa.dot.gov/

Flexibility in Highway Design (1997)

Available: http://www.fhwa.dot.gov/environment/flex/index.htm

In 1997, FHWA published Flexibility in Highway Design that recommended flexibility in application of the Green Book design values, particularly when considering impacts on the community. The guide was written for highway engineers and project managers who want to

learn more about flexibility available to them when designing roads and illustrates successful approaches used in other highway projects. The guide aimed also at provoking innovative thinking for fully considering the scenic, historic, aesthetic, and other cultural values of communities, along with safety and mobility needs. It did not establish any new or different geometric design standards or criteria for highways and streets in scenic, historic, or otherwise environmentally or culturally sensitive areas, nor did it imply that safety and mobility are less important design considerations.

Transportation Research Board (TRB)

Link: http://www.trb.org/Main/Home.aspx

Designing Safer Roads, Practices for Resurfacing, Restoration and Rehabilitation [3R]. Special Report 214. (1987)

Available for purchase: http://books.trbbookstore.org/SR214.aspx

Changes in federal-aid policy in 1976 allowed states to use federal money to extend the life and improve safety of existing roads and bridges while retaining their characteristics through a program known as 3R (resurfacing, restoration or rehabilitation). The program was intended to address incremental work like bridge rehabilitation and related safety improvements when there is no need to revise an alignment or increase roadway capacity, and states are encouraged to develop, in conjunction with FHWA, their own site-specific 3R design criteria that are tailored to eliminate the frequent use of a particular design exception. The state-developed 3R standards also include ranges of treatments that are based on the documented operational and safety history associated with existing roads.

Because the work is incremental in nature and to roads and bridges with a performance history, 3R design criteria generally have lesser design values than those for new or full reconstruction. However, striking a balance between road and bridge preservation and incremental safety and geometric improvements, proved controversial because there was no national definition of which minimum geometric standards would apply to 3R projects. Consequently, there was no national consistency on how the program was being used. Most 3R projects emphasized much-needed repaving with the reasoning that pavement repairs were safety improvement enough. Many states reasoned that anything else took money away from and delayed other needed repaving projects. Other states viewed 3R as an opportunity to simultaneously make long-needed improvements to older highways. The purpose of the 1987 research and report was to evaluate the safety and cost effectiveness of geometric design standards in 3R projects and to make recommendations. The findings have been used to inform subsequent thinking about highway design and flexible application of full Green Book standards on existing, non-freeway roads, particularly the *Guidelines for Geometric Design of Very Low-Volume Local Roads (ADT<400).*

3R projects typically involve rehabilitating short segments of pavement with partial-depth repairs and targeted safety improvements to existing facilities. Since 3R projects involve retention of existing three-dimensional alignment, they represent a category of work

commonly associated with existing bridges and their approaches. The value of the 3R program is that state and local agencies have experience with flexibility in application of geometric design standards for existing facilities. Advancing a project as a 3R affords the opportunity for stakeholders and decision makers to utilize the flexibility and state/local control that characterizes the successful, well-established federal-aid program.

A.2.4 Other Resources

Hauer, Ezra. Safety in Geometric Design Standards. University of Toronto. 1999.

This piece describes what underlies design criteria decisions, reflecting the relationship between roadway design and safety. Hauer has developed statistical methods and theories that translate data into guidance for state and federal transportation agencies, including the new Highway Safety Manual. His analysis is what is being used to determine the safety performance of roads and bridges and is what is being used to set design values, including bridge width. Through analysis of the evolution of design criteria decision making, he argues that engineers really do not know how a selected value affects safety, and he demonstrates that standards are written to govern the occurrence of situations, like head-on crashes, rather than safety outcomes. It has been assumed that roads and bridges that conform to design standards are safe, but what does that mean? Appropriately safe? Safe as it can be? Safe as it should be? Or, is that assumption unsupportable given that the relationship between safety and a particular value or range of values like vertical crest, horizontal curve, or even lane width, has not been proven?

Hauer suggests defining safety-based design criteria by making a clear distinction between two kinds of safety; (1) nominal safety, that is, compliance with standards, etc. and (2) substantive safety, that is, the expected crash frequency and severity. What level of substantive safety is appropriate would be governed by considering what level of safety is attainable with resources available, which in reality is how many existing bridge improvement projects are advanced. He also argues that design decisions should be based on known relationships between safety and design decisions, that such data should be periodically updated, that decisions should be approved by those who have “mastered” currently available knowledge, and that political guidance on the level of safety should be provided to designers in order to address liability and share responsibility for decisions. The trend is toward developing approaches to measuring and assessing safety, which is becoming increasingly accepted as the basis for establishing design values.

Stein, W. J., and T. R. Neuman. Mitigation Strategies for Design Exceptions. FHWA Report FHWA-SA-07-011. 2007.

When it is determined to be necessary to use a value for one of the 13 design criteria lower than the normal range in order to avoid an adverse effect on another value, a design exception may be considered. It is important to consider the effect of the lesser value on substantive safety, and the report outlines how to evaluate and then analyze the risk of the design exception. Since a design exception is expected to result in adverse operation and/or safety

impacts, effective and useful ways to mitigate the effect(s) of the design criteria are described. The mitigation ranges from construction options, like placing barriers in front of fixed objects and adding climbing lanes, to fairly simple solutions, like signage and placing reflective panels or tape. The publication is particularly useful because it offers various ways to achieve a transportation objective. The host of alternatives presented can inform a fair and balanced evaluation of rehabilitation potential through consideration of non-traditional approaches to meeting a purpose and need.

A.2.5 Technical Literature

The following are a list of some organizations that have published technical papers related to historic bridge rehabilitation, but it is not an exhaustive list.

American Concrete Institute (ACI)

Link: http://www.concrete.org/general/home.asp

The ACI publishes two journals (*ACI Materials Journal* and *ACI Structural Journal*) and a magazine (*Concrete International*) that feature research, analysis and projects related to the development of the professional knowledge and application of concrete, including occasional papers on maintenance, repair and historic analysis. Most of the information presented is project specific but there are some synopses of issues facing the rehabilitation of historic reinforced concrete. The ACI journals and magazine are indexed and abstracted, available on-line at http://www.concrete.org [June 2006].

Examples:

- Kemp, E. L., "An Introduction to the Structural Evaluation of Historic Reinforced Concrete Structures." *Concrete International*. Vol. 1, No. 10. Oct. 1979.
- O'Connor, J. P., J. M. Cutts, G. R. Yates, and C. A. Olson. "Evaluation of Historic Concrete Structures." *Concrete International*. Vol. 19, No. 8. Aug. 1997.

American Society of Civil Engineers (ASCE)

Link: http://www.asce.org/

Among the many useful ASCE publications are:

- Conference Proceedings
- Transactions
- Journal of Bridge Engineering
- Journal of Materials in Civil Engineering

Articles are abstracted and searchable on-line at http://ascelibrary.aip.org. The application of the ASCE literature to specific bridge rehabilitation solutions is wide ranging and offers a body of professional experience treating most historic bridge types and materials. Articles offer strategies for addressing issues of structural analysis, load-carrying capacity and rehabilitation

techniques. Data is offered that has potential use in the establishment of specific rehabilitation protocols, e.g., reliable and proven methods of testing the strength of wrought-iron truss members, often resulting in higher than assumed strength.

Examples:

- Gordon, R. and R Knopf. "Evaluation of Wrought Iron for Continued Service in Historic Bridges." *Journal of Materials in Civil Engineering*. Vol. 17, No. 4. July/August 2005, pp. 393-399.
- Green, P. S. "Rehabilitation of a Nineteenth Century Cast and Wrought Iron Bridge." *ASCE Structures Congress, Proceedings.* 1999, pp. 259-262.
- Lamar, D. M. and B. W. Schafer. "Structural Analysis of Two Historic Covered Wooden Bridges." *Journal of Bridge Engineering*. Vol. 9, No. 6. November/December 2004, pp. 623-633.
- Pullaro, J. "Restoring Historic Bridges Using Modern Methods." *ASCE Structures Congress, Proceedings.* 1999, pp. 263-267.

The Association for Preservation Technology (APT) International

Link: http://www.apti.org/

The *APT Bulletin* publishes case studies and technical information in the field of historic preservation, including the history of building materials and state-of-the-art technical information for preservation. Many of the articles are derived from papers presented at the annual APT conference.

Examples:

- Fischetti, D. C. "Conservation Case Study of the Cornish-Windsor Covered Bridge." *APT Bulletin*. Vol. 23, No. 1. 1991, pp. 22-28.
- Sparks, S. P. and M. E. Badoux. "Non-destructive Evaluation of Historic Wrought-Iron Truss Bridge in New Braunfels, Texas." *APT Bulletin*. Vol. 29, No. 1. 1998, pp. 5-10.

Engineering Manuals and Books

American Association of State Highway and Transportation Officials. *Maintenance Manual for Roadways and Bridges*. 2007.

The manual is intended for professionals early in their careers of highway and bridge maintenance, but it contains a great deal of practical information on how deterioration starts, common-sense preventative maintenance that few owners ever perform, and many appropriate treatments to repair and rehabilitate all types of bridges. The logistics associated with making repairs are also explained. This is an overly ambitious work, and as a compilation of data from many sources, it seems inconsistent at times. It does contain useful information and an extensive bibliography of TRB and NCHRP research on all manner of topics from waterproofing membranes to heat straightening out of plane bridge members.

Parsons Brinckerhoff, Inc. *Bridge Inspection and Rehabilitation*. New York: John Wiley & Sons, Inc., 1993.

The book is another compilation of inspection and repair information produced by PB engineers to assist with effectively implementing the federal bridge inspection and bridge replacement programs triggered by the 1967 collapse of the Silver Bridge over the Ohio River between Ohio and West Virginia. It contains useful information on inspection techniques, as well as repairs to details associated with all types of older static and movable bridges. It does not go into the prudence of such actions or provide guidance on rehabilitation or replacement decision making. However, it does contain some good sketches and illustrations that will assist lay persons understand bridge design and how details work.

Sowden, A.M., ed. The Maintenance of Bridge and Stone Masonry Structures. London: E. & F.N. Spon, 1990.

Intended as a practical guide for maintenance of stone structures, this British publication provides a great deal of useful information on the "corrective" treatments that are not familiar to engineers more experienced in design than rehabilitation. It addresses issues starting with initial detection of defects through treatments and monitoring their cost effectiveness. Well illustrated and comprehensive in the topics covered, from testing to destruction to waterproofing and the importance of aesthetic consideration, the information is heavy on corrective techniques and case studies of British structures. The philosophies and principles expressed are universal. This is an excellent reference for preservationists and engineers alike because of its holistic considerations and breadth of topics covered.

National Park Service, Technical Preservation Services

Link: http://www.nps.gov/history/hps/tps/

The National Park Service's Preservation Briefs series offers general guidance on preserving, rehabilitating, and restoring historic buildings and structures. The briefs synthesize important and widely accepted professional guidance on the treatment of historic materials, much of it applicable to bridge rehabilitation approaches that meet The Secretary of the Interior's Standards for Rehabilitation and The Secretary of the Interior's Treatments for Historic Property.

Examples:

- Gaudette, Paul and Deborah Slaton. "Preservation of Historic Concrete." Preservation Brief No. 15, National Park Service, Technical Preservation Services, Washington, DC. 2007, 16 pp.
- Mack, R. C. and A. Grimmer. "Assessing Cleaning and Water-Repellent Treatments for Historic Masonry Buildings." Preservation Brief No. 1, National Park Service, Technical Preservation Services, Washington, DC. Revised, 2000, 17 pp.

- Mack, R. C. and J. P. Speweik. "Repointing Mortar Joints in Historic Masonry Buildings." Preservation Brief No. 2, National Park Service, Technical Preservation Services, Washington, DC. Revised, 1988, 21 pp.
- Weaver, M. E. "Removing Graffiti from Historic Masonry." Preservation Brief No. 38, National Park Service, Technical Preservation Services, Washington, DC. 1995, 15 pp.

Other Resources

- Cooper, James. Repairing & Restoring Historic Bridges: Keeping Faith with Their Makers. 1998.
- Cooper, James. Restoring Historic Metal Truss Bridges: A Handbook for Keeping Faith with Their Makers. 2001.

A.2.6 Technical Websites

American Society of Civil Engineers

Link: http://www.asce.org/

Association for Preservation Technology International

Link: http://www.apti.org/

Center for Environmental Excellence by AASHTO, Historic Preservation/Cultural Resources

Link: http://environment.transportation.org/environmental_issues/historic_cultural/docs_reports.aspx

This is the site managed by AASHTO's Center for Environmental Excellence offers a library of research, documents and reports pertinent to historic preservation and cultural resources. It offers access to national experts and practitioners in historic bridge preservation and rehabilitation through its Historic Bridge Community of Practice.

Center for Environmental Excellence by AASHTO, Historic Bridges Community of Practice (COP)

Link: http://environment.transportation.org/cop/groups/historic_bridges/default.aspx

This site provides an online venue for invited participants to identify emerging issues, trends, procedures, research, and data needs associated with the identification, evaluation, and management of our nation's historic bridges.

Federal Highway Administration

Link: http://environment.fhwa.dot.gov/histpres/bridges.asp

On its Historic Bridges website, FHWA provides technical assistance resources for relating to the historic bridges, including maintenance manuals, case studies, and best practices reports.

Indiana's Historic Bridges

Link: http://www.indianahistoricbridges.com

This is the web site maintained by historic bridge scholar and advocate James L. Cooper, Professor Emeritus of History, DePauw University at Greencastle, IN. A long-time student of bridge building technology, Jim has worked with consulting engineers, elected officials and county and municipal engineers to promote logical approaches to historic bridge preservation. He has also written or compiled books on the history of metal and reinforced concrete bridges in the state and compilations of papers and period technical literature on materials and rehabilitation techniques, like *Restoring Historic Metal-Truss Bridges: A Handbook for Keeping Faith with Their Makers* (2001). This includes heat- (or flame-) straightening, a lost art that is gaining currency as an aptly titled article "a friend in need" describes. *Repairing and Restoring Historic Bridges Keeping Faith with Their Makers* (1998) is a compilation of papers presented a late-1990s bridge restoration workshop organized by Cooper. Of particular note is "Restoring Metal-Truss Brides to Serve Today's Needs" by James Barker, P.E.

This source hits all the bases from practical considerations for keeping historic bridges in service and economical ways to paint metal trusses, as well as the information needed to understand material properties and thus approaches to their preservation and conservation. The author also understands the importance of systematic change in how old bridges are regarded by the public and governmental agencies and how to effectively use education to promote keeping historic bridges in service. He was part of the grassroots effort that resulted in the INDOT, SHPO and FHWA program for historic bridges.

The web site offers articles, case studies, commentary, and practical considerations for preserving historic bridges as well as the means to obtain Cooper's publications.

National Park Service, Technical Preservation Services

Link: http://www.nps.gov/history/hps/tps/

Technical Preservation Services, National Park Service, recently launched an expanded and redesigned website. The site contains the Secretary of the Interior's Standards and Guidelines, information about the Historic Preservation Tax Incentives, all of our publications, including the Preservation Briefs and Preservation Tech Notes; guidance on meeting the Standards in rehabilitation projects; information on the Historic Surplus Property Program and the Historic Preservation Internship Training Program; online training; and much more.

VJM Metal Craftsman, LLC

Link: http://www.historicbridgerestoration.com

This is the web site authored and maintained by Vern Mesler to provide information on historic metal truss bridge restoration and riveting as well as the related services and research provided by VJM Metal Craftsman, LLC. Mr. Mesler has over 35 years experience as a welder and steel fabricator, and over 30 years as an adjunct welding instructor at Lansing Community College. He is also project manager for Calhoun County's (Michigan) impressive bridge park and the force behind Lansing Community College's workshops on iron and steel bridges preservation techniques. He also produces the periodic *Craftsman's Newsletter.* Some of the

material was produced in conjunction with the 2010 Workshop sponsored in part by the National Center for Preservation Technology and Training.

The web site is a compilation of data on how to relocate and conserve/preserve metal truss bridges, especially in a protected setting. It contains practical, hands-on demonstrations that prove deteriorated fabric can prudently be repaired, particularly heat straightening, welded repairs to steel and wrought iron and treating pack rust. Mr. Mesler's web site demonstrates that much is possible, as well as shows how to do it. What makes his information so useful is that it starts with a sound understanding of how bridges work, which then informs ways to successfully and economically rehabilitate it. Engineering analysis is provided by Dr. Frank J. Hatfield, emeritus professor of structural engineering at Michigan State University.

A.2.7 International Documents

Other countries have historic bridges that date back hundreds, and some thousands, of years. There is the potential to learn from well established procedures in other countries that could be adapted for use here.

DeLony, Eric. Context for World Heritage Bridges. International Council on Monuments and Sites and The International Committee for the Conservation of the Industrial Heritage, a joint publication. 1996.

This effort is intended to organize the known historic bridges and identify those that have a first-in-kind place in the world community. As context, it offers a view of what makes the most significant bridges valuable, but does not propose management or technical practices to preserve that value.

Ryall, M. J., G. A. R. Parke, J. E. Harding, eds. Manual of Bridge Engineering. Thomas Telford Publishing, London. 2000.

This is a very informative engineering manual that offers detailed descriptions of the development of bridge types through history and around the world, with many existing examples. It provides a thorough description of the principles of bridge design and modern examples. The extent of its coverage of historic bridges and their engineering gives a strong indication of a high value placed on historic structures by European bridge engineers.

A.2.8 Effective Practices

These are practices in use, with some measure of documentation, that have resulted in good decisions, whichever the outcome.

Chamberlin, W. P. Historic Highway Bridge Preservation Practices. NCHRP Synthesis of Highway Practice No. 275. Transportation Research Board, National Research Council, Washington, DC. 1999.

The research and synthesis summarizes the variety of methods state highway agencies use to manage their historic bridges. It makes clear that addressing historic bridges is done to satisfy

federal laws, but how historic bridges are managed and decisions are made is a state issue; there is not a national approach. In addition to explaining the laws and issues associated with preserving or replacing historic bridges, the report provides specific examples of various state approaches to bridge preservation, which illustrate superbly his point that methods vary greatly from formal, stand-alone documents to memoranda of agreement, protocols that outline a hierarchy of treatments to be considered, and unwritten but spoken understandings of how decisions will be made.

Maine Department of Transportation. "Chapter 10: Rehabilitation," Bridge Design Guide. August 2003.

Link: http://www.maine.gov/mdot/technical-publications/brdesignguide.php

Missouri Department of Transportation. Practical Design Implementation Manual. 2005.

Link: http://www.modot.mo.gov/business/PracticalDesign.htm

In 2005, Missouri Department of Transportation (MDOT) implemented its practical design policy to allow increased flexibility and creativity for project-specific locations. MDOT's approach was to make practical design, also known as "right-sizing," the dominant approach to highway design throughout the state. The focus of establishing design criteria begins with the project purpose and need and the context of the road's surroundings (beginning with whether it is urban or rural) rather than striving toward maximum nominal values and standards based on road classification. The policy encourages designers and decision makers "to think outside the box" with the primary goal of gaining the best value for the least cost, thus spreading the department's budget to the greatest number of projects possible without compromising safety.

MDOT's manual establishes *desirable* values and design guidance with constant emphasis on not over-building while improving safety. Road design criteria are based on several factors, but the primary measure of adequacy of the design is operational level-of-service (LOS) on a 20-year projection. Adequacy is defined by urban LOS D/E (off-peak/peak hour) and rural LOS C/D (off-peak/peak hour). [LOS is defined by levels A to F, with A being the highest free flow level and F being the lowest forced or breakdown flow level.] LOS targets are themselves recognized as subjective measures that are based on traffic models and professional judgments. Design speeds on all projects must equal and not exceed the posted speed limit.

The manual addresses desirable characteristics and values of typical section elements (lane width, shoulder width, median width, clear zones and cut and fill slopes, roadside ditches); horizontal and vertical alignment (Green Book values to serve as a maximum); pavements (thickness and type based on ADT); structures/hydraulics (all new bridges to be at least 12' travel lanes); and roadside safety (rumble strips mandatory on all shoulders 2' or wider). Lesser values are recommended for minor rural roads with reference to AASHTO's very low-volume road guidance. The manual also makes it MDOT policy to consider non-motorized transportation, including bicycles and pedestrians. While the manual does not specifically address the environmental planning framework or types of settings beyond general categories

of urban or rural (e.g., wetlands, residential, commercial, historic districts), it does encourage collaboration and flexibility. The surrounding environment, which could include a historic road corridor, is to help determine project-specific design criteria.

In testimony before the House Committee on Transportation and Infrastructure on June 10, 2010, The Honorable Peter A. DeFazio, chair of the Subcommittee on Highways and Transit, noted that "after five years of using its Practical Design Implementation Manual, 83 percent of Missouri's highways were rated in 2009 to be in good condition, versus 44 percent in 2003, and the Missouri DOT estimated it saved 13 percent on project costs."

Ohio Department of Transportation. Bridge Design Manual. 2007 Edition. Sections Updated April 2010.

Link: http://www.dot.state.oh.us/Divisions/Highwayops/Structures/Standard/Bridges/Pages/BDM2004.aspx

Oregon Revised Statutes 366.550 through 366.553. Historic Columbia River Highway: Defined, Policy, Program, Advisory Committee. 1987.

Link: https://www.oregonlaws.org/ors/366.550

As used in ORS 366.550 (Historic Columbia River Highway defined) to 366.553 (Advisory committee), Historic Columbia River Highway means all parts of the original Columbia River Highway, constructed between 1913 and 1922, in Multnomah, Hood River and Wasco Counties, that have been designated as a Historic and Scenic Highway under ORS 377.100 (Study of highway system) and all properties and structures that are within the Columbia River Highway Historic District, National Register of Historic Places. The intent of the legislation is to preserve and restore the continuity and historic integrity of the remaining segments of the Historic Columbia River Highway, including the rehabilitation, restoration, maintenance and preservation of all original roadway and highway-related structures on the intact and usable highway segments.

Oregon Department of Transportation. Practical Design Strategy, March 2010.

Link: http://www.oregon.gov/ODOT/HWY/TECHSERV/practical_design.shtml

Practical Design is a term applied to a strategy adopted by several states to reduce cost and still deliver focused benefits. As the transportation infrastructure ages and demands to move people and freight increase, jurisdictions everywhere are recognizing the need to stretch scarce dollar resources to address as many needs on the system as possible. Rather than achieving the perfect or near perfect solution, projects have to deliver some benefits within the money available, even if those benefits do not last for decades in the future.

Exactly how practical design is implemented varies by situation. At a minimum, considerations include safety, economic development, communities if a project passes through them, the environment, the overall transportation system (not just highways) and cost. For the past several years, ODOT has actively explored ways to more effectively deliver projects under fiscal constraints while concurrently meeting stakeholder expectations—key tenets of the Practical

Design concept. Practical Design at ODOT provides a foundation for thought and processes to achieve more focused improvements at a lower cost, even if those improvements are not as long lived as traditional ODOT highway improvements.

This report defines ODOT's strategy for achieving practical design principals.

Texas Department of Transportation. Historic Bridge Manual. June 2010.

Link: http://onlinemanuals.txdot.gov/txdotmanuals/his/index.htm

The manual "provides guidance on TxDOT-required coordination activities, funding restrictions, and reuse options to be considered when preserving historic bridges in the course of bridge replacement and rehabilitation projects." It contains minimum design criteria or thresholds for load and width for off-system bridges with ADT <251. Note that this is more stringent than AASHTO policy for the same classification of highway.

Vermont Agency of Transportation. Vermont Historic Bridge Program.

Link:
http://www.aot.state.vt.us/progdev/Sections/Structures/VermontHistoricBridgeProgram/HBP00vermonthistoricbridgeprogram.htm

The website contains all of the pieces for this state's comprehensive approach to preservation and maintenance of historic bridges. It includes programmatic agreements defining how the program will work, development of bridge-specific studies to identify preservation potential, uses and treatments, and state design standards that balance engineering and impacts on natural resources, historic, scenic, or other community values. The goal of each metal truss bridge plan is/was to identify preservation use and treatments, so there are no specific decision-making criteria or protocol. The Vermont program represents an exemplary agency commitment to rehabilitation being the rule rather than the exception with all of the pieces in place, from state design standards that tolerate "reasonable" widths and sight distances to financial incentives for towns. Consequently, its guidance is more process rather than rehab versus replacement decision making oriented. Their update of the approach to evolving plans for covered bridges represents an important movement to applying a holistic approach with emphasis on public education and involvement.

Vermont Agency for Transportation. Vermont State Design Standards. 1997.

Link: http://www.aot.state.vt.us/progdev/standards/statabta.htm

The State of Vermont developed and adopted its own design standards for the construction, reconstruction and rehabilitation of its roads and bridges. In the spirit of the flexibility encouraged by Intermodal Surface Transportation Efficiency Act, the goal of the Vermont standards is to provide for a safe and efficient transportation system that is sensitive to the social and environmental context of the state. Many would agree that their goal has been met. The guidelines are independent of their 3R standards, and they are organized by roadway functional classification with "special design guidelines" for each classification, from interstate

to local street. The new standards also include making design exceptions that the Vermont Agency of Transportation and FHWA were frequently granting as acceptable values.

The design standards, like the Green Book, offer a range of geometric values. In some instances, the values are the same as the Green Book while others vary slightly. For example, the Vermont standards use 11' and 12' as the standard lane widths on their arterials, and then use traffic volumes (ADT) to differentiate when it is appropriate to use the lesser value. The Green Book would require the higher value. Other values for features like shoulder widths also vary but are typically within a foot of Green Book values for the same element with the same controlling criteria. In addition to the range of values, the design standards offer guidance on avoidance and mitigation treatments.

The special design guidelines for each roadway classification offer a list of common tools for achieving a better fit, as well as specific treatments for projects with historic or archaeological, natural, scenic or recreational significance (similar to the Scenic Byways intrinsic qualities) and village entrances. The special design guidelines are similar in content, but become progressively less rigid and permissive as the functional classification moves from arterials to local roads. Treatments specific to historic bridges include considering "retrofitting of historical bridges," and "when existing historic bridges are structurally deficient, and replacement the only solution, new bridge and approach designs should consider aesthetic treatments consistent with the historical context.

Virginia Transportation Research Council. "Best Practices for the Rehabilitation and Moving of Historic Metal Truss Bridges." VTRC Final Report 06-R31. June 2006.

Link: www.virginiadot.org/vtrc/main/online_reports/pdf/06-r31.pdf

The Virginia Department of Transportation and the Department of Historic Resources are responsible for the management of about 30 historic truss bridges. All too often, these structures do not meet today's traffic demands or safety standards. Their general deterioration requires disassembly and relocation, rehabilitation and re-erection, or storage. The technology and materials used to build them are no longer in use, and many of the people with practical experience are no longer working. Little information is readily available on safely and effectively identifying and performing necessary operations.

The purpose of this research effort was to create a reference for use by engineers and historic resource personnel involved in the dismantling and reassembly of truss bridges. The scope of the study was limited to pin-connected and riveted metal truss bridges. The question to be answered was: "How did they design them, build them, take them down, move them, and reassemble them?"

Although the primary emphasis was the structural engineering aspects of the question, guidelines for the rehabilitation of historic structures in a manner that would preserve their integrity and the associated operational and environmental issues were also considered.

Carefully structured interviews with regard to the design, construction, evaluation, disassembly, moving, and rehabilitation of historic structures combined with documentary research formed the foundation of this study of best practices. The process involved in the refurbishing of a truss bridge crossing the Calfpasture River in the town of Goshen, Virginia, was used as a detailed case study to present the many issues that must be addressed during the dismantling and restoration of a historic truss bridge.

A.2.9 **Tort Liability**

Tort liability has been a recurring concern, finding expression in both increasing the level of protection of the public in the development of new standards, and in the reluctance to exercise professional judgment to deviate from standards, despite justifiable reasons. Research into cases, adjudged or settled, can potentially give a better view of the reality of such liability, and whether reasonable measures can be taken to mitigate the risk, short of rebuilding the entire highway system to current standards.

Three documents are provided here. The first is a presentation by then Deputy Counsel for the California Department of Transportation to the Transportation Research Board on this subject. The second two are the court decisions of the only recorded cases that clearly involve damages associated with an historic bridge that did not meet current standards. In both cases, the courts ultimately found that the owner was not liable.

In June 2010, the NCHRP 20-6 Project Panel: Continuing Project on Legal Problems Arising out of Highway Programs awarded Project 17-02: Tort Liability Defense Practices for Design Flexibility Including Design Documentation. It is expected that the project will be completed sometime in late 2011 or early 2012.

- Gowan, Brelend C. *Standards vs. Guidelines: Engineering Tools or Legal Weapons?* Session 322, 77th Annual Meeting, Transportation Research Board. January 1998.
- Carlton v. Cleburne County, Ark. U.S. Court of Appeals, Eighth Circuit, No 95-2843. August 21, 1996.
- Helton vs. Knox County, Tenn. Supreme Court of Tennessee, No 03-S-01-9502-CV-00015. May 13, 1996.

Appendix B Interviewees

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Appendix C Interview Questions

C.1 Core Questions (Not applicable to Owner Legal Staff)

1. What do you see as the biggest issues in managing historic bridges?
2. How does your Agency manage historic bridges? Are historic bridge treated as a special asset group or do they receive special consideration? What practices or processes does your agency use to program work that will have an effect on historic bridges?
3. What steps does your agency follow in its practice of identifying and programming a potential project that will result in the rehabilitation or replacement of an historic bridge? What steps does it follow in the practice of developing such a project when programmed?
4. At what point in the planning process leading up to a potential project is rehabilitation versus replacement considered? If not decided in the planning process, at what point is rehabilitation versus replacement considered in the project development process? What steps are taken to ensure the evaluation between the two choices is fair?
5. Do you use the AASHTO guidelines for historic bridges to help select rehabilitation or replacement of historic bridges? What other guidelines or tools do you use, including those specifically developed by your agency, such as a historic bridge plan or manual?
6. How does your agency handle cost estimating for rehabilitation versus new construction? Describe differences for smaller versus larger signature bridges.
7. Does tort liability affect decision making related to historic bridges in your agency?
8. Who have you consulted with for ideas in dealing with historic bridges? Are there other agencies or people that you recommend we contact?
9. What information do you need to consistently achieve balanced decisions?
10. What changes or improvements to your process would you like to implement?
11. How well are the agency's practices working in addressing the preservation or rehabilitation of historic bridges? Have rehabilitations resulted? Have replacements been streamlined?
12. What procedures or treatments have been useful in rehabilitating historic bridges, especially smaller workhorse bridges? Any lessons learned?
13. What practices have been useful for historic bridge preservation in your jurisdiction? Any lesson learned?
14. Which of your processes or procedures would you recommend to other agencies?
15. Would a central location or guide with documented best practices and lessons learned for addressing historic bridges be of value?
16. Please identify one or more bridge projects (see below) where your process or procedures resulted in a project that would be a good example to follow.

C.2 Owner Transportation Managers Individual Questions

1. Do you program projects to specifically address historic bridges or are they included in projects that address other issues with the roadway?
2. How does your Agency identify and set aside sufficient funding for historic bridge rehabilitation, repair and maintenance projects? How much per year goes into historic bridge projects, on average?
3. How does your agency handle cost estimating for rehabilitation versus new construction? Describe differences for smaller versus larger signature bridges.
4. How do you balance safety and load capacity against historic values in determining the scope of rehabilitation for bridge rails, roadway width, and structural support systems for historic bridges?
5. When, and by whom, the final decision on rehabilitation vs. replacement typically is made, and what internal review does this decision receive?
6. What procedures, guidelines or management plans does your Agency use to guide maintenance of historic bridges, and how have they led to implementation of rehab options in projects?
7. Are there specific policies that your agency has for dealing with emergency repairs that consider the Secretary of the Interior's Standards for the Treatment of Historic Properties while also addressing time-sensitive safety repairs?
8. Please describe briefly any unwritten procedures you typically follow that help you decide whether to rehabilitate or replace historic bridges.

C.3 Transportation Planners Individual Questions

1. Do you program projects to specifically address historic bridges or are they included in projects that address other issues with the roadway?
2. How does your Agency identify and set aside sufficient funding for historic bridge rehabilitation, repair and maintenance projects? How much per year goes into historic bridge projects, on average? Are these Highway Bridge Program funds?
3. How does your agency handle cost estimating for rehabilitation versus new construction? Describe differences for smaller versus larger signature bridges.
4. How do you engage cultural resources professionals to assist in deciding if rehabilitation vs. replacement is appropriate?
5. At what point during system planning or project development do you seek determination of the National Register eligibility of an older bridge?
6. Are there other tools that would assist you in advocating for rehabilitation, if appropriate, in discussions with decision-makers in other disciplines within your agency?
7. Please describe briefly any unwritten procedures you typically follow that help you decide whether to rehabilitate or replace historic bridges.

C.4 Cultural Resource Specialists Individual Questions

1. Does your agency have an asset management plan or a resource management plan that identifies specific historic bridges selected for preservation or rehabilitation versus those selected for demolition and replacement? What percentage of those bridges selected for preservation or rehabilitation have not been replaced??
2. How has the Agency used the Section 4(f) review to ensure thorough consideration of rehabilitation prior to selection of replacement, and is this an established practice or procedure? Please describe where it has resulted in rehabilitation?
3. How have programmatic agreements (PAs) resulted in rehabilitation instead of replacement? How have the PAs simplified replacement? Do you determine National Register eligibility of bridges as part of an asset or resource management plan? If not, at what point during project development do you determine the eligibility of a bridge?
4. Are cultural resources professionals actively engaged in deciding if rehabilitation vs. replacement is appropriate? Are they engaged at the System or Program level, or only at the project review level?
5. Are there other tools that would assist you in advocating for rehabilitation, if appropriate, in discussions with decision-makers in other disciplines within your agency?
6. What procedures, guidelines or management plans does your Agency use to guide maintenance of historic bridges, and how have they led to implementation of rehab options in projects?
7. Does your agency have specific policies have with emergency repairs that consider the Secretary of the Interior's Standards for the Treatment of Historic Properties while also addressing time-sensitive safety repairs? Please describe.
8. Please describe briefly any unwritten procedures you typically follow that help you decide whether to rehabilitate or replace historic bridges.

C.5 Design Engineers Individual Questions

1. When you consider rehabilitation of a historic bridge, what resources do you use to help you design the repairs and determine what those repairs will cost?
2. How does your agency handle cost estimating for rehabilitation versus new construction? Describe differences for smaller versus larger signature bridges.
3. How do you balance safety and load capacity against historic values in determining the scope of rehabilitation for bridge rails, roadway width, and structural support systems for historic bridges?
4. How have you used Context Sensitive Solutions and Flexibility in Design to address existing bridges which do not meet new construction design standards?
5. How have you used Practical Design in approaching repair, rehabilitation or replacement of a bridge?
6. What engineering analysis, strengthening techniques, deck repair, seismic retrofit approaches, widening, coating specifications, innovative materials, design exceptions, or

other procedures or treatments have been useful to you in rehabilitating historic bridges, especially smaller workhorse bridges? Any lessons learned?

C.6 Owner Legal Staff Pertaining to Tort Liability Individual Questions

1. Are you aware of any legal issues that have arisen in your agency that involve the preservation of a historic bridge?
2. Have issues relating to potential tort liability arisen in connection with a decision regarding whether to preserve a historic bridge as opposed to replacing the bridge or upgrading it to existing standards?
3. If so, please explain how those issues arose and how they were resolved.
4. Specifically, if the decision was made to replace or upgrade a historic bridge, what were the deciding factors that resulted in that decision?
5. If the decision was made to preserve a historic bridge, what were the specific factors that resulted in that decision and how were any potential tort liability concerns resolved?
6. Are you aware of any tort-related litigation in which a historic bridge has been the focus of allegations that the location was below standards or otherwise in a defective or dangerous condition?
7. Please explain the nature of any such allegations, the agency's defense to those allegations, the result of the litigation, and the ultimate outcome with regard to the historic bridge (e.g., upgraded, replaced, or preserved?).
8. Did potential tort liability play a significant role in the decision to upgrade, replace, or preserve the historic bridge?

C.7 FHWA Staff Individual Questions

1. Do you encourage projects that specifically address historic bridges or do you just review projects for compliance with standards and policies?
2. Do bridge owners ask you for ideas or support in rehabilitating historic bridges?
3. How does your agency view the continuing decline in the number of historic bridges? What efforts have you promoted to address this?
4. How does your agency view the use of Context Sensitive Solutions, Flexibility in Design and Practical Design? Do you allow and encourage design exceptions for historic bridges?
5. How have programmatic agreements resulted in rehabilitation instead of replacement? How have they simplified replacement?
6. How has your agency used Section 4(f) review to ensure thorough consideration of rehabilitation prior to selection of replacement, and where has it resulted in rehabilitation?
7. How have you ensured cost comparisons between rehabilitation and replacement are adequate and fair?

C.8 SHPO Staff Individual Questions

1. Do you encourage projects that specifically address historic bridges or do you just review projects for compliance with standards and policies?
2. Do bridge owners ask you for ideas or support in rehabilitating historic bridges?
3. How does your agency view the continuing decline in the number of historic bridges? What efforts have you promoted to address this?
4. How does your agency view the use of Context Sensitive Solutions and Flexibility in Design? Do you advocate design exceptions for historic bridges? Do you offer relaxation of Department of Interior Visual Standards when the agency uses design exceptions or other methods to actively retain an historic bridge in service?
5. How have programmatic agreements resulted in rehabilitation instead of replacement? How have they simplified replacement?

C.9 Bridge Preservation Civic Groups Individual Questions

1. Are you or other organizations brought in early as stakeholders in projects that affect historic bridges?
2. When you participate, are you able to make useful contributions that positively influence the resulting project? Any lessons learned?
3. How would you characterize the success rate of bridge owners you work with in preserving or rehabilitating historic bridges?

C.10 Knowledgeable Individuals Individual Questions

1. Do you see projects developed to specifically address historic bridges or only projects where they included when addressing other issues with the roadway?
2. What procedures or treatments have been useful in rehabilitating historic bridges, especially smaller workhorse bridges? Any lessons learned?
3. How do you balance safety and load capacity against historic values in determining the scope of rehabilitation for bridge rails, roadway width, and structural support systems for historic bridges?
4. What procedures, guidelines or management plans have you used or developed as a guide to maintenance of historic bridges, and how have they contributed to implementation of rehab options in projects?
5. Where have you observed particularly successful approaches used? Could these be exported to other agencies?

C.11 Example Bridge Project Details (Not applicable to Owner Legal Staff)

1. Bridge name and identification number
2. Length and number of lanes

3. Age of construction
4. Work (full rehabilitation, in-kind repairs, widening, replacement)
5. Cost of work and, if available, estimated cost of alternative(s) considered
6. Photograph(s) (before, one or more in progress, and after would be helpful)
7. Lessons learned (brief statement(s) would be sufficient)

Appendix D Tools, Techniques and Examples

D.1 Assessments / Exceptions for Historic Bridges

Use of engineering design exceptions and alternative standards to provide safe, reasonable and practical design approaches for repair, strengthening and widening in context with the historic character of the bridge can often demonstrate that preservation is indeed an option.

- New York City Department of Transportation (NYCDOT) makes a distinction between safety and load capacity. The Department has also accepted that certain bridges will remain functionally obsolete. As an example, the Brooklyn Bridge is substandard for geometry and weight capacity. (Henry Perahia, NYCDOT)
- NYCDOT has established a process so that repairs are done in two phases. In the short term, repairs are made in order to make the bridge and roadway safe again. In the long term, the department addresses any short-term repairs out of context with the historic structure. (Henry Perahia, NYCDOT)
- Hawaii DOT has recently started using a Context Sensitive Solution approach in project development. In part, this approach came about in response to community interests in preserving their one-lane bridges The Koukou'ai bridge, built in 1911, is a one-lane reinforced concrete arch bridge 15 feet wide and 58 feet in length. When this and other bridges were slated for replacement with modern bridges, the community residents expressed their desire to preserve the area's rural character. They worried that wider bridges would mean wider roads and more and faster traffic, and that better roads would open the remote area to further development. The bridge is currently slated for rehabilitation. (See Figures D-1 and D-2.)

D.2 Flexibility in Design

Working cooperatively to develop design solutions that maintain safety standards or implement approaches that preserve the historic bridge allow for preservation or rehabilitation. Often, these solutions allow character-defining features to be maintained in an appropriate manner as a long-term solution. In other cases, design flexibility can allow these features to be preserved until a better long-term alternative is available.

- The Oregon DOT and FHWA worked cooperatively to develop a railing design that would be crashworthy, but would still preserve the historic bridge character. While slightly different in some dimensions, these “stealth railings” replicate the appearance of the original pedestrian rails, but have a structural steel frame embedded in the precast concrete which functions as a crashworthy vehicle rail. Examples of the original and the replacement rails are shown below as Figures D-3, D-4 and D-5. (Ben Tang, Oregon Department of Transportation and Frank Nelson, Consultant.)

- The Maryland State Highway Administration used an off-the-shelf component that was only 1/8" larger than the original for a historic bridge rail replacement on the Licking Creek Bridge. This negligible difference allowed the agency to avoid the cost of fabricating a custom bridge railing, making preservation of the historic bridge affordable. (Anne Bruder, Maryland State Highway Administration)
- In cases where decorative railings do not meet safety codes, the Maryland State Highway Administration will replicate the railings, but then add jersey barriers in front of them. While not an ideal solution, this approach preserves the bridge until a better alternative arises. (Anne Bruder, Maryland State Highway Administration)
- Recognizing that design standards do not adequately address historic bridges TxDOT developed minimum strength design criteria, based on average daily traffic (ADT) and available alternative routes. (Charles Walker, TxDOT)
- The Texas Transportation Institute developed a retrofit railing for truss bridges that protects traffic while upgrading the strength and retaining the character of the bridge. (Charles Walker, TxDOT)

Figure D-1: Koukou'ai Bridge on the Hana Road, Maui, Hawaii. Shown in 2005, this is a one lane, load limited bridge.

Figure D-2: Koukou'ai Bridge on the Hana Road in 2005.

Figure D-3: North Umpqua River (Old Winchester) Bridge, Oregon, showing the original bridge rail and pedestrian refuge.

Figure D-4: North Umpqua River (Old Winchester) Bridge, showing new stealth rails with arch hoops and pedestrian refuge.

Figure D-5: A portion of the Coos Bay bridge rail (South Arched Section), in Oregon. The new stealth rail is in the foreground and the darker, original rail is shown in the background.

D.3 Testing and Analysis

Aided by modern technologies and computers, the types of testing that can be done to understand the nature and extent of deficiencies is becoming increasingly more sophisticated and useful. Effective practices use the following tests when needed to understand deficiencies before moving to potential solutions. Some of the frequently used tests include those described below, but practitioners are encouraged to stay current with research results as new methods may emerge.

- **Material Testing**
  - Core (Concrete) Sampling. Construction material samples are taken from areas of low stress (representing the entire structure). These samples are then sent to a laboratory for analysis. Common concrete analyses includes petrographic, to examine reinforced concrete samples for voids, cracks and signs of debonding; chloride context, which can adversely affect reinforcing steel; and compressive strength of material. This test is commonly performed when considering repair or replacement of older reinforced concrete bridges whether they are historic or not.
  - Sonic. This mechanical test uses sonic (sound) impulses to determine areas of delamination in material and material properties. A tedious, but reliable test for vertical surfaces, but it is recommended for small areas. Chain drags and portable automated acoustic methods are more commonly used to detect unsound concrete on larger horizontal surfaces like bridge decks. Its accuracy decreases with an asphalt overlay.
  - Ultrasonic. Ultrasonic methods can be used to determine the condition of concrete and the presence of cracks in reinforced concrete and cracks and internal flaws in metal. If properly calibrated, ultrasound can also show compressive strength of concrete. It can also locate reinforcing steel if it is unknown. Pachometers can also be used to locate reinforcing steel and the depth of cover material if the concrete is not heavily reinforced or close to large steel members.
  - Electrical. Electrical resistance is used to predict the possibility of concrete spalling by determining the potential for the reinforcing steel to rust.
  - Spark Test. This is an easy field test that examines the length of spark generated by grinding metal to determine if a material is steel, mild steel or wrought iron. The higher the carbon content, the longer the spark. Knowing if the material is iron, mild steel or steel is very important to determining load capacity.
- **Load-Carrying Capacity**
  - Functional Classification/ADTs. This information is used to determine functional classification and actual ADTs and to determine appropriate design vehicle/load requirement. The lesser H-12 and H-15 loads are often adequate for local roads.
  - Assess the Use of the Bridge. Understanding how the crossing is used helps

to inform a performance-based load carrying capacity analysis. If nearby alternate routes and full capacity crossings are nearby, consider a lesser load requirement for the historic bridge. If the bridge is already load posted, assess how emergency vehicles and school buses are currently bypassing the restricted crossing. In rural areas, assess if the vehicles projected to use the bridge (like oversized farm equipment) actually use the crossing of if there are other routes.

- Strain-gauging. If the bridge is a rare or exceptional example of its type, strain-gauging to determine load-carrying capacity may be warranted. A best practice is to conduct the testing to reflect how traffic will actually use the bridge (i.e., where wheel loads are concentrated) and how this loading will affect the member ratings.
- Three-dimensional Finite Element Analysis. On large bridges, using three-dimensional finite element analysis coupled with load testing and strain-gauging often results in findings that the bridge is capable of supporting more load than was computed using conventional means.

D.4 Technical Transfer on Rehabilitation Technique

Demonstration projects and workshops to inform engineers and stakeholders about appropriate rehabilitation techniques for historic structures can increase the understanding of economical and technically sound treatments that have been around for decades. Old and new approaches are often viewed extremely cautiously by engineers involved with structures having life spans in excess of 100 years, so workshops to help understand various treatments and may lead to adopting them as acceptable practice.

- Vern Mesler's Lansing Community College Historic Metal Workshop combines academic research with hands-on training in techniques to rehabilitate metal bridges. The workshop includes such topics as welded repair and heat straightening and brings tradesmen's experience and knowledge to the practice.
- ``The Ohio DOT's *Ohio Historic Bridge Maintenance & Preservation Guidance* are on ODOT's website and available for download at http://www.dot.state.oh.us/divisions/planning/environment/cultural_resources/historic_bridges/Pages/default.aspx. The guidelines specifically reference AASHTO's *Guidelines for Historic Bridge Rehabilitation and Replacement*.

D.5 Other Tools and Techniques

A variety of cost effective tools and techniques are available to help preserve and/or rehabilitate historic bridges.

- Laser scanning to document base line data can be a cost-effective approach, especially when the original bridge plans cannot be located. (Steve Olson, OneMn)
- T-beam bridges, a common historic bridge type, are often replaced because there is no cost effective way to improve the rating and condition of the bridge. A new technique (used successfully on several Minneapolis Greenway bridges) adds precast slabs and fills any voids with a hydraulic application of concrete to conserve bridges *in situ*. (Steve Olson, OneMn)
- Although an old practice, heat straightening of truss and metal beam bridges is a cost effective method of bringing bent metal members back into place.
- Additional lights or signage can serve as mitigation to preserve low or narrow bridges. (Kristen Zschomler, MNDOT)
- System wide consideration, rather than bridge-by-bridge consideration, often yields better results. (Frank Nelson, Consultant)
- Prequalification of contractors in order to demonstrate their capability in rehabilitating historic bridges is an important step. (Frank Nelson, Consultant)
- The rehabilitation of historic bridges often involves repairs of a specialized nature that do not conform to standard bid items. Maintaining costs for historic bridge repairs, supplier quotes, etc., can aid in estimating costs. (Charles Walker, TxDOT)
- Finite element modeling calibrated with load testing provides a more accurate assessment of the load capacity of a bridge. (Charles Walker, TxDOT)
- Where applicable, consider adapting the bridge setting instead of altering the bridge. For instance, if the width of the bridge creates a safety issue, use traffic calming measures off of the bridge to reduce speeds. (Patrick Sparks, Sparks Engineering)

A.6 Proactive Maintenance/Preservation of Historic Bridges

Keeping bridges in a state of good repair is the most effective form of preservation. The bridge preservation engineering group at Oregon DOT is responsible for monitoring the condition of the bridges and developing techniques to maintain and rehabilitate them while preserving their historic significance. This includes treatments like epoxy sealing, cathodic protection, substructure stabilization, strengthening with composite materials, as well as sensitive and appropriate upgrades, like redesigning the architectonic pedestrian railings to be acceptable traffic railings. The group also established

procedures for monitoring bridges and prioritizing work so that the most needed repairs are done first. The group also provides technical assistance on bridge preservation to the department's regional technical centers and works with other stakeholders, including in-house historians and the SHPO, to keep history an integral part of all work. (See Figure D-6 and D-7.)

The bridge section also maintains a program to assist owners of covered bridges by assisting with funding for inspections, maintenance and rehabilitation. The department's commitment to bridge preservation is summarized in Oregon DOT's current (2010) Bridge Practices and Procedure Manual. The collection of bridges is extensive, as is the number of rehabilitation projects completed, but the following examples are representative of the results.

Figure D -6-: The Cape Creek Bridge (1927), Oregon, was the first bridge rehabilitated with full cathodic protection.

Figure D-7: The Rogue River Bridge (1931), Oregon, was rehabilitated with cathodic protection and a new deep foundation (Pier 1).

Ohio DOT Preservation through Relocation and Maintenance

The Ohio DOT has been preserving and rehabilitating bridges for some time. It is starting to focus on assisting Local Agencies in doing the same. One excellent example of this attention to the many smaller "workhorse" bridges in the country is the preservation of this pre-1890 Van Wert City petite pony truss.

Figure D-8: Van Wert, Van Wert County, Ohio Petite Pony Truss Pedestrian Bridge

Based on Sanborn maps from 1890, all of the crossings in this industrial area of Van Wert, Ohio, had "foot bridges". This last remaining one may have been built by the New Columbus Bridge Co. who specialized in pedestrian and RR structures.

Ohio DOT worked to help the County and incorporated an Environmental Commitment to relocate the bridge to the Van Wert Historical Society Museum grounds (based on a letter of commitment by the museum to maintain and preserve the bridge), for No Adverse Effect .

This was accomplished in the planning and scoping phase of the new bridge replacement project as a deliberate preservation strategy, which enabled the maintenance and preservation commitment, not an as after-the-fact Section 106 mitigation item.

Figure D-9: Van Wert Petite Pony Truss in the Van Wert Historical Society Museum Grounds

Vermont Retention of Through-Truss Bridge through Widening

Figure D-10: Checkered Bridge, Winooski River, 1929, Richmond, VT

This historic bridge in Richmond Vermont is being widened by the Vermont agency of Transportation (VTrans) in a unique $16 million project that is relocating one of the 350 foot trusses 12.5 feet farther apart from the other, with extension of the floor beams and cross-bracing, and a new deck, to provide the needed functionality to continue carry U.S. Route 2, and still maintain its historic appearance.

The images are from the project website: http://checkeredhousebridge.com/index.html

Figure-11: Checkered House Bridge with a new section of cross-bracing in place.

Minnesota DOT Preservation of Historic Bridges through Individual Bridge Management Plans

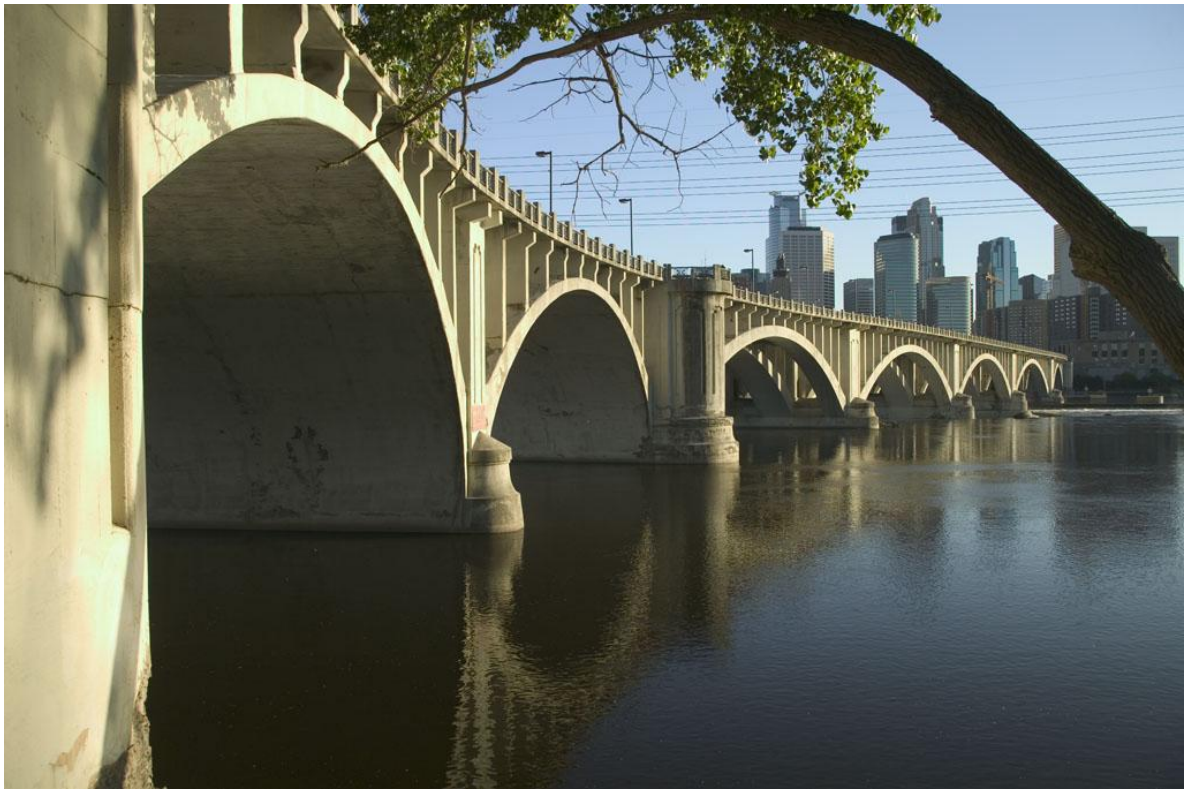

Figure D-12: Third Avenue Bridge, Number 2440, Mississippi River, Concrete Arch, 1917, MNDOT

The Third Avenue Bridge crosses the Mississippi River just above St. Anthony Falls in Minneapolis. It has seven reinforced-concrete main spans, including five open-spandrel, rib-arch spans and two open-spandrel, barrel-arch spans. The significant design features are the use of the Melan system (steel I-beams) of concrete reinforcing in the main spans and the reverse S-curve of the alignment.

The Third Avenue Bridge was rehabilitated in 1980, receiving a complete deck and floorbeam replacement, extension of the spandrel columns to raise the new deck five feet, and reinstallation of the ornamental railing added in 1939.

Recommended Stabilization Activities:

1. Repair the exposed and undermined regions of the foundations for the river piers.
2. Identify the source of water leaking from north river-bank pier to prevent additional deterioration.
3. Damage indicates the bridge is moving in unanticipated directions. Monitor and record changes in bridge geometry as it moves with changes in temperature for a period of at least two years.

Recommended Preservation Activities:

1. Conduct a concrete material testing. Quantify deteriorated regions for future rehabilitation.
2. Develop three-dimensional structural analysis model of the bridge. Calibrate with movement data.
3. Load rate the bridge utilizing the calibrated three-dimensional analysis model.
4. Seal cracks in the deck and sidewalks.

5. Clean and paint the metal components of the vehicular railings, matching the pedestrian railing.
6. Replace missing roadway lights. Paint the roadway light standards to match the metal railings. When the vehicular railing is replaced, install historically appropriate roadway lighting.
7. Reconstruct approach panels to minimize future movements and settlement.
8. Remove graffiti and vegetation.
9. Based on the results of the concrete testing, identify and repair deteriorated regions. Utilize electrochemical chloride extraction rehabilitation and repair concrete in compliance with National Park Service Preservation Bulletin 15 – Preservation of Historic Concrete. Apply MNDOT special surface finish to exposed concrete after repairs. Apply anti-graffiti coating to areas needed.
11. Attach signage to the sidewalk, utilizing base plates and inserts, not to the pedestrian railing.

Recommended Maintenance Activities:

1. Flush the deck, railings, sidewalks, and fascia components with water annually.
2. Seal cracks in the deck and sidewalks on a 5-year cycle.
3. Spot paint metal railing components on a 5-year cycle.
4. Repaint metal railing components on a 40-year cycle.
5. Confirm strip-seal glands are functioning during routine inspections and replace damaged glands.

The plan recommends the bridge continue in vehicle use on site.

Figure D-13: Anoka-Champlin Mississippi River Bridge, Number 4380, Concrete Arch, 1929, MNDOT

Bridge consists of six 108-foot, and two 106-foot, open-spandrel, rib-arch spans, and two 39-foot, filled-spandrel, rib-arch spans.

A major rehabilitation and widening in 1997 included replacement of all superstructure elements above the arch ribs. In addition, the end of each arch rib was strengthened by enlarging it with additional concrete. The detailing in the ribs, piers, floor beams, railings, and abutments was either restored or reconstructed. Original iron lamp posts were retained. Solid concrete barriers between the roadway and sidewalks were added.

Bridge is in good condition and is expected to function well for its projected 20-year planning window.

The plan recommends the following maintenance actions:

1. Flush deck, railings, and sidewalks with water annually.
2. Seal cracks in the deck and sidewalks on a 5-year cycle utilizing standard Mn/DOT practices.
3. Remove vegetation growing between concrete elements on a 5-year cycle.

The plan recommends the bridge continue in vehicular use on-site.

Figure D-14: Broadway Bridge, Number 4930, Minnesota River, Steel Through-Truss, 1931, MNDOT

The Broadway Bridge, a steel, riveted, two-span, Pennsylvania through-truss, was built in 1931 to carry vehicular traffic on Trunk Highway 21 (now TH99). Site conditions dictated that the river pier be skewed and not parallel with the abutments, resulting in unequal length trusses in each span. False members were added between the east and west spans to give the appearance of a continuous-truss superstructure when viewed from the north or south. Ornamental railings, light standards, and Classical Revival detailing of concrete elements reflect the bridge's gateway location for the city of St. Peter.

In 1964, the bridge's portals and overhead sway bracing were raised to 15.6 feet to provide greater vertical clearance. The remodeling retained the original configuration of the features and did not significantly affect the bridge's historical integrity.

In 1983 the deck was replaced. The plans indicate that a single, bottom, mat of epoxy-coated reinforcement was used, which has resulted in cracking that will need to be addressed.

Embankment erosion near the west abutment has occurred during high stream flow conditions in the past. The bridge was closed due to high water in 1993, 1997, and 2001. A portion of the embankment has been stabilized with shotcrete and large rip rap.

The red-lead paint system has failed for truss components, the floor system, and the railings, leading to exposed structural steel, minor section loss, and pack-rusted components.

Recommended Stabilization Activities:

1. Seal cracks in the deck, slab, and sidewalk.
2. Trim brush adjacent to wingwalls.
3. Remove the metal sign lodged on the gas line on the north side of the bridge.
4. Remove the light standard with the corroded base at the southwest corner of the bridge.

Recommended Preservation Activities:

1. Repaint the truss, floor system, metal railings, and ornamental light standards.
2. Determine the chloride contamination of the sidewalk, deck, slabs, and substructure elements. Quantify and repair deteriorated portions of concrete, consistent with the National Park Service's Preservation Bulletin 15 - Preservation of Historic Concrete. Apply MNDOT special surface finish to exposed concrete subsequent to the repairs. Apply anti-graffiti where needed.
3. Repair the north curbs on the abutment slab spans.
4. Add an approach panel at the east end of the bridge.
5. Repair the sleeper-slab approach pavement joints on the west approach.
6. Mill and overlay the deck and abutment slab spans and the west approach slab.
7. Extend the deck drains to an elevation that matches the bottom of the lower chords.
8. Repair the original ornamental lighting components. Following the Secretary's Standards, replace components that are missing or deteriorated beyond repair.
9. Perform a load rating analysis of the truss, floor system, and abutment slab spans using a three Dimensional structural model for the truss to capture effects associated with the skewed pier. If elements are deemed to have inadequate capacity, investigate retrofit options that increase load capacity and meet the Secretary's Standards for minimal effect on character-defining features.

Recommended Maintenance Activities

1. Flush truss members, sidewalk, deck, railings, and substructure units with water annually.
2. Seal cracks in the deck and sidewalk on a 5-year cycle.
3. Spot-paint the truss and railings on a 10-year cycle.
4. Completely repaint the truss and railings on a 40-year cycle.

The plan recommends the bridge continue in vehicular use on-site.