NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM
SYNTHESIS OF HIGHWAY PRACTICE 101

HISTORIC BRIDGES—CRITERIA FOR DECISION MAKING

TRANSPORTATION RESEARCH BOARD
National Research Council

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HISTORIC BRIDGES—CRITERIA FOR DECISION MAKING

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NATIONAL RESEARCH COUNCIL
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NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

Systematic, well-designed reasearch provides the most effective approach to the solution of many problems facing highway administrators and engineers. Often, highway problems are of local interest and can best be studied by highway departments individually or in cooperation with their state universities and others. However, the accelerating growth of highway transportation develops increasingly complex problems of wide interest to highway authorities. These problems are best studied through a coordinated program of cooperative research.

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The program is developed on the basis of research needs identified by chief administrators of the highway and transportation departments and by committees of AASHTO. Each year, specific areas of research needs to be included in the program are proposed to the Academy and the Board by the American Association of State Highway and Transportation Officials. Research projects to fulfill these needs are defined by the Board, and qualified research agencies are selected from those that have submitted proposals. Administration and surveillance of research contracts are the responsibilities of the Academy and its Transportation Research Board.

The needs for highway research are many, and the National Cooperative Highway Research Program can make significant contributions to the solution of highway transportation problems of mutual concern to many responsible groups. The program, however, is intended to complement rather than to substitute for or duplicate other highway research programs.

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PREFACE

A vast storehouse of information exists on nearly every subject of concern to highway administrators and engineers. Much of this information has resulted from both research and the successful application of solutions to the problems faced by practitioners in their daily work. Because previously there has been no systematic means for compiling such useful information and making it available to the entire highway community, the American Association of State Highway and Transportation Officials has, through the mechanism of the National Cooperative Highway Research Program, authorized the Transportation Research Board to undertake a continuing project to search out and synthesize useful knowledge from all available sources and to prepare documented reports on current practices in the subject areas of concern.

This synthesis series reports on various practices, making specific recommendations where appropriate but without the detailed directions usually found in handbooks or design manuals. Nonetheless, these documents can serve similar purposes, for each is a compendium of the best knowledge available on those measures found to be the most successful in resolving specific problems. The extent to which these reports are useful will be tempered by the user's knowledge and experience in the particular problem area.

FOREWORD

By Staff
Transportation Research Board

This synthesis will be of special interest to highway administrators, bridge engineers and others concerned with disposition of historic bridges. Guidance is presented for making decisions within the constraints of conflicting priorities that must be considered in programs for preservation of historic bridges.

Administrators, engineers, and researchers are continually faced with highway problems on which much information exists, either in the form of reports or in terms of undocumented experience and practice. Unfortunately, this information often is scattered and unevaluated, and, as a consequence, in seeking solutions, full information on what has been learned about a problem frequently is not assembled. Costly research findings may go unused, valuable experience may be overlooked, and full consideration may not be given to available practices for solving or alleviating the problem. In an effort to correct this situation, a continuing NCHRP project, carried out by the Transportation Research Board as the research agency, has the objective of reporting on common highway problems and synthesizing available information. The synthesis reports from this endeavor constitute an NCHRP publication series in which various forms of relevant information are assembled into single, concise documents pertaining to specific highway problems or sets of closely related problems.

As many as 50,000 bridges in the United States might be eligible to be considered for historic preservation. A high proportion of these bridges are structurally deficient or functionally obsolete or both and are, therefore, in need of rehabilitation or replacement. Resolution of conflicting priorities when carried out on a case-by-case basis using ad hoc procedures can lead to inordinate delays and controversy. This report of the Transportation Research Board contains information on procedures used to deal with technical, legal, financial and other considerations involved in making decisions on disposition of historic bridges.

To develop this synthesis in a comprehensive manner and to ensure inclusion of significant knowledge, the Board analyzed available information assembled from numerous sources, including a large number of state highway and transportation departments. A topic panel of experts in the subject area was established to guide the researcher in organizing and evaluating the collected data, and to review the final synthesis report.

This synthesis is an immediately useful document that records practices that were acceptable within the limitations of the knowledge available at the time of its preparation. As the processes of advancement continue, new knowledge can be expected to be added to that now at hand.

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Information on current practice was provided by many highway and transportation agencies. Their cooperation and assistance were most helpful.

HISTORIC BRIDGES—CRITERIA FOR DECISION MAKING

SUMMARY

In recent years there has been increasing awareness among historians and the general public that bridges are objects that need to be preserved. At the same time there has been increasing concern for their condition and safety, and billions of dollars have been authorized by Congress for replacement and rehabilitation of those that are deficient. As a result of the growth in federal funds for these purposes, historic bridge investigations have become an increasingly larger factor in cultural resource surveys. Nearly a quarter of a million bridges, for instance, are eligible for replacement under the National Highway Bridge Replacement and Rehabilitation Program and many of these meet criteria for listing on the National Register of Historic Places. However, the requirements of federal legislation concerning historic preservation and bridge safety are conflicting, and failure to manage this issue skillfully risks unnecessary and costly delay to needed bridge projects or irrevocable loss of important examples of the nation's engineering and industrial heritage.

A statewide inventory is the first step in resolving conflicts between the goals of providing safe and efficient transportation and of preserving historic bridges. It provides a framework for evaluating the historic importance of individual bridges and for making determinations of National Register eligibility. When planning such an inventory, consideration must be given to the funding level and source, types and ages of bridges to be surveyed, staffing, data collection and recording procedures, and methods of analysis and reporting. A number of statewide inventories have now been completed and they can serve as useful guides. The second step is to determine the relative importance of the inventoried bridges and their National Register eligibility. However, because bridges are so extensive in both number and type, states have had to develop supplemental evaluation standards specifically for bridges. Some states have attempted to apply National Register criteria directly, whereas others have developed numerical rating systems as a supplement to the criteria and designated only those bridges that score above some predetermined value. Still others have used a combination of these two approaches. Use of such criteria in five states resulted in between two and six percent of bridges surveyed being eligible for the National Register.

Many bridges that are determined eligible for the National Register are eventually demolished or substantially altered because of technical, legal, or financial considerations that impose constraints on their preservation. Most older bridges, for instance, were built for lighter loads, less traffic, slower speeds, narrower vehicles, and single-lane roads. In addition, they have suffered diminished load-carrying capacity because of deterioration by a variety of natural and artificial agents. The result is deficient

bridges with respect to structural capacity and safety according to present AASHTO (American Association of State Highway and Transportation Officials) and federal standards. The consequences of rehabilitating bridges or continuing in service those that do not comply with such standards, and the liability that may result from leaving a bridge for other purposes, are legal considerations that discourage preservation efforts. Another legal problem is that laws in some states require abandoned right-of-way to revert to adjacent land owners.

Even when technical and legal considerations are not a problem there may be difficulty in obtaining the money required to restore and maintain a historic structure. Preservation organizations are usually modestly funded and highway agencies typically do not have authority to maintain facilities that are not part of the highway system. If these constraints can be overcome there are a variety of preservation alternatives for historic bridges, including: continued use for vehicular purposes at the original or an alternative site, adaptive use for some nonvehicular purpose, and destruction with acceptable mitigation.

The ultimate objective of activities concerned with historic bridges should be a preservation plan that includes preservation warrants for each bridge, an assessment of preservation feasibility, and identified practical disposition alternatives. It should also be a preservation policy that includes a preference hierarchy of alternatives and selection of a specific disposition action for each bridge.

The synthesis was unable to provide specific criteria that could be applied universally for decisions with respect to historic bridges. This was because the population of surviving early bridges varies widely from state to state, the historical importance of specific structural forms also varies around the country, and not enough agencies have yet developed preservation plans to assess which decision model (or models) might be preferred. Nonetheless, the process concept outlined in the synthesis will be helpful to those who have to make such decisions.

CHAPTER ONE

INTRODUCTION

STATEMENT OF THE PROBLEM

The authors of a recent study for the Council of State Planning Agencies (*1*, p. 40) have estimated that one-fifth of the nation's $80 billion public works appropriations are lost annually because of delays that occur both before and during construction. Although most of these are assignable to the preconstruction stage (*1*, p. 40), specific causes and their relative importance in the highway industry have apparently not been studied. However, a recent analysis (*2*) of delays in the construction grants program of the U.S. Environmental Protection Agency identified "slow historical resource investigations" as one of four fundamental sources of preconstruction delay. A comparable impact in the highway construction industry is likely.

As a result of the substantial increase in federal funds that have been available since 1978 for replacement of bridges (*3*) (particularly on local systems where most bridges of historical interest occur), historic bridge investigations have become an increasingly larger factor in cultural resource surveys. Nearly a quarter of a million bridges, for instance, are eligible for replacement under the National Highway Bridge Replacement and Rehabilitation Program (HBRRP) (*4*) and many of these may meet criteria for listing on the National Register of Historic Places (NR). Few would argue that all of these should be preserved, but the requirements of federal legislation concerning historic preservation and bridge safety are often conflicting, and processes for avoiding or mediating these conflicts efficiently are generally lacking. Thus, resolution is often by ad hoc actions on a case-by-case basis, which can lead to inordinate delays and controversy. When this situation is viewed against an annual increase in construction costs that averaged 12.5 percent between 1973 and 1981 (*5*), it is apparent that delays from historic bridge investigations should be minimized and such investigations restricted to only those structures of true merit. Clearly, failure to manage the historic bridge issue skillfully risks not only unnecessary and costly delays to needed bridge projects, but also irrevocable loss of important elements of the cultural environment as well as examples of the nation's engineering and industrial heritage.

PURPOSE AND SCOPE OF THE SYNTHESIS

The purpose of this synthesis is to provide information that will assist those in both the transportation and preservation communities who make and execute decisions involving historic bridges. The synthesis includes a review of the general background of the "historic bridge issue," relevant legislation, bridge inventory procedures, significance criteria, constraints on bridge preservation, preservation alternatives, and bridge disposition criteria. Because the literature on this topic is scant, much of the information has been drawn from unpublished documents, interviews, and other "soft" sources. Some aspects of the topic have been the subject of review by others (both published and in process), and these have been drawn on liberally and with credit, where they exist.

GENERAL BACKGROUND

According to estimates of the Federal Highway Administration (FHWA) (*4*, p. 4), there are approximately 570,000 bridges on the nation's federal-aid and other highway systems, 75 percent of which were built before 1935 (*6*, p. 12). Approximately 45 percent of these bridges are either deteriorated to the point of structural deficiency or otherwise unable to carry their present traffic efficiently and safely (*4*). Concern for the condition of the total bridges became a national priority with passage of the Federal-Aid Highway Act of 1968 (*7*). The Act followed by one year, and resulted directly from, the collapse of a 40-year-old eyebar suspension bridge crossing the Ohio River at Point Pleasant, West Virginia, causing the loss of 46 lives (*8*). Since 1971, more than $12 billion has been authorized by the U.S. Congress for replacement and rehabilitation of deficient and obsolete bridges (Figure 1), and state highway and transportation departments are programming bridge replacement projects at an increasing rate.

Paralleling the national government's commitment to addressing the "bridge problem" has been a burgeoning awareness among historians and preservationists that bridges need atten-

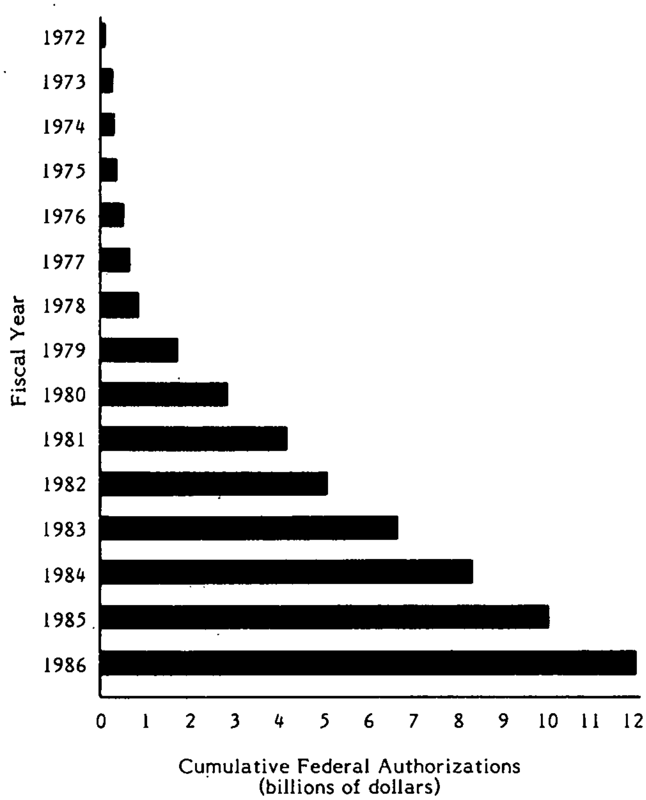


FIGURE 1 Federal authorizations for bridge replacements (*6* and Surface Transportation Assistance Act of 1982).

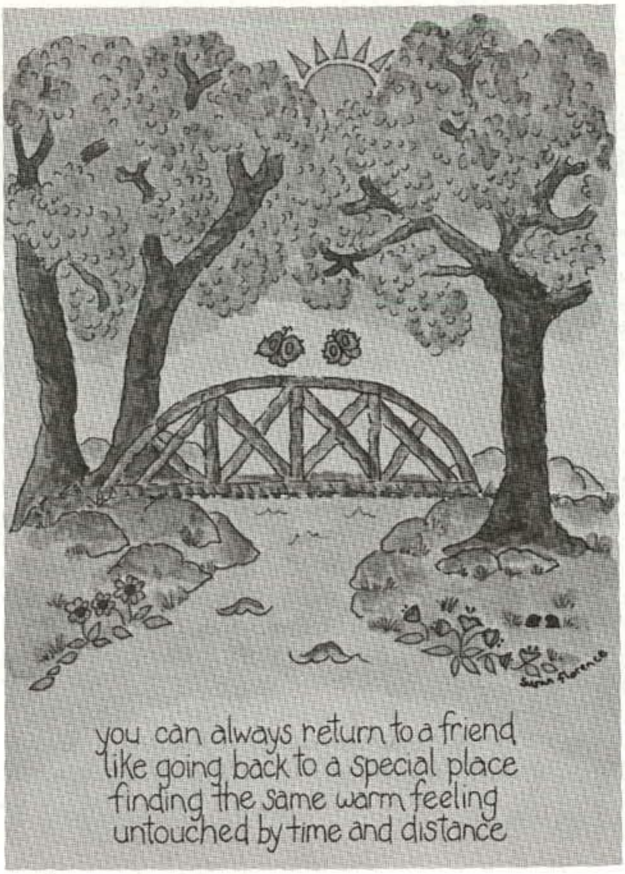


FIGURE 2 Stylized 19th-century metal truss bridge appearing on a contemporary greeting card. (Copyright © 1981 by People Productions, reproduced with permission.)

tion as legitimate objects for preservation. There is even evidence that such a blatantly functional structure as the metal truss is now creeping into popular awareness and becoming a part of the national nostalgia (Figure 2), as the covered timber bridge did 30 or 40 years earlier. This phenomenon has resulted in large measure from the general infusion of vitality and status given the entire preservation movement by the National Historic Preservation Act (NHPA) of 1966 (*9*) with its subsequent amendments and regulations. More specifically, it has resulted from the growth of interest in the technological and industrial history of the nation and in the preservation of artifacts of that history. Much of that interest focuses on the last half of the 19th and first quarter of the 20th centuries, a period when bridge building was evolving from a craft-based to a science-based industry. It is probable that most of the existing bridges that represent that evolution are, or will be, among those identified for replacement because they are old and unsafe, or obsolete.

Thus, one set of federal requirements that concerns safety and promotes replacement is often in conflict with another set that concerns environmental quality and promotes preservation (*10*). It has been estimated, for instance, that ten to twenty percent of the bridges eligible for replacement under the National HBRRP may also meet criteria for listing in the National Register. This status guarantees consideration of preservation values and can trigger a time-consuming administrative process that often delays construction. Because of the coincidence (since about 1979) of enhanced funding for bridge replacement (Figure 1) and the increasing number of National Register eligibility determinations for bridges (Figure 3), conflicts involving bridges are arising with unprecedented frequency. In the absence of generally accepted criteria for assessing the relative importance of historically important bridges, these conflicts are being dealt with by procedures that guarantee neither consistency nor the best long-term interests of either transportation or preservation values. This dilemma is aggravated because it typically occurs in a programming-construction environment of fixed schedules and specific funding, where delay translates directly into increased costs and where options may be limited.

The present situation has not been unanticipated. In April 1977, the Society for Industrial Archeology (SIA) held a Bridge Preservation Workshop (at their annual meeting in Wilmington, Delaware) that included participants from the FHWA, various preservation organizations, and two state departments of transportation (*11*). This was followed by a similar session at the 1978 annual meeting of State Historic Preservation Officers (SHPO) in Washington, D.C. The Historic American Engineering Record (HAER), in cooperation with FHWA, sponsored three regional Historic Bridge Symposia in 1979, in Washington, Sacramento, and Minneapolis-St. Paul, in which they attempted to bring representatives of SHPOs together with highway bridge engineers to discuss information and attitudes relevant to such structures (*12, 13*). Also in 1979, SIA devoted an entire issue of its bimonthly newsletter to bridges (*14*). A Transportation Research Board (TRB) subcommittee, Historic and Archeologic Considerations in Transportation Planning, was formed in 1977 and has regularly sponsored conference sessions at the annual meetings of that organization (*15*). Nearly half of the presentations at these sessions have dealt with historic bridges and the issues they present.

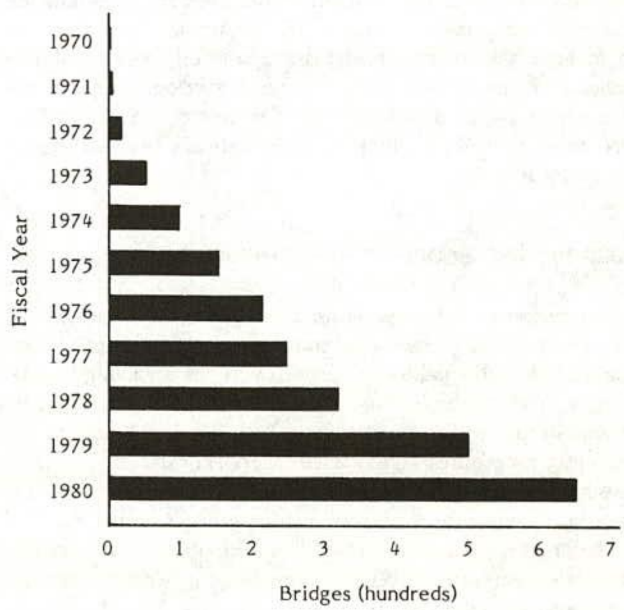


FIGURE 3 Bridges listed and eligible for the National Register (Federal Register).

A principal objective of all of these activities has been to increase awareness of the approaching problem and to develop a mutual understanding of the concerns of both preservation and transportation interests. A recurring theme of these several conferences has been (a) that the first step in determining which bridges warrant preservation attention is to compile an inventory of existing early structures, and (b) that this inventory must be followed by a valuing process in which the relative importance of the different bridges is established. Only after these steps have been completed can an intelligent and consistent assessment of preservation warrants be made and alternatives considered.

Most attempts to anticipate the historic bridge issue have either been initiated or substantially supported by HAER (*16–19*), an agency of the former Heritage Conservation and Recreation Service, U.S. Department of the Interior. HAER was formed in 1969 to inventory and record important engineering and industrial structures in cooperation with the American Society of Civil Engineers (ASCE) and the Library of Congress, but has also become an influential advocate of preservation values with regard to such structures. Two of HAER's educational efforts that have been particularly effective in enhancing awareness outside of the preservation community are a poster (Figure 4) and a small leaflet (*17*) prepared for state and local historians to illustrate and describe bridge truss types, and a 35-mm slide-cassette tape visual aid on historic bridges prepared with FHWA for viewing by state highway and transportation departments (*19*).

Although ASCE was instrumental in creating HAER, HAER's constituency has been drawn more from preservationists than from engineers, and it is among the former group that it has had its greatest visibility. Generally, state highway and transportation departments have reacted to, rather than anticipated, the historic bridge issue; and then only as it has begun to occupy a progressively greater importance among the myriad of other environmental affairs that require attention when advancing modern public works. An exception has been the pioneering effort of the Virginia Department of Highways and Transportation, which in 1973 initiated a research effort on the history of road and bridge building (*20*), the first reported project of which was a survey of Virginia's approximately 500 pre-1932 metal truss bridges (*21, 22*). The Virginia inventory has become the prototype for most of the inventories now completed or in progress in other states. Taking their lead from Virginia, several other states began historic bridge inventories early, notably New York (*23, 24*) and Wisconsin (*25, 26*) in 1975. By May 1983, most states had initiated an inventory activity, 13 had completed or substantially completed an inventory, 13 had developed a method of determining the relative importance of their historic bridges, and a few had made preliminary progress on a "preservation plan." These various activities are discussed at length in Chapters Three, Four, and Five.

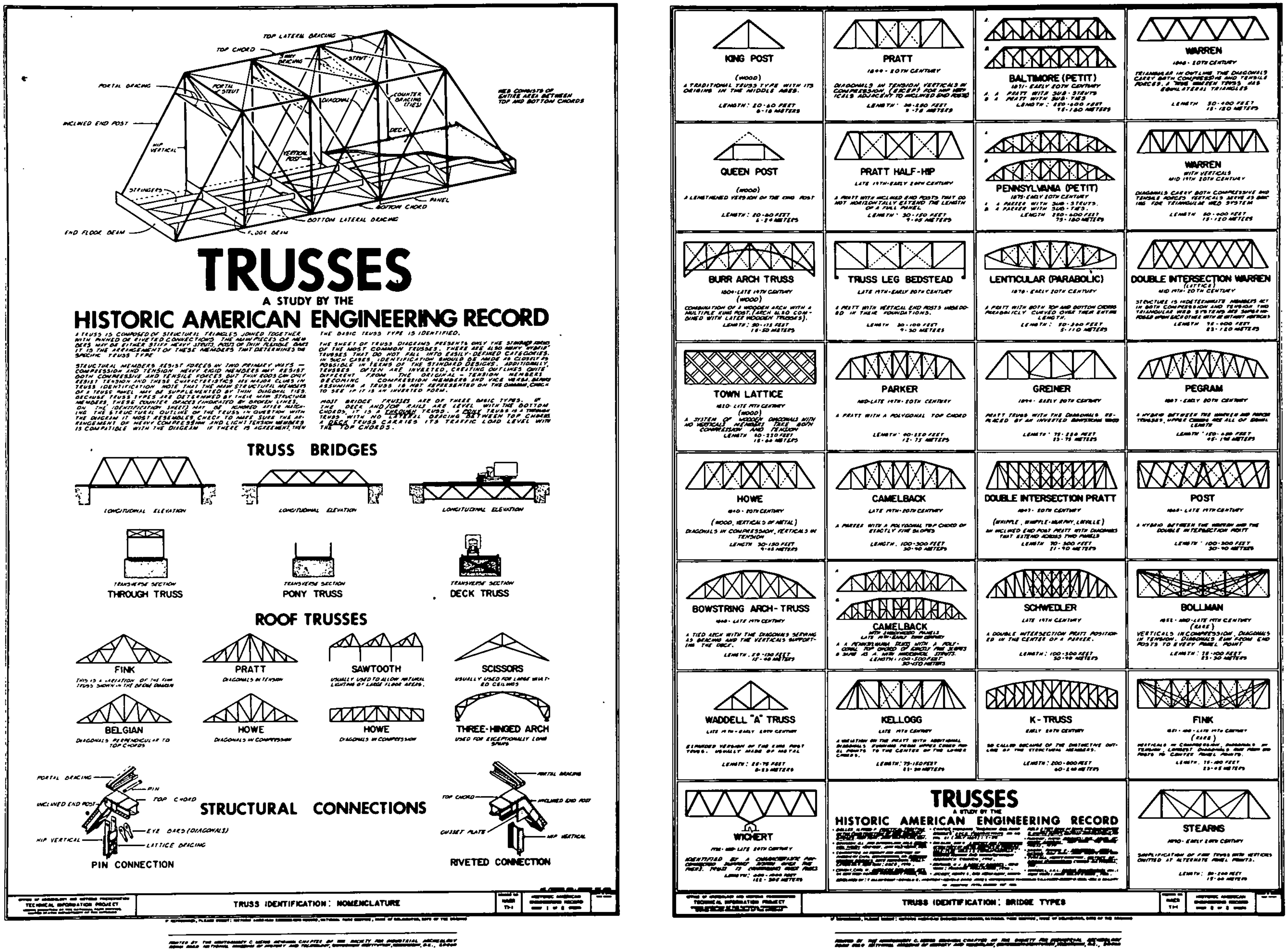


FIGURE 4 Explanation of bridge truss types (HAER).

CHAPTER TWO

FEDERAL LEGISLATION AND PROGRAMS

BRIDGE SAFETY

The December 1967 collapse of the Point Pleasant Bridge is universally cited as the single event most responsible for the present level of national concern for bridge safety. In terms of the 46 lives lost it was the worst American bridge disaster of the 20th century. Soon after the collapse, the cause was traced to one of the steel eyebars forming the two suspension chains. The eyebar had fractured across the eye and through the center of the pin hole on a line roughly perpendicular to the bar's axis (*8*). Although the specific mechanism of the fracture remains a subject of controversy, the operative facts are that the bridge was more than 40 years old when it failed and that the failure resulted from a time-dependent factor (stress corrosion, corrosion fatigue, stress fatigue) or a combination of these (*27, 28*).

Immediately following the Point Pleasant disaster, the President directed that three task forces be established. The first was to determine the probable cause of the failure, the second to ensure a timely replacement of the collapsed bridge, and the third to examine the effectiveness of then current bridge inspection practices. As a result of these activities, the U.S. Congress established two major bridge safety programs: (a) periodic inspections to identify bridge conditions, maintenance needs, and safety problems; and (b) funding to assist the states in replacing unsafe bridges. These programs have recently been critically reviewed in a report (*6*) prepared by the General Accounting Office.

The National Bridge Inspection Program

The first of these programs, the National Bridge Inspection Program, was established by the Federal Aid Highway Act of 1968 (*7*). The act required the Secretary of Transportation, in consultation with state highway departments and other interested and knowledgeable parties, to establish standards for inspecting federal-aid bridges. The standards were to set forth: (a) methods for state highway departments to use in conducting safety inspections, (b) minimum time lapse between inspections, and (c) qualifications of those responsible for carrying out the inspections. The act further required each state to maintain written inspection reports and a current inventory of all federal-aid bridges. The states, including the District of Columbia and Puerto Rico, were authorized to use federal-aid highway planning and research funds for these purposes. The act also required the Secretary of Transportation to establish an inspection training program for federal and state employees (*6*).

As a result of the 1968 act, National Bridge Inspection Standards were developed and published in the Federal Register on April 27, 1970 (*29*). The proposed standards, which were generally based on the 1970 AASHO *Manual for Maintenance Inspection of Bridges* (*30*), required the states to inventory and inspect their federal-aid bridges by July 1, 1973 and to inspect them at least every 2 years thereafter. The standards also required that inventory data be maintained on each bridge, as well as a record of inspector's qualifications and the inspection methods used. To facilitate inspection uniformity and quality, a comprehensive training course for bridge inspectors was developed (*31*) by a joint federal-state task force.

The Surface Transportation Assistance Act of 1978 (*3*) extended the inventory and inspection requirements of the National Bridge Inspection Program to off-system bridges. Initial inspections under this act were required to be completed by December 31, 1980.

Special Bridge Replacement Program

The second major bridge safety effort initiated by the U. S. Congress was the Special Bridge Replacement Program. It was established by the Federal-Aid Highway Act of 1970 (*32*) to supplement the states' efforts to replace unsafe bridges over waterways and topographic barriers. Under the act, the Secretary of Transportation, in consultation with the states, was to inspect and classify all federal-aid bridges. Detailed information was to be gathered on 84 items relating to safety, serviceability, and essentiality for public use (*33*). Procedures were established to develop for each structure a numerical "sufficiency rating" whereby the states could evaluate the sufficiency of bridges to remain in service in their present condition and set priorities for replacement, and whereby FHWA could determine funding eligibility (*34*).

The sufficiency rating was to be reported as a numerical value between 0 and 100 arrived at by applying a mathematical formula to inventory data developed by the states. The lower the rating, the higher the priority for replacement. Structures with a rating of less than 50 were eligible for replacement with federal funds. The general elements of the sufficiency rating formula follow (*33*):

$$\text{Sufficiency rating} = S_1 + S_2 + S_3 - S_4$$

where

S_1 = structural adequacy and safety (maximum weight, 55 percent),

S_2 = serviceability and functional obsolescence (maximum weight, 30 percent),

S_3 = essentiality for public use (maximum weight, 15 percent), and

S_4 = special reductions for specific deficiences including the proximity of alternative crossings, below-standard guide rails and transitions, and certain types of structures (maximum weight, 16 percent).

Structural adequacy (S_1), which accounts for slightly more than half of the rating, evaluates the load-carrying capacity of the superstructure and substructure; serviceability (S_2), the geometric and traffic capacity features; and essentiality (S_3), the frequency of use of the structure and its importance as part of the defense highway system. Special reductions (S_4) apply only when the total of S_1, S_2, and S_3 equals or exceeds 50. A complete description of the sufficiency rating formula is contained in the *Recording and Coding Guide for the Structures Inventory and Appraisal of the Nation's Bridges* (*34*), and is shown diagramatically in Figure 5.

The Federal-Aid Highway Act of 1970 (*32*) authorized $100 million for fiscal year 1972 and $150 million for 1973 for bridge replacement. This funding was continued for fiscal years 1974–1978 for a total of $585 million (Figure 1) (*35, 36*). The Surface Transportation Assistance Act of 1978 (*3*), however, extended and expanded the Special Bridge Replacement Program to what is currently known as the Highway Bridge Replacement and Rehabilitation Program (HBRR). Rehabilitation, rather than complete replacement, of unsafe bridges was permitted for the first time for bridges with a sufficiency rating of 80 or less (provided that the rating would be increased to at least 80), and funding was greatly increased over previous authorizations. The $4.2 billion authorized for the four fiscal years 1979-1982 ($900 million, $1.1 billion, $1.3 billion, and $900 million, respectively) was about five times the $835 million authorized for the previous seven-year period. However, the program now included bridges off the federal-aid system, and for the first time included bridges over highways and railroads. Also, the federal share of replacement and rehabilitation costs was increased from 75 to 80 percent. The Surface Transportation Assistance Act of 1982 authorized $1.6, 1.65, 1.75, and 2.05 billion for fiscal years 1983 through 1986 for a total of $7.05 billion for the four-year period.

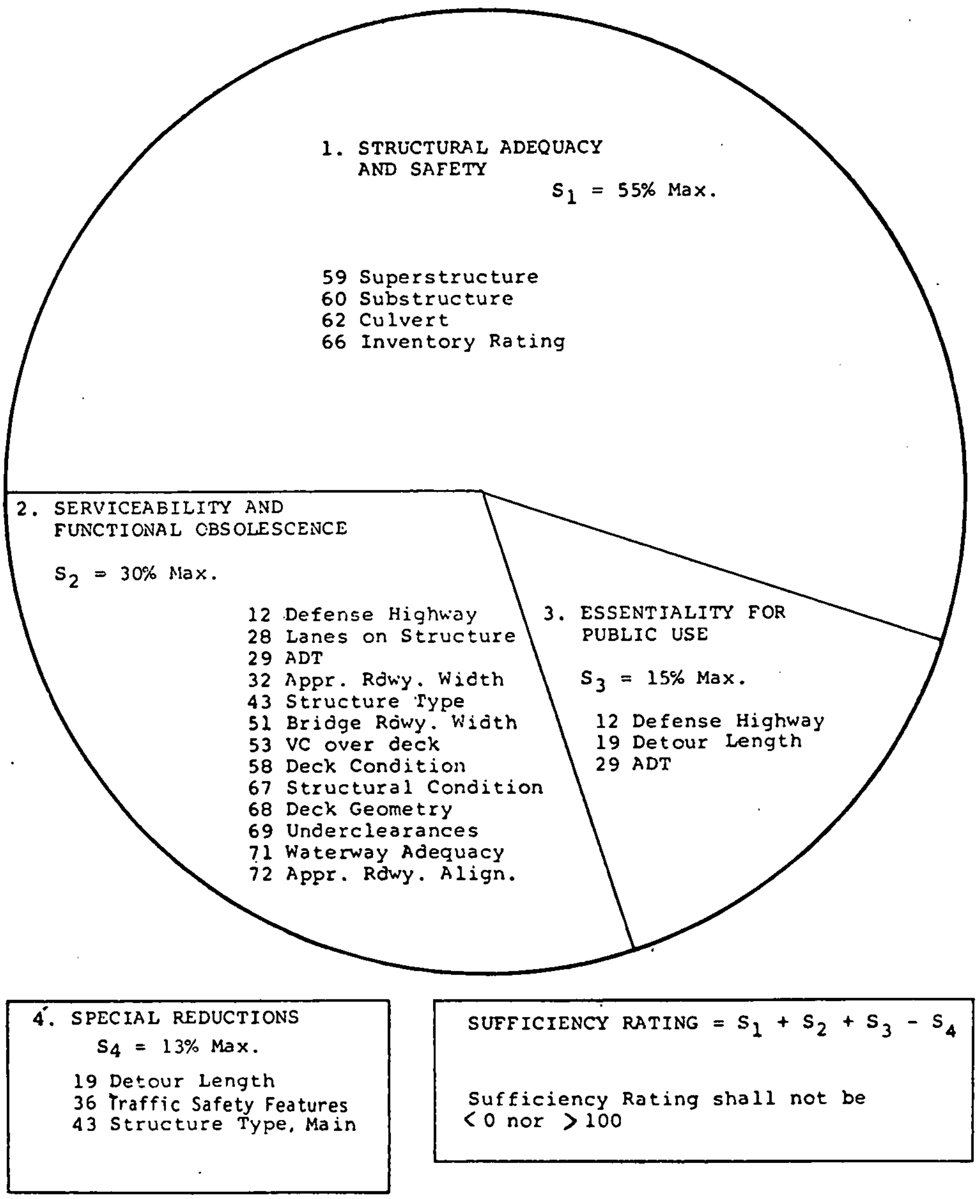


FIGURE 5 Summary of sufficiency rating factors (*34*).

TABLE 1

CONDITION OF THE NATION'S BRIDGES[a]

	Federal-aid system	Off-system	Total
Total bridges	259,950	297,566	557,516
Structurally deficient bridges[b]	27,354	99,301	126,655
Percent	10.5	33.4	22.7
Functionally obsolete bridges	40,342	81,530	121,872
Percent	15.5	27.4	21.8
Intolerable overall structural condition[c]	19,466	68,203	87,669
Percent	7.5	22.9	15.7
Should be posted to lower level	27,100	122,800	149,900
Percent	10.4	41.3	26.9
Closed	316	3,100	3,416
Percent	0.1	1.0	0.6

[a]Based on data in the National Bridge Inventory as of December 31, 1980 (reported in Reference 4, p. 4), which is thought to include essentially 100 percent of Federal-aid system bridges and 96 percent of approximately 310,000 off-system bridges (except as noted below).

[b]All bridges that are both structurally deficient and functionally obsolete are included in this category and are not reported in the category of functionally obsolete bridges.

[c]Reference 7, p. 11.

THE BRIDGE PROBLEM

According to the most recent compilation of FHWA's national bridge inventory data (*4*, p. 4), there are about 570,000 bridges on the nation's highways, including approximately 260,000 on the federal-aid system and approximately 310,000 off the system. More than 25 percent of all federal-aid bridges, and more than 60 percent of all off-system bridges are deficient according to FHWA, which is about 4 of every 10, or more than 248,000 (Table 1).

These bridges are of special concern. Their failure can cause loss of life and their rehabilitation or replacement is usually more expensive and disruptive to traffic than other highway improvements. It has been estimated (*6*, p. 12) that an average of 150 bridges in the United States collapse each year, killing about 12 people. Fortunately, most deteriorated or otherwise weakened bridges do not collapse. Their deficiency, when noted, most often results in load limits being posted or the bridge being removed from service, both of which interrupt efficient traffic flow. Other bridges, which have adequate load-carrying capacity, are deficient because of poorly aligned approaches, inadequate clearances, or narrow decks. These conditions are also hazards to safety. The terms "structural deficiency" and "functional obsolescence" have been coined to describe these two categories of deficiency, and both appear as major elements in the sufficiency rating formula.

The specific procedures for gauging these deficiencies for particular bridges are beyond the scope of this review; however, the operative definitions are given in Appendix A, and references *31* and *34* are suggested for further reading. For the purpose of this synthesis, it is sufficient to refer to Table 1, which summarizes bridge conditions both on and off the federal-aid systems. This table shows that approximately half of all deficient bridges are lacking structurally, and that most of these are such that their overall structural condition has been rated as "basically intolerable" and warranting immediate repair, replacement, or closure. Approximately one quarter of all bridges are in need of posting to lower load levels than they now carry, and 0.6 percent are already closed. Of particular relevance to the historic bridge issue is that the condition of structures off the federal-aid system, where most bridges of historic interest are classified, is substantially worse than the condition of those on the system.

It is also noteworthy that although procedures for gauging bridge deficiences are set by FHWA, priorities for bridge replacement and rehabilitation are set by the individual states. As a result, bridge replacement and rehabilitation priorities vary among the states. One reason for this is that there is disagreement over whether structural adequacy or functional obsolescence should receive the most weight in the sufficiency formula. Proponents of structural adequacy focus on the potential for major catastrophes, such as the Point Pleasant Bridge, and on the impact of posting and closing; those favoring functional obsolescence focus on the accidents and fatalities that occur on narrow and poorly aligned bridges. Thus, the states generally use the sufficiency ratings to identify eligible projects and as one of the factors in project selection, but the weight given to the sufficiency ratings in project selection varies (*6*, p. 47).

HISTORIC PRESERVATION

The early preservation movement in the United States is considered by Hosmer (*37, 38*) to have been entirely indigenous, even though many of its ideas resembled those of the European preservationists. The principal motivations of the 19th and early 20th centuries had been a desire to educate the American people into a deeper regard for their history; aesthetic and economic considerations were incidental. The movement has been described (*37*) as being thoroughly romantic, seeking to inculcate a patriotic love of past glories by setting aside as symbols the homes of important figures in our national history. It was believed that visits to such historic sites could help to unify a nation of diversity, particularly in the years immediately following the Civil War, by focusing on the sacrifices of the Founding Fathers. Further, it was believed that such visits would facilitate the Americanization of immigrant children, serve to create a militant loyalty among the nation's citizens in times of war, and help to engender cultural awareness in the nation's youth by exposing them to homes symbolic of virtues of the past.

In the 1920s aesthetic arguments for preservation were introduced that emphasized an appreciation of beauty and harmony, and the preservation of old homes for their architectural merit alone gained acceptance. The practice soon extended to other architectural works as well. This period also witnessed the birth of "restoration architecture" as a specific professional endeavor. In 1933 the Historic American Building Survey (HABS) was established to photograph and record the nation's significant architectural works in cooperation with the American Institute of Architects and the Library of Congress (*39*). The American Society of Architectural Historians (since 1947, Society of Architectural Historians), formed in 1940, stimulated and gave outlet to scholarly research on architectural works.

Ironically, the structures of commerce, industry, and engineering that displaced many earlier architectural works became objects of preservation attention themselves in the 1960s. This development was part of a general growth of interest in the history of science and technology. Particularly important in responding to this interest were the Historic American Engineering Record established in 1969 in the National Park Service as a sister organization to and modeled after HABS, and the Society for Industrial Archeology, founded in 1971. The 1960s were also a time when adaptive reuse became popular and old structures were recycled from an earlier function to a newer one with benefits that were often both economic and aesthetic.

Stipe (*40*) has summarized the arguments that have been advanced for preservation as fulfilling a combination of social, psychological, economical, and intellectual needs. He notes that our historical resources are our only physical link with the past, and that they have inherent in them historic associations that help us to understand and appreciate that past. Because we live with them, they are familiar and have become a "part of us." In a time of rapid change and increasing cultural homogeneity, they remind us of our uniqueness. Many are, in themselves, achievements of art or craftsmanship, and have intrinsic value for those reasons alone, and risk being replaced by structures of less merit on both counts. And finally, preservation can serve important human and social purposes by providing living and working space that is more economical and stimulating than what might otherwise replace it.

Federal legislation relevant to historic preservation, as well as attendant policies and regulations, has been reviewed by Gray (*41*), Fowler (*42*), Newlon (*10*), and Bower (*43*). Bower's review is particularly valuable as it focuses on transportation issues and includes, as well, a synthesis of case law. All of these references have been drawn from in the paragraphs that follow.

Before 1966, federal legislation provided only limited protection to some historic sites (*41*). Under the Antiquities Act of 1906 (*44*), limited protection was accorded to sites on lands owned or controlled by the United States. The President was authorized to designate historic landmarks, historic and prehistoric structures, and other objects of historic or scientific interest as national monuments. He was also authorized to reserve as part of these monuments parcels of land necessary for their proper care, and to promulgate regulations for their management.

The beginnings of a national preservation policy appeared in the Historic Sites and Buildings Act of 1935 (*45*) by which Congress declared a "policy to preserve for the public use historic sites, buildings and objects of national significance for the inspiration and benefit of the people of the United States." It authorized the Secretary of the Interior to carry out a number of functions relevant to the protection of such sites, granting him powers to make a survey of historic and archaeological sites and to acquire, restore, maintain, and manage them. Implementation of this authorization resulted in creation of the National Historic Landmarks Program, which maintained a national register of historic properties, and more recently HABS, mentioned earlier.

The first significant federal legislation concerning preservation (in the broad sense) that dealt directly with transportation programs appeared in the Federal-Aid Highway Act of 1956 (*46*). The Act authorized, for the first time, federal participation in the cost of archaeological and paleontological salvage. Policies and procedures for implementing this provision are set forth in FHWA Policy and Procedure Memorandum 20-7 of March 31, 1971.

Provisions of the 1935 and 1956 acts have been useful for both scholarship and preservation (*41*); however, they did little to protect privately owned properties from destruction in cases where owners or governmental authorities desired to put the associated lands to other use. Likewise, they did nothing to restrain such destruction by the United States government itself. This problem was dealt with in two landmark federal statutes in 1966.

The first of these statutes was the National Historic Preservation Act of 1966 (NHPA) (*9*). This legislation significantly strengthened the federal commitment to preservation and provided the first new federal funding of architectural preservation activities since 1935. The 1966 Act removed national significance as a controlling criterion by including resources of state and local significance, and thereby greatly expanded the existing register into what is now known as the National Register of Historic Places (see Chapter 4 for a review of the NR significance criteria). The substance of the Act's protective provisions is found in Section 106, which established the Advisory Council on Historic Preservation.

The Advisory Council was to be a high-level body composed of 19 members selected by the president on the basis of their interest and service in the field of historic preservation. Seven were to be federal officials and 12 were to be appointed from outside the federal government. Under Section 106 of the Act, the Council was given a highly significant role in protecting National Register properties from undertakings with federal involvement. If a federal agency has direct or indirect jurisdiction over a proposed federal undertaking or federally assisted undertaking, or if the federal agency has authority to license the undertaking, and if the undertaking would affect any property listed in the National Register, the head of that federal agency has two responsibilities under Section 106 before approving the expenditure of federal funds or before issuing any license. The agency head must "take into account the effect of the undertaking" on the National Register property and "shall afford the Advisory Council on Historic Preservation . . . a reasonable opportunity to comment with regard to such undertaking." Specifically, the agency head is charged with assessing the effect of the undertaking on the property. The participation of the Advisory Council often results in a negotiated agreement to mitigate an adverse effect, and their comments have generally been taken as binding.

Although Section 106 of the NHPA represented a major step forward in the preservation program, it contained certain shortcomings, which were addressed in Executive Order 11593 issued by President Nixon on May 13, 1971. The order, titled "Protection and Enhancement of the Cultural Environment," contained two major new directions. One extended the federal agency's review process to properties eligible for, but not yet formally entered in, the National Register. The second extended the administrative interpretation of Section 106 to nonfederally owned properties as well as to those owned by the federal government. In 1976 the National Historic Preservation Act of 1966 was amended (*47*) to incorporate the important features of Executive Order 11593, and in 1980 Executive Order 11593 was made part of the NHPA (*48*).

Thus, Section 106 of the NHPA and Executive Order 11593 combined with provisions of the existing National Environmental Policy Act (*49*), which required comments from the Advisory Council in environmental impact statements, dictate at the earliest possible stages of planning consideration of any potential impact of projects on properties or structures that are on or eligible for the National Register of Historic Places, if these projects involve, directly or indirectly, use of federal funds or issuance of federal permits. The NHPA and Executive Order 11593 placed on the funding federal agency the responsibility for resolution of conflicts, subject to review by the Advisory Council. The federal agency has final responsibility to regulate the impact of federal agency actions on National Register properties.

The other of these 1966 landmark statutes was the Department of Transportation Act (*50*). Section 4(f) of that act, enacted largely in response to the requirements being placed on federal agencies by the new NHPA, reads in part that the Secretary of Transportation:

> [S]hall not approve any program or project which requires the use of . . . any land from an historic site of national, State, or local significance as so determined by such officials [federal, state, or local officials having jurisdiction thereof] unless (1) there is no feasible and prudent alternative to the use of such land, and (2) such program includes all possible planning to minimize harm to such . . . historic site resulting from such use.

Thus, all federal "undertakings" require application of Section 106 of NHPA, which involves review and comment by the Advisory Council. In addition, any project funded by any part of the Department of Transportation requires consideration of the provisions of Section 4(f) of the DOT Act.

The requirements of Section 4(f) are more restrictive than are those of Section 106. Under Section 4(f), "feasible and prudent" alternatives may be identified that are possible but extraordinarily expensive, or that alter the project substantially. However, Section 106 permits mitigation of adverse effects through a memorandum of agreement that may permit the property to be demolished with proper recording when faced with otherwise prohibitively expensive alternatives. Thus, Section 106 agreements usually reflect a compromise between preservation and transportation goals, with consideration of social and economic factors.

As a result of the relatively recent preservation interest in industrial and engineering structures, bridges have assumed a historical importance not foreseen when the earlier legislation relating to replacement was drafted. Of special importance to the replacement of structurally deficient or functionally obsolete bridges is the obvious conflict between the federal requirements for preservation on the one hand and those requiring replacement on the other. Because priorities in such circumstances are usually determined by which legislation is best funded, replacement usually results. The legitimate concerns for preservation and those for safety, in many cases, are clearly diametrically opposed. Interestingly, adaptive reuse, being considered with increasing frequency for all industrial structures, offers some unique applications for bridges. More is said about this later.

CHAPTER THREE

HISTORIC BRIDGE INVENTORIES

RATIONALE AND DEVELOPMENT

The issue of historic bridges, which brings transportation and preservation values into conflict, has elements in common with other environmental concerns, but differs in at least two important respects. No other cultural resource existing in such large numbers has been threatened with the possibility of such complete loss in such a short period of time as have historic bridges. The situation is complicated by an absence of objective criteria for judging historic importance. Such criteria derive in part from factors intrinsic to the bridge itself (i.e., its technology and the history of its manufacture), and also from a knowledge of how many of what kinds built by whom survive. Thus, an 1885 high Pratt truss in Pennsylvania may be less important as one of a number of early examples of this common structural form than it is as the only known survivor of a short-lived bridge company. In South Carolina, say, where fewer early Pratt trusses survive, this same bridge might be important on both counts. Or, a rare Whipple arch-truss may be less important in New York where others are known, than in Ohio where it is the only survivor of its type. This statistical context is needed to facilitate historical assessment and resolution of potential conflicts early in the transportation planning process.

A statewide inventory is now generally viewed as an important first step in resolving conflicts between the divergent goals of preserving historic bridges and providing safe and efficient transportation. It is thought that such inventories will provide a realistic framework for identifying and evaluating these resources. In addition, the inventory data can facilitate a responsible determination of eligibility or noneligibility of individual structures for listing on the National Register of Historic Places, and thereby a cost-effective means of reducing the number and length of costly delays now associated with projects that include potentially historic bridges. And finally, an inventory of historic bridges can provide a sound basis for a statewide preservation plan that includes a full range of options.

The Virginia Department of Highways and Transportation recognized this need and was the first state-level agency to act on it in a thorough and systematic manner. Their survey and photographic inventory of metal truss bridges was begun in 1973 and published in a series of eight reports between 1975 and 1982 (*21, 22*). A survey of Virginia's concrete and stone arch bridges has been completed but not yet published. Yet, the thematic regional survey is a traditional technique for inventorying cultural resources, and the Virginia survey had at least one precedent in the state and regional checklists of covered bridges published by Allen between 1957 and 1970 (*51–54*). In contrast to the present activities, however, the motivation to locate, photograph, and research covered bridges was engendered by the hobby interests of hundreds of covered bridge enthusiasts, many organized into a variety of covered bridge societies (*51*, pp. 104–106; *52*, pp. 102–103). Some smaller regional bridge inventories were completed soon after the first report of the Virginia survey was published (*26, 55, 56*); however, it was not until 1979 that another state highway or transportation department (North Carolina) published an inventory comparable in scope to Virginia's (*57*).

With the completion of the Virginia inventory, staff members of the Historic American Engineering Record actively began promoting awareness and inventory of bridges (*16*), particularly among state preservation officers. In 1977 HAER, with the National Trust for Historic Preservation, Preservation Action (a preservation lobby organization), and the National Conference of State Historic Preservation Officers, was influential in obtaining a provision in the 1978 Surface Transportation Assistance Act (*3*) permitting the optional use of Federal Highway Bridge Replacement and Rehabilitation funds for inventory of historic bridges. In 1980, the Federal Highway Administration adopted a policy of encouraging the states to conduct such inventories (*58*), and has recently moved to add a one-digit entry for historicity to the National Bridge Inventory (*59*) data format. This entry will enable each bridge to be coded in one of five ways:

1. On the National Register of Historic Places,
2. Eligible for the National Register of Historic Places,
3. Possibly eligible for the National Register of Historic Places, or on a state or local historic register (requires further investigation before determination can be made),
4. Historical significance not now determinable, or
5. Not eligible for the National Register of Historic Places.

In August 1981, the U.S. Department of Transportation published a summary of the status of historic bridge inventories in the various states (*60*). This summary was updated, expanded, and presented by Anderson at the 1982 Annual Meeting of the Transportation Research Board (*61*). Much of the factual information in the narrative that follows is drawn from Anderson's summary.

INVENTORY METHODS

Planning

Because the burden of assessing the impact of construction lies with the state highway and transportation departments and the determination of National Register eligibility with the SHPO, it is not surprising that most plans for historic bridge surveys have originated in discussions between representatives of these two agencies, even though the initiative may have been with only one or even (as in some instances) with an interested third party. Typically, the FHWA as the responsible federal agency has been represented in these early discussions. Decisions that must be made early include: considerations of funding level and source, types and ages of bridges to be surveyed, inventory staffing, data collection and recording procedures, and methods of analysis and reporting. Study of procedures used in neighboring states where the context may be similar has sometimes been helpful. Eventually, criteria for evaluation, standards for National Register eligibility, and decision criteria for ultimate disposition of specific bridges may be addressed by this same team, although not necessarily.

A technique used by some states has been to create a multidisciplinary, multiagency advisory committee to provide both planning and review functions during all stages of the inventory. Highway agency representation on such committees has typically varied from state to state but has included individuals from any or all of the following offices: bridge design, maintenance, environmental or cultural affairs, and research. Use of "outside" resource people on such committees is common. These may be academicians (civil engineers, historians, or specialists in the history of technology), staff of the state historical society or the state historian's office, or private citizens with special interest or credentials. HAER has been represented on the advisory committee of several states, West Virginia has incorporated a key citizens advisory group, and Ohio and New York have included a representative of their county highway engineer's association. Most states that have used such an advisory committee have found it to facilitate coordination among the agencies involved, and ultimately to increase the range of options available to the highway agency.

Regardless of composition, the function of such committees has been to provide a broad viewpoint and base of participation. This strategy has been particularly advantageous when the inventory has been completed and judgments have been required on such sensitive issues as the relative importance of specific bridges and criteria for National Register eligibility. Most states that have addressed these questions have found consensus relatively easy when the participants have been involved in the earlier decisions.

Funding

Historic bridge surveys have been funded from a variety of sources, both singly and in combination. The 1978 Surface Transportation Assistance Act (*3*) permitted the use of federal HBRR funds for historic bridge inventories (this funding has not been affected by the 1982 Act), but because of the relative paucity of these funds compared to bridge replacement and rehabilitation needs, FHWA has encouraged use of Highway Planning and Research (HP&R) funds (*61*). In addition to HBRR and HP&R monies, federal funding through the Department of the Interior's Survey and Planning Grants Program has been applied to historic bridge inventories. However, these funds, administered by the SHPO in each state, have substantially diminished since 1979. HBRR and HP&R sources have had the advantage of requiring only 20 percent and 20 to 25 percent local matching monies, respectively, whereas the Grants Program has required 50 percent local monies. The other major source of financial support has been from 100 percent state monies, most often from the highway agency but also occasionally from the SHPO. In some instances, HAER has provided direct financial support, but more often in the form of services. In at least one instance the contract agency performing the inventory (a university) also contributed financial support.

Estimating the costs associated with such inventories is difficult. Anderson (*61*) reported values between $15,000 and $295,000, although 5 of the 6 values he reported were $75,000 or less. Clearly, reported costs are highly dependent on what activities are included in the estimate, how many bridges are surveyed, whether site visits are conducted, and the compensation rate of the individual performing the service. A more useful figure for planning purposes would be a typical per-bridge estimate of the man-hours required for the actual inventory; that is, trip planning, transportation, on-site data collection, and data-form completion. Direct and ancillary costs could then be calculated to fit the situation more appropriately in a particular state. Alternatively, the cost per bridge for such activities would be useful. Such estimates were solicited from those states that reported having completed all or a portion of their inventory. The information received, however, was cursory and not easily evaluated without a level of effort beyond the scope of this synthesis. Some examples follow.

- Virginia reported average inventory rates of 2 to 4 metal trusses or 4 to 6 concrete arches per day.
- Wisconsin was able to complete an average of 2 metal trusses per day with complete recording plus an additional 7 on a photo-reconnaissance basis only.
- Washington spent $38,000 on inventory staff and visited 1400 bridges, for a per-bridge personal service cost of $27.
- Ohio, which is conducting their inventory by a series of consultant agreements, has alloted $94 per bridge for all costs.

Scope

Of the decisions usually made early in the inventory planning process, those that determine the types of bridges to be included, their limiting ages, and the jurisdictions to be surveyed are among the most important.

Bridges can be classified on the basis of the engineering principles by which they support load (beam, truss, arch, cantilever, suspension, etc.), the materials of which they are made (wood, stone, iron, steel, concrete, etc.), the functions that they serve (pedestrian, vehicular, railroad, aqueduct, etc.), or a combination of these. A taxonomy of bridge types is beyond the scope of this work; however, a number of helpful references are available. Possibly the best single reference to nineteenth and early twentieth century types is Waddell (*62*).

Metal trusses have received the most intense and earliest attention by many states because their great number and variety have made them particularly conspicuous to preservation interests. Metal trusses, plus concrete and stone masonry arches, have been included in virtually all inventories planned to date. In many states, these three types are the only types being surveyed. Other structural forms are often included because of their particular role in the development of the region, such as movable bridges in coastal or inland water areas and timber trestles in parts of the west and midwest. Some categories, although of interest, have been excluded from some inventories because their context is already known; covered timber bridges are an example. Types rarely inventoried include: concrete slab, steel and/or concrete girder, and plate girder bridges unless of exceptional age. HAER considers these latter forms to be unimportant unless erected before 1911 (*61*). Culverts have been universally excluded, and usually so have bridges with span lengths less than a specific value, 20 ft (6 m) being the most common.

In terms of limiting age, the National Register's 50-year minimum standard has frequently been invoked. This has given rise to "cut-off" dates between 1930, which has a multiple-of-ten "ring" and is approximately 50 years past, and 1941, which allows a ten-year grace period and ends with the beginning of World War II, when much bridge building activity in this country was suspended. Earlier cut-off dates have been chosen that suit the particular needs and perceptions of particular states, and different dates have sometimes been adopted for different bridge types within the same state.

Regarding jurisdictions, an attempt has usually been made to include all publicly owned bridges that are within the scope of the HBRR Program, regardless of whether they are state, county, town, or municipally owned. Privately owned bridges have also occasionally been included, most frequently those carrying railroads. In at least one instance, surveys were limited to structures on the state system alone.

Although some railroad bridges have been included in these inventories, as noted above, the vast majority have not, probably because many are privately owned and do not cross public roads. Washington is the only state known to have included a comprehensive listing of railroad bridges in their inventory (*63*). This situation is seen by some to be a major shortcoming of the current efforts, even though the prevailing threat to historic bridges comes primarily from highway programs. Also, many of the differences between railroad and highway bridges tend to mitigate a need for their immediate replacement. Their open, unsalted decks are not subject to the same corrosive influences that cause loss of structural capacity, their loads are often lighter and slower moving than those for which they were designed, and they do not have the geometric problems that render obsolescence to so many early highway bridges.

Data Collection

The first step in actually conducting an inventory has usually been to estimate the number of potentially important bridges. Only then has it been possible to grasp the full scope of the task to estimate time and costs, and to plan field visitations. This has been done most easily by accessing existing inventory or inspection data files, which are usually machine stored. Entry data need be nothing more than the structural forms and limiting dates of interest. Information, other than location, that may be useful in later stages of the inventory can also be extracted at this time. Some agencies have used such listings without discrimination to plan field trips, whereas others have screened the listings or set priorities. Photographic files, listings of bridge replacement and rehabilitation priorities, sufficiency ratings, and condition information have all been helpful in this regard.

Once the survey population has been established and data collection methods tentatively set, some states faced with large numbers of bridges have found a pilot survey useful to "fine tune" their procedures before embarking on a statewide effort. Typically, these have consisted of inventorying a small geographic region or a small number of sample bridges or types, and then making appropriate changes based on that experience.

The inventory itself has typically consisted of a site visit by the survey staff, observation and recording of specific information, usually on a standardized survey form, and photography of the overall site and specific details that may be significant in later assessment of the structure's importance. Both black-and-white photographs (for documentation) and 35-mm color slides (for projection) have been found useful. Forms for data recording have included letter-size as well as smaller formats (see New York and Ohio in Appendix B for examples), and many have used the inventory card developed by HAER (Appendix C). In some instances, data have been transferred to computer storage or to a manual punch card sort and retrieval system, such as that used by HAER.

Because much data can be collected without a site visit, depending on the extent and accuracy of local records, some states (such as New York) have opted to make field visits only to bridges that survive one or more stages of screening. An existing photographic file that happens to be a component of the local record is extremely helpful in this respect. Reasonably accurate pre-visit screening can be done with no more information than date of construction, designer/builder, structural configuration, and a good photograph. With experience, the builder of many metal truss bridges can sometimes be inferred from portal configuration or other details when a builder's plate is absent. Obviously, contextual and aesthetic assessments (if required) are difficult without viewing structures in their surroundings. The New York data card shown in Appendix B was designed for such pre-visit screening.

Staff to conduct actual data collection has been drawn from a variety of sources. In at least one instance the survey was conducted by the SHPO's staff, highway agency personnel have directly managed data collection in others, and in a few the

TABLE 2

STATUS OF HISTORIC BRIDGE INVENTORIES[a]

All or Part Completed	Significant Progress	Modest Progress	Not Started
California	Alabama	Arizona	Alaska
Georgia	Arkansas	Colorado	Connecticut
Kentucky	Delaware	Idaho	District of Columbia
Maine	Florida	Illinois	Missouri
Montana	Hawaii	Iowa	Nebraska
New York	Indiana	Massachusetts	Oklahoma
North Carolina	Kansas	Mississippi	South Dakota
Ohio	Louisiana	Nevada	Texas
South Carolina	Maryland	New Mexico	Utah
Virginia	Michigan	North Dakota	
Washington	Minnesota	Puerto Rico	
West Virginia	New Hampshire	Rhode Island	
Wyoming	New Jersey	Tennessee	
	Oregon	Vermont	
	Pennsylvania		
	Wisconsin		

[a]Updated from Anderson summary in Reference 61.

agencies have cooperated, each providing those services for which they are best suited. The fact remains, however, that few SHPOs have the manpower and few highway agencies either the expertise or the willingness to divert staff from other duties. Thus, consultants have been relied on extensively and are usually chosen for their background in industrial or engineering history, frequently from a college or university. HAER has been the consultant in a few instances and, in an apparently unique approach, one state (Ohio) has let eight unit-price contracts with different consulting firms for different regions of their state.

Inventories completed to date have generally resulted in a written report. These reports have varied from as little as a bound and indexed collection of completed inventory forms to a document that includes analysis and recommendations for National Register nomination. To varying degrees, such reports have included some or all of the following: inventory methodology, completed inventory forms, statistical or tabular summaries of attributes, general history of bridge building technology, information about specific bridge building companies, history and importance of specific structural forms, archival information on specific bridges, analysis and interpretation of observed patterns or trends, analysis of relative importance, and recommendations for National Register nomination. Reports published as of this writing are listed in the references (*21, 22, 57, 63–69*).

STATUS OF INVENTORIES

As of the spring of 1983, 13 states were known to have completed or very nearly completed inventories of potentially historic bridges (Table 2). Sixteen others reported significant progress, 14 were in the early stages, and 9 were continuing to assess the historicity of bridges on an individual ad hoc basis when they were brought into consideration for replacement or rehabilitation.

CHAPTER FOUR

EVALUATION OF RELATIVE IMPORTANCE

NATIONAL REGISTER CRITERIA

The National Register of Historic Places is the instrument by which properties are determined to be important enough to warrant protection under the National Historic Preservation Act of 1966. This protection, which is extended to both listed and eligible properties, requires that the head of the federal agency having jurisdiction over a potentially harmful undertaking (usually a construction project) must consider and be accountable for the effect of the undertaking on the historic resource. Determinations of eligibility are based on criteria specified by the Keeper of the National Register of Historic Places, as set forth in 36 CFR Part 60.4 (*70*). These criteria are general to provide for a diversity of resources and are given below.

> The quality of *significance* in American history, architecture, archeology, engineering and culture is present in districts, sites, buildings, structures and objects of state and local importance that possess integrity of location, design, setting, materials, workmanship, feeling and association, and:
> (A) that are associated with events that have made a significant contribution to the broad patterns of our history; or
> (B) that are associated with the lives of persons significant in our past; or
> (C) that embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
> (D) that have yielded or may be likely to yield information important in prehistory or history.

Generally, properties that have been moved from their original location have been excluded unless their significance derives primarily from intrinsic architectural or engineering value. Likewise properties less than 50 years old are excluded unless of exceptional importance.

In applying the criteria, it is obvious that each integrity attribute may vary in degree from property to property. However, in order to be judged *significant*, it has usually been assumed that a candidate property must not be totally lacking in any of the seven categories. It is also true in practice that the more important a property is, the greater the propensity to compromise on integrity. A fairly common understanding has evolved with regard to the meaning of the different attributes. The first five are more physical in their nature and easier to evaluate than the last two.

1. *Integrity of location* deals simply with whether the property is at its original site or has been moved. For many properties, including many bridges (i.e., stone masonry and concrete arches, long suspension bridges, etc.) the issue is moot because they are for practical purposes immovable. However, for others, such as some of the metal truss bridges, exceptions are usually made, particularly if there is no strong association with other cultural features. The very nature of early truss fabrication and erection enabled them to be conveniently removed to other sites as crossings were upgraded. At least one company advertised this feature (*71*).

2. *Integrity of design* relates to whether the property retains the features of its class; that is, the essential elements of what it is intended to represent. Where paving over a timber deck in a truss bridge to better serve modern traffic may not be perceived as a serious compromise of design integrity, the addition of stiffening cables to the truss might, because the principal focus of interest is usually the truss itself. Likewise, replacement of deteriorated parapets on a concrete arch bridge or grouting of the facia of an unmortared stone arch would likely be seen as altering an essential design element.

3. *Integrity of setting* addresses changes that have occurred to the immediate surroundings and how these changes (buildings, land use, foliage, topography, etc.) have affected the relationship of the property to its setting. Truss bridges, for instance, built over railroads or canals may have distinctive features in some regions. Removal of the trackage or filling of the canal in such instances would probably be interpreted as compromising the integrity of their setting.

4. *Integrity of materials* has to do with whether original materials of historic importance associated with the property have been substantially altered by deterioration or replacement and, if replaced, whether the new materials are equivalent to or compatible with the original. A bridge that has had its original random unmortared stone abutments replaced with reinforced concrete might suffer from a loss of materials integrity.

5. *Integrity of workmanship* deals with the relationship between the specific form of different materials and the way they are combined, and the technology of producing these forms and combinations. This attribute is more subtle and difficult to define for bridges, but may be illustrated by a covered timber bridge in which some hand-hewn members with mortised and tenoned joints have been replaced by machine-sawn timbers using modern connectors. In this instance, integrity of materials has been maintained but integrity of workmanship compromised. Similarly, replacement of a damaged truss member consisting of a riveted built-up section with one that was welded would entail a loss of integrity of workmanship.

Most of these attributes are interrelated (for instance, design and materials or location and setting), and it is hard to lose a total of one without some of another as well. The last two attributes are more interpretive than the first five, and are typically considered together.

6. & 7. *Integrity of feeling and association* is considered to be present if the property communicates to an informed observer a sense of what it was like in its historic period. This generally occurs if the other five attributes are present to a high degree. However, for older highway bridges one could argue that only those on unpaved roads in rural areas can truly communicate such a sense.

Thus, *significance* is defined by the presence of specific attributes of integrity occurring in properties of state or local *importance*. (Properties of national importance may also be designated as national landmarks.) Although of considerable consequence, the distinction between *significance* and *importance* is not explicit in the criteria, and the phrase "of state and local importance" (for some unknown reason) is frequently omitted when the criteria are stated in print.

To determine *importance*, one must be able to identify first the theme or pattern of which the property is a part, and second how well the property communicates that theme in comparison to other similar properties. The latter task has typically been approached in one of two ways.

1. *Systematically*. One surveys all properties in the class and decides which one or ones best represent the class. This procedure is particularly useful, in fact virtually essential, when dealing with a theme such as bridges that exist in such large numbers and about which so little is known (i.e., of their context). It is for exactly these reasons that the FHWA and others (*16, 18, 58*) have emphasized the need for inventories of potentially historic bridges. Theoretically, the approach may be pursued in one of two ways: (a) a survey followed by analysis of the identified properties; or (b) contextual research to identify attributes of the class that define eligibility, followed by survey and comparison of specific properties with the eligibility "model." In reality, the two ways are interdependent—a study of survivors can yield information only on the population of survivors, not on the population built; and even extensive library research on bridge building history will be incomplete without supplement from examining the artifacts of that history.
2. *Intuitively*. One simply knows from experience, without having to look systematically at other properties in the class, that the object in question is clearly a good representation. From Table 2, it is apparent that some state highway and transportation departments have chosen this approach for their bridges. As money for surveying cultural resources becomes more scarce, this approach may become more popular.

Obviously, some properties "communicate the theme" better than others, that is, they are more representative. In that sense, there are degrees of importance and a judgment must be made as to which properties are sufficiently important to be considered for National Register status. Likewise, there are degrees of integrity requiring a similar judgment. In the last analysis, application of the National Register criteria is subjective. In an effort to facilitate more uniform application, the National Register Division of the National Park Service has recently prepared and distributed an elaborate guideline (*72*).

STATE SIGNIFICANCE CRITERIA FOR BRIDGES

To get at the issue of relative importance with regard to bridges, the systematic approach has been encouraged (*16, 18,* and *58*), and a number of states have developed criteria of their own by which they have attempted to complement and expand on the National Register criteria. Through telephone contacts with the Regional FHWA Environmental Coordinator, 14 states were identified in which supplementary criteria have been developed, committed to writing (through December 31, 1981), and in some instances, applied. Discussion with the appropriate people in these states revealed that although the experience of each has been unique, their results can be grouped into three patterns based on how they conduct their initial screening: numerical rating methods, modified National Register methods, and stratified sampling.

Numerical Rating Methods

Numerical methods are based on a checklist of desirable attributes each with a specific numerical value. Evaluation consists of comparing the attributes of individual bridges against the checklist and assigning points based on the presence or degree of presence of the listed attribute. Typically, bridges are ranked on the basis of cumulative point score and a minimum score is agreed on as the standard for National Register eligibility. The specific attributes that form the checklist, the relative weight given to each, and the eligibility standard (or "cutoff" value) are arbitrary and vary among users of this approach. Typically, these checklists include attributes that reflect both representativeness and integrity.

The prototype for all numerical bridge rating systems was developed by Newlon (*10, 73*) in Virginia, apparently without knowledge of precedent, although the concept had had prior use in preservation circles and had also been suggested in connection with appraisals of real estate with historic value (*74*). The Virginia criteria, developed for metal truss bridges, is based on a 27-point scale that includes the factors noted below. The complete criteria are included in Appendix C, and a narrative description of the specific factors are given in references *10* and *73*.

	Assignable Points
Documentation	
1. Builder	0–3
2. Date	0–4
Technological Significance	
1. Technology	0–6
2. Geometry/Configuration	0–3
Environmental	
1. Aesthetics	0 or 4
2. History	0 or 3
3. Integrity	0 or 4
Maximum possible:	27

Newlon applied the criteria to 48 metal truss bridges that were subjectively selected by the survey staff from 513 pre-1932 bridges surveyed. Nine that scored 20 points or higher were judged to be historically significant and National Register eligible. Thirty-nine others that scored between 10 and 19.5 points were judged potentially significant and thought to merit further study, particularly those above 16. All 465 of the remainder were judged to have no significance.

In deciding on numerical criteria, the Virginia staff apparently was influenced (*10*) by the numerical "sufficiency rating" (*32*) then being proposed by FHWA to aid in setting bridge replacement priorities, and possibly also by the natural inclinations of engineers and others to seek quantification where none existed before. The specific evaluation factors used were selected in such a way to create what they thought to be a reasonable balance between significance as viewed by those whose primary interest is technological (documentation and technological significance factors accounted for 16 points) and those whose primary concern is more general (environmental factors accounted for 11 points). It is appropriate to note here that inclusion of these environmental factors is superfluous with regard to the National Register criteria per se, where technical significance alone is sufficient to qualify a property. In selecting a significance threshold of 20 points, Newlon acknowledged (*10*, p. 18) (a) the practical advantage of choosing to nominate a comparatively small number of bridges in the first application of such a pioneering effort, and (b) the probability of future refinement and even a lowered standard.

Early applications of the Virginia criteria to other geographic areas yielded conflicting results that reflect the influence of regional differences in the historical use of these structures as part of transportation systems and in the number and variety of surviving early bridges. In North Carolina, for instance, where metal truss bridges as a group are fewer in number and much younger than in Virginia, only a single bridge out of 250 (pre-1932) examined qualified when a cutoff value of 20 was used. Investigators in North Carolina eventually modified the Virginia criteria and lowered the standard to 15 (*57*). Chamberlin (*56*), on the other hand, applied the Virginia criteria and standard to 57 pre-1900 metal truss bridges from a three-county area of New York, where a larger number of such bridges and earlier dates exist. The resulting distribution of scores was remarkably similar to that for Virginia, the difference being largely consistent with the original selectivity of the Virginia sample (*75*).

Six states, in addition to Virginia, were identified that have either developed or adopted specific written numerical criteria for rating historic bridges: Hawaii, Michigan, North Carolina, Ohio, West Virginia, and Wisconsin. As might be expected, there are common elements among the seven systems. Those from Hawaii, Michigan, North Carolina, and Ohio, for instance, resemble the Virginia criteria closely in terms of their enumeration factors. West Virginia's criteria are generalized for all bridge types and include a much wider range of factors, while Michigan's and Wisconsin's use substantially different weightings. An analysis of these evaluation systems is given in Tables 3 and 4, and the criteria themselves appear in Appendix C.

Choosing which specific factors to include in a numerical rating system is one of three subjective judgments to be made when designing such a system, the other two being how to weigh the individual factors and what eligibility standard to use. The first judgment is facilitated by realizing that these factors can be classified on the basis of whether they are intrinsic or extrinsic to the bridge itself, and, if extrinsic, whether they relate primarily to historical value, environmental quality, preservation potential, or to considerations endemic to the particular state (Table 4). Most agencies that have developed numerical systems thus far have considered primarily the intrinsic factors (group A) plus those extrinsic factors relating to historical value (group B), and to a lesser extent environmental quality (group C). Notably, only Ohio seems to have weighted preservation potential (group D) heavily in the first instance. In New York, an approach is being considered in which bridges will be screened first on the basis of their intrinsic engineering and historical value (groups A and B1–B4), and then factors of environmental quality and preservation potential will be used to select priorities for preservation consideration (as opposed to NR eligibility) within that group.

Factor weighting among the seven states breaks down primarily on whether the weights proposed by Virginia have been adapted without essential change (as in Hawaii and North Carolina) or not. A principal issue here is how much relative weight is given to the more subjective elements of environmental quality (group C) and site significance (groups B5 and B6). The range is bracketed by Virginia with a maximum of 41 percent and Ohio with a maximum of 18 percent.

TABLE 3

PARAMETERS OF NUMERICAL RATING SYSTEMS[a]

	Hawaii	Michigan[b]	N. Carolina	Ohio	Virginia	W. Virginia	Wisconsin
Limiting date	1940	1936	None	1941	1932	1933	1936
Scale range (pts.)	27	100	26	100	27	41	100
Standards (min. pts.)							
National Register eligible	19	50	15	None yet	20	26	Not used[c]
Possibly eligible	10	35	—	None yet	10	18	Not used
Applicability	All bridges	Metal trusses	Metal trusses[d]	All bridges	Metal trusses	All bridges	Metal trusses
Implementation							
National Register eligible[e]	Not appl'd.	Not appl'd.	13	Not appl'd.	9	In progress	NA[c]
Possibly eligible	Not appl'd.	Not appl'd.	41	Not appl'd.	39	In progress	NA
Not eligible	Not appl'd.	Not appl'd.	196	Not appl'd.	465	In progress	NA

[a]Current as of December 31, 1981

[b]Proposed only

[c]Used only to rank within bridge type categories.

[d]Exclusive of deck trusses and movable bridges.

[e]Reserved for future consideration.

TABLE 4

EVALUATION FACTORS IN NUMERICAL RATING SYSTEMS STATED OR IMPLIED

Factor	H. I.	Mich.	N. C.	Ohio	Va.	W. Va.	Wis.
A. INTRINSIC							
1. Builder identified on bridge	X	X	X	X	X	X	X
2. Construction date identified on bridge	X	X	X	X	X	X	X
3. Patented elements	X	X	X	X	X		
4. Ornamental features	X	X	X	X	X	X	X
5. Distinctive/artistic structural details	X	X	X	X	X	X	X
6. Unusual materials	X	X	X	X	X	X	
7. Structural integrity	X	X	X	X*	X	X	X
8. Materials integrity							
9. Number of spans	X	X	X	X	X	X	X
10. Span length	X	X	X	X	X	X	X
11. Height	X						
B. EXTRINSIC - HISTORICITY							
1. Builder known, and significance	X	X	X	X	X	X	X
2. Construction date known, and significance	X	X	X	X	X	X	X
3. Rarity at present	X	X	X	X	X	X	
4. Typicality in its time	X	X	X		X	X	
5. Site significance	X	X	X	X	X	X	X
6. Association with events/persons	X	X	X	X	X	X	X
C. EXTRINSIC - ENVIRONMENTAL QUALITY							
1. Structure esthetics						X	
2. Site esthetics	X	X	X	X	X	X	X
3. Site integrity	X	X	X	X	X	X	X
4. Site accessibility	X						
5. Vantage quality	X						
D. EXTRINSIC - PRESERVATION POTENTIAL							
1. Condition				X			X
2. Route compatibility						X	
3. Bypass Potential				X			
4. Maintenance Difficulty				X			
E. ENDEMIC							
1. Local designer/builder		X					
2. Geographic distribution			X*				
3. Oldest/longest		X*				X	

*Not considered in first instance

When the telephone survey was completed (December 31, 1981), only two states had progressed to the point of selecting an eligibility standard, or "cutoff value," through numerical rating procedures. Of these, Virginia had qualified 9 bridges (1.8 percent) and North Carolina 13 (5.2 percent). It is significant that both also identified relatively large groups of "potentially eligible" bridges to be given additional consideration. In North Carolina, 26 (5.0 percent) of this latter group were subsequently determined to be National Register eligible (B. J. O'Quinn, North Carolina DOT, personal communication). In Virginia, it was agreed (H. H. Newlon, Jr., Virginia Highway and Transportation Research Council, personal communication) that the highway department would record the 39 (7.6 percent) bridges in this group through documentary photography and line drawings prepared from terrestrial photogrammetry (*76*).

Some of the attributes of numerical rating systems that were cited by the various people contacted in preparing this section of the synthesis follow. Each can be perceived as an advantage or disadvantage depending on one's point of view.

1. They add specificity to the National Register criteria; yet, many aspects remain highly judgmental, particularly the weight given to the various factors, and the eligibility standard chosen (i.e., cutoff value).

2. Environmental factors, which are among the most subjective, are typically given heavy weight. However, recently developed techniques of visual resource assessment (*77*) offer an approach to evaluating the aesthetic components of a cultural resource that gives repeatable and defendable results when ap-

plied by trained staff. Such techniques can be useful in mitigating this aspect of numerical rating systems.

3. They clearly identify the "best" and the "worst" among the candidate properties according to the particular evaluation system, but tend to leave a large "in-between" category that requires another level of evaluation.

4. They provide a checklist of attributes that can help to standardize the evaluation process, but some of the checklists fail to include all factors thought by some to be relevant, and most are specific to metal truss bridges only.

5. Because they are more specific than other methods, and are numerical, the criteria are more easily communicated and defended, may be more readily accepted by persons not involved in the valuing process, and may lend themselves to more consistent application.

6. Judgments can be made on individual bridges without a completed inventory.

7. They do not identify the "vernacular" or typical bridge.

8. Evaluation of a specific bridge may be more time consuming than with other methods.

A major criticism that has been made of all of the numerical rating schemes used thus far, regardless of how they are structured, is that although they purport to be devices for identifying National Register eligibility, they incorporate elements that are beyond the scope of the National Register criteria. Referring to Table 4, for instance, most of the extrinsic factors relating to environmental quality and preservation potential (i.e., C1, C2, C4, C5, and D2–D4) as well as some of the endemic factors (E2 and E3) have no meaning relative to the National Register criteria, development of historical context, or analysis of historical importance (see Reference *72*). Rather, they are factors that should be weighed as part of planning which of the eligible properties can, should, or will be preserved.

Modified National Register Methods

States that use this approach attempt a direct application of the National Register criteria, sometimes aided by a supplemental list of standards but always without assignment of numerical values. Five states were identified that had developed and applied such methods: California, Georgia, Massachusetts, Montana, and Washington.

Eligibility decisions using this approach vary widely among the five states (Table 5); however, all except Georgia have made liberal use of the resources of HAER. In California, a consultant to HAER actually conducted the survey and made the nominations; in Montana, HAER was the consultant and thus performed both tasks; and in Washington, HAER provided technical assistance, which is presumed to have included advice on criteria. Although these states, plus Massachusetts, describe their valuing standards as a combination of both National Register and HAER criteria, the latter organization actually has no specific criteria for bridges beyond the following general standards applied to all engineering and industrial sites that are candidates for HAER documentation (*78*).

1. An engineering invention or innovation of importance to the economic or industrial development of an area, a region, or the nation;

2. Significant in the history of a particular branch of engineering:

3. Designed or built by famous engineers, mechanics, architects, or master builders;

4. Typical of an early engineering or industrial structure commonly used throughout an area for a specific purpose; or

5. The sole remaining example or a representative example of a specific type.

TABLE 5

PARAMETERS OF MODIFIED NATIONAL REGISTER RATING SYSTEM

	California	Georgia	Massachusetts	Montana	Washington
Limiting date	1935	1940	1930	1935	1941
Criteria	NR & HAER	NR & Ga.	NR, HAER & Mass.	NR & HAER	NR & HAER
Eligibility					
Recommended by	Consultant[a]	Consultant	Mass. DPW	HAER	SHPO[b]
Reviewed by	Advisory Comm.	GA DOT & SHPO	NA	Advisory Comm.	NA
Applied to	All state bridges	Conc. Arches Timber Trusses Metal Trusses	All bridges	All bridges	All bridges
Implementation					
National Register eligible	46±	In progress	In progress	21	89
Possibly eligible[c]	120±	In progress	In progress	56	440±
Not eligible	846±	In progress	In progress	404	900±

[a]Hired by HAER

[b]With technical assistance from HAER

[c]Reserved for future consideration

FIGURE 6 Reinforced concrete rainbow (or Marsh) arch bridge (1916). (Wisconsin DOT photo.)

Because of the close relationship that has traditionally existed between HAER and ASCE, it is reasonable to assume that the standards for ASCE Civil Engineering Landmarks (*79*, see Appendix D), as well as the above, have influenced National Register recommendations from those states using this approach.

Among the states that claim to use those modified NR methods, only Georgia and Washington have written supplemental criteria. Georgia's (Appendix D) incorporate many of those factors used in the numerical methods, already discussed, and Washington's (Appendix D) closely resemble the HAER criteria noted above.

As a result of using these standards, California established NR eligibility for 46 (4.5 percent) of their inventoried bridges, Montana 21 (4.2 percent), and Washington 60 (6.9 percent). All three also identified substantial categories of "possibly eligible" bridges. Georgia and Massachusetts had not completed their evaluations as of December 31, 1981.

As with the numerical methods, certain attributes of the modified National Register methods were cited.

1. They are more intuitive than numerical methods and, therefore, are less easily communicated and defended, are more subjective than numerical methods, and may be more vulnerable to inconsistent application.

2. They do not require specific weighting of individual factors, nor do they require a numerical eligibility standard, both of which are somewhat arbitrary.

3. They are not specific to a particular bridge type.

4. As applied, they also result in a large in-between category that requires another level of evaluation.

5. Though not precluded, typically they do not rank properties in order of relative value.

6. They are more readily applied by those who already have experience with the NR criteria, in contrast to others who might participate in the valuing process.

7. They are more likely than numerical methods to result in the collection of data and in the development of analyses that will eventually support NR nomination/determination documents as well as 4(f) and 106 reports.

Stratified Sampling Methods

Simply stated, users of this approach identify specific categories into which all or most of their bridges are grouped, and then proceed to identify the best examples in each category. These bridges are then designated as National Register eligible. Of the states identified that have considered this approach (Kansas, Wisconsin, and Wyoming), only Kansas had actually made use of it by the time this survey was completed. The Kansas experience has value as a case study of the method.

As of December 31, 1981 Kansas had not completed its historic bridge inventory, nor had it developed a specific process for judging relative historic importance of its bridges. However, as an expediency it did inventory surviving rainbow arches, a distinctive form of reinforced concrete arch built extensively in portions of the midwest from 1912 (the patent date) through the early 1930s (Figure 6). This bridge is often referred to also as a Marsh arch after its designer and patentee, James B. Marsh (*80, 81*).

Seventy rainbow arches were inventoried on state and local roads, among which good preservation candidates were identified on the basis of: (a) absence of replacement interest by virtue of their location, or (b) high probability of a realignment of the crossing that would preclude the need for destruction of the original bridge. Applying these standards, 12 bridges were selected for preservation consideration including both fixed-end and tied-arch types, as well as single- and multiple-span examples. A third selection factor, geographic distribution, was also included with the added proviso that no more than one bridge of the type be designated in any one county.

Wisconsin and Wyoming provide an interesting contrast to both Kansas and to each other in that a numerical rating method is proposed in Wisconsin (Appendix C) to rank specific bridges within categories, whereas Wyoming will rely on the recommendations of a single consultant for within-category selections without benefit of a numerical rating.

Clearly, these methods merely stratify the "relative importance" task into smaller and possibly more manageable units. Once done, it still remains to make judgments among the properties in each unit. For that, either a numerical or modified NR type of method can be used or, as with Kansas, an approach that looks first at the practical question of preservation potential. In any event, the principal advantage of this approach is that it assures a degree of representativeness that the other two approaches do not.

SUMMARY

The question of whether or not a particular bridge is important enough to warrant protection under the National Historic Preservation Act is one of deciding whether it is eligible for listing in the National Register of Historic Places. National Register eligibility criteria apply standards of integrity to properties determined to be of state or local importance. However, because bridges are so extensive in both number and diversity, state and local criteria that have been applied successfully to other properties have been generally inadequate for bridges. Some states have addressed this deficiency by developing supplemental criteria specific to bridges, following one of three models: numerical rating, modified National Register selection, or stratified sampling. Each approach has distinct attributes that may be viewed as either advantages or disadvantages depending on one's point of view. The approach taken by any particular state seems to be a function both of the background of those devising the evaluation system and their perceptions of the number and nature of their state's older bridges. Although there is general diversity in this regard among the evaluation systems studied, there is some consistency in the proportion of bridges determined NR eligible. For five states reporting such data, this value ranges between 1.8 and 6.2 percent of bridges surveyed. If those in the "possibly eligible" category are added to those in the "eligible" category, and the Kansas data for Marsh arches included, then the range is 9.4 to 21.6 percent of bridges surveyed (exclusive of Washington, which at 58.7 percent is an anomaly).

CHAPTER FIVE

CONSTRAINTS ON THE PRESERVATION OF HISTORICALLY IMPORTANT BRIDGES

In the terms of this synthesis, the determination of National Register eligibility establishes a warrant for preservation consideration with respect to historically important bridges. In spite of this protection, however, most such bridges have eventually been destroyed or substantially altered. This has occurred because of a variety of technical, legal, and financial considerations that have taken precedence over preservation interests. These considerations are the substance of much of what separates the preservation and transportation communities over the historic bridge issue.

TECHNICAL CONSIDERATIONS

The concern most frequently and strongly expressed by the transportation community, when the suggestion is made to preserve and maintain in service a bridge of historical importance, are those of safety. The reality is that most of these bridges were designed to meet less rigorous standards than today's use demands. These older bridges were built when there were lighter loads, less traffic, slower speeds, narrower vehicles, and single-lane roads. Also, most have suffered diminished load-carrying capacity because of deterioration by natural or artificial agents insufficiently mitigated by maintenance operations. In colder climates particularly, deicing chemicals have caused corrosion damage and scaling of reinforced concrete bridges, and snowplows or errant vehicles have scarred or structurally damaged nearly all types. Thus, many bridges in which preservation interest is expressed are perceived to be unsafe and expensive to maintain, and preservation is therefore seen to be contrary to the overall public interest.

The federal government has taken a leadership role in setting standards for bridge safety. In addition to rating the condition of various bridge elements, the current federal guidelines for structure inventory (*34*) require appraisal of the following six features on a ten-point scale from "condition superior" to "immediate replacement necessary" (see Appendix A):

1. *Overall structural condition,* taking into account the major structural deficiencies of the deck, superstructure, and substructure as well as the design load-carrying capacity of the bridge.
2. *Deck geometry,* including an assessment of the bridge's width with respect to that of the approach roadway.
3. *Underclearances,* including vertical and horizontal clearances from the through roadway to superstructure or substructure units.
4. *Safe load capacity,* or the maximum load for which the bridge is posted, regardless of its design.
5. *Waterway adequacy,* including the present or potential hazard resulting from scour, condition of slope protection, etc.
6. *Approach roadway alignment,* considering conditions that could impair safe use of the bridge.

The intention of these appraisals is ". . . to evaluate a bridge in relation to the highway system and functional classification of which the bridge is a part" (*34,* p. 31). In this exercise, the structure is compared to a new bridge built to the state's current standards for the particular type of road that the bridge carries. Although a state may develop and have approved by FHWA its own design standards, most, if not all, follow those developed and promulgated by the American Association of State Highway and Transportation Officials (AASHTO).

AASHTO standards are developed through a consensus process that involves representatives of the various state highway and transportation departments acting through a structure of technical committees. FHWA evaluates and adopts the standards, and requires their use on projects constructed with federal-aid funds (*82*). Those specific standards that are most frequently in conflict with preservation interests are summarized in Tables 6–8. Table 6 gives minimum curvatures applicable to approach roadways; Table 7, minimum clear roadway widths for reconstructed bridges for different traffic volumes and design speeds; and Table 8, minimum structural capacities and clear widths for different highway traffic volumes. Table 8 applies when the approach roadways are being improved even though the bridge is not. The minimum widths given in Table 7 are selected to be at least 4 ft (1.2 m) greater than the width of pavement in the approaching roadway.

Although not exclusively required, states generally adhere to the AASHTO standards where federal monies are involved rather than going to the trouble and expense of developing their own standards and negotiating with FHWA for their approval. In fact, the issue is rarely (if ever) raised, one reason being that, as members of AASHTO, the states have themselves participated in developing the standards and have confidence in them. Undoubtedly, another reason is the awareness among engineers of the drastic increase in accident potential associated with bridges compared to other roadway locations, and a desire to maximize safety at those sites (*85*). To protect the user as well as their own liability, most states apply the AASHTO standards to 100 percent state-funded projects as well, and many local jurisdictions use them for the same reasons, even though they may not be bound by state or federal codes. Such broad use, in fact, is encouraged by the FHWA's Highway Safety Program (*86*).

Within the preservation community there is a strongly held attitude that absolute adherence to the AASHTO standards has resulted in loss of important historic properties in instances where exceptions could have been made without increasing the public's risk. A recent review of bridge accident data studies (*87*), which states that except for ". . . relative structure width and traffic volumes . . . the majority of factors that influence bridge accidents has not been quantitatively defined," tends to support this attitude but offers little information helpful in overcoming the situation. Likewise, the processes used to load rate

TABLE 6

AASHTO GUIDE FOR MAXIMUM DEGREE OF CURVE AND MINIMUM RADIUS FOR DIFFERENT VALUES OF MAXIMUM SUPERELEVATION (*83*, Table 4)

Design Speed	Maximum e*	Minimum Radius (Rounded)	Max. Degree of Curve (Rounded)
MPH		Feet	Degrees
20	.06	115	50.0
30	.06	275	21.0
40	.06	510	11.5
50	.06	830	7.0
60	.06	1260	4.5
20	.08	110	53.5
30	.08	250	23.0
40	.08	460	12.5
50	.08	760	7.5
60	.08	1140	5.0
20	.10	100	58.0
30	.10	230	25.0
40	.10	430	13.5
50	.10	690	8.5
60	.10	1040	5.5
20	.12	95	62.5
30	.12	215	26.5
40	.12	400	14.5
50	.12	640	9.0
60	.12	960	6.0

**Note: e = rate of roadway superelevation, foot per foot*

some bridge structures are known to be of limited use. This is especially true for reinforced concrete and stone masonry, a fact that tends to produce conservative ratings for these types. In a recent study, for instance, Beal and Chamberlin (*88*) reported on two identically designed reinforced concrete girder bridges that responded similarly to load tests even though one had been given a condition rating of 7 (generally good condition—potential exists for minor maintenance) and the other a condition rating of 4 (minimum adequacy to tolerate present traffic—immediate rehabilitation necessary to keep open). An NCHRP-sponsored research project is aimed at giving better guidance on rating concrete bridges (*89*).

Although infrequently used for reasons of historicity, there are provisions under which AASHTO standards may be relaxed. The Design Standards for Highways (*82*) include an exception procedure by which a state may request, and the FHWA Division Administrator may consider, a project that does not conform to the minimum design criteria if: (a) it involves an experimental feature, or (b) unusual conditions warrant that exceptions be made. The "unusual conditions" clause has been applied in instances (usually of geometric deficiency) where the FHWA Division Administrator believed the action justifiable based on the lesser cost of rehabilitation (as compared to replacement) and in consideration of a favorable assessment of structural condition, accident history, and anticipated future use of the crossing. However, because such decisions are discretionary with the Division Administrator, the unusual conditions clause is not thought to be applied uniformly among FHWA Divisions. Also, most of these decisions are made locally and are not widely publicized.

Two applications of the unusual conditions clause that have been widely publicized are those connected with the Elm Street Bridge in Woodstock, Vermont and the Second Street Bridge in Allegan, Michigan. In both instances, the unusual condition was the historical importance of the bridge, and in both instances upgrading of the crossing was permitted with federal funds in the absence of total compliance with the applicable AASHTO standards. Common to both cases were strong local support to retain the bridge for its historical value, a frequency of accidents at the site that was not abnormally high, and engineering studies that supported the modified crossing's capacity to carry the anticipated loads and traffic safely.

The Elm Street bridge was an iron Parker pony truss fabricated in 1870 by the National Bridge and Iron Works of Boston, Massachusetts. It carried Vermont Route 12 from the north over the Ottauquechee River directly into the business section of the Village of Woodstock (*90, 91*). In 1975, the Vermont Highway Department announced plans to replace the bridge under the FHWA's Special Bridge Replacement Program, arguing both structural inadequacy and functional obsolescence. The bridge had been posted for 7 tons (6.3 Mg) and heavier traffic routed to an alternate crossing; the curb-to-curb width was only 18 ft (5.5 m); and the northern approach (downhill) required a potentially dangerous turn of about 45 degrees immediately before entering the bridge. At the time, the Elm Street bridge had a sufficiency rating of 26.5 on a 100-point scale (see Chapter 2), and in 1971 it had been assigned a condition rating of 2, "critical" (see Appendix A). Local interest, which favored rehabilitation, argued that the existing structure, in addition to being historically significant on its own merit (i.e., National Register listed), was more compatible with the architectural fabric of the Woodstock community (itself a designated historic

TABLE 7

AASHTO GUIDE FOR CLEAR ROADWAY WIDTHS FOR NEW AND RECONSTRUCTED BRIDGES (*83*, Table 8)

Design Speed	ADT Volume	Minimum Clear Roadway Width of Bridge
50 MPH and over	750 or Greater	Approach Roadway Width
50 MPH and over	Under 750	Pavement Width + 6'
Under 50 MPH	400 or Greater	Pavement Width + 6'
Under 50 MPH	Under 400	Pavement Width + 4'

Notes: (1) Where the approach roadway is surfaced for the full crown width that surfaced width should be carried across structures.
(2) On highways with a current ADT over 750, bridges with a total length over 100 feet may be constructed with a minimum clear roadway width of the surfacing width plus six feet.

TABLE 8

AASHTO GUIDE FOR MINIMUM STRUCTURAL CAPACITIES AND MINIMUM ROADWAY WIDTHS FOR BRIDGES UP TO 100-FT (30-m) LENGTH TO REMAIN IN PLACE (*84*, Table 8)

Traffic		Design Loading Structural Capacity		Roadway Clear Width Feet(1)	
Current ADT	DHV	Desirable Minimum	Minimum	Desirable Minimum	Minimum(2)
0-50	-	H-15	H-10	24	20
50-250	-	H-15	H-15	26	20
250-400	-	H-15	H-15	28	22
400-750	100-200	H-15	H-15	28	22
	200-400	HS-15	H-15	32	24
	Over 400	H-20	H-15	36	30

Notes: (1) Clear width between curbs or rails, whichever is the lesser.
(2) For design speeds of 50 mph or less, minimum clear widths that are two feet narrower may be used on minor roads with few trucks. In no case shall the minimum clear width be less than the approach surfacing width.

FIGURE 7 Elm Street Bridge (1870), Woodstock, Vermont, showing the restored Parker trusses incorporated into the replacement structure. (Clay Gates photo.)

district) than its proposed replacement, and that the existing site geometrics beneficially slowed traffic that might otherwise enter the village at an unsafe speed. After much negotiation, a mitigation agreement was signed that permitted construction of a new steel and concrete bridge but that provided for incorporating the original Parker trusses (restored) and wrought iron railings (Figure 7), limited the curb-to-curb width to 24 ft (7.3 m) [FHWA had proposed 30 ft (9.1 m)], restricted the skew to 2° 30′, and required certain other treatments to make the new bridge more compatible with its original appearance. The Elm Street bridge was the first instance in which there was a modification of AASHTO standards on a federally-funded bridge *replacement* project because of historical consideration.

The case of the Second Street bridge is equally important, but for different reasons (*92*). It is an 1886 double-intersection Pratt through truss fabricated by the King Iron Bridge and Manufacturing Company of Cleveland, Ohio. The bridge, 18-ft (5.5-m) wide and 225-ft (69-m) long, has been restored to carry one-way traffic out of Allegan's business district and to serve as a "relief valve" during peak hours (Figure 8). Its case was similar to that of the Elm Street bridge but differed in two important respects: it was in reasonably good structural condition, and it was not part of a critical transportation corridor. These facts enabled the City of Allegan to argue successfully for federal funding to restore, rather than replace, this historically important bridge. Even though AASHTO standards would not be met, engineering analysis demonstrated that with renovation of the deck and sympathetic replacement of the vertical web members, the bridge would be more than adequate to carry the local one-way traffic anticipated without seriously compromising historical integrity, and at a cost of less than 40 percent of the $1.2 million estimated for replacement. The Second Street bridge was the first instance in which there was a modification of AASHTO standards on a federally-funded bridge *rehabilitation* project because of historical considerations.

The FHWA has encouraged flexibility in applying the AASHTO standards when rehabilitating historic bridges (*93*), with the proviso that the bridge is upgraded sufficiently to remove it from the deficient bridge list following rehabilitation. The common, although unwritten, understanding is that at least two conditions must be met to invoke the unusual conditions clause: (a) strong local support for preservation, and (b) a frequency of accidents at the site that is not abnormally high.

Another provision under which AASHTO standards, at least theoretically, may be relaxed is that portion of the highway law dealing with Certification Acceptance (*94*). Under this provision, a state may apply for and be granted much of the approval authority now retained by FHWA for a wide range of actions, including approval of design standards. Because application under this provision is tied to broad acceptance by FHWA of the state's capacity to administer such a program, it is not thought to provide a realistic approach for seeking compromise of specific design requirements, and is therefore not used. In reality, it is not a practical option, as most (if not all) states adopt AASHTO standards.

A mechanism whereby Certification Acceptance could be applied to design standards alone has been proposed for the federal non-Interstate 3-R Program (*95*). Standards for 3-R work have heretofore been negotiated between the states and FHWA on a project-by-project basis. The new proposal would allow each state to enter into an agreement with FHWA as to the standards to be employed by the state on all 3-R projects. A provision of the new proposal would seem to allow states to single out historic bridges as a category for special consideration (*95*).

> . . . Criteria could be established to cover all projects within a state, individual projects, or projects grouped by various factors such as geographic region, type of work involved, functional classification, special project features (e.g., historic bridges), etc.

There are other technical constraints to bridge preservation, but they are generally of a lower order of concern than those relating to geometric and structural standards. However, in individual cases they can become paramount. They include the following:

1. The U.S. Coast Guard, which has jurisdiction over navigable waterways, has sometimes declared an older bridge to be hazardous to navigation once the replacement structure has been opened. The concern has usually been that portions of the unmaintained and deteriorating older bridge may fall into and obstruct the channel, or that a more satisfactory channel alignment possible with the new structure is precluded by continuance of the old.

2. U.S. Army Corps of Engineers flood control projects have also, though less frequently, dictated replacement of older

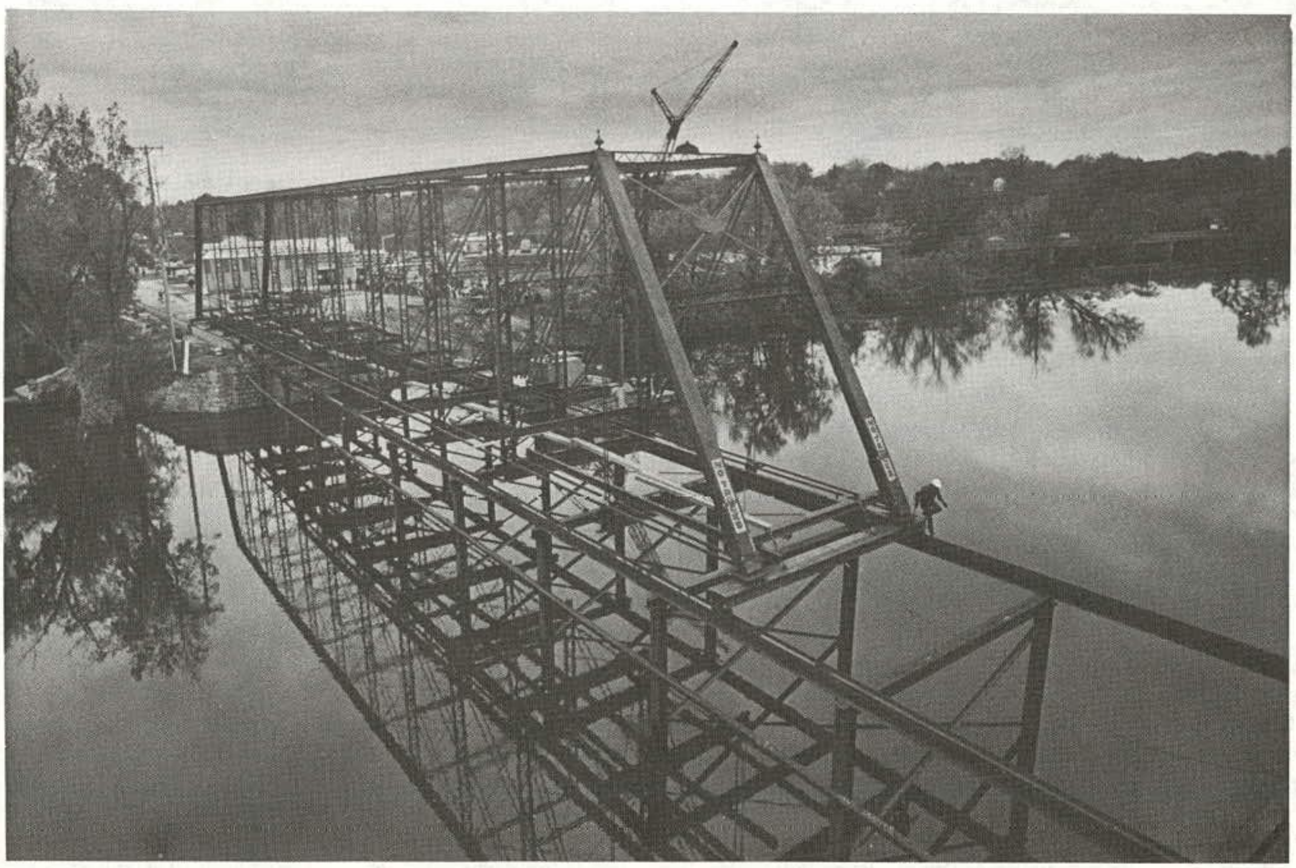


FIGURE 8 Second Street Bridge (1886), Allegan, Michigan, being removed from its abutments for rehabilitation. (Grand Rapids Press photo.)

bridges on tributary streams where increasing the hydraulic opening beneath the bridge was deemed necessary.

3. An issue that has been raised but not clarified is whether AASHTO standards for pedestrian handrails would apply in instances where FHWA funds are being used to move a bridge from a highway setting to a park setting, even though the new use is nonvehicular. In many, if not all instances, such a requirement would result in a rail that is inconsistent with the historical feeling that the bridge is intended to convey at its new location.

4. An irony peculiar to concrete bridges is that those features that are of greatest historical interest from a technological point of view are often those associated with the reinforcing system, and these are not apparent until the bridge is destroyed.

In summary, although consideration of structural condition and site geometrics are and will continue to be valid and proper constraints in preserving many historic bridges, there appears to be a growing willingness to consider compromise in those instances where design standards can be relaxed without jeopardizing public safety. Because quantitative relationships between specific bridge design features and accident frequency are generally lacking, such compromise will probably be restricted to those sites where accident history is acceptable and local support strong.

LEGAL CONSIDERATIONS

After considerations of safety, the concerns most vigorously expressed by transportation officials in response to suggestions that bridges of historical importance be maintained in service or otherwise preserved are those related to tort liability. These concerns focus primarily on the legal consequences of rehabilitating or continuing in service bridges that fail to comply with contemporary standards of safety, typically the AASHTO standards discussed in Chapter Two. The AASHTO standards, however, are not the only ones at issue as most jurisdictions include at least minimum load-carrying requirements to accommodate school buses, fire-fighting equipment, and other unusually heavy vehicles. The latter typically apply whether federal funds are involved in the improvement or not.

A related concern is whether liability exposure increases in a situation where a historically important bridge may be discontinued as part of the highway system but is left standing as a crossing for pedestrians or bicycles, for recreational uses such as fishing, or as a historical monument or ruin. Most highway agencies do not perceive their authorization to include such functions and, although they may be sympathetic, would choose to transfer ownership of the bridge and the abandoned right-of-way to another party in such instances. An exception might be where the alternative use is part of some legitimate ancillary function of the highway agency, such as a roadside rest area or scenic vista.

With regard to both concerns, the question is whether the traditional protections afforded under the law of the various jurisdictions apply in these instances. A discussion of these protections is beyond the scope of this synthesis but they include sovereign immunity, design immunity, notice of dangerous conditions, adequacy of public warning, and the distinction between liability based on the conduct of governmental functions as opposed to proprietary functions (*43*). The application of these protections to the more traditional functions of highway agencies has been reviewed in a series of publications produced under NCHRP Project 20-6, "Right-of-Way and Legal Problems Arising Out of Highway Programs" (*96–102*). Unfortunately, the potential liability of highway agencies that attempt to accommodate preservation considerations in the above ways is not specifically addressed in this series.

A third concern expressed by transportation officials unrelated to liability, has to do with the ownership of rights-of-way once the route has been removed from the highway system and retained to provide access to a historic bridge now serving some alternative function. Many states have laws requiring that such abandonments revert to the contiguous landowners. The ownership status of such parcels of real estate is unclear should attempts be made to invoke such reversion laws.

Clearly, there is a need for both highway officials and preservationists to have a better understanding of those aspects of the law that relate to bridges treated in other than normal ways because of their historical importance.

FINANCIAL CONSIDERATIONS

Even when there is motivation for preservation and the technical and legal constraints can be overcome, the issue is often whether or not someone is willing to spend the money required to restore and/or maintain the structure, either with or without vehicular traffic. This is often a function of how important the structure is, not whether it is eligible for the National Register. A common perception among highway officials is that preservation interest ceases with the first offer to transfer ownership from the highway agency to those advocating preservation. The problem is underscored by the unanswered offers of donation that appear from time to time in preservation newsletters (*103–105*). The fact is that those organizations and agencies that seek preservation are usually modestly funded and those that are more amply funded (i.e., highway and transportation departments) do not have the authority to maintain facilities that are no longer a part of or support the highway system.

The cost of what would seem to be even a modest preservation effort can be considerable, as the following example illustrates (*117*). In the mid-1970s, an abandoned 60-ft (18-m) bowstring truss bridge in good condition was salvaged from a small city in upstate New York. It was dismantled, cleaned, repainted, and re-erected as a footbridge in a public park 80 miles (50 km) from its original site. Even though the bridge was essentially cost free, the stone facing for the new abutments was donated and most of the labor was provided by public employees, the total cost of the effort was estimated to approach $47,000 (Table 9). Several similar examples of a small metal truss bridge recently moved from a highway to a park setting were related to this writer with costs in the $30,000 to $60,000 range. Judged by the standards of modern construction, these values are not unreasonable, but they would strain the resources of many organizations or groups that might otherwise seek preservation by such means.

A policy adopted by the Tennessee Department of Transportation (M. Carver, Tennessee DOT, personal communication) as part of a mitigation agreement partially overcomes such constraints. The state has agreed to: (a) advertise the availability

TABLE 9

ANALYSIS OF COST TO MOVE A 60-FOOT TRUSS BRIDGE IN NEW YORK

Activity	Cost ($) Supervision	Labor	Engineering	Equipment	Materials	Total
Acquisition	1,000	-	-	-	-	1,000
Removal	2,000	2,500	-	1,500	-	6,000
Restoration	2,000	3,000	-	-	500	5,500
Erection	3,000	9,500	-	1,500	8,000	22,000
Analysis & Reinforcing	1,000	-	5,200	-	-	6,200
Load Testing	1,000	-	5,000	-	-	6,000
Totals	10,000	15,000	10,200	3,000	8,500	46,700

of appropriate bridges that are salvageable, (b) move such bridges without cost to the recipient to a new site within a radius of 100 miles (60 km), (c) sandblast and repaint them in one piece, and (d) place them on abutments provided by the new owner. The recipient is to assume the design and construction costs of the new abutments plus a new deck for the bridge, as well as the cost of replacing any damaged or missing structural members.

Even with such incentives, it is likely that even after lengthy and costly compliance proceedings, few important bridges will survive unless funding sources not now apparent become available.

CHAPTER SIX

PRESERVATION ALTERNATIVES FOR HISTORIC BRIDGES

The objective of preservation legislation is to prevent intentional or uninformed adverse impact to structures that possess historical value without first considering alternatives that either avoid or mitigate the detrimental effect. Section 4(f) of the Department of Transportation Act requires a demonstration of no prudent or feasible alternative to the adverse impact, and Section 106 of the National Historic Preservation Act requires search for an economical mitigation. Both requirements are applicable only when the project is federally funded or requires a federal permit.

It is recognized that for many historic bridges there is no acceptable alternative to removing them from vehicular service. They were designed for relatively light loadings, have narrow roadways that are inadequate for present traffic, and have often suffered from insufficient maintenance, vehicle impacts, or both. In fact, a prevalent attitude among bridge engineers is that most of them are obsolete and unsafe, and that rehabilitation should be undertaken primarily to add a few more years of service until they can be replaced (*106*, p. 3). Yet, the rapidly rising cost of bridge replacement is, on its own merit, causing a more thoughtful consideration of the rehabilitation option, and a body of literature specific to that technology has begun to develop (*106–109*).

A somewhat different attitude, expressed recently by Zuk et al. (*110*, p. 3), is that "... identification of a bridge as historically significant carries with it the responsibility to consider strategies for continuing the structure in service or finding sympathetic adaptive uses." This attitude has led to at least one study devoted entirely to finding methods of adapting historic bridges to contemporary uses (*110*). It is also partially responsible for the publicity given in newsletters of such organizations as the Society of Architectural Historians and the Society for Industrial Archeology to innovative adaptations, and to a recent initiative on behalf of HAER to serve as a clearinghouse for such information (*111*).

The purpose of this chapter is to review briefly the various alternatives that have been suggested for dealing with historic bridges and to illustrate them by reference to specific cases, where they exist. Much information of this sort has already been compiled by Zuk et al. (*110*), and some of the results of that study are abstracted here, supplemented by cases drawn from the general literature and the writer's experience. Individual topics are discussed under the following headings:

1. Continued use for vehicular purposes, including:
   a. Structural upgrading,
   b. Geometric modification,
   c. Alignment adjustment and/or restriction to one-way traffic, and
   d. Removal to a less demanding site.
2. Continued use for nonvehicular purposes at an existing or new site, including:
   a. Various pedestrian and bicycling uses,
   b. Architectural adaptation for residential, commercial, or educational space, and
   c. As a historical ruin or public monument.
3. Demolition with mitigation, including:
   a. Match marking, dismantling, and storing for future use,
   b. Educational use of specific elements as artifacts, and
   c. Documentation.

CONTINUED USE FOR VEHICULAR PURPOSES

Clearly the best use for a historically important bridge from a preservation point of view is to have it continue as a bridge at its present location. The issue for the highway agency is whether rehabilitation that will upgrade the structure to contemporary standards for the route that it serves is in fact possible and, if possible, whether it can be accomplished at a life cost that is competitive with the replacement structure's life cost. For the preservationist, the issue is whether the rehabilitation can be accomplished without altering significantly those aspects of the bridge that give it importance.

Procedures for upgrading the load-carrying capacity of bridges and improving their geometrics are many and varied. In response to the national concern over bridge safety, four major publications have recently addressed this issue in a summary manner. A study for FHWA (*107*) inventoried and evaluated techniques utilized by state highway agencies for bridges constructed of steel, concrete, and timber; ASCE, through one of its technical committees, published a primer (*106*) on the inspection, rating, and upgrading of pre-1920 metal truss bridges; and two reports of the National Cooperative Highway Research Program (*108, 109*) have been prepared as a manual of recommended practices for repair, rehabilitation, and retrofitting of bridges on secondary highways and local roads.

These publications emphasize rehabilitation, not restoration and preservation, but are generally applicable. There are procedures for replacing or reinforcing virtually any member of a truss or reinforcing the entire truss, for increasing the capacity of trusses as well as the individual members of concrete bridges, for rehabilitating and/or strengthening floor systems, for repairing deteriorated connections, for increasing live-load capacity by decreasing dead load, and for widening and increasing vertical clearance.

One problem with most of these procedures is that although they may readily enable a bridge to be returned to the standard prevailing at the time of its construction, it is rarely possible to meet the standards set by AASHTO (and adopted by FHWA) for all new and rehabilitated bridges. This situation is reflected by the dearth of rehabilitation projects in the HBRR Program and by recurring statements of research needs relating to increasing structural capacity (*106*, p. 74; *107*, p. 83), improving geometrics (*106*, p. 74), and reviewing existing standards (*110*,

p. 40; *107*, p. 83). Such needs arise as much from concerns of economy as they do from concerns of preservation. Rehabilitation, if standards can be met, is frequently less costly than replacement.

A second problem is that rehabilitation to enhance safety often destroys or significantly alters design or materials integrity, in the National Register sense. This is particularly true with geometric improvements, such as widening, that can significantly alter gross proportions or destroy important truss portal bracing details. Zuk et al. (*110*) have reviewed the current methods used to rehabilitate bridge structures from the perspective of their compatibility with historic values. These methods include: (a) replacing individual truss members that may be damaged; (b) increasing the capacity of tension members by posttensioning, particularly the lower chord; (c) increasing the capacity of the entire truss by "doubling up" with a geometrically identical truss or by connecting adjacent simple spans to form a single continuous structure; (d) enhancing live-load capacity by decreasing dead load, particularly in the deck; and (e) various approaches to strengthening the floor system.

Kirby (*112*) analytically investigated some traditional as well as new methods for strengthening four different historically important metal truss bridges in Virginia to carry an HS20 loading. He investigated a two-span Pratt through truss, a Parker through truss, a Thacher through truss, and a Pratt bedstead pony truss. He concluded that strengthening old truss bridges to carry modern traffic loadings is difficult, but identified a few promising procedures (*110*, p. 23):

> 1. An auxiliary truss, such as the Warren truss . . . might be effective if its visual intrusion were not objectionable. As the length of the existing span becomes greater, the auxiliary truss will . . . become more prominent.
> 2. Longitudinal beams or hybrid members under the truss may be effective if the span length is not too great and economy of materials is not a critical factor.
> 3. The use of posttensioning rods at or just below the lower chords is apparently feasible on shorter spans. Additional reinforcement of critical truss members may be required.
> 4. The addition of individual reinforcement to supplement critical members may be sufficient if the proposed capacity is not extreme.

Concrete bridges present a particularly frustrating rehabilitation problem. They are vulnerable to forms of deterioration that, once initiated, are progressive, not easily arrested, and expensive to repair. Freeze-thaw damage and corrosion of steel reinforcement, which in snow belt states are aggravated by winter deicing chemicals, are the most troublesome. Modern concrete is air entrained, which protects it from most forms of freeze-thaw damage, but that innovation was not discovered until the late 1930s and was not widely practiced until after World War II.

In lieu of widening to accommodate two lanes of traffic, Zuk et al. (*110*, p. 12) have suggested that some historic bridges might be left in place to carry a single lane, and a visually compatible bridge be moved to an adjacent site to carry the second. Of course, this option would still require upgrading for load, and possibly correction of a poor approach alignment.

Still another alternative is to move the historic structure to a less demanding site where requirements for load capacity and/or traffic are more consistent either with the bridge as it exists or as it could feasibly be modified. This practice, incidentally, was very common after about 1920 as the state highway systems began developing uniform standards and improving their roads to accommodate increasing automobile traffic. Old bridges no longer adequate for major routes of the 1920s and 1930s were moved to town and county roads.

Published case studies of historic bridges that have been successfully rehabilitated and left in service for vehicular traffic are rare. Their compilation, analysis, and reporting would be a worthwhile contribution both for their engineering value (*106*, p. 75; *111*) and for what they reveal about the antecedent political processes. Most of the cases that have received publicity have several factors in common: in addition to being National Register eligible, the bridges tend to be very important historically; most involve some compromise of integrity and occasionally engineering standards; and most were controversial but with strong local support. A selection follows:

- Cabin John Aqueduct (Glen Echo, Maryland), 1853-63, hollow-spandrel segmental stone arch, longest clear-span stone-masonry arch in North America—third longest in the world; deteriorating stone parapets and shadow course replaced by pigmented precast concrete (*113*) (Figure 9).

- Neshantic Station Bridge (Somerset Co., New Jersey), 1896, two-span iron lenticular through truss; upgraded structurally to carry local traffic loads (*114*) (Figure 10).

- Second Street Bridge (Allegan, Michigan), 1886, double-intersection Pratt through truss (*92*); discussed in Chapter 5 (Figure 8).

CONTINUED USE FOR NONVEHICULAR PURPOSES

Using a bridge for a function other than to carry vehicular traffic is somewhat unorthodox. Although many bridges have been designed throughout history for multiple use where vehicular traffic coexisted with small shops and houses (as the old London Bridge and the Ponte Vecchio in Florence, Italy), there are fewer examples of bridges that have been converted completely from vehicular to nonvehicular use.

The most common conversion has been to pedestrian use, either at the existing site or at a new one. There are many examples, for instance, of covered timber bridges that have been taken out of service and used as historic landmarks or for pedestrian use only (Figure 11). Because of the distinctive problem that trafficked bridges pose for bicyclists, that group has actively promoted incorporating abandoned obsolete bridges into bicycle trails (*115*) (Figure 12). In the states of Ohio (D. Simons, personal communication), Maryland (*116*, p. 5), New York (*117*), Virginia (*118*), and New Hampshire (W. Zuk, personal communication), historic metal truss bridges have been relocated from a highway to a park for use by pedestrians and bicyclists (Figure 13). In most instances, these have been relatively small-span bridges because of the logistics and cost, and they have usually embodied distinctive features of more than average interest, such as bowstring or lenticular trusses.

In many areas, old highway bridges have been taken out of service for vehicles but left in place, totally or partially, for pedestrian uses other than crossings. Zuk et al. (*110*, p. 24) report that a 1,500-ft (460-m) section of a partially removed concrete girder bridge in Virginia has been left standing in the

FIGURE 9 Cabin John Aqueduct (1853–1863), Glen Echo, Maryland. The deteriorated stone parapets and masonry shadow course were replaced by pigmented precast concrete. (Photo by Eric DeLony, HAER.)

James River at Newport News to serve as a fishing pier. A second structure, a rare partially flood-destroyed composite (wood and iron) truss bridge that also crossed the James River, remains standing as a historic attraction and as a scenic overlook (*119*). In the latter case, a local ad hoc association, formed to preserve the two remaining spans, has assumed their maintenance and historical interpretation, an extremely important factor in implementing this alternative. In this case, the U.S. Coast Guard determined that these spans were not a hazard to navigation.

A less common nonvehicular use of a retired bridge is for space that can be converted to a residential, commercial, educational, or recreational purpose. Such uses typically, but not always, require architectural modification. One privately owned covered wooden bridge in Strasburg, Pennsylvania has been converted into a gift shop and museum (*110*, p. 25), and one in Blenheim, New York that was bypassed with a new route and bridge is now the centerpiece of a traveler's rest and picnic area with the deck of the old bridge supporting an array of neatly ordered rustic tables. Another bridge, in Hancock, New York, also privately owned, has been converted into a restaurant. A portion of this abandoned 500-ft (150-m) long steel deck-truss railroad bridge has been enclosed below the deck for this facility (*110*, p. 25).

Two major U.S. projects, still in planning, are of particular interest because of their boldness. The first (*120*) would convert the historic Eads Bridge in St. Louis into an extensive commercial development. The lower railway deck would be subdivided into offices, restaurants, and other commercial uses, and the upper automobile deck would become a promenade. In the second project (*121*), an abandoned six-span steel through-truss railroad bridge over the Ohio River in Louisville, Kentucky is being studied for conversion into a large residential, commercial, and office complex. Planned for this space are restaurants, hotels, condominiums, apartments, offices, retail shops, exhibition halls, and parking garages.

Although such plans as these are clearly out of scale for the vastly more modest structures that for the most part are the concern of this synthesis, they do suggest a variety of alternative uses that individually merit consideration if one is willing to think expansively. Perhaps motivated by such examples, researchers in Virginia (*110*) critically evaluated the potential for adaptive use of 21 of their older truss bridges, including 10 listed on the National Register of historic places. After considering their historical attributes, cultural and natural surroundings, and geometrics, specific uses were suggested for each (Table 10) and an architectural rendering prepared (Figure 14). Of particular interest is the wide range of potential uses considered.

There have also been instances where nonvehicular utilitarian use was either not apparent or not considered and a bridge has been left standing as a historic attraction, or if it has sufficient aesthetic or historical attributes, moved to a more appropriate site as a historic monument. For the latter, a willing sponsor is critical. An interesting instance of this occurred recently in the town of Groton, New York where New York's most prolific bridge building company, the Groton Iron Bridge Company (later the Groton Bridge and Manufacturing Company and the Groton Bridge Company) was founded in 1877. The only known example of a bowstring truss bridge built of bent railroad rails on the founder's original patent was moved from a rural town road east of the village to be erected as a monument and footbridge over a small creek at the approximate site where the original plant had been located.

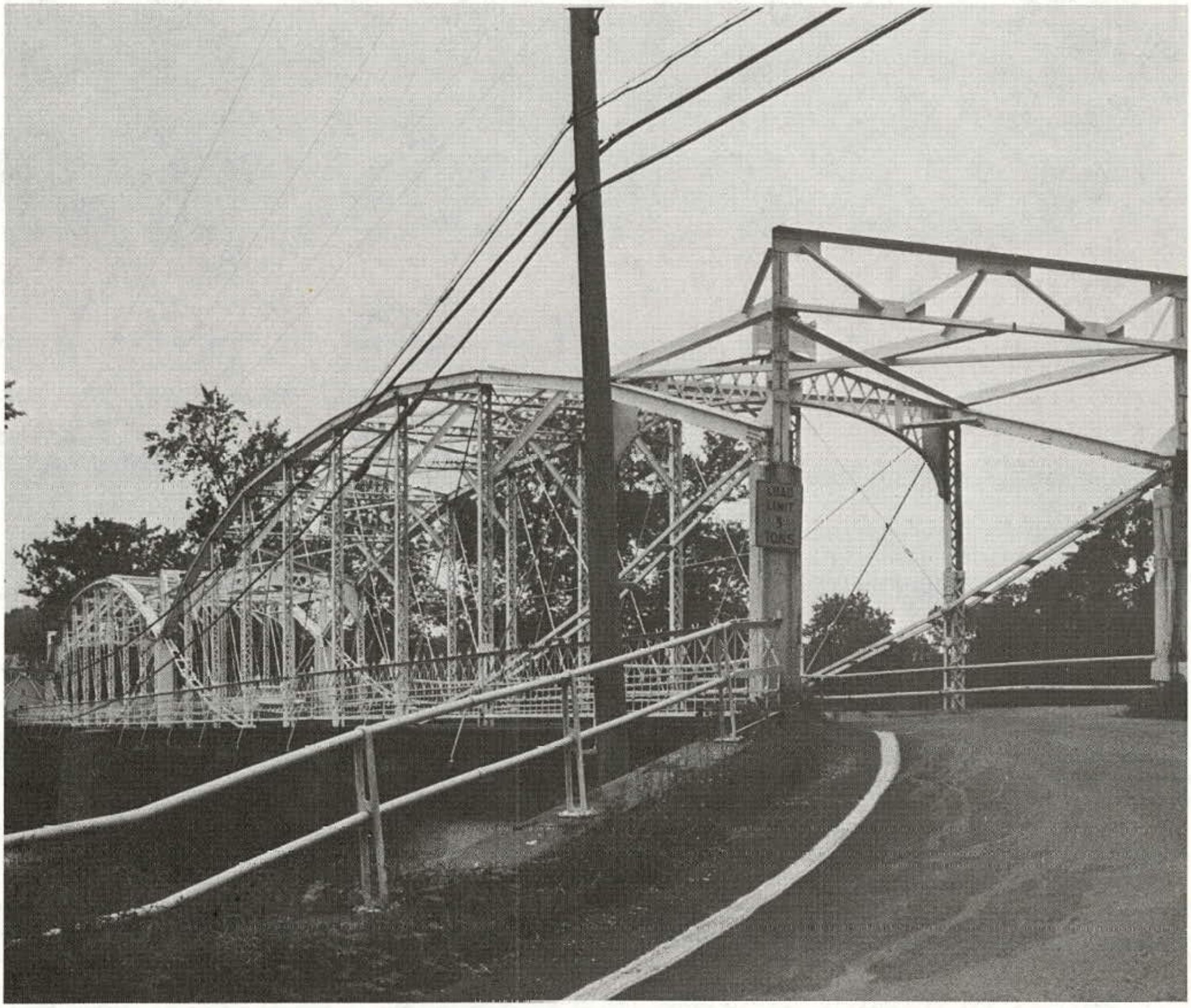


FIGURE 10 Neshantic Station Bridge (1896), Neshantic Station, New Jersey, was upgraded structurally with local funds to carry local traffic. (Photo by Eric DeLony, HAER.)

TABLE 10

POSSIBLE NONVEHICULAR USES FOR 21 METAL TRUSS BRIDGES IN VIRGINIA (*110*)

Truss Type	Spans - Total Length (ft)	Special Features	Recommendation
Fink, deck	1-52	Extreme rarity	Museum display
Pratt, through (wood)	3-375	Only timber truss extant, local bldgs.	Historic landmark & footbridge
Pratt, through	2-260	Proximity to national forest	Rustic general store or retail greenhouse
Pratt, through	1-99	Remote site over RR	Move & use as highway or bicycle bridge or as information center
Pratt, through	2-186	Rural site near college	Housing unit, craft or information center
Pratt, through	1-74	Semi-rural site over RR	Small office
Thacher, through	1-133	Small-town site	Surveyor's office
Parker, through	2-333	Remote location	Historic ruin
Pratt, through; Warren, deck	2-224	Extremely ornate structure	Bicycle bridge or historic ruin
Pratt, through	1-157	Rural area near historic town	Chapel or meditation center
Pratt, pony	5-414	Rural woodland site	Picnic shelter
Pratt, through	1-124	Remote site, decorative elements	Vacation home, decorative reuse of parts
Pratt, through; Pratt, pony	2-142	Relatively short spans	Move & use as bicycle bridge, play structure or information center
Quadrangular, through	1-146	Unusual form over RR	Transportation museum
Pratt, through	2-162	Short spans, near small city	Variety of commercial or recreational uses
Pratt, through; Pratt pony	2-192	Proximity to Richmond	Residential unit
Pennsylvania & Pratt, through	4-541	Unusual length	Wildlife research facility
Pratt, through	1-98	Rural site	Vacation home or move & use as bicycle bridge, craft or information center
Pratt, through	1-110	Rural site	Vacation home or move & use as bicycle bridge, craft or information center
Pratt, bedstead	1-119	Very scenic rural site	Vacation home
Warren, pony	1-46	Small size	Move and use as bicycle or foot bridge

FIGURE 11 Tuscarora Club Bridge (1870), Delaware County, New York, was moved in 1935 from Donraven, New York, and re-erected on a private preserve for fishing access. (Richard S. Allen photo.)

FIGURE 12 Early Erie Canal stone masonry towpath bridge near Rotterdam, New York, now part of an improved bicycle path. (Photo from New York State Office of Parks, Recreation and Historic Preservation.)

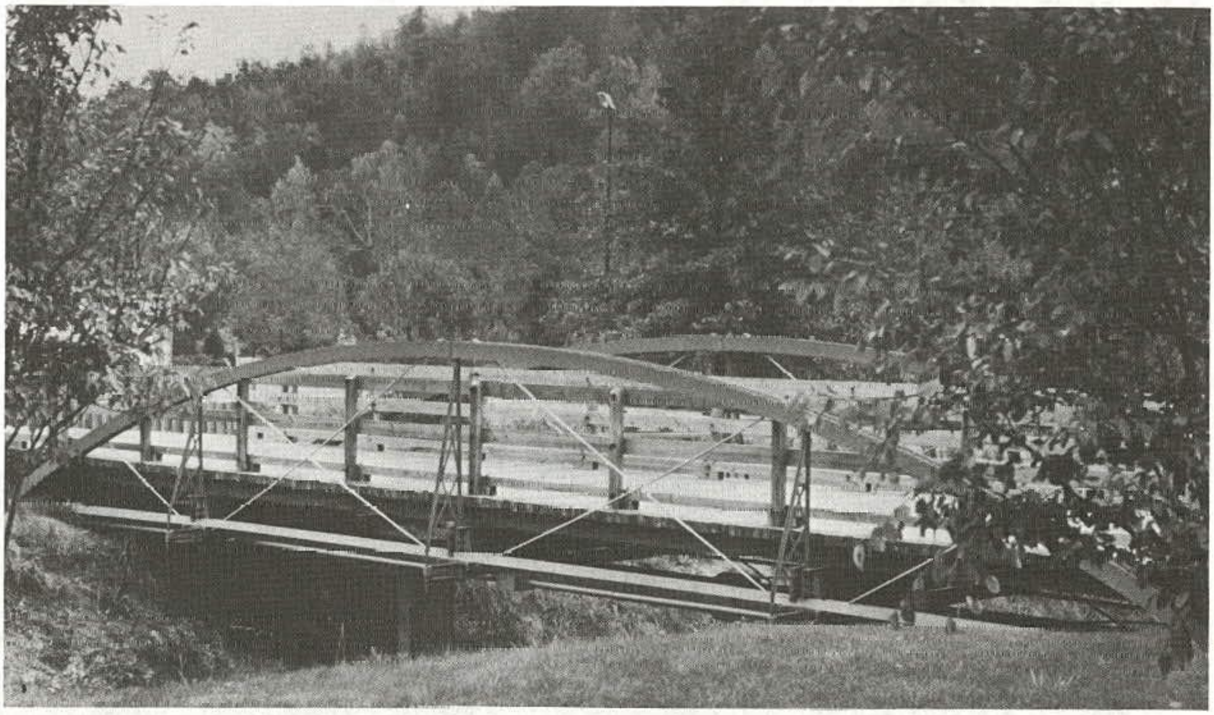
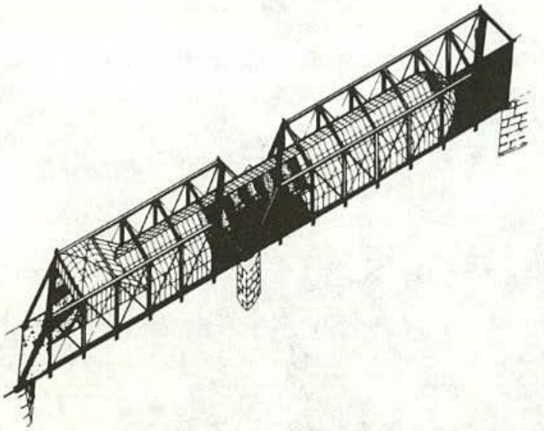
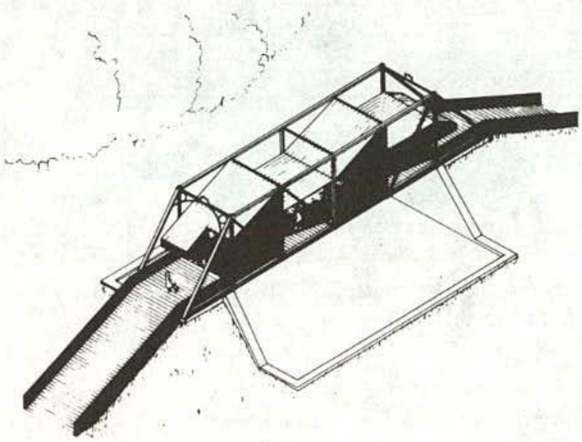


FIGURE 13 King Iron Bridge and Mfg. Co. iron bowstring truss (1878), now a footbridge at an Interstate rest area near Roanoke, Virginia. (Virginia Department of Highways and Transportation photo.)

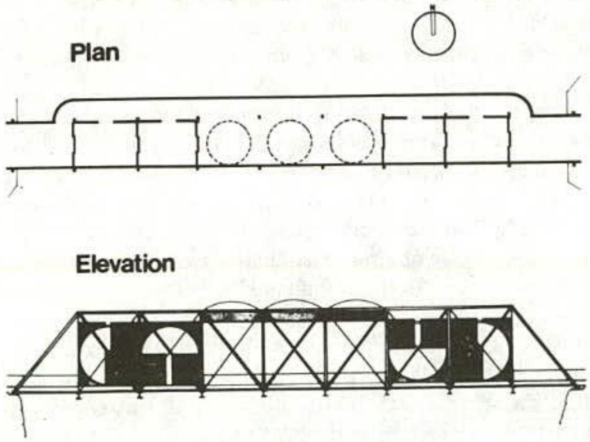
Bridge on VA-746 over Calfpasture River as a greenhouse.



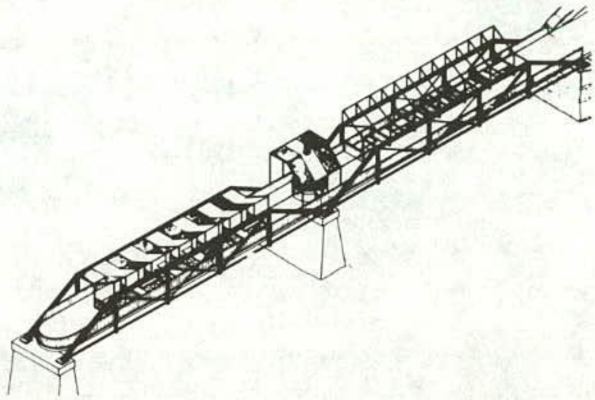
Bridge on VA-715 over Meherrin River converted to an information center at a relocated site.



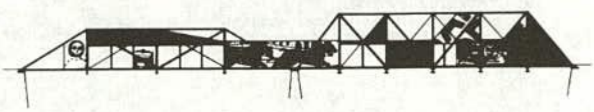
Bridge on VA-673 over Catoctin Creek as a meditation center.



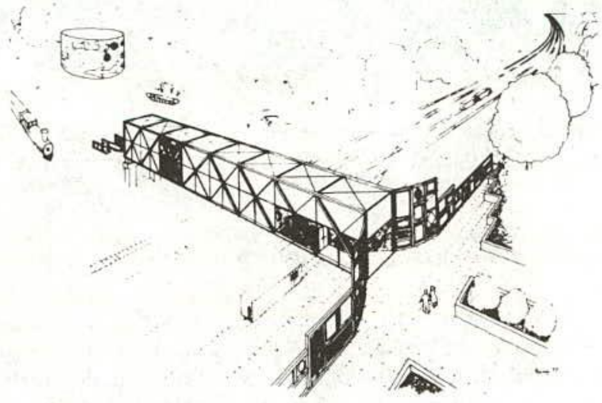
Bridge on VA-620 over Rappahannock River as a picnic shelter.



Bridge on VA-640 over Reed Creek as a craft center.



Bridge on VA-657 over railroad converted to a transportation museum.



Bridge on VA-632 over South River as a cafe-restaurant.

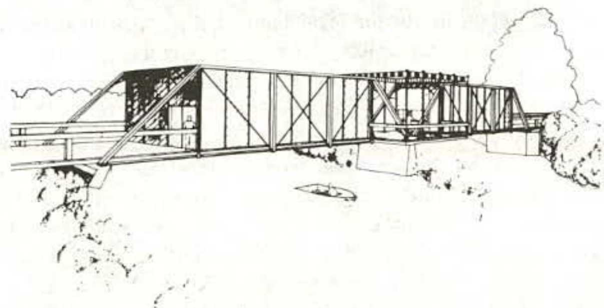


FIGURE 14 Examples of nonvehicular adaptive use for historic bridges suggested by Zuk et al. (*110*).

FIGURE 15 Trusses of the Tiaronda Bridge, Beacon, New York, built on the 1867 patent of Glass, Schneider, and Rezner, have been retained to delineate the replacement structure. (Photo by R. M. Vogel, Smithsonian Institution.)

DEMOLITION WITH MITIGATION

With local community support for preservation, a willingness to cooperate on behalf of both highway and preservation officials, and an alternative that is consistent with the needs of traffic at the specific site, it has been possible to continue some important historic bridges in a vehicular use. Where there has been a willingness on the part of either the highway agency, the commercial sector, or private parties to commit funds and to assume responsibility for legal liability and continued maintenance, it has been possible to find nonvehicular uses for other historic bridges. In the absence of these factors, destruction of the bridge has usually followed. However, workers in this field point out (*16, 20*) that historical interests are served when preservation values are considered at the time a bridge's disposition is determined, and that preservation in situ or in some adaptive use are not the only acceptable alternatives. Thus, various other actions have been taken to mitigate the loss of the actual bridge and to preserve aspects of its technology.

An alternative particularly applicable to the smaller metal truss bridges is to match mark the individual parts, carefully dismantle them, clean and paint the surfaces, and place them in secured storage pending a decision and funds for re-erection at another site at some future time. A 70-ft (22-m) segmental bowstring pony truss, now rare but once a "stock item" of the 19th century Phoenix Bridge Company, was recently preserved in this way by the city of Beacon, New York as the result of a memorandum of agreement between the city and the Advisory Council on Historic Preservation (*122*). This solution is not without cost, borne in this instance by the city's Community Development Agency. It also carries with it the risk that the parts will become separated from one another, inadvertently used for other purposes, or scrapped.

Where funding, opportunity, motivation, or just the scale of the logistics preclude preserving an entire structure, selected components that would otherwise be destroyed have been saved. Typically, these have been used for educational purposes in museums, by historical societies or in other exhibits. Examples include the salvage of a range of "hardware," such as a column segment or section from an individual truss member, a typical truss connection, or in some instances even the entire truss. Occasionally, salvaged components have also been used ornamentally or even functionally in connection with a new bridge built at the same site. A common example of this is the use of trusses from the former bridge as "guide rails" or as edge delineators on a new structure (Figure 15). Obviously, truss bridges lend themselves more readily to this mode of preservation than do other forms, although examples of such items as early patented concrete reinforcing systems and wire or chain cables from early suspension bridges are seen.

Documentation is possibly the most common form of mitigation in those instances where physical preservation is not feasible. The concept is that although the structure itself may not survive, the essential elements of its technology can be preserved for future study in public records. Documentation may include any or all of the following elements:

1. On-site photography of the structure in its present condition;
2. Preparation of measured drawings representing overall dimensions as well as important details;
3. Photocopying of important early photographs, drawings, maps, and other relevant documents;
4. Preparation of a narrative report describing the structure and its importance; and
5. Finding a suitable public repository for the records.

The Historic American Engineering Record was established specifically for the purpose of assisting in the documentation of important industrial and engineering resources being altered or demolished because of projects undertaken or funded by a federal agency. HAER has set rigorous standards to be used when properties of unusually high importance are to be recorded, in particular those deemed to be of national significance (*123, 124*). HAER standards, however, are flexible to accommodate properties of varying size, condition, and significance. As a minimum, large format photographs and a historical report are usually required. Records prepared to HAER standards are stored at the Library of Congress, Prints and Photographs Division. Typical examples of photographs and measured drawings prepared to HAER standards are shown in Figure 16.

The large number of recent bridge replacements coupled with the perceived cost of HAER-level recording has given rise to a variety of expedients that vary from the unacceptable (e.g., Polaroid snapshots) to some that are quite innovative and promising. An example of the latter is the use of terrestrial close-range photogrammetry to produce documentation drawings. The technique is similar in principle to aerial photogrammetry except that the camera is operated on either a horizontal or vertical (e.g., from a cherry picker) alignment near ground level, and the stereo plotter is adjusted to compensate for the shorter lens-to-object distance. As with aerial photography, the cameras tend to be expensive and targeting of the bridge is necessary to develop scale and to orient photographs during plotting. The principal disadvantages are those that are inherent in the photographic process including the need for a stable base on which to mount a camera tripod, an unobstructed vantage, and suitable weather. If these conditions can be met, the technique offers a relatively inexpensive alternative to preparing measured drawings manually. The application of terrestrial photogrammetry to recording cultural resources in general is described by Borchers (*125*), and to bridges in particular by Bearfoot (*76*). An example is shown in Figure 17.

(*a*)

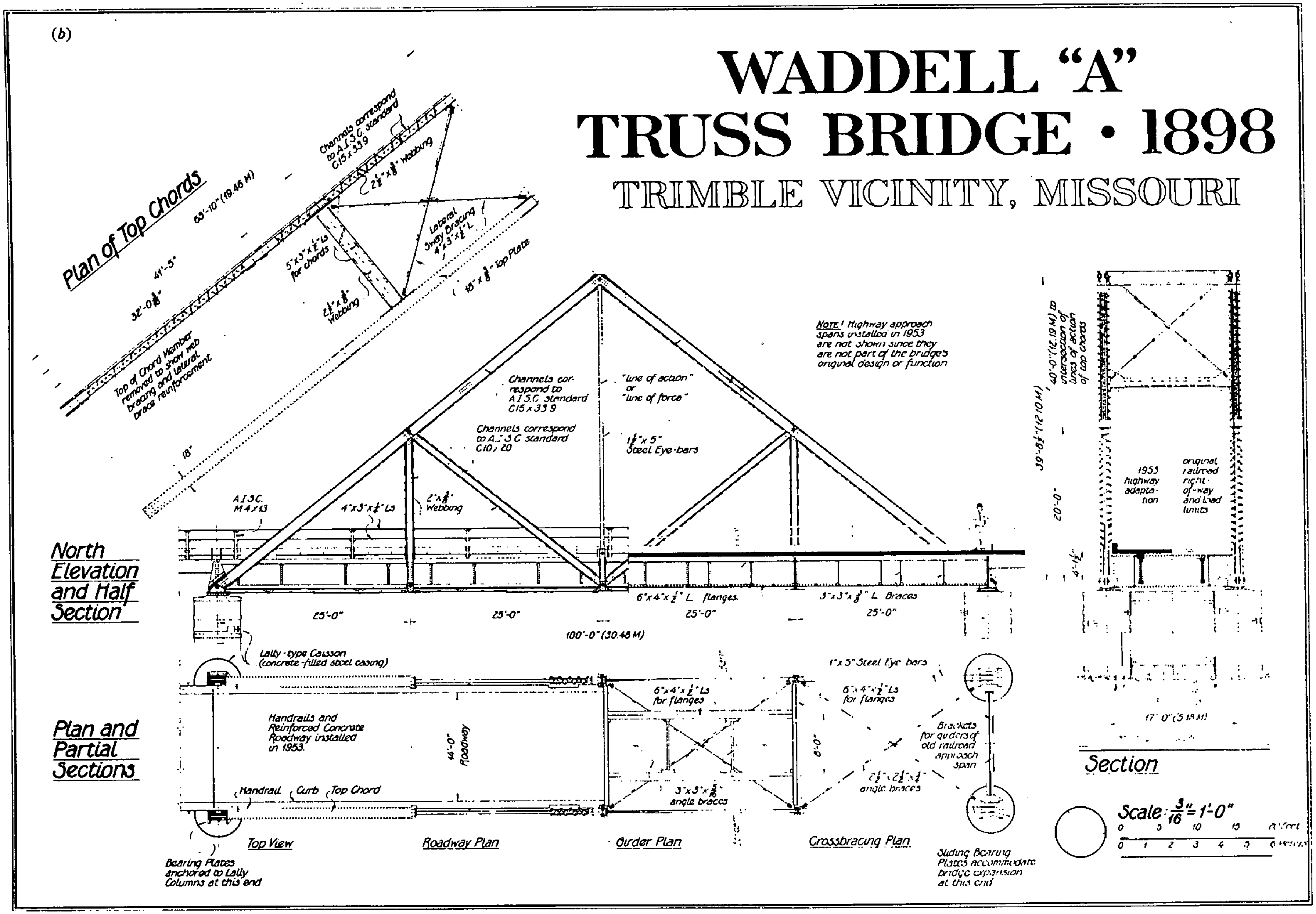
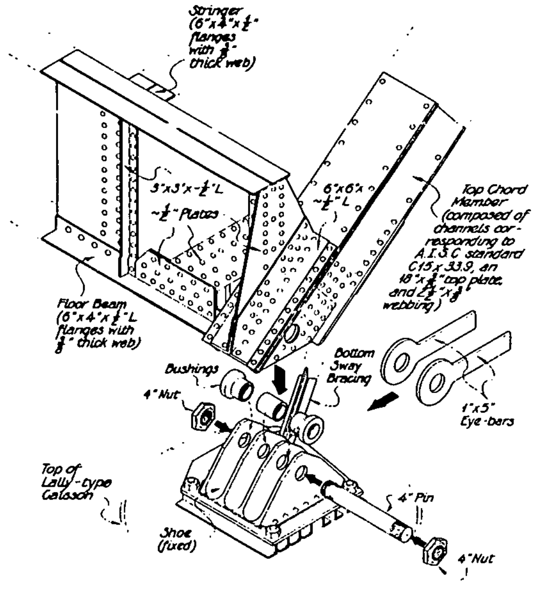
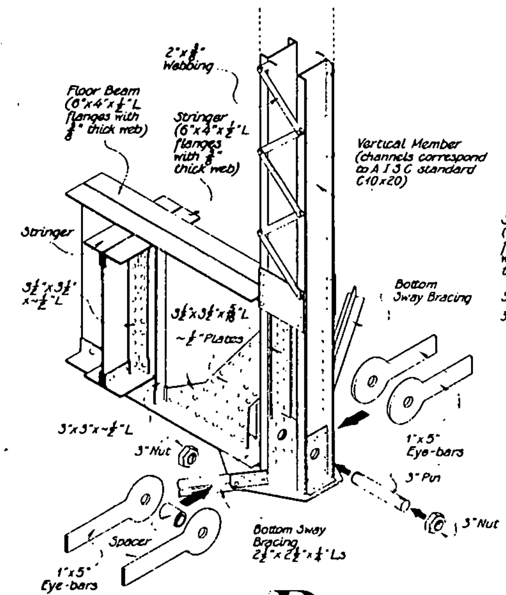


FIGURE 16 Documentation to HAER standards requires large-format photography (*a*) and measured drawings (*b-d*) (delineated by Richard K. Anderson, Jr., 1980). (Photo by DeBacker, HAER.)

(c)



A



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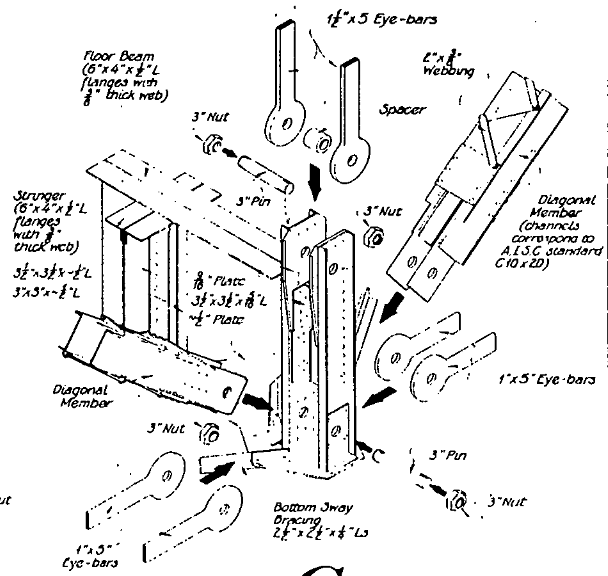

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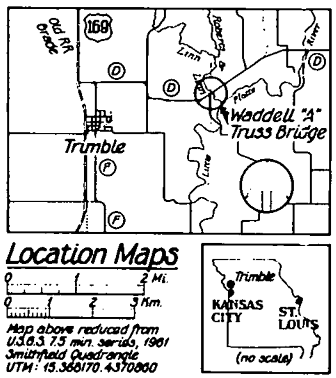


Location Maps

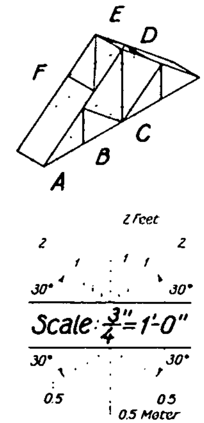
0 1 2 Mi.
0 1 2 3 Km.

Map above reduced from U.S.G.S. 7.5 min. series, 1961 Smithfield Quadrangle UTM: 15.366170.4370860

Truss Type:	Waddell "A" truss, patented by J.A.L. Waddell Nov. 13, 1894; Nº 529,220.
Constructed:	1898
Fabricator:	A.& P. Roberts Co, Pencoyd Bridge Works, Pencoyd, PA
Owner/ Builder:	The Quincy, Omaha and Kansas City Railway Co. (later a part of the Chicago, Burlington and Quincy Railroad)
Significant Dates:	1939 - removed from rail service when line was abandoned 1953 - converted to highway use, approach spans replaced with steel I-beams and new reinforced concrete traffic deck built 1980 - dismantled and removed from flood pool of Smithville Reservoir.

The Waddell "A" truss bridge on County Road "D" near Trimble, Missouri was documented by the Historic American Engineering Record as part of the Army Corps of Engineers' Smithville Reservoir Project. It is the only surviving example of this truss type identified by HAER at this time (1979). J.A.L. Waddell was one of America's most important bridge engineers of the late 19th and early 20th centuries and received wide acclaim for his books Designing Ordinary Iron Highway Bridges (1884), De Pontibus (1898), and Bridge Engineering (1916). The "A" truss was conceived by Waddell as an economical short-span, pin-connected structure capable of carrying heavy traffic without excessive vibration. In his patent application he acknowledged that many roof trusses had been built using a triangular form similar to his "A" truss and consequently confined his patent to triangular bridges that employed lateral bracing between the upper chords. Waddell also indicated that his "A" truss was "...designed especially for railroads." During the late 19th and early 20th centuries it was widely used in the Midwest and in Japan.

The HAER recording team for this project included: Donald C. Jackson, Engineer/Historian, Richard K. Anderson, Jr., Architectural Supervisor, and Thomas M. Hocker, Jr., Architectural Delineator.



Scale: ¾" = 1'-0"

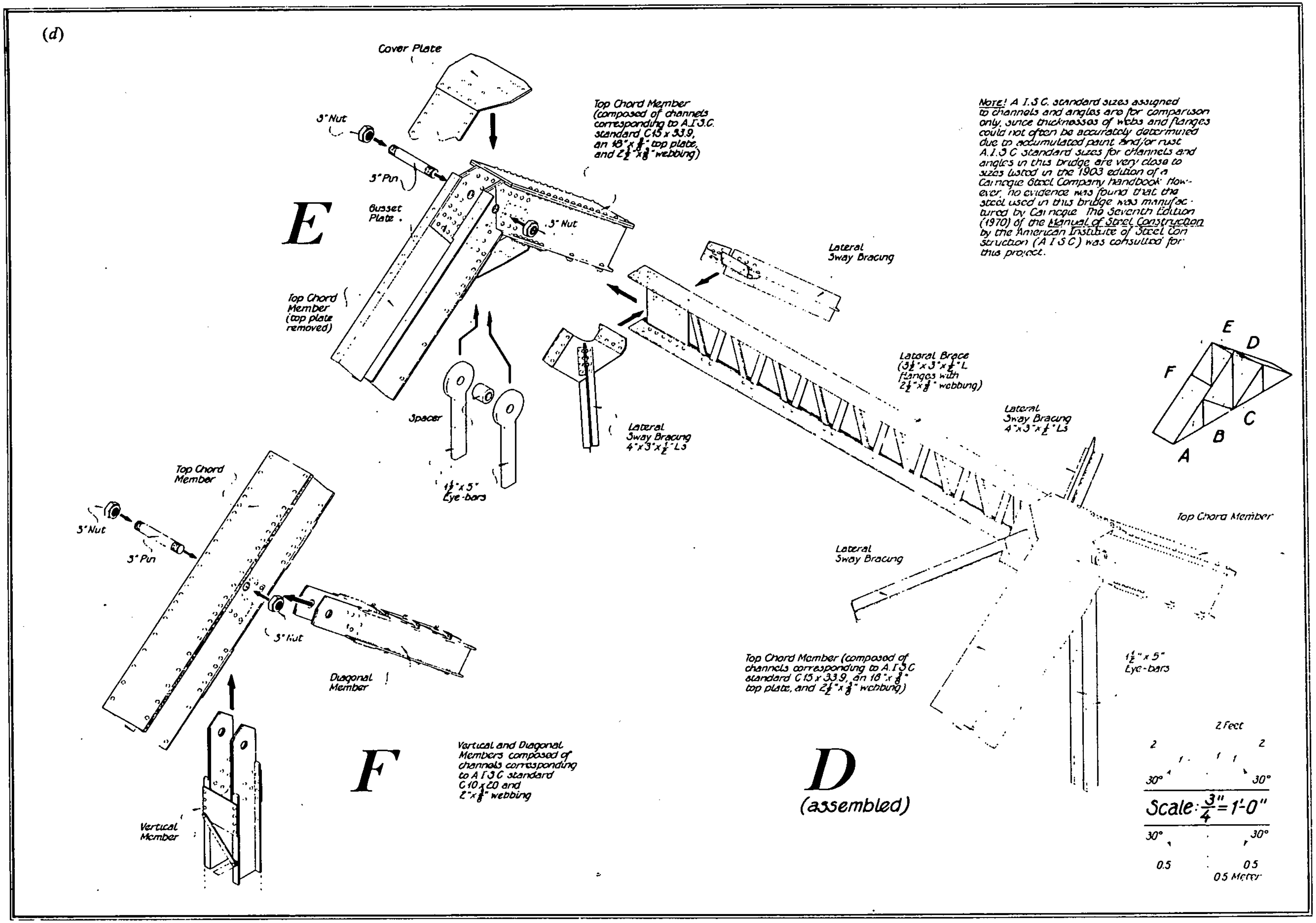
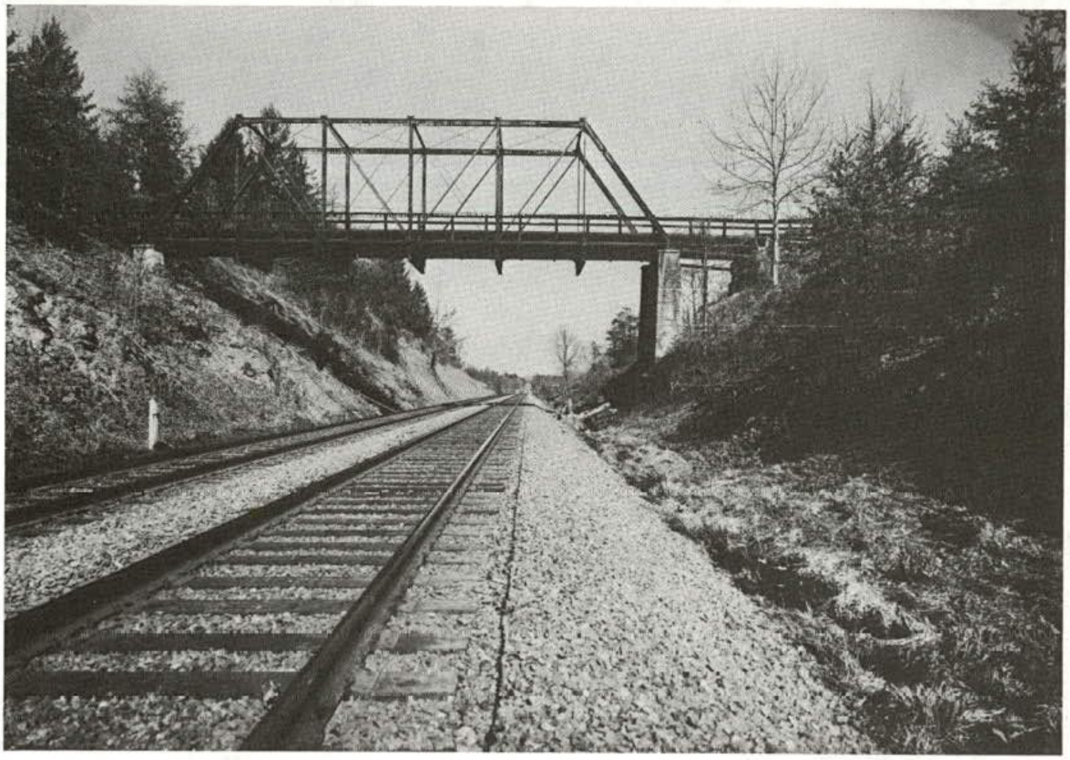
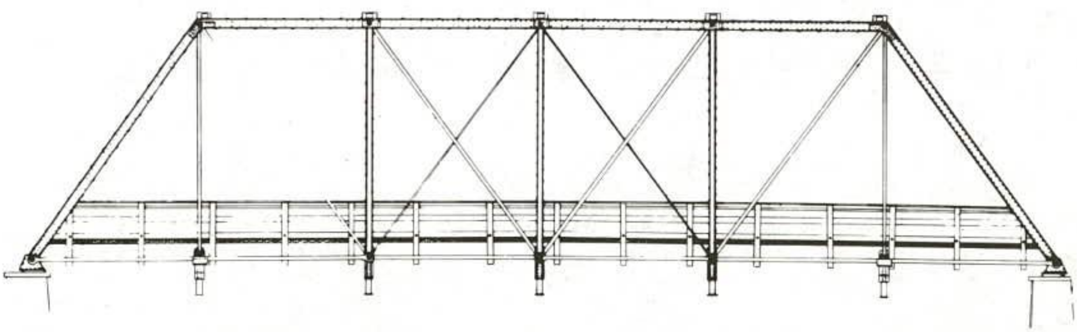


FIGURE 16 (*Continued*) Documentation to HAER standards requires large-format photography (*a*) and measured drawings (*b-d*) (delineated by Richard K. Anderson, Jr., 1980). (Photo by DeBacker, HAER.)



(a)



(b)

FIGURE 17 Example of the use of terrestrial, close-range photogrammetry (a) to produce a line drawing (b) of an historic bridge (Virginia Highway and Transportation Research Council).

CHAPTER SEVEN

DECISION CRITERIA

The ultimate objective of the various activities that have been described in the preceding chapters has been to develop what some have called a preservation plan. By this is meant a plan that identifies specific actions to be taken with regard to specific bridges that have a warrant for preservation consideration, usually by virtue of a determination of National Register eligibility. The purpose of this chapter was to have been to examine the standards that are being used by different agencies to determine these actions. Unfortunately, few states have yet to arrive at the point where such decisions can even be considered on a systematic basis for the entire group of bridges within their jurisdiction. Of the fairly large number of states, for instance, that had initiated inventory activities by the time Anderson (*61*) updated his survey, only five (California, Montana, North Carolina, Virginia, and Washington) had developed and applied criteria for judging relative importance. Further, no state was found that had fully developed and implemented a preservation plan; however, the experience to date of Virginia and North Carolina in this regard is instructive and is reviewed below. Also the experience of Frederick County, Maryland is reviewed. Although on a considerably smaller scale, it provides a useful case study of cooperation between preservation and transportation interests in developing and implementing such a plan.

THE VIRGINIA EXPERIENCE

Although Virginia has neither adopted criteria for making decisions on the disposition of its important early bridges nor formulated a specific preservation plan, some important preliminary steps have been taken. Upon completion of an inventory of metal truss bridges, Virginia identified eight as being National Register eligible and took the initiative of nominating the seven that were as yet unlisted (two had been listed previously, one of which was eligible by the new Virginia criteria). An additional 39 were judged not to be of sufficient importance to justify nomination but worthy of some consideration. It was decided (H. H. Newlon, Jr., Virginia Highway & Transportation Research Council, personal communication) that at the very least these 39 would be photographed using techniques of terrestrial close-range photography (*76*) and line drawings prepared from the photographs as a form of documentation.

Also, from among the total number of 48 eligible and near-eligible bridges, a representative sample of 21 were selected to serve as a pilot group for which a variety of preservation alternatives could be explored. The technical aspects of upgrading to an AASHTO HS 20 loading for continued vehicular use were studied analytically (*112*) as well as the feasibility of such non-vehicular uses as pedestrian and bicycle crossings, space for residential and commercial activities, accommodations for public services such as information booths or museums, and as historic attractions (*110*). Specific uses were suggested for each of the 21 bridges that were compatible with their particular features, condition, present siting, and criticality to traffic.

What appears to be evolving in Virginia is a model for viewing historic bridges as a resource for community exploitation rather than only as a liability to be disposed of in the least costly manner. This point of view is not intended to discount the very real and legitimate concerns of highway engineers for bridge safety and transportation needs, but to suggest opportunities for creative entrepreneurship. A more conventional approach is represented by the experience in North Carolina.

THE NORTH CAROLINA EXPERIENCE

North Carolina determined that 35 of its bridges were eligible for the National Register and proceeded to develop a preservation plan (B. J. O'Quinn, North Carolina DOT, personal communication). Seventeen had already been included in that state's transportation improvement program and tentative decisions had either already been made or were pending as to whether they would be rehabilitated, replaced, or closed. The department's Environmental Planning Unit caused similar planning studies to be conducted on the remaining 18 bridges.

The following alternatives were considered for each of the 35 bridges. The numbers in parentheses indicate the number of bridges for which each alternative was proposed.

1. Maintain in service with present traffic:
   a. Continue normal maintenance (12 bridges), or
   b. Schedule major rehabilitation (2 bridges).
2. Remove from service but stabilize and continue to maintain as a pedestrian and bicycle crossing:
   a. Replace with parallel structure on new right-of-way (5 bridges),
   b. Close the bridge and discontinue the crossing (2 bridges), or
   c. Move the structure to a new site (1 bridge).
3. Document and demolish where the bridge is beyond rehabilitation at reasonable cost:
   a. Replace with a new structure at the same or at an alternative site (11 bridges), or
   b. No replacement (2 bridges).
4. Dismantle, sandblast, paint, and store for possible future use (0 bridges).

Recommendations were made largely on the basis of an estimate of first costs considering transportation needs. However, consideration was also given to such factors as the singularity of the structure (compared with the other 34), the aesthetics of the setting where the bridge might remain if vehicular traffic was withdrawn, and special problems that might arise because of public misuse, right-of-way reversion, or liability.

As the cost of new construction has increased, rehabilitation to extend service life has become a more viable practice in North Carolina (as opposed to replacement). The historical importance of a bridge is a factor that would be considered in instances where the cost advantages of the two options might otherwise be approximately equivalent. When rehabilitation is performed on these bridges, it is planned to be with 100 percent state funds, and AASHTO standards will not apply. It is planned that most would remain as single-lane bridges posted for less than AASHTO standards would otherwise dictate.

An agreement was reached between North Carolina DOT and SHPO that the 11 most representative of the 35 National Register eligible bridges would be documented to HAER standards, with DOT providing funding and the SHPO technical supervision. It was agreed that all 35 bridges would be photographed on large format film, and that original design drawings, which survive for a few of the bridges, would be turned over to the state archive.

In those instances where a bridge was to be left standing without vehicular traffic, North Carolina DOT would attempt to transfer ownership to another party under a restrictive covenant that would limit use to that which is consistent with the historical value of the property. Their present plan is to continue maintenance of both the rights-of-way (for access) and the bridges (for nonvehicular use). The legal position of the DOT, however, is not clear at this time should a challenge arise under existing North Carolina law that reverts abandoned rights-of-way to local property owners.

At this writing the plan has the status of a recommendation of the Environmental Planning Unit within the DOT and is considered internally to be a "working document." To the extent that neither North Carolina DOT, FHWA, nor the SHPO is bound to act in accordance with it, it has no official status. At one time, consideration was given to using the plan as the basis for a programmatic memorandum of agreement for all 35 bridges under Section 106. Because there was so much disagreement on specific elements of individual bridges, the proposal was abandoned. For the same reason, the approach also failed when considered for groups of six bridges at a time, and it has therefore been decided to process such submissions on a case-by-case basis.

The difficulty experienced by the North Carolina DOT Environmental Planning Unit in obtaining a more broadly based acceptance of the plan within the DOT, as well as among other concerned agencies (i.e., FHWA and the SHPO), suggests that the formulation of such plans might better be negotiated in the first instance with broader participation. This approach has been used successfully in determining the National Register eligibility of bridges by those states that employ an "advisory committee," even when the judgments are based on highly subjective criteria as in the so-called "modified National Register Methods."

THE FREDERICK COUNTY, MARYLAND EXPERIENCE

The experience of Frederick County, Maryland, although on a somewhat smaller scale than Virginia or North Carolina, illustrates what can be accomplished in an atmosphere where mutual involvement and compromise do exist. In the summer and fall of 1977, the Frederick County Department of Historic Preservation included, as part of an ongoing survey of historical resources, an inventory of bridges on its 1100-mile (1800-km) road system (*55*). The inventory was stimulated by the HAER pamphlet (*17*), published earlier in the year, and was conducted entirely by Preservation Department staff with federal funding assistance. Because of their generally higher visibility and greater aesthetic appeal compared to other common types, only covered timber bridges, concrete and stone arches, and metal trusses were included in the survey. The inventory identified three covered bridges dating from the 1880s, a five-span stone arch bridge, and 40 metal trusses dating from 1878 through the 1930s.

After consultation with HAER, 12 of the bridges were identified as being most worthy of National Register nomination (Table 11) (*126* and C. Widell, personal communication). The selection criteria were subjective intuitively following the "modified National Register" approach described earlier, and included the following considerations:

1. Preference was given to structural forms that were either unique in the county or generally uncommon wherever they occur. The stone arch and a through Parker truss were selected on the basis of the former; and two bowstring trusses, two double-intersection Pratt trusses and the three covered bridges on the basis of the latter.
2. Preference was also given to representative examples of forms that were more common. The two high Pratt trusses and the low Pratt half-hip truss were selected on the basis of this consideration.
3. Where choice was possible, preference was given to those bridges that were in the best condition, that had the highest degree of integrity (in the National Register sense), and that were among the earliest built.
4. The total number selected was kept to a level that was thought would be acceptable to the county highway engineer, recognizing that preservation of all or even most of the structures was an unrealistic expectation.

At this point, the Frederick County Highway Department was approached with the preservation proposal (*127*). Engineering and financial constraints were discussed between the two organizations, and a preservation plan developed that was presented to the County Commissioners. The plan that resulted was a compromise between the Preservation Department that at one point had naively considered that all 44 bridges might be preserved, and the Highway Department that had not considered retaining any of them in service for other than utility reasons. Once developed, the plan was actively supported by both agencies and approved by the County Commissioners who budgeted additional restoration funds specifically for these bridges.

The preservation plan included the following elements (Table 11) (*127*):

1. One structure, the 1878 double-intersection Pratt truss, was left in place without improvement. This was possible because of its remote location with low traffic volume and because of its high by-pass potential in the event of major roadway improvement.
2. Most of the other trusses could be rehabilitated in place to bring them up to a 10-ton capacity, the state minimum for school bus loading. Most of their trusses and floor beam systems were in relatively good condition. Rehabilitation consisted largely of replacing stringers, wooden decks and nail strips, and painting superstructure. Where unmortared stone abutments had deteriorated, they were encased in concrete and provision left for subsequent facing with stone to restore the original appearance.
3. The stone arch was retained as a single lane bridge because of the large estimated cost of erecting a replacement ($2,000,000) and because of its historical importance. It was eventually rehabilitated, in large part with noncounty funds, at a cost of $500,000.
4. Because the load capacity of the covered timber bridges could not be improved to the 10 T level, it was thought best to take them out of service and to preserve them in place as pedestrian and bicycle crossings or as historic monuments. However, funds were not immediately available for acquisition of new

TABLE 11

FREDERICK COUNTY, MARYLAND HISTORIC BRIDGE PRESERVATION PLAN

Bridge Type	Design	Spans	Length (ft.)	Year Built	Builder	Resolution
Leave in Place, No Rehabilitation						
Metal truss	Double Int. Pratt	1	124	1878	Penn Br. Wks.	Leave as is
Leave in Place, Rehabilitate						
Metal truss	Pratt, through	1	103	c1896	Wrought Iron Br. Co.	New deck and stingers, paint
Metal truss	Pratt, through	1	65	1882	Pittsburg Br. Co.	New deck and stringers, paint, encase abut.
Metal truss	Parker, through	1	183	1908	York Br. Co.	New deck and stringers
Metal truss	Bowstring, pony	1	94	c1880	King Iron Br. & Mfg. Co.	New deck and stringers, paint, encase abut.
Metal truss	Bowstring, pony	1	61	c1880	Wrought Iron Br. Co.	Paint, encase abutments
Arch	Stone, earth filled	5	200	c1898	J.W. Legore	Planned for future rehab. with state funds
Remove From Service, Restore for Pedestrian Use						
Covered timber	Kingpost	1	42	c1880	Unknown	Temporarily left in place, rehabilitated, posted for 10 T loads.
Covered timber	Multiple kingpost	1 (aux. pier)	85	c1880	Unknown	Temporarily left in place, rehabilitated, posted for 10 T loads
Covered timber	Burr arch	1 (aux. pier)	68	1889	Unknown	Temporarily left in place, rehabilitated, posted for 10 T loads.
Remove From Service, Replace						
Metal truss	Double Int. Pratt	2 of 5	120 ea.	Unknown	Unknown	Destroyed
Metal truss	Pratt, pony	1	62	c1891	Penn Br. Wks.	Destroyed

rights-of-way and construction of new bridges, so they were rehabilitated at a lesser cost, posted for less than 10 tons and allowed to remain in service. Their long-term disposition is not clear at this point.

5. Two of the metal truss bridges were replaced because of a combination of poor condition and dangerous geometrics.

6. All of the other 32 metal trusses, none of which had been nominated for the National Register, were left for replacement as their condition and funding warranted. As a group, however, they were considered to be candidates for future alternative use at a county park or other recreational area.

The Frederick County experience provides a useful model of cooperation between preservation and transportation interest. Were it not for several facts, it would be easy to discount its value with the simplistic observation that the scale of problems at the county level is smaller and thus more easily solved. Both principals involved in the project (*127* and C. Widell, personal communication) agreed that:

- There was a common willingness to cooperate,
- Appreciation by each agency of the role and responsibilities of the other was essential, and
- Compromise on behalf of each was necessary.

Thus, without compromising public safety, Frederick County was able to preserve many structures that would otherwise have been replaced from a strictly engineering point of view. Included were at least two that from a national perspective were rare (the double-intersection Pratt and the King bowstring), and one that was unique (the Wrought Iron bowstring because of its upper-chord detail).

Finally, it is appropriate to note that in both the North Carolina and Frederick County, Maryland cases described above the use of federal money for bridge rehabilitation was not anticipated. Although this typically resulted in bridges being posted for loads less than compliance with AASHTO standards would have permitted, it did provide a degree of flexibility not generally found possible where federal money is involved. This advantage, of course, must be weighed carefully against the need for the higher standards at each site. It is significant in this regard that in preparing this synthesis a number of instances were discovered in which local jurisdictions had opted to rehabilitate local bridges with local funds rather than to apply for replacement with HBRR monies, because the cost was less than their share (20 percent) of what the cost of replacement would have been.

PROPOSED DECISION MODEL

Information presented in the preceding chapters, plus that contained in the case studies just reviewed, suggests a model that can be useful in developing a programmatic approach to decisions involving historic bridges. The model is diagrammed in Figure 18 and described below. Its various elements flow logically from the earlier discussions.

Ideally, decisions regarding the treatment of historic bridges should evolve from at least four sets of prior considerations, three of which are bridge or project related and one of which is program related.

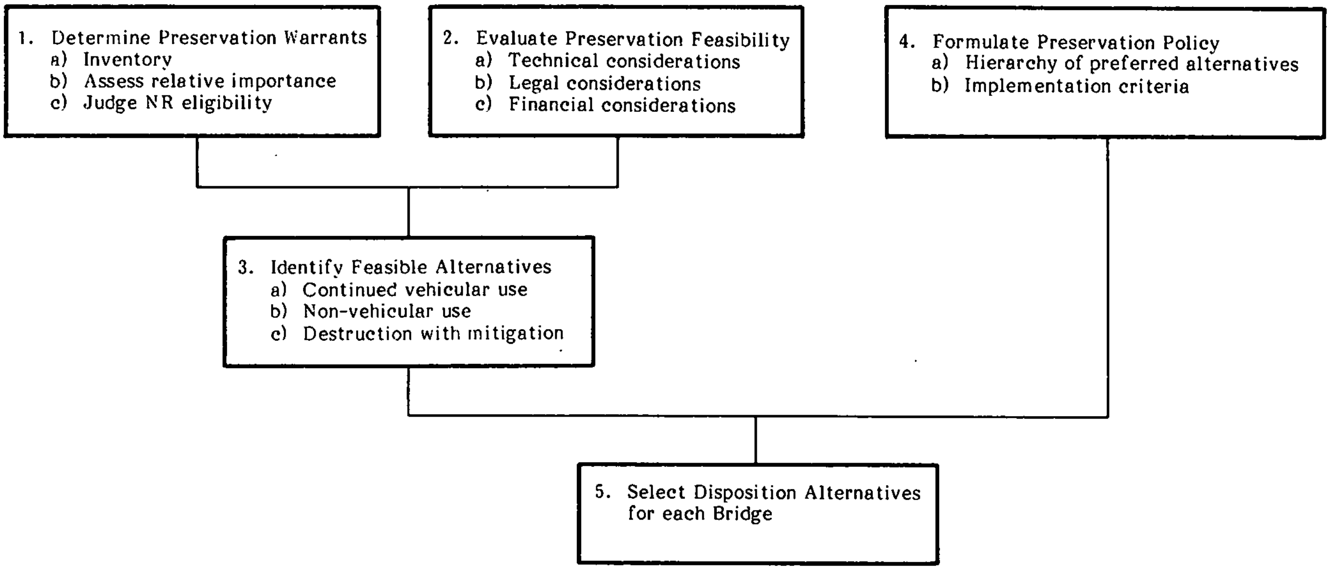


FIGURE 18 A model for disposition decisions involving historic bridges.

TABLE 12

ZUK'S PREFERRED ORDER OF DISPOSITION ALTERNATIVES FOR HISTORIC BRIDGES (*110*)

1. The best use is to continue to use the bridge as a bridge in its present location. If repair or strengthening is needed, it should be done discreetly. . . .

2. Should the traffic situation demand widening, . . . the historic structure should be left in place, . . . upgraded discreetly . . . (and a) second bridge, as similar in design to the existing one as possible . . . moved to the site of the historic one and erected adjacent to it.

3. In the event that a historic bridge cannot be left at its original site, it should be moved to another site of a less demanding nature where it can continue to function as a bridge for light vehicles, bicycles, or pedestrians.

4. If no vehicular (or pedestrian) use of the historic bridge can be foreseen, it should be converted into some architectural use . . .

5. In situations where none of the preceding four solutions are possible, the structure should be set off as a historic (attraction). . . .

6. If of necessity the structure can no longer be left standing, it should be match-marked, carefully disassembled, and stored in a protected environment with the hope that at some time and place in the future it could be rebuilt.

7. Further down on the scale of desirability from a preservation point of view is to save only selected components of the bridge that would be otherwise totally destroyed. These components could be made into exhibits, as in museums, or even be incorporated as ornamental elements into a new bridge built on the site of the old one.

8. As a minimum, whenever a historic bridge is to be razed, it should be documented with drawings and photographs and such documents should be preserved in some archive.

1. *Preservation Warrants.* Some processes must be undertaken in which defensible decisions are made as to which specific bridges merit National Register status and which do not. For a cultural resource as numerous and diverse as bridges, this is best done after inventorying the properties within the jurisdiction and then ranking their relative importance. Chapters Three and Four of this synthesis should be helpful in this regard.

2. *Preservation Feasibility.* Concurrently, the feasibility of preserving each NR eligible bridge must be determined. This can be done by assessing the importance of a variety of technical, legal, and financial considerations that may constrain one or more of the desirable preservation alternatives. These constraints are discussed in Chapter Five of the synthesis.

3. *Disposition Alternatives.* Using input from the two activities just described, viable disposition alternatives for each bridge can then be identified. These may include alternatives that permit the bridge to continue in service for vehicular purposes at the same or at an alternative site, that remove it from vehicular service but permit continued use either as a bridge or in some adaptive mode, or that incorporate some form of mitigation if the bridge is destroyed, such as recording. Consideration of the widest range of alternatives should assure choices other than the extremes of "rehabilitate" or "destroy."

4. *Preservation Policy.* Agreement on a hierarchy of preferred use can provide a convenient checklist for weighing those alternatives that will help to assure the best use of the historic structures. When combined with a statement of the conditions that need to be met in order to implement the various alternatives, a "bridge preservation policy," or bridge disposition criteria, can be said to exist. Although no written bridge preservation policies (as defined) were found, Zuk et al. (*110*, pp. 37–39) have suggested that there is a preferred order of disposition choices, at least from a preservation point of view (Table 12). Whether or not one agrees with these choices and their ranking, they do illustrate that it is possible to design a policy that can be helpful in developing a preservation plan for historically important bridges.

5. *Decision.* Consideration of feasible alternatives within the framework of a sensible preservation policy should result in the best decision for the disposition of each bridge.

CHAPTER EIGHT

CONCLUSIONS AND RECOMMENDATIONS

In this synthesis, an attempt has been made to describe: (a) the events that have resulted in the current attention given to bridges as objects of both preservation and replacement/rehabilitation interest, (b) the conflicts inherent when these interests focus on the same bridge, and (c) the efforts of government agencies to seek mutually acceptable resolution of these conflicts. Although the stated objective of the synthesis, "to provide information that will assist persons . . . who make and execute decisions involving historic bridges," is believed to have been met, the more specific objective implied by the synthesis title, to provide "criteria for decision making," has certainly not been. This failure is due to at least three factors that collectively render the setting of universally applicable criteria not only difficult but probably unwise:

1. The population of surviving early bridges varies substantially from state to state in number, kind, and age;
2. The historical importance of specific structural forms is likewise variable among regions of the country; and, most importantly,
3. Too few agencies have yet to develop anything approaching what could be called a preservation plan to assess with any accuracy which decision criteria might be preferred.

Because of these circumstances, it is likely that each state will develop decision criteria that are unique to their particular needs and to the perceptions of those in authority. This is not considered to be undesirable, and many of the criteria that emerge will certainly be similar.

What has evolved, in spite of this situation, is the conception of a process that should be helpful when attempting to develop a well-reasoned approach to decisions involving historic bridges. That process is represented by Figure 18 and has been described in Chapter Seven. In substance it parallels the content of Chapters Three through Seven of the synthesis. What follows are some general conclusions that are drawn from the synthesis and that relate to elements of the proposed process. In some instances, recommendations are also offered for consideration.

1. All but a small number of states have begun to inventory at least certain categories of historic bridges that are on or associated with their public roads. Results of a sufficient number of these inventories have been published to provide guidance to others regarding survey methods and reporting formats. It is recommended that the FHWA enhance its efforts to promote the completion and publication of those inventories that have been started and the beginning of those that have not.

2. A vastly fewer number of states have yet to complete the task of establishing the relative technological and historical importance of their inventoried bridges, or of assessing their National Register eligibility. It is recommended that they be encouraged to do so as quickly as possible, particularly in view of the enhanced funding for bridge replacement and rehabilitation now available under the Surface Transportation Assistance Act of 1982 (which includes the new $0.05 per gallon gasoline tax). To facilitate this effort, it is recommended that wider distribution should be made of the various evaluation schemes already developed (only Virginia's has been published in the general literature). Among the numerical rating methods reviewed, West Virginia's (Appendix C) is particularly recommended because of the wider variety of factors that it includes and because it is generalized for all bridge types. Among the nonnumerical methods, Wisconsin's is recommended because it is designed specifically to include a representative number of each bridge type of interest, even though it uses numerical rating within bridge-type groups.

3. Notwithstanding the fact that some state highway and transportation departments (in cooperation with their local SHPOs) have assessed the National Register eligibility of their bridges using factors that include consideration of aesthetics and preservation feasibility, a literal interpretation of the NR criteria plus a recently drafted guideline for its application seem to preclude these considerations. The argument is that such factors (i.e., aesthetics and preservation feasibility) should be weighed as part of a subsequent planning process to determine which of the NR eligible bridges are in fact preservable, and not used in the first instance to determine eligibility by limiting choices to only the "most preservable." Although this argument is logical from the perspective of preservation values and the intent of the NR program (i.e., to ensure preservation considerations when properties are altered or demolished), it has the potential of negating much of the benefit anticipated by highway agencies in processing historic bridge inventories. For instance, if the number of bridges declared eligible (by a permissive application of the criteria) should approach the number that would have been so declared under case-by-case review (i.e., without benefit of inventory), then nothing has been gained for the highway agency. The object of the inventory is to improve the quality of the eligibility judgments by the SHPO, and the object of concurrent consideration of these other factors is to reduce the number of eligibility declarations to the benefit of the highway agencies. This problem has been dealt with in some states by identifying bridges as "interesting" or as "potentially eligible" (rather than as "eligible") until the other factors could be determined and considered. This gives such bridges a preferred status without triggering administrative delays for the highway agency, but may raise a question of the SHPO's integrity in carrying out the mandates of the office. Typically those that are "interesting" but not subsequently "eligible" are by agreement subjected to some mitigation, say record photography. Only one state was encountered where this conflict was at issue, but with the broad dissemination of the application guideline, more can be expected. It is recommended that the National Register Division address this issue in the final draft of its application guideline.

4. The principal technical constraint to preserving bridges of historical importance when federal money is involved has

been the need to comply with the design standards set by AASHTO. Although federal programs do permit rehabilitation, it is rarely possible to rehabilitate an early bridge in a manner that is both consistent with the standards and that maintains the historical integrity of the bridge; although there are provisions under which the standards may be relaxed, they are rarely invoked. Thus, it is no coincidence that many of the most successful preservation efforts have been those involving only local funds. However, there appears to be a growing willingness to consider compromise in those instances where design standards can be relaxed without jeopardizing public safety, particularly at sites where accident history is acceptable, where the rehabilitation will be consistant with the use anticipated, and where local support for compromise is strong. It is recommended that the AASHTO standards be reviewed, particularly with regard to how they might legitimately be modified to encourage more flexibility and more uniform application under the special conditions clause in situations involving historic bridges. One positive step in this regard would be to develop criteria or guidelines that define conditions under which exceptions might be considered. Although the results of such an effort may be to require more innovative and case-specific designs, they should increase the frequency of rehabilitation and at a potentially lower cost than replacement.

5. Legal constraints to preservation of historic bridges focus primarily on concerns related to tort liability, specifically whether the protections traditionally accorded to governments apply under conditions (a) where a rehabilitated bridge is continued in service even though it fails to comply with contemporary standards of safety, or (b) where a bridge is discontinued as part of the highway system but left standing for nonhighway uses. Secondary concerns relate to the ownership status of rights-of-way that are removed from the highway system to provide access to a historic bridge now serving an alternative function; for example, many states have laws requiring that such abandonments revert to the contiguous landowners. Regrettably, there appears to be no comprehensive review of case or statute law that is helpful in clarifying for the transportation community the position of highway agencies in these situations. It is recommended that such a review be conducted at the earliest time possible.

6. The federal government, through legislation, executive order, and administrative action, has put in place programs that give high priority to replacing or rehabilitating the nation's unsafe bridges, and that provide a mechanism whereby historical values and preservation interests associated with these bridges are considered when bridge projects are programmed. However, experience has been that where these interests are in conflict, preservation in the physical sense rarely results, even after lengthy compliance proceedings. In such instances, no one wins; the bridges are destroyed and the highway agencies suffer costly delays. A primary reason for this is that preservation and maintenance of a bridge that is no longer part of a highway system requires a substantial financial commitment, and organizations that seek preservation are usually moderately funded whereas the highway agencies that are more amply funded do not have the authority. Clearly, funding sources not now apparent will have to become available if the prospects for bridge preservation are to be improved.

7. A far wider range of alternatives has been suggested for preserving historic bridges than will probably ever be implemented. These alternatives include options for continuing the bridge in vehicular service, for converting it to some nonvehicular use, or for mitigating its loss in instances where demolition is unavoidable. What is needed now are not more alternatives but a compilation and analysis of successful case studies that describe the technical, legal, financial, and political problems associated with bridge preservation and how they were solved. Such information would be of inestimable value to both transportation and preservation communities. The beginning of such a project has been undertaken through a cooperative effort of TRB Subcommittee A1B03(1) and completion, and dissemination should be encouraged.

8. No state was found that had yet developed a preservation plan for its historic bridges, at least in the terms defined in this synthesis. Such a plan should include:

- Preservation warrants for each bridge,
- Evaluations of preservation feasibility for important bridges,
- Identification of feasible alternatives for important bridges,
- A preservation policy that includes a preference hierarchy of alternatives and the requirements for implementation of each, and
- A specific action plan for each bridge.

It is recommended that the development of such plans be aggressively encouraged by FHWA for the benefit of both preservation and transportation interests.

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APPENDIX A

FHWA'S DEFINITION OF A DEFICIENT BRIDGE

A bridge is:

Structurally deficient if it has

A condition rating of 4 or less for its
- —Deck, or
- —Superstructure, or
- —Substructure, or
- —Culvert and retaining walls.

Or an appraisal rating of 2 or less for its
- —Structural condition, or
- —Waterway adequacy.

Functionally obsolete if it has

An appraisal rating of 3 or less for its
- —Deck geometry, or
- —Underclearances, or
- —Approach roadway alignment.

Or an appraisal rating of 3 for its
- —Structural condition, or
- —Waterway adequacy.

Condition rating codes

N	Not applicable.
9	New condition.
8	Good condition--no repairs needed.
7	Generally good condition--potential exists for minor maintenance.
6	Fair condition--potential exists for major maintenance.
5	Generally fair condition--potential exists for minor rehabilitation.
4	Marginal condition--potential exists for major rehabilitation.
3	Poor condition--repair or rehabilitation required immediately.
2	Critical condition--the need for repair or rehabilitation is urgent. Facility should be closed until the indicated repair is complete.
1	Critical condition--facility is closed. Study should determine the feasibility for repair.
0	Critical condition--facility is closed and is beyond repair.

Appraisal rating codes

N	Not applicable.
9	Conditions superior to present desirable criteria.
8	Conditions equal to present desirable criteria.
7	Condition better than present minimum criteria.
6	Condition equal to present minimum criteria.
5	Condition somewhat better than minimum adequacy to tolerate being left in place as is.
4	Condition meeting minimum tolerable limits to be left in place as is.
3	Basically intolerable condition requiring high priority of repair.
2	Basically intolerable condition requiring high priority of replacement.
1	Immediate repair necessary to put back in service.
0	Immediate replacement necessary to put back in service.

(from Reference 6)

APPENDIX B

HISTORIC BRIDGE DATA FORMS

OHIO

BRIDGE SURVEY AND INVENTORY FORM

1) GEOGRAPHIC INFORMATION

FOR BES USE ONLY

State: Ohio
Ohio Department of Transportation District 3
County: Crawford
City/Town 2 1/2 miles northeast of Bucyrus
Street/Road T. R. 82
River/Stream/Railroad (crossing) Sandusky River
UTM Coordinates: 17/337200/4520700
Attach U.S.G.S. map to form.

2) HISTORIC INFORMATION

Structure File No. 1743260
Local Designation
Builder Toledo- Massillon Bridge Co.
basis for Nameplate
Date 1909 basis for Nameplate
Original Owner County use vehicular bridge
Present Owner County use vehicular bridge

3) HISTORICAL OR TECHNOLOGICAL INFORMATION
Section to be completed by BES staff

____Unique/Unusual in its time

____Rare survivor of standard design

____Typical example of its time & a common survivor

____Other Remarks/Explanation

PHOTOGRAPHIC DOCUMENTATION

See instructions for completing Bridge Survey and Inventory form for photographic documentation.

Recorder: David L. Jones
Date: 5/20/81
Affiliation Burgess & Niple, Limited

4) DESIGN INFORMATION

Architectural or decorative features

Very decorative portal bracing and nameplate.

No. of spans 1 ; length; overall 102'

Span types:

(1) Through Truss length 101'

(2) length

(3) length

(4) length

(5) length

(6) length

No. of lanes 1 roadway width 18.5' c to c.

By Pass Potential ☐ Good ☐ Fair ☒ Poor

5) STRUCTURAL INFORMATION

Substructure Material

Piers N/A

Abutments Concrete

Wings Concrete

Seats Concrete

Superstructure

Material Metal - Steel (Cambria)

Characteristics

Top Chords 2 channels with solid plates on top & single lacing on bottom

End Posts 2 channels with solid plates on top & single lacing on bottom

Botton Chords 2 flat eyebars

Posts 2 channels with single lacing on both sides

Diagonals 2 flat eyebars

Counters 1 square eyebar

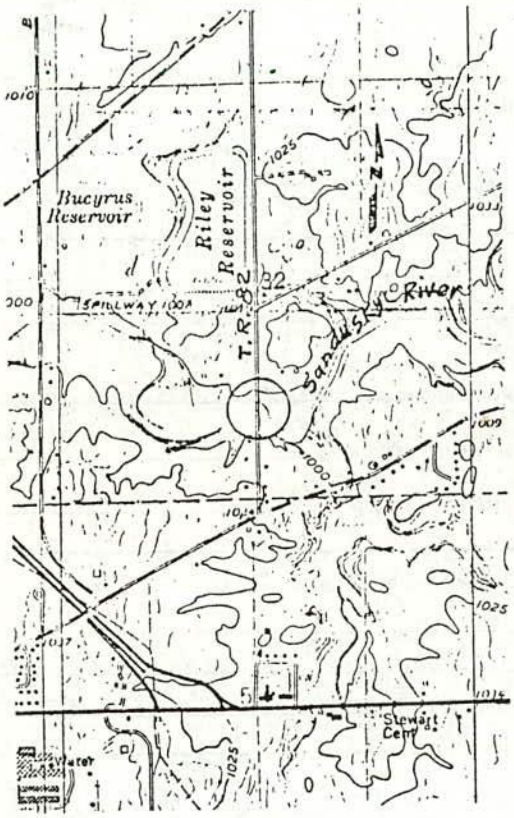
Connections Pinned

Condition 3P

6) TRUSS CONFIGURATION

Main span type Pratt Through /~~Pony/Deck~~

Secondary span type Through/Pony/Deck



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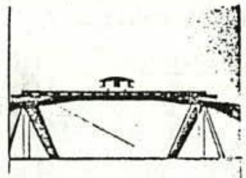
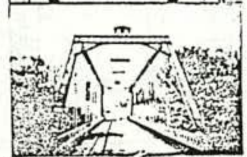
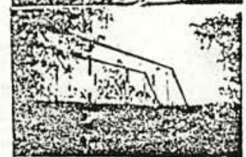


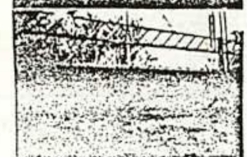
Nameplate looking north



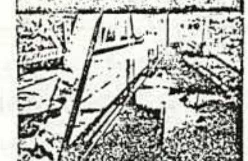
Portal closeup looking north



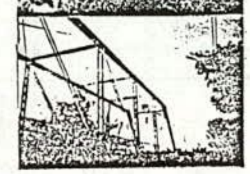
Side view looking northwest



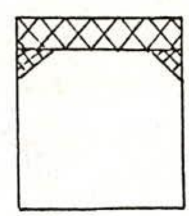
Substructure looking west

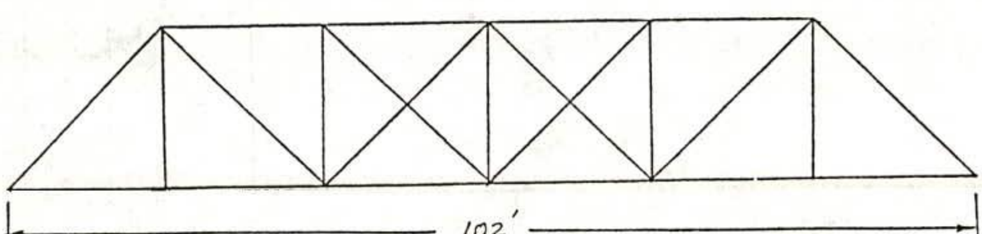


Lower chord looking north



Counter crossing looking northwest





NEW YORK

HISTORIC BRIDGE INVENTORY – SCREENING DATA

(Obverse)

BIN No. ____________ In Service ________

Listing ____________

Region ____________ County ________

Feature Carried ____________

Route Carried ____________

Feature Crossed ____________

Sketch

Date of Construction ________ Date Present ____

Builder ________ Plate Present ____

Special Features ____________

Condition Rating ____________

General Recommendation ____________

Site Integrity (if known) ____________

Number of Spans ________ Total Bridge Length ________

Superstructure: Main Span ____________

Other ____________

Span Length: Main Span ________ Width (out-to-out) ________

Other ________ Width (curb-to-curb) ________

(Reverse)

Photograph(s)

Plate Information as given (if recorded):

Photo Negative Number(s) ________

Other Remarks ________

HABS/HAER INVENTORY

U.S. Department of the Interior
National Park Service
Washington, DC 20240

1. SITE I.D. NO

2. NAME(S) OF STRUCTURE

5. ORIGINAL USE

7. CLASSIFICATION

9. RATING

10. DATE

3. SITE ADDRESS (STREET & NO)

6. PRESENT USE

8. UTM ZONE | EASTING | NORTHING

11. REGION

4. CITY/VICINITY | COUNTY | STATE

SCALE 1:24 1:62.5 OTHER ______ QUAD NAME ______

12. OWNER/ADMIN ADDRESS

13. DESCRIPTION AND BACKGROUND HISTORY INCLUDING CONSTRUCTION DATE(S), PHYSICAL DIMENSIONS, MATERIALS, MAJOR ALTERATIONS, EXTANT EQUIPMENT, AND IMPORTANT BUILDERS, ARCHITECTS, ENGINEERS, ETC.

14. CONDITION ☐ EXCELLENT ☐ GOOD ☐ FAIR ☐ DETERIORATED ☐ RUINS

15. DANGER OF DEMOLITION? (SPECIFY THREAT) ☐ YES ☐ NO ☐ UNKNOWN

16. SIGNIFICANCE

10-909 2/82

17 PHOTOS AND SKETCH MAP OF LOCATION

18 LOCATED IN AN HISTORIC DISTRICT? ☐ YES ☐ NO ☐ NAME

19 PUBLIC ACCESSIBILITY ☐ YES, LIMITED ☐ YES, UNLIMITED ☐ NO ☐ UNKNOWN

20. EXISTING SURVEYS ☐ NR ☐ NHL ☐ HABS ☐ HAER-1 ☐ HAER ☐ NPS ☐ STATE ☐ COUNTY ☐ LOCAL ☐ OTHER

21 REFERENCES—HISTORICAL REFERENCES, PERSONAL CONTACTS, AND/OR OTHER

22 INVENTORIED BY	AFFILIATION	DATE

APPENDIX C

CRITERIA FOR HISTORICAL SIGNIFICANCE OF BRIDGES

Hawaii

DOCUMENTATION (26%)			
1. Builder			
	a. Unknown	0	
	b. Known	1	
	c. Known, prolific	2	
	d. Known, unusual	3	
2. Construction dates			
	a. Post 1940	0	
	b. 1936 - 1940	1	
	c. 1926 - 1935	2	
	d. 1911 - 1925	3	
	e. pre - 1910	4	Maximum 7 pts.
TECHNOLOGY (33%)			
1. Technical			
	a. Patented technology*	1	
	b. Number of spans	1	
	c. Span lengths	1	
	d. Materials	1	
	e. Integrity	1	
	f. Special feature	1	
2. Geometric Configuration			
	a. Unique	3	
	b. Unusual	2	
	c. Typical	1	Maximum 9 pts.
ENVIRONMENTAL			
1. Aesthetics			
	a. Poor	1	
	b. Average	2	
	c. Excellent	3	
2. History			
	a. Poor	2	
	b. Average	4	
	c. Excellent	6	
3. Integrity			
	a. Vantage pt.	1	
	b. Visual +	1	Maximum 11 pts.

* For bridges other than metal trusses, this factor is replaced with span "height."

Michigan

Significance Criteria for Metal Truss Highway Bridges

Factor	Points Assigned
A. Documentation	Maximum 25
1. Date	
a. Pre-1890	15
b. 1890-99	10
c. 1900-1914	6
d. 1915-1934	4
e. Post-1934	0
2. Builder	
a. Known, unusual designer	10
b. Known, prolific designer	8
c. Known, local builder	8
d. Known, contribution to truss technology undetermined	6
e. Unknown	0
B. Technological Significance	Maximum 50
1. Technology	
a. Patented technology	5
b. Number of spans	5
c. Individual span lengths	5
d. Materials	5
e. Integrity	5
f. Special features	5
2. Geometry/configuration	
a. Unique	20
b. Rare	10
C. Environmental	Maximum 25
1. Aesthetics	9
2. History	9
3. Integrity	7
	Maximum 100

It is proposed to award 5 additional points for the bridge which meets each of the following criteria:

1. Oldest known metal through truss bridge in Michigan
2. Oldest known example of a particular truss type (through truss) in Michigan
3. Longest known metal through truss bridge in Michigan

4. Longest known metal pony truss bridge in Michigan

5. Longest known example (individual span) of a particular truss type (through truss)

6. Longest known example (individual span) of a particular truss type (pony truss).

North Carolina

Point System for Evaluation of North Carolina Truss Bridges

	Points
A. Documentation	
1. Builder	
a. Unknown	0
b. Known, contribution to truss technology undetermined	1
c. Known, prolific builder or N.C. Company	2
d. Known, unusual designer	3
2. Date	
a. Post-1940	0
b. 1931-1940	1
c. 1921-1930	2
d. 1901-1920	3
e. Pre-1900	4
	(7 points maximum)
B. Technological Significance	
1. Technology	
a. Patented innovations in truss technology	1
b. Number of spans (point for three or more spans 1920 or earlier)	1
c. Length of individual spans (point for span of 100' or more built 1920 or earlier)	1
d. Integrity (No changes to truss)	1
e. Special features	1

	Points
2. Geometry/Configuration	
a. Rare (three or less of the type extant)	4
b. Unusual (4-20 of the type extant)	2
c. Novel, or Parker or Camelback type	1
	(9 points maximum)
C. Environment	
1. Aesthetics	
a. Excellent	4
b. Fair	2
c. Poor	0
2. History	
a. Excellent. Significance known, bridge and crossing of historical importance	4
b. Good. Local significance very likely	2
c. Significance undetermined	0
3. Integrity of Location	
a. Original location and substructure	2
b. Original location, substructure replaced	1
c. Not original location	0
	(10 Points Maximum)
	TOTAL 26 POSSIBLE POINTS

Ohio

Points Assigned - Maximum - 23

A. Documentation

1. Date

a. Pre-1980	15
b. 1880-1899	10
c. 1900-1912	8
d. 1913-1929	6
e. 1930-1940	4
f. Post-1940	0

2. Builder

a. Known prolific Ohio builder	8
b. Known prolific out-of state builder	6
c. Known Ohio builder	4
d. Known out-of-state builder	2
e. Unknown	0

Maximum - 20

B. Technological Significance

1. Number of spans (point for each when two or more spans)	5 maximum
2. Length of individual spans (pony truss 60-80' = 3 points; pony truss greater than 80' = 5 points; Pratt through truss greater than 125' = 3 points, Pratt through truss greater than 150' = 5 points; other through trusses greater than 150' = 3 points, other through trusses greater than 170' = 5 points. Concrete structures - 1 point for each 100')	5 maximum

3. Special Features

a. Decorative elements (non-structural)	2
b. Artistic treatment of structural elements	2
c. The builders distinctive structural elements	2
d. Patented features (technology)	2
e. Cast or wrought iron structural elements	2

Maximum - 38

C. General Significance

1. Aesthetics

a. Excellent	8
b. Good	6
c. Fair	4
d. Poor	0

	Points Assigned - Maximum - 23
2. History	
a. National Significance	8
b. State Significance	6
c. Local Significance	4
d. Significance Undetermined	0
3. Surviving numbers in Ohio	1 - 2 = 20
	3 - 4 = 18
	5 - 6 = 16
	7 - 8 = 14
	9 - 10 = 12
	11 - 12 = 10
	13 - 14 = 8
	15 - 16 = 6
	17 - 18 = 4
	19 - 20 = 2
4. Integrity	2
D. Preservation Potential	Maximum - 19
1. By-Pass Potential	8
a. Good	8
b. Fair	4
c. Poor	0
2. Condition*	
a. Good	8
b. Fair	4
c. Poor	0
3. Maintenance Difficulty	
a. Good	3
b. Fair	2
c. Poor	0
	100

* Integrity, which was originally part of this, will be considered separately after the initial sort.

Virginia

Factor	Points Assigned Maximum possible - 7
A. Documentation	
1. Builder	
a. Unknown	0
b. Known, contribution to truss technology undetermined	1
c. Known, prolific builder	2
d. Known, unusual designer	3
2. Date*	
a. Post-1932	0
b. 1918-1932	1
c. 1900-1917	2
d. 1886-1899	3
e. Pre-1885	4
B. Technological Significance	Maximum possible - 9
1. Technology	
a. Patented technology	1
b. Number of spans	1
c. Individual span lengths	1
d. Materials	1
e. Integrity	1
f. Special features	1
2. Geometry/configuration	
a. Unique	3
b. Unusual	2
c. Novel	1
C. Environmental	Maximum possible - 11
1. Aesthetics	4
2. History	3
3. Integrity	4

* When date is estimated, one-half value is assigned.

West Virginia

	Points	Max. Pts.
HISTORICITY		
1. Development Period		
pioneering phase	6	6
early flourishing phase	4	
mature flourishing phase	2	
obsolescent phase	0	
2. Technological Significance		
engineer/builder/company		
international leader	4	4
significant or unusual	3	
prolific builder of conventional types	2	
contribution limited or unknown	1	
unknown	0	
structural system and materials		
outstanding early example	4	4
significant early example	3	
unusual or novel	2	
excellent example of a widely used type	1	
typical	0	
length and number of spans		
outstanding length and/or number of spans	3	3
noteworthy length and/or number of spans	2	
significant length and/or number of spans	1	
typical length and/or number of spans	0	
architectural and/or engineering details		
outstanding	3	3
unusual or novel	2	
noteworthy example	1	
typical	0	
rarity in W. Va.		
sole survivor	6	6
rare	4	
unusual	2	
common	0	
integrity		
in original condition	3	3
minor alterations	2	
substantially original condition	1	
major alterations	0	

West Virginia

	Points	Max. Pts.
historicity of site		
national historical significance	3	3
state historical significance	2	
local historical significance	1	
not significant	0	
		32
ENVIRONMENTAL QUALITY		
aesthetic		
unusually fine proportions and details	4	4
noteworthy proportions and details	3	
excellent example of widely used type	2	
typical but in an attractive location	1	
not significant	0	
route compatibility		
exceeds alignment and geometric requirements	3	3
acceptable alignment and geometric requirements	2	
minor alterations only to meet geometric requirements	1	
functionally obsolete	0	
integrity of site		
site in original condition	2	2
minor site alterations	1	
site greatly altered	0	
		9

Wisconsin

A. TECHNOLOGY 30

1. Span length 10
2. Number of spans 10
3. Distinctive features 10

30

B. INTEGRITY 20

1. Top and bottom chords 6
2. Intermediate posts 6
3. Bracing (diagonals, counters, top and bottom laterals, ties, struts, etc.) 6
4. Abutments 2

20

C. CONDITION 20

1. Top and bottom chords 6
2. Intermediate posts 6
3. Bracing 6
4. Abutments 2

20

D. DOCUMENTATION 15

1. Date 5
2. Manufacturer 10

15

a. Known, unusual designer or prolific builder 10
b. Known, local builder 6
c. Known, contribution unknown 3

E. CONTEXT 15

1. History 7
2. Integrity of location 4
3. Aesthetics 4

15

ASCE

National historic significance is not a quality or characteristic which lends itself to easy evaluation. As a result, the Committee uses the following as guidelines as it considers the merits of a specific nomination:

1. This nomination must be of National historic civil engineering significance. Size or technical complexity of design or construction is not sufficient in itself.

2. The project must represent a significant facet of civil engineering history, but need not have been designed or constructed by one who was or who identified himself a civil engineer.

3. Nominations must have some special uniqueness, such as a first project constructed, oldest project extant or have made some significant contribution, such as the first project designed by some method, or on which some unique and significant construction or engineering technique was first used. The project itself must have contributed to the development of the nation or at least a very large region. Thus a project which did not make a contribution did not lead to some other development, or which was a technical "dead end" will not be of national historic significance, even though it was the "first" (and only one) of its kind.

4. Projects should be generally available to public view, although safety considerations or geographic isolation may restrict access.

5. No criterion as to the date of construction is established, but nominated projects should be at least 50 years old.

6. There should be a suitable place to mount a bronze plaque to be supplied by national ASCE headquarters which can be viewed by the public.

Georgia

In General:

Criteria for determining the eligibility of historic bridges should be based on the standard National Register Criteria for Evaluation.

More Specifically:

Criteria for evaluating historic bridges should include consideration of:

1. Integrity of:

   (a) location (in original location or moved according to historical practices);

   (b) setting (compatibility of condition of current setting with original setting);

   (c) design (form, type, general arrangement);

   (d) materials (original construction materials, except for elements routinely repaired or replaced);

   (e) workmanship (signs of construction techniques, fabrication methods, craftsmanship).

2. Representativeness, the ability to characterize or typify, in terms of location, setting, design, materials, and/or workmanship.

3. Singularity, the quality of being unusual, distinctive, distinguished, or unique, in terms of location, setting, design, materials, and/or workmanship.

4. Condition, only insofar as it affects formal or material integrity (NOTE: "Functional" integrity - the ability of a bridge to continue serving in that capacity - is not a National Register criteria for evaluating bridges).

5. Chronology, the quality of being "sufficiently old" for evaluation; in general bridges built through the mid-1930's are "sufficiently old" but this cut-off date may vary according to bridge type and location; newer bridges will have to justify an exception to this rule.

6. Historical Association, in terms of:

   (a) periods, events, activities, or people in local, regional, state, or national history;

   (b) bridge builders, engineers, companies.

7. Place Association, as part of a recognized historical "place," in terms of:

   (a) traditional crossings; if it maintains the environment of an earlier crossing, it may be historically significant.

(b) associated development (mills, stores, houses, etc.).

8. Information, the ability to yield valuable and/or otherwise unavailable data about historic bridge design, construction, materials, etc.

Prepared By:

Historic Preservation Section
Georgia Department of Natural Resources
October 21, 1980

Washington

Those bridges eligible for listing in the National Register of Historic Places were evaluated according to the general criteria stated in 36 CFR Part 60.6, which includes bridges "that are associated with events that have made a significant contribution to the broad pattern of our history; that are associated with the lives of persons significant in our past; that embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values."

More specifically, those bridges eligible for listing in the National Register include bridges that:

1. are significant in the history of bridge engineering, in the history of bridge design principles, and in the development of bridge construction techniques;
2. are significant in the social, economic, and industrial development of the locality, state, region, or nation;
3. are significant examples of bridges designed or built by renowned engineers;
4. are significant examples of structural designs associated with the efforts of historic individuals or groups;
5. are significant examples of an early bridge engineering effort commonly used throughout the State of Washington for a specific purpose or reason;
6. are significant early examples, or significant representative examples, of a specific bridge type;
7. are the sole remaining example of a specific bridge type within the state;
8. possess architectural or artistic significance.

One element that is carefully considered in evaluating a bridge's eligibility for inclusion in the National Register is the integrity of the bridge in relation to its surrounding environment; a bridge's historic significance is enhanced if the context and environment surrounding the bridge is similar to the one in which it was constructed.

APPENDIX D

HISTORICAL ORGANIZATIONS AND SOCIETIES

The national organizations listed below are among those that have activities, publications, and/or resource persons that can be helfpul in developing historical information on bridges.

American Association for State and Local History 1315 8th Avenue South Nashville, Tennessee 37203	(monthly newsletter; "Directory of Historical Societies and Agencies in the United States and Canada")
American Canal Society 809 Rathton Road York, Pennsylvania 17403	(Monthly bulletin and occasional other historical publications)
American Concrete Institute Committee 120 - History of Concrete Box 19150, Redford Station Detroit, Michigan 43219	(occasional historical publications)
American Public Works Historical Association 1313 East 60th Street Chicago, Illinois 60637	(occasional historical publications
American Society of Civil Engineers Committee on the History and Heritage of Concrete 345 East 47th Street New York, New York 10017	(occasional historical publications)
Association of Preservation Technology Box 2487, Station D Ottawa, Ontario Canada K1P 5W6	(bimonthly newsletter; quarterly bulletin)
Federal Highway Administration 400 7th Street, S.W. Washington, D.C. 20590	—
National Railway Historical Society Box 643 Conneaut, Ohio 44030	(bimonthly bulletin)
National Society for the Preservation of Covered Bridges 63 Fairview Avenue South Peabody, Massachusetts 01960	(quarterly bulletin)

National Trust for Historic Preservation 740-748 Jackson Place, N.W. Washington, D.C. 20006	(monthly newsletter; bimonthly magazine)
Society for History of Technology University of Chicago Press 5801 Ellis Avenue Chicago, Illinois 60837	(quarterly newsletter; quarterly journal)
Society for Industrial Archeology Room 5020 National Museum of American History Washington, D.C. 20560	(quarterly newsletter; annual journal)
Society of Architectural Historians 1700 Walnut Street Philadelphia, Pennsylvania 19103	(bimonthly newsletter; quarterly journal)
The Railway and Locomotive Historical Society Kresge Hall Harvard School of Business Boston, Massachusetts 02163	—
The Smithsonian Institution 1000 Jefferson Drive, S.W. Washington, D.C. 20560	(occasional publications)

THE TRANSPORTATION RESEARCH BOARD is an agency of the National Research Council, which serves the National Academy of Sciences and the National Academy of Engineering. The Board's purpose is to stimulate research concerning the nature and performance of transportation systems, to disseminate information that the research produces, and to encourage the application of appropriate research findings. The Board's program is carried out by more than 270 committees, task forces, and panels composed of more than 3,300 administrators, engineers, social scientists, attorneys, educators, and others concerned with transportation; they serve without compensation. The program is supported by state transportation and highway departments, the modal administrations of the U.S. Department of Transportation, the Association of American Railroads, the National Highway Traffic Safety Administration, and other organizations and individuals interested in the development of transportation.

The National Research Council was established by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academy's purposes of furthering knowledge and of advising the Federal Government. The Council operates in accordance with general policies determined by the Academy under the authority of its congressional charter of 1863, which establishes the Academy as a private, nonprofit, self-governing membership corporation. The Council has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in the conduct of their services to the government, the public, and the scientific and engineering communities. It is administered jointly by both Academies and the Institute of Medicine.

The National Academy of Sciences was established in 1863 by Act of Congress as a private, nonprofit, self-governing membership corporation for the furtherance of science and technology, required to advise the Federal Government upon request within its fields of competence. Under its corporate charter the Academy established the National Research Council in 1916, the National Academy of Engineering in 1964, and the Institute of Medicine in 1970.

TRANSPORTATION RESEARCH BOARD
National Research Council
2101 Constitution Avenue, N.W.
Washington, D.C. 20418

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