INTRODUCTION
This document provides guidance on design exception and variance considerations on historic bridges projects (i.e., projects on bridges eligible for or listed in the National Register of Historic Places). Mn/DOT recognizes that historic bridges represent the Department’s transportation engineering accomplishments, and that their preservation is important. These guidelines are meant to aid in the preservation of our engineering heritage.

Mn/DOT’s Cultural Resources Unit (CRU) maintains the list of historic bridges in the state, and CRU should be contacted prior to any planning on a bridge project to determine if the bridge involved is historic.

Federal and state laws provide certain protections for bridges determined to have historic significance. For example, Section 4(f) of the USDOT Act of 1966 does not allow FHWA to fund a project that “uses” (i.e., impacts) a historic bridge unless there is no “feasible and prudent alternative”. Because of these protections, if work needs to occur on a historic bridge, the preferred alternative of rehabilitation of the structure must be considered before all other alternatives. If the results of the rehabilitation study show that there is a feasible and prudent rehabilitation alternative that meets the project’s purpose and need, the rehabilitation option will be selected. Cost is merely one aspect of the prudence determination. It is not considered until after feasibility has been determined and *all* other aspects of prudence have been evaluated. If there is not a feasible and prudent rehabilitation alternative or a feasible and prudent avoidance alternative, then the preferred alternative will become replacement. However, whenever an historic bridge is replaced, federal preservation law will require negotiation of appropriate mitigation measures, such as relocating the historic bridge. Also, for state-funded projects, the Minnesota Historic Sites Act requires that agencies consult with the Minnesota Historical Society before undertaking or licensing projects that may affect properties listed in the State or National Registers of Historic Places.

PURPOSE AND NEED
The first step in any project is identifying what the transportation problem is that needs to be addressed. The NEPA process requires that a project clearly state what the transportation issue is, and identify a solution that avoids impacting a variety of resources (including historic bridges) through an alternatives analysis.

Because it is crucial to begin a project involving a historic bridge with an appropriate purpose and need statement, the project proposer must submit a draft purpose and need statement and information on which alternatives will be analyzed for each project involving a historic bridge. For Trunk Highway projects, the information must be submitted to the head of the Environmental Assessment Unit in Mn/DOT’s Office of Environmental Services; and for State Aid projects, to the State Aid Project Development Engineer for federal projects. These respective groups will forward the information to FHWA. The purpose and need and alternatives can change over time as new information is obtained during the study, but a general agreement must be obtained between the project proposer and FHWA prior to in-depth CRU involvement.
While it is not possible to develop a standard purpose and need statement that will apply to all historic bridge projects, often, a statement such as the following will be an adequate P&N:

- *The purpose of this project is to provide a structurally sound crossing of the [Feature] for [both] motorized [and non-motorized] traffic.*

Statements that are not be included in the P&N statement:

- “The purpose of the project is to replace Bridge 0123.”
- “The purpose of the project is to have a structure with a 75 year life span.”
  - Design life is not the purpose for doing a project – it is just a consideration for the investment on a new structure.
- “The purpose of the project is to eliminate this fracture critical structure (or, “…to have a non-fracture-critical structure”)”
  - There are many safe, functioning fracture-critical bridges in the state and nation. There is no federal guidance that says fracture critical bridges must be removed; therefore, it is not the purpose for doing a project.
- “The purpose of the project is to remove an unsafe bridge” (or “to build a safe bridge”)
  - Safety should not be mentioned unless there is a documented history of safety issues. Safety issues cannot be expressed as a nebulous statement that the old bridge is not safe. Rather, safety concerns need to be supported through accident data that can directly tie an element on the bridge to the accidents.
- “The purpose of this project is to meet current design standards.”
  - It is important to note that rehabilitation may have different standards that new bridge projects. The purpose of a project is not to meet new standards. Rather, the engineer meets whatever standards are required for the level of necessary work, OR the engineer is expected to get a design exception (for State jobs) or variance (for local jobs). Typically, statements about meeting design elements (such as ADA) or other federal requirements do not belong in a P&N statement – those are items that all projects must comply with, it is not the reason for doing the project.

For historic bridge projects, the rehabilitation alternative needs to be the main alternative studied. If rehabilitation is the selected preferred alternative, there will likely be no mitigation under Section 106 and no Section 4(f) issues.

**BACKGROUND**

The Federal Highway Administration (FHWA), State Historic Preservation Office (SHPO), Advisory Council on Historic Preservation (ACHP), the U.S. Army Corps of Engineers (USACE) and Mn/DOT signed a Programmatic Agreement (PA) in 2008 to substantially streamline the historic review process on bridge projects for bridges built prior to 1956. By establishing strict criteria for which bridges are significant, only a small percent of the total bridge population in the state were deemed historic. It was agreed that higher level of commitment would be given to select state-owned historic bridges, and that the Department would advocate for and assist in the preservation of historic bridges on the local system. In order to successfully preserve historic bridges, the following stipulation was included in the PA:

"**STIPULATION 4. USE OF DESIGN EXEMPTIONS AND VARIANCES**
Context Sensitive Solutions (CSS) is an integral part of FHWA and Mn/DOT projects. CSS is a collaborative, interdisciplinary approach that involves all stakeholders to
develop a transportation facility that fits its physical setting and preserves scenic, aesthetic, historic and environmental resources, while maintaining safety and mobility. CSS is an approach that considers the total context within which a transportation improvement project will exist. CSS principles include the employment of early, continuous and meaningful involvement of the public and all stakeholders throughout the project development process. The implementation of a CSS approach to navigating the project development process will ensure the best possible outcome to the process. Therefore, FHWA and Mn/DOT strongly encourage the development of historic bridge projects in a context sensitive manner, including the use of design exceptions and variances when practical.

A. Within one (1) year of the signing of this Agreement, Mn/DOT will develop and distribute guidelines on how to effectively apply and utilize design exceptions and variances on historic bridges. This document will be distributed to all Mn/DOT districts and offices and local agencies within three (3) months of its completion, and will be used in reviewing projects on historic bridges.”

This document fulfills the above-referenced definition by including information on design exceptions and variances, as per the terms of the PA.

**DESIGN EXCEPTIONS AND VARIANCES**

The preservation of a historic bridge and its character-defining features through the use of a design exception and variance can be an appropriate application. Design exceptions and variances should consider the effect of the design deviation on the safety and operation of the structure, and its compatibility with adjacent sections of roadway. If there is a documented history of safety concerns on a bridge and it is directly related to an element for which a design exception or variance is being considered, there could be difficulty in obtaining a design exception or variance. However, if there are no documented safety issues related to the items for which the exception or variance is being sought or if safety concerns can be effectively mitigated, then a design exception or variance should be pursued in spirit of stewardship to the historic nature of the bridge.

**PROCESS FOR OBTAINING A DESIGN EXCEPTION**

Design exception requests should be discussed collaboratively with District Management, the State Bridge Engineer, the Bridge Office, the State Geometrics Engineer (and the State Design Engineer, as needed), Mn/DOT’s Cultural Resources Unit, and the FHWA. Design exceptions should be documented in the Design Memo including a complete description and a thorough justification for each exception. If a design exception is identified after the Design Memo has been completed and approved, submit an addendum to the Design Memo. For more information on processing a design exception, see “Design Standards and Exceptions – Submittal Steps for Design Exceptions” in Mn/DOT’s Highway Project Development Process (HPDP) guidance. For specifics on how to complete a design exception, please see: [http://www.dot.state.mn.us/design/geometric/formal-design.html](http://www.dot.state.mn.us/design/geometric/formal-design.html).

**PROCESS FOR OBTAINING A DESIGN VARIANCE FOR LOCAL PROJECTS**

It is anticipated that most historic bridge rehabilitation projects will occur with federal funds and no state aid funding, making the need for a local variance unlikely. However, if state aid funds are used, information on how to obtain a design variance can be found at [http://www.dot.state.mn.us/stateaid/manual/sam07/chapter1/1-7.html](http://www.dot.state.mn.us/stateaid/manual/sam07/chapter1/1-7.html)
CRITICAL GEOMETRIC DESIGN CRITERIA
It is recognized that criteria spelled out in various manuals (Mn/DOT and State Aid Standards, the AASHTO Green Book, the Road Design Manual, etc.) are not all typically achieved with a bridge rehabilitation project. However, these standards need to be considered during the development process and design exceptions or variances from these standards should be pursued if it can be shown that there are minimal documented safety issues, or safety concerns can be effectively mitigated.

Despite the range of flexibility that exists with respect to virtually all the major road design features, there are situations in which the application of even the minimum criteria would result in unacceptably high costs or major impact on the adjacent environment. For such instances when it is appropriate, the design exception and variance process allows for the use of criteria lower than those specified as minimum acceptable values in the Green Book.

If the highway project is not on the NHS and is not a full federal oversight project, the State does not need FHWA approval for a design exception. For projects on NHS routes, FHWA requires that all exceptions from accepted guidelines and policies be justified and documented in some manner and requires formal approval for the 13 specific controlling criteria (listed in the “Design Exceptions” guidance document referenced in an earlier section above). The State Design Engineer approves design exceptions for State-administered projects on the NHS and State/local administered Federal-aid projects off of the NHS. The State Design Engineer *and* FHWA approve all design exceptions for full Federal oversight projects.

The following section was taken from Guidelines for Historic Bridge Rehabilitation and Replacement by Lichtenstein Consulting Engineers and Parsons Brinkerhoff (2007).

**ANALYSIS OF GEOMETRY AND SAFETY FEATURES**
This step provides guidance on how geometric and safety-feature data needs to be analyzed to determine if deficiencies can be brought into conformance with current standards/guidelines in a feasible and prudent manner without adversely affecting what makes the bridge historic. When working with historic bridges, geometry and safety-feature deficiencies often prove to be the most challenging to solve.

For a bridge to continue in use, it must be geometrically (functionally) adequate and safe. Geometric adequacy includes consideration of the number of travel lanes, roadway width, shoulder width, approach roadway width, vertical clearance over the roadway, underclearances, horizontal clearances, sight distances across the bridge and at the approaches, proximity to intersections and the functional classification of roadways carried and any crossed. Safety features include the crashworthiness of guide rail and railing systems based on their capability to effectively redirect an errant vehicle and to safely stop it in a controlled manner.

Two parameters that are used to evaluate the geometric adequacy of a bridge are the functional classification of the roadway, which is based on whether it serves as an arterial, collector or local road and whether the setting is urban or rural, and the average daily traffic (ADT) count. The ADT also considers the percentage of that count that is truck traffic. Traffic volume affects historic bridges because they are often geometrically inadequate for today’s usage demands. Since geometric adequacy is defined by the characteristics of the traffic serviced, ADT is an important consideration affecting the required number and width of lanes, shoulder widths, and roadway alignment. These parameters are often used together to set minimum acceptable geometric guidelines and standards.
Bridges with geometry or safety features that do not meet current design standards are classified as functionally obsolete. However, a bridge classified as functionally obsolete because it does not meet current guidelines should not automatically be considered unsafe and in need of replacement. Many functionally obsolete bridges perform adequately. For those instances, a design exception for width should be considered and used if it is appropriate. Design exceptions are based on in-depth studies that include data such as accident history, travel speed, etc., to support using a lesser design criteria. Under certain conditions, a reduced roadway width can be justified.

**Geometry on Very Low Volume Local Roads**
To account for the correlation between lower traffic volume and lack of accidents caused by substandard geometry, AASHTO in its 2001 *Guidelines for Geometric Design of Very Low-Volume Local Roads (ADT <400)* established geometric guidelines that are now part of its *A Policy on Geometric Design of Highways and Streets* (5th edition, 2004). The very low-volume local road guidance uses risk assessment in determining roadway and bridge width adequacy by weighing the cost effectiveness of the work against "substantial safety improvements.” The AASHTO guidelines state that “existing bridges can remain in place without widening unless there is evidence of site-specific safety problems related to the width of the bridge.” Based on this guidance, if the bridge is on a local road, is performing well, and is structurally adequate, it probably has rehabilitation potential. This policy supports and reinforces earlier guidance from AASHTO that a certain level of flexibility, when applied to bridges on low-volume roads, would allow lesser design values based on specific, minimal, "tolerable" criteria. Bridges that are functioning adequately now, and can be considered to do the same into the future with appropriate maintenance, are considered to have rehabilitation potential even though they do not meet current standards.

Many states have adopted their own bridge and roadway geometric policies for various classifications of highways. These policies are considered to be a starting point for bridge widths. Additionally, width of the approach roadways and their continuity with the bridge roadway width can be an important consideration that may affect the definition of "tolerable" and thus rehabilitation potential. If the bridge roadway width is equal to that of the approaches and neither the bridge roadway width or approach roadway width meet current design requirements, the bridge may still be a candidate for rehabilitation until such time as the approach roads are also upgraded and as long as other considerations, like accident history, demonstrate adequate safety performance. This concept is being used increasingly by state DOTs to “right-size” projects.

**Using Accident History to Understand Deficiencies**
Accident reports are an extremely useful source of specific information about what geometric features of the bridge, if any, are problematic. It is important to review specific accident reports to determine what types of accidents are attributable to the bridge itself, including its geometric characteristics and its safety features. The reports are generally compiled by highway segment, not for a bridge alone, so accidents may not be related to bridge deficiencies. A nearby intersection, for instance, may have turning movement-related accidents. Since the intersection and bridge share a common highway segment, all accidents will be reported with the bridge, which may in fact be functioning adequately. The review of accident reports will also assist with assessing risk management.
Considerations for Improving Geometry and Safety Problems
Common problems associated with geometry and safety are many and include bridge width, shoulder width, clearances, stopping sight distances (or vertical and horizontal alignment of the approaches that results in insufficient stopping sight distances), superelevation, proximity to intersections, and railing/barrier design. Additionally, there can be safety problems related to substandard geometry and roadside features at the ends of the bridge, like the blunt ends of superstructures above the roadway, lack of a proper barrier system (length, inadequate transition, inadequate attachment to the bridge railing), and crashworthiness of bridge railings.

While not comprehensive, the following are important questions to consider. The relevance of particular questions will vary depending on site constraints.
- Can a bridge be widened without adversely affecting its scale?
- Can the vertical clearance be increased to remain in scale with the bridge and not have an adverse effect?
- Does the original design make it possible to consider adding cantilevered deck sections? Can sidewalks be cantilevered from the superstructure?
- Can substandard approaches be improved to an acceptable level using techniques like adding shoulders, flattening curves, flattening side slopes, adding superelevation, removing hazardous features, etc.?
- Likewise, can sight distance be improved?
- Can any sidewalks be eliminated to provide more roadway width?
- Can signals or signage be installed to control alternating flow of traffic on a low-volume road?
- When the proposed improvement is for a highway or street that is already substandard, can minimally acceptable standards/guidelines be used?
- Can custom or context-based railings appropriate for the bridge type and setting be used?
- Can a crashworthy traffic barrier be placed at the curb line, and the historic railing retained?
- Would a design exception result in maintaining the [historic integrity of the] historic bridge and meeting the project goals?
- Can the roadway be reclassified?
- Can the historic bridge be retained and used for pedestrian sidewalks/bikeway in combination with a new vehicular bridge using a funding source other than the Highway Bridge Replacement and Rehabilitation Program (HBRRP)? Using the historic bridge to maintain some of the functionality of the upgraded crossing may result in being able to keep it on-system and thus eligible for future maintenance funds.
- Can a parallel bridge be constructed to create a one-way pair? If so, visual changes should not be considered adverse when the historic bridge is preserved.
- Can the scale and proportions of a bridge contributing to a historic district be maintained by a new, replacement bridge and have no adverse affect to the district?
- Is it prudent to avoid use by constructing a bypass? This frequently means that the historic bridge will not remain on-system and will require a new owner.

Considerations in Determining a Historic Bridge’s Load Capacity
It is critical that the actual load capacity on a historic bridge is known, and that the analysis is fair to the historic bridge. In some cases, in order to accurately determine allowable stresses, material strength tests may be needed. These results provide solid, scientific data that bring credibility to the decision-making process, especially when SHPO or members of the public are involved in a project.
Three-dimensional finite element analysis coupled with load-testing and strain-gauging may be appropriate especially on larger bridges. The results from this analysis often results in a finding that the bridge is capable of supporting more load than was computed using conventional methods.

The NBI ratings (inventory and operating) can be used as a starting point, but an independent analysis must also be made. It is during this point of the project that methods to reduce dead load should also be considered and evaluated. Under some circumstances, it may be appropriate to consider a lesser design vehicle, such as an H15 vehicle for roadways where there is a nearby detour route for heavier truck traffic.

There are several common methods to address load-carrying deficiencies:
- Increasing the live-load capacity of the members either by strengthening individual members or member replacement using higher strength material.
- Reducing dead load by replacing the existing deck with a new, lighter-weight deck.

**METHODS FOR IMPROVING LOAD-CARRYING CAPACITY**

As discussed above, inadequate load-carrying capacity can be caused by deteriorated members, inadequate load capacity of the original design to meet current requirements, too much dead load, simplistic analysis that does not reflect the true capacity of a bridge, and roadway classification.

At a minimum, for historic bridge projects, the following approaches to addressing load-carrying capacity deficiencies should be analyzed.
- Can dead load be reduced by replacing the deck with a lighter one?
- Can carbon-fiber reinforcing polymer wrapping be used to strengthen concrete components?
- Can material be added to individual members to increase capacity? This includes installing high-strength rods as well as plates.
- Can the roadway be reclassified? This could result in a different definition of adequate.
- Can deteriorated members or sections of members be replaced in kind to restore structural integrity and/or increase capacity?
- Can use of the bridge be restricted? Is there a full-capacity crossing nearby?
- Can a parallel bridge be constructed to create a one-way pair and thus reduce the live load? If so, any visual changes should not be considered adverse when the historic bridge is preserved.

**Arch Bridges**
- Can existing fill material be replaced with lighter-weight fill or engineered fill to decrease dead load?
- Can a relieving slab or auxiliary member be placed to carry some or all of the live loads?

**Truss and Girder-Floorbeam Bridges**
- Can the flooring system be replaced in kind with higher capacity members? Upgrading floorbeams and stringers can increase load-carrying capacity significantly.
- Can the truss lines or girders be used to support themselves and any sidewalks as part of a new superstructure? The usefulness of this alternative is predicated on many factors including original dimensions and how much the bridge can be widened so that scale of the bridge is not compromised.
- Can post-tensioning be used?
RESOURCES FOR ADDRESSING BRIDGE WIDTH STANDARDS

BRIDGE RAILING
The railing is an important safety feature on the bridge, and is often a character-defining feature that makes the bridge historic. For typical rehabilitation projects, rail replacement with a TL-4 railing is required by Mn/DOT standards if minimum strength and safety levels are not met. For historic bridges, Mn/DOT is willing to apply the AASHTO standards as follows:

1. The rail may be left in place if there is no documented crash history or other evidence of crash history; and the rail strength, by analysis, meets criteria:
   • TL-3 for design speeds 45 mph or more (LRFD 10 ton load analysis method)
   • TL-2 for design speeds of less than 45 mph

2. If rail has been damaged by collision or deterioration is beyond repair, the railing should be replaced. A new bridge railing should be provided as described in Mn/DOT’s Bridge Design Manual. If the rail is not a character-defining historic feature, a new rail meeting strength criteria will be provided. Standard new railing will be used when possible; however, consideration to the scale, form, shape of the railing on the character-defining elements of the historic bridge may require that non-standard new railing be used. Consideration should be given to the long-term structural integrity and maintenance implications of installing a non-standard railing.

   If the railing is a character-defining feature, it shall be replicated to the extent possible with a railing meeting either the Mn/DOT Standards or the AASHTO standards, when applicable. In addition, there are other railings which have passed NCHRP 350 crash tests for specified test levels. If one of these rails is desired to be used for a specific project, the documentation to be provided is as follows:
   a. An acceptance letter from the FHWA that approves the device for use;
   b. Complete details for the device, either showing actual successful crash tested results or calculated results.

3. For historic bridges where the existing or reconstructed original railing design has a 6-inch or less opening, the AASHTO Standards for pedestrian railing will be followed and a design exception or variance will be sought. The height of the rail must be at least 42 inches. Protective screening, that would normally be required, may be waived if there is no history of problems and the bridge is not carrying pedestrians over a highly traveled roadway.

4. If original railing created maintenance or safety issues such that modifications were made to it over time, those maintenance or safety issues should be considered in design of the rehabilitation.

Approach guardrail may remain if crash history shows no recent repairs were required. If there is indication of crashes or if the guardrail must be replaced, a proper end anchor post must be provided on the bridge or as a separate post adjacent to the bridge rail end. For many historic bridges, the addition of a separate post is preferable to anchoring the guardrail to the structure; however, each property needs to be individually evaluated to determine the most appropriate approach.
The following section was taken from *Guidelines for Historic Bridge Rehabilitation and Replacement* by Lichtenstein Consulting Engineers and Parsons Brinkerhoff (2007).

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<th>Railings</th>
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<td>• Can deficient railings be replaced “in kind” with no adverse effect, i.e., with a design that incorporates modern load and safety features with the historic design?</td>
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<td>• Can an aesthetic, crash-tested design be used as an in-kind replacement?</td>
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<td>• Can crashworthy traffic railings be installed at the roadway, leaving the historic railings in place?</td>
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<td>• Can an adequate guide rail system be placed in front of historic railings, which will be left in place?</td>
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<td>• Can a stone parapet be rebuilt in reinforced concrete capable of meeting current codes and faced with a stone veneer that matches the historic pattern?</td>
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<td>• Can members be added to increase height or reduce opening size?</td>
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