# APPENDIX E

## SUPPLEMENTAL INFORMATION

1. Glossary of Terms
2. Significant Designers of Historic Hawaii Bridges
3. Bridge Rehabilitation Guidelines
4. Kuhio Highway (Route 560) Historic Roadway Corridor Plan (2005)
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# GLOSSARY OF TERMS

The definitions of terms used in the inventory report are provided below. For identification of bridge types and individual bridge components, please see Chapter 1. All terms marked with an asterisk (*) are defined by the U.S. Department of the Interior, National Park Service.

**Advisory Council on Historic Preservation (ACHP).** An independent federal agency that promotes the preservation, enhancement, and productive use of our nation's historic resources, and advises the President and Congress on national historic preservation policy.

**American Association of State Highway Transportation Officials (AASHTO).** A non-governmental organization that publishes specifications, test protocols and guidelines utilized in highway design and construction. In 1973, the American Association of State Highway Officials (AASHO) changed its name to AASHTO in order to reflect a broader scope of representation, which now includes not only highways, but also air, rail, water, and public transportation. Where referred to in this inventory report, the organization is thus referred to in context as "AASHO" prior to 1973, and as "AASHTO" in contexts from 1973 to the present day.

**Base Highway Network.** The Base Highway Network includes the through-lane (mainline) portions of the HIS, rural/urban principal arterial system and rural minor arterial system. Ramps, frontage roads, and other roadways are not included in the Base Highway Network.

**Bridge.** The NBI Standards published in 23 C.F.R. § 650.3 give the following definition: A structure including supports erected over a depression or an obstruction, such as water, highway, or railway, and having a track or passageway for carrying traffic or other moving loads, and having an opening measured along the center of the roadway of more than 20 feet between undercopings of abutments or spring lines of arches, or extreme ends of openings for multiple boxes; it may also include multiple pipes, where the clear distance between openings is less than half of the smaller contiguous opening.

**Bridge Management System.** A system designed to optimize the use of available resources for the inspection, maintenance, rehabilitation and replacement of bridges.

**Certified Local Government (CLG).*** A certified local government is a local government (e.g., a City or County) officially certified to carry out some of the purposes of the National Historic Preservation Act, as amended. CLGs are granted authority for reviewing various cultural resources projects which might otherwise require federal review. In addition, CLGs may receive special grants for cultural resources activities.

**Commonly Recognized (CoRe) Structural Elements.** A group of structural elements endorsed by AASHTO as a means of providing a uniform basis for data collection for any bridge management system, to enable the sharing of data between States, and to allow for a uniform translation of data to NBI Items 58, 59, 60 and 62.

**Contributing Resource.*** A building, site, structure, or object adding to the historic significance of a property.

**Culvert.** A structure designed hydraulically to take advantage of submergence to increase hydraulic capacity. Culverts, as distinguished from bridges, are usually covered with

embankment and are composed of structural material around the entire perimeter, although some are supported on spread footings with the streambed serving as the bottom of the culvert. Culverts may qualify to be considered "bridge" length.

**District.*** A significant concentration, linkage, or continuity of sites, buildings, structures, or objects united historically or aesthetically by plan or physical development.

**Federal Aid Primary (FAP).** A system of connected main highways of the Interstate System and important routes, selected by each state highway department subject to the approval of the Bureau of Public Roads.

**Forest Highway.** A road, under the jurisdiction of, and maintained by, a public authority and open to public travel; wholly or partly within, or adjacent to, and serving the National Forest System and which is necessary for the protection, administration, and utilization of the National Forest System and the use and development of its resources (23 C.F.R. § 660).

**Forest Service Development Road.** A forest road wholly under the jurisdiction of the Forest Service, which may be "open to public travel". Bridges on Forest Service Development Roads which are "open to public travel" are subject to the NBIS.

**Hawaii Register of Historic Places (HRHP).** A statewide program to identify, evaluate, register and protect Hawaii's historical resources.

**Highway Performance Monitoring System.** The Highway Performance Monitoring System is a database of universe and sample data that describes the nation's public road mileage. The data are annually updated and submitted to FHWA by the State Highway Agencies, Puerto Rico and the District of Columbia. The universe data provides some basic characteristics of all public road mileage while the sample of the arterial and collector systems allows for assessment of the condition, performance, usage and additional characteristics of the nation's major highway systems.

**Historic American Engineering Record (HAER).*** A nationwide documentation program producing a permanent collection of architectural, engineering and landscape documentation at the Library of Congress consisting of measured and interpretive drawings, large-format black and white and color photographs, written historical and descriptive data, and original field notes.

**Integrity.*** Authenticity of a property's historic identity, evidenced by the survival of physical characteristics that existed during the property's historic or prehistoric period. NRB 15 defines integrity is the ability of a property to convey its significance through its physical features. The National Register criteria recognizes seven aspects or qualities that, in various combinations, define integrity. These aspects are Location, Design, Setting, Materials, Workmanship, Feeling, and Association.[1]

**Inventory Route.** The route for which the applicable inventory data is to be recorded. The inventory route may be on the structure or under the structure. Generally, inventories along a route are made from west to east and south to north.

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[1] NRB 15, *How to Apply the National Register Criteria for Evaluation*.

**Land Management Highway System.** Consists of adjoining state and local public roads that provide major public access to Bureau of Land Management administered public lands, resources, and facilities.

**National Bridge Inspection Standards.** Federal regulations establishing requirements for inspection procedures, frequency of inspections, qualifications of personnel, inspection reports, and preparation and maintenance of a State bridge inventory. The National Bridge Inspection Standards apply to all structures defined as bridges located on all public roads.

**National Bridge Inventory (NBI).** The aggregation of structure inventory and appraisal data collected to fulfill the requirements of the National Bridge Inspection Standards. Each State shall prepare and maintain an inventory of all bridges subject to the National Bridge Inspection Standards.

**National Bridge Inventory (NBI) Record.** Data which has been coded according to the Guide for each structure carrying highway traffic or each inventory route which goes under a structure. These data are furnished and stored in a compact alphanumeric format on magnetic tapes or disks suitable for electronic data processing.

**National Register of Historic Places (NRHP).*** The official list of recognized properties of national, state and local significance in American history, architecture, archeology, engineering, and culture, maintained and expanded by the National Park Service on behalf of the Secretary of the Interior.

**Preservation.*** Preservation places a premium on the retention of all historic fabric through conservation, maintenance and repair. It reflects a building's continuum over time, through successive occupancies, and the respectful changes and alterations that are made.

**Public Road.** Any road under the jurisdiction of and maintained by a public authority and open to public travel.

**Reconstruction.*** Reconstruction establishes limited opportunities to re-create a non-surviving site, landscape, building, structure, or object in all new materials.

**Rehabilitation.*** Rehabilitation emphasizes the retention and repair of historic materials, but more latitude is provided for replacement because it is assumed the property is more deteriorated prior to work. Both Preservation and Rehabilitation standards focus attention on the preservation of those materials, features, finishes, spaces, and spatial relationships that, together, give a property its historic character.

**Restoration.*** Restoration focuses on the retention of materials from the most significant time in a property's history, while permitting the removal of materials from other periods.

**Secretary of the Interior's Standards for the Treatment of Historic Properties.*** Intended to promote responsible preservation practices that help protect our Nation's irreplaceable cultural resources.

**Strategic Highway Corridor Network.** A system of highways which are strategically important to the defense of the United States. It includes the Interstate Highways and 25,215 kilometers of

other non-interstate highways. The Military Traffic Management Command Report SE 89-4b-27, Strategic Highway Corridor Network, January 1991, contains additional information on the Network.

**Structure Inventory and Appraisal Sheet.** The graphic representation of the data recorded and stored for each NBI record in accordance with this Guide.

# SIGNIFICANT DESIGNERS OF HISTORIC HAWAII BRIDGES

**William R. Bartels (Chief Engineer, Territorial Highway Department)**

As Chief Engineer for the Territorial Highway Department (THD), William R. Bartels was responsible for all major territorial bridge projects constructed from 1932 to 1956. In addition to displaying a refined aesthetic sensibility, bridges designed by Bartels characteristically utilized the latest technology and involved a high degree of engineering complexity.

Bartels was a German born engineer who briefly worked for a sugar plantation on Maui before being hired by the Territorial Highway Department in 1932. He designed most of the territorial bridges for the next 25 years. Bartels was responsible for the largest and most sophisticated bridge construction projects in Hawaii during this time, and there was a marked shift towards construction of large deck girder and rigid frame bridges.

In 1950, the THD, under the direction of William R. Bartels, and the Independent Iron Works of Oakland, California undertook the "Seismic Wave Damage Rehabilitation Project." Plans were developed to adapt the existing steel railroad trestles into highway bridges. Utilizing remnants of railroad trestles and trusses, roadbeds were widened and strengthened. The two remaining truss spans of the Wailuku River Railroad Bridge were incorporated into the reconstruction of the Kolekole Highway Bridge. Two concrete piers from the truss bridge remain in use under the present Wailuku Bridge, which carries the Hawaii Belt Road (FAP 19) over the river.

Bartels ended his tenure as Chief of the Bridge Division at age 70. This was well past the standard age of retirement, but he was kept on by special permission and out of necessity because his abilities were so great.

**Robert M. Belt (Kauai)**

Robert M. Belt served as Resident Engineer and then District Engineer for the THD on Kauai during the first half of the 20th century. Belt's contributions include several bridges significant to the development of the Kauai Belt Road System, as well as bridges that exemplify the geometric styling and increasing complexity characteristic of the late 1930s.

At 365 feet in length, the Waimea Bridge, designed by Belt, was one of the longest bridges on Kauai when it was built in 1940; the engineering of this bridge and the curved lines of its concrete substructure would have been considered complex for its time. An article about the opening of the Waimea Bridge stated that "from an engineer's point of view... it has been one of the most satisfactory construction jobs on the island."

From his work supervising construction of the Wahiawa Bridge on Kauai, Belt reported that the construction process was difficult because the foundations had to be dug quite deep. Subsequently, he wrote about the event in a poem entitled "Prayer of the Inspecting Engineer." He is noted to have written several other poems about early engineering in Hawaii.

**William Hoy Chun (Hawaii)**

William Hoy "Cappy" Chun acted as project engineer for the County of Hawaii during the 1920s and 1930s. Born and raised in Hawaii, Chun was a graduate of the Illinois Institute of Technology. In

1925, Chun was appointed Assistant County Engineer for the County of Hawaii where he was responsible for the "investigations, surveys and preparations of plans and specifications for highways, waterways, sewerage, bridges and reinforced concrete 8 - 8 structures" in the County of Hawaii under the Engineer's Department.[2] During 1931-1932 he participated in Federal Aid Programs where he surveyed and planned the first Federal Aid Highway System on the island of Hawaii, made the first traffic census, and surveyed the North Kona, South Kona, Kohala Mountain, and Hamakua Road projects which totaled forty miles of road.[3]

Chun was the designer of the Wailoa bridge in Hilo (previously listed on the NHRP and since demolished); the Mamalahoa-Waipunahina and Ainako Stream-Waianuenue Bridges (both feature Italianate balustrades and are two of the most ornate open-spandrel arch bridges in the state); and many early concrete slab and girder bridges built for the county during the 1920s along the Mamalahoa Highway.

He also designed the sewer system of Hilo in the 1930s and was the chief engineer for Hilo Water Works until 1961.[4] Working with Chun on many projects was En Leong Wung of whom little is known. Wung designed many important county bridge projects and later served as County Engineer until he stepped down in 1946.

**G.K. Dawson (Oahu)**

G. K. Dawson, an engineer with the City and County of Honolulu, is credited with designing the steel truss Kaukonahua Bridge (also known as the Karsten Thot Bridge) in 1932. The Karsten Thot Bridge was constructed at a major crossing, the north fork of the Kaukonahua Stream, north of Wahiawa, a sugar plantation town in central Oahu. The bridge was an important transportation link for the central Oahu region and contributed to the growth of Wahiawa, in particular.

The Karsten Thot Bridge is the only steel truss erected in Hawaii during the Depression-era. The construction and material choice was likely made possible due to cost considerations regarding the bridge's long span (210 feet) required by the Kaukonahua Stream; it was authorized by the City and County of Honolulu, despite the THD's policy against the use of metal bridges due to salt water corrosion problems. It is one of only three metal trusses in the islands and the only bridge of its type on Oahu.

**Ralph L. Garlingouse (Kauai)**

Ralph L. Garlinghouse was one of two main County Engineers for Kauai during the early 20th century. Garlinghouse and Joseph H. Moragne, who acted as County Engineer during the early 1900s, designed and/or oversaw most of Kauai's early bridge construction projects.

Bridges designed by Garlinghouse include: Koloa Bridge (1928), constructed to by-pass and straighten out the old belt road; the Waipa Bridge extension (1925), which added a 90-foot long, five span, cast-in-place concrete structure; and the Lawai Bridge widening (1928), a reinforced

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[2] L.C. Newton, ed., *Who's Who of the Island of Hawaii*, Vol. I (Hilo, Hawaii: John A. Lee, 1939), 52-53.
[3] Ibid., 52-53.
[4] Ibid., 52-53.

concrete solid-spandrel arch deck bridge originally constructed circa 1907 – it is the only remaining arch deck structure on Kauai.

**Hugh Howell (Maui)**

Hugh Howell served as the County of Maui Engineer from 1905-1913 and as a private roads contractor from 1913- 1921. Howell was responsible for much of the initial road and bridge construction work on the Hana Belt Road in both his public and private professional capacities.

**Joseph Hughes Moragne (Kauai)**

Joseph Hughes Moragne, was born and educated in Alabama. Prior to his arrival in Hawaii in 1898, he served in the U.S. 2nd Regiment, 5th Engineer Battalion during the Spanish-American War. He worked with the Territorial Survey Department and the Territorial DPW until he became the first County Engineer for the County of Kauai Engineer's Office in 1907.[5]

Following a recommendation from the SPW to use concrete arch bridges "wherever the span is not too great," Moragne popularized the use of reinforced concrete on Kauai beginning in 1909.[6] He also engineered the Kauai Belt Road, constructed from 1910-1920, engineered the Kokee irrigation system, and during the 1920s designed the Hanalei and Kaapoko Tunnels, which spanned 6,028 feet and 3,558 feet, respectively.

Significant bridges designed by Moragne include: the Waioli Bridge (1912), the earliest concrete girder bridge on Kauai and in the state at the time of its construction; the Huleia Cane Haul Bridge (1909), the first reinforced concrete bridge built in Hawaii; and the Hanalei River Bridge (steel truss, 1912) and the Waipa Stream Bridge (concrete, 1912), some of the earliest examples of road construction progress and development through formal engineering expertise and industrial technology funded by the new Territorial Government.

**Fred Ohrt (Oahu)**

Previously of the firm Libby, McNeill & Libby, Fred Ohrt became the first Manager and Chief Engineer of the Honolulu Board of Water Supply in 1929 and remained in the position until 1952. Among his many endeavors as Chief Engineer, he also established a primary principle that construction necessary to support a utility need not spoil the surrounding landscape, thus balancing aesthetics, functionality, and nature unique to the islands.[7]

Along with fellow designer Guy Rothwell, Ohrt is credited with designing the Anahulu Stream Bridge (1921), which carries Kamehameha Highway across the Anahulu Stream in Haleiwa. This unique double "rainbow" or Marsh through-deck arch bridge constructed of reinforced concrete exhibits the work of highly skilled craftsmen and designers. The bridge's historic association as an important civic structure associated with the development of Haleiwa can be readily discerned by pedestrian and automobile traffic along Kamehameha Avenue.

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[5] "Civil Engineer Joseph H. Maragne," *The Garden Isle* (Lihue, Hawaii), April 21, 2013.
[6] Ibid.
[7] "EAH History," Engineers and Architects of Hawaii, accessed August 23, 2013, https://sites.google.com/site/eahawaii2/eahhistory.

**Guy Rothwell (Oahu)**

Guy Rothwell attended Oahu College (Punahou School) and graduated from the University of Washington with a degree in architectural engineering. He began his career as a Navy Yard draftsman in Puget Sound, Washington, and worked as a ship draftsman at the Navy Yard in Pearl Harbor during the First World War. In 1924, he became a Registered Professional Engineer and Architect within the Territory of Hawaii.

Along with fellow designer Fred Ohrt, Rothwell is credited with designing the Anahulu Stream Bridge (1921), which carries Kamehameha Highway across the Anahulu Stream in Haleiwa. This unique double "rainbow" or Marsh through-deck arch bridge constructed of reinforced concrete exhibits the work of highly skilled craftsmen and designers. The bridge's historic association as an important civic structure associated with the development of Haleiwa can be readily discerned by pedestrian and automobile traffic along Kamehameha Avenue.

Rothwell's other buildings include: Palama Settlement in Kalihi, the Harris Memorial Church in Nuuanu, Roosevelt High School, Honolulu Hale (City Hall), the Honolulu Stadium, the 1928 gymnasium at the University of Hawaii at Manoa, and the Beretania, Kalihi, and Kaimuki pumping stations for the Sewer and Water Commission of Honolulu.[8]

**W.F. Way (Oahu)**

W.F. Way designed the Puowaina Drive Bridge (at Auwaiolimu Street), constructed in 1936. The bridge, a reinforced concrete continuous tee beam structure built on reinforced concrete trestles, exhibits a high level of complexity for its time due to the continuous tee beam design of the structure, which eliminates the need for expansion joints in the deck, and because of its exceptional height.

**John Mason Young (Hawaii)**

John Mason Young was born in Lewisburg, Tennessee in 1847. Following his military stint in the Spanish American War as a young man, Young became Professor of Mechanical Engineering at the University of Florida, his alma mater. While obtaining additional engineering degrees from Cornell University, Young worked for various companies on the east coast designing bridges and cableways.[9]

In 1908, he became the first Professor of Engineering at the University of Hawaii at Manoa and was instrumental in helping to draw up plans for the campus and oversee construction of four campus

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[8] "Descendants of Captain Robert Brown, 1809 – 1894," http://www.captainbrown.net/famtree/nti/nti00550.html (accessed August 23, 2013); Victor N. Kobayashi, *Building a Rainbow: A History of the Buildings and Grounds of the University of Hawaii's Manoa Campus* (Honolulu: Hui O Students, University of Hawaii at Manoa, 1983), 41, retrieved from https://evols.library.manoa.hawaii.edu/items/31e17ed4-f256-4c8a-b20a-f5c781d05a00..

[9] Carin Lim, "The Young Quadrangle (1915, 1925, 1928)," in *Building a Rainbow: A History of the Buildings and Grounds of the University of Hawaii's Manoa Campus*, ed. Victor N. Kobayashi (University of Hawaii at Monoa: Hui O Students, 1983), 21-24.

buildings: Hawaii Hall, Miller Hall, Dean Hall, and Crawford Hall. That same year, he also founded the Pacific Engineering Company, which helped construct many significant buildings in Hawaii.[10]

Young worked with William R. Bartels on the design of several steel trestle bridges constructed during the 1950s along the Hawaii Belt Road (FAP 19). The five steel trestle bridges associated with Young include: the Paheehee Stream Bridge (1950), Kapue Stream Bridge (1950), Nanue Stream Bridge (1952), Umauma Stream Bridge (1952), and Hakalau Stream Bridge (1953) – one of the longest bridges in the Territory at 774.9-feet long at the time of its construction.

[10] Ibid., 21-24.

# BRIDGE REHABILITATION GUIDELINES

## SOI STANDARDS AND POST-1945 PROGRAM COMMENT BRIDGES AND CULVERTS

### STANDARDS AND GUIDELINES FOR THE TREATMENT OF HISTORIC BRIDGES

The principles, priorities, and guidelines for rehabilitating historic bridges comprised in this document are intended as a preliminary guide for evaluating rehabilitation options and determining appropriate treatments of historic bridges. These guidelines should be considered along with other requirements such as safety, cost-effectiveness, and other factors normally considered in bridge rehabilitation projects. The term “historic bridge” is applied to those bridges listed on or determined to be eligible for the NHRP by the application of criteria developed for that purpose.

A coherent approach to the treatment of historic bridges requires (1) identification and evaluation of the resources to be preserved or protected, (2) a comprehensive plan for dealing with the resources identified, and (3) a methodology for the application of appropriate treatments, including standards and guidelines.

The identification and evaluation of structures and a commitment to preservation plans are necessary steps for the retention of historically significant bridges. The successful implementation of a bridge preservation program is dependent upon acceptable guidelines and standards that accommodate the perspectives of both the preservation community and transportation agencies. Because civil engineering structures primarily serve functions in the public domain, their preservation focuses attention on what appears to be diametrically opposed legislative mandates. Thus, today's bridge repair and replacement projects bring together two sets of professionals whose divergent approaches have been established by legislation whose ultimate aim is the public good.

At present, the standards referred to in bridge rehabilitation projects are: AASHTO Load and Resistance Factor Design (LRFD) Bridge Design Specifications, adopted by the American Association of State Highway and Transportation Officials (AASHTO), and the Secretary of the Interior’s Standards for Rehabilitation and Guidelines for Rehabilitating Historic Buildings. The first is a detailed manual on bridge design; the second is a set of ten standards and expanded guidelines for the evaluation of proposed rehabilitations. The former must be quantitative and detailed to be useful for safe design practice, while the latter must be qualitative and broad enough to be applicable to a wide variety of historic resources.

Structural inadequacies can be corrected by rehabilitation alternatives which include strengthening the critical members, adding supplemental members, reducing the dead load, modifying the structural system, and repairing or replacing damaged members. The most obvious structural deficiency is inadequate load-carrying capacity for the superstructure. Other, often hidden deficiencies include mechanical problems with joints, bearings or other details, and substructure deterioration or instability. Engineering concerns are compounded by problems of functional obsolescence which include inadequate geometrics (vertical clearance, deck width, and approach alignments), inadequate safety barriers, and inadequate hydraulic capacity. Solutions to correct these defects are complex because bridges are "pure" structures designed to

carry maximum loads with minimal materials. Unlike the case for most buildings, the structural framework of most bridges is exposed and unsheathed. Therefore, working on the structural system without affecting the appearance of the structure is extremely difficult.

It is difficult to force an old bridge, designed for the loads, speeds, and vehicles of decades past, into the design mold for a new bridge. This problem has been acknowledged by the FHWA and the ability to grant exceptions to AASHTO standards for historic bridges has been addressed by officials of that agency in the past few years. A report issued by the FHWA in October 1984, “Mitigation Options Related to Historic and Archeological Properties,” states:

> The standards are unlikely to be changed or modified now or in the near future. However, the frequency of granting exceptions is likely to increase as those standards are being questioned more routinely. Division Administrators are authorized to grant exceptions on a case-by-case basis if they believe the exception is justified.

The AASHTO's issued Policy on Geometric Design of Highways and Streets (2004) includes historical significance as a factor for granting exceptions on local roads and streets:

> Existing substandard structures should be improved, but because of their high replacement cost, reasonably adequate bridges and culverts that meet tolerable criteria may be retained. Some of the non-technical factors that should be considered are the esthetic value and the historical significance attached to famous structures, covered bridges, and stone arches.

It is important to recognize throughout the rehabilitative process the need to emphasize public safety. Thus, exceptions are granted on a case-by-case basis, and they specifically state that such exceptions are not to be construed as precedent-setting actions. "Tolerable criteria" have sometimes been interpreted to include engineering studies that support the capacity of a bridge to carry the anticipated loads and traffic safely, and an accident frequency that is not abnormally high. Non-technical factors which should be considered when determining the treatment of historic bridges include the degree of local public interest in the bridge; the importance of the bridge as a representative of the period, type of design, or example remaining in the state; the cost-effectiveness of rehabilitation; and the extent and magnitude of variances from AASHTO standards. The needs of each bridge and its site must be considered in light of the needs of the overall highway network. In cases where a substandard historic bridge meets tolerable criteria, exceptions may be encouraged by local transportation officials when guidelines for the appropriate treatment of historic bridges are readily available.

## Standards and Guidelines for Rehabilitation of Historic Bridges

The STANDARDS, patterned after the Secretary of Interior's “Standards for Rehabilitation,” are intentionally general so as to be applicable to all bridges. They are not rigid rules which evaluate all bridges alike. While there is a system of options and alternatives which may apply to most bridges, each historic bridge should be evaluated on its own merits with respect to its historic, character - defining elements. A hierarchy of important elements for each bridge should be established and referred to as rehabilitation plans commence. Thus, creative solutions might be found in the process of designing necessary upgrades.

The GUIDELINES consist of a general section that addresses structural upgrading, geometric modification, materials repair and maintenance, and removal to a less demanding site. Following the general guidelines are additional guidelines which may be necessary when considering non-vehicular uses, replacement, or bridges located in historic districts. Through AASHTO, *Historic Bridge Preservation Guide*, 1st Edition, was published in 2020 and is available for reference online at: https://store.transportation.org/Item/CollectionDetail?ID=215.

The concepts contained in this document are intended for use in the treatment of all historic bridges and should not be restricted solely to bridge rehabilitation and replacement projects. The STANDARDS and GUIDELINES are applicable to any historic bridge project, including upgrading for safety or other purposes and bridge maintenance. It is hoped that the document will serve as a framework for an expanded version of guidelines that may be compiled as the body of information from successful bridge rehabilitation projects develops.

## STANDARDS FOR THE TREATMENT OF HISTORIC BRIDGES

The decision to retain a bridge in service must be based on legislative mandates and considerations such as economy, safety, and the existing and future transportation needs of the overall highway network. The historical importance of the structure at the national, state, and local levels must be fully considered to assure a reasonable, balanced decision. As suggested in AASHTO's most recent policy, where the bridge meets tolerable criteria, exceptions to current accepted engineering standards should be sought.

Regardless of which alternative is chosen for rehabilitation of the historic bridge, the treatment should be carried out with careful consideration of the following standards:

1. Every reasonable effort should be made to continue the historic bridge in some form of useful transportation service. Primary consideration should be given to rehabilitation of the bridge on site. Only when this option has been fully exhausted should other alternatives be explored.

2. The original character-defining qualities or elements of a bridge, its site, and its environment should be respected. The removal, concealment, or alteration of any historic material or distinctive engineering or architectural features should be avoided when possible.

3. All bridges should be recognized as products of their own time. Proposed alterations that have no historical basis and which seek to create a false historical appearance should be discouraged.

4. Changes which have taken place in the course of time may be evidence of the history and development of a bridge, its site, and its environment. These changes may have acquired significance in their own right, and this significance should be recognized, be carefully evaluated, and respected.

5. Distinctive engineering and stylistic features or examples of skilled craftsmanship which characterize a bridge should be treated with sensitivity.

6. Deteriorated structural members and architectural details should be retained and repaired, rather than replaced, whenever possible. In the event replacement is necessary, the new material should match the material being replaced in design, color, texture, and other visual qualities.

7. The surface cleaning and treatments of bridges should be done with processes that will not damage the historic materials.

8. Every reasonable effort should be made to protect and preserve significant archeological and other cultural and environmental resources by or adjacent to any bridge.

9. Contemporary designs for new bridges located in historic districts, should not be discouraged. Contemporary designs for proposed alterations and additions to historic bridges should be compatible with the size, scale, visual quality, and character of the historic district, or of the bridge and its environment, and any alterations and additions should not destroy or conceal significant structural, architectural, or historical materials.

10. Wherever possible, additions or alterations to bridges should be made in such a manner that their subsequent removal would not impair the essential form and integrity of the original bridge.

## FEDERAL GUIDELINES FOR THE TREATMENT OF HISTORIC BRIDGES

### THE SURFACE TRANSPORTATION AND UNIFORM RELOCATION ASSISTANCE ACT OF 1987

The Surface Transportation and Uniform Relocation Assistance Act of 1987 (Public Law 100 - 17), Section 123 (f), Historic Bridges, established a series of requirements and emphasis areas concerning historic bridges on and off the Federal Aid system.

The legislation encouraged states to give special consideration to rehabilitating, reusing, and preserving historic bridges by explicitly making these activities eligible for reimbursable project costs on bridges in service for motorized vehicles. It is the policy of the Federal Highway Administration (FHWA) to consider a wide range of preservation options including avoidance, rehabilitation, modified use, marketing, and relocation. If the load capacity and safety features (geometrics) of a historic bridge are adequate to serve on the public road at its existing location, the bridge should be rehabilitated at a reasonable cost, so it can continue to provide service. If the bridge's load capacity and safety features are adequate to serve on a public road at another location, the movement of the bridge to the new location should be considered as part of the original project. If such relocation of the historic bridge is made part of the Federal Aid proposal, then reasonable costs associated with actions to relocate and preserve the historic integrity of the historic bridge are eligible for reimbursement without reference to the cost of demolition.

These actions could include work approved by the FHWA which ensures the historical integrity of design, scale, and materials. This would include replacing portions of historic elements of the structure in - kind, cleaning, repainting, or rehabilitating to maintain (preserve) both the structural and the historic integrity of the historic bridge. At the completion of the project, the bridge may no longer be classified as deficient for purposes of the NBI for at least 10 years.

## PRESERVATION

The Surface Transportation and Uniform Relocation Assistance Act (STURAA) of 1987 makes funds, which otherwise would have been used for bridge demolition, available for actions to preserve or reduce the impact of the project on a historic bridge.

In the case of historic bridges which can no longer be used on a public road, reasonable costs associated with preservation could include modification for recreational use, relocation, etc. The FHWA will determine the reasonable level of funding, not exceeding the estimated cost of demolition (based upon professional advice of the state highway bridge engineer). These bridges will be removed from the NBI and are no longer eligible for FHWA funding.

STURAA imposes a requirement that, prior to demolition of a historic bridge, the state shall market (sell or donate) the bridge to a state or local government agency or responsible private entity. This preservation effort is to be coordinated with the SHPO and the local historical society to ensure that a reasonable audience is reached and a good faith effort is made.

In the marketing effort, the state needs to specify what preservation work is needed; that reasonable funding is available for the preservation work; and that any potential recipients must be able to demonstrate their ability to assume legal and financial responsibility for the bridge, including holding highway agencies harmless in any liability action. Any non - governmental party must be able to demonstrate its economic and administrative ability to perform the essential obligations necessary for the operation of the bridge.

If a bridge cannot be sold and a recipient accepts donation of the bridge, the recipient can be reimbursed for costs incurred in such activities as relocation, site preparation, reassembly, etc. Costs eligible for reimbursement to preserve a historic bridge which is no longer used on a public road shall not exceed the estimated cost of demolition. Maintenance costs (including prepaid annuities) are not eligible for reimbursement. No bridge will be marketed or donated to a party unless that. party agrees to; (1) accept title, (2) maintain (preserve) the bridge and the features that give it its historic significance (qualities that qualify it to the National Register), and (3) assume all future legal and financial responsibility for the bridge and to hold the state highway agency and the FHWA harmless in any liability action. In the event that no acceptable party is found by a good - faith effort and within a reasonable period of time, the requirements of the new legislation are satisfied and the FHWA may complete the Section 106 and Section 4(f) processes.

## GENERAL GUIDELINES FOR THE TREATMENT OF HISTORIC BRIDGES

The specifics of each historic bridge and its environment will determine whether rehabilitation options for the continued use of the bridge are feasible. In planning the proposed treatment of a historic bridge, the following priorities should be explored.

### *CONTINUED USE FOR VEHICULAR PURPOSES*

The preferred use for historic bridges is continued service for vehicular purposes. This alternative will probably require consideration of one or more of the following:

I. Structural Upgrading

   a. Identify the structural system and its individual character-defining features.

i. The structural system should be evaluated using non-destructive testing techniques, where possible.

ii. Passive solutions which adjust the live load by restricting vehicles should be explored, examples include load posting, signaling, and channeling.

iii. The structural system should be respected, and its visual characteristics should be retained if modifications are necessary.

1. The original load-carrying system should be retained, if possible.

2. The dead load should be reduced by providing a lighter deck system, if possible.

3. If the load-carrying system must be altered, the character-defining visual qualities of the original structural system should be retained. Modified systems which can be visually minimized include the introduction of structure continuity and other methods of reinforcement.

4. If visual modifications are necessary, they should be kept as unobtrusive as possible.

a. Modifications may include changing the configuration of isolated members or the addition of helping structures.

b. Supplemental members should be added as needed under the deck of the structure, if possible.

b. Modifications should follow the following guidelines:

i. Visually intrusive structural modifications should be kept as inconspicuous as possible, and should affect only secondary views, if possible. Consideration should be given to whether there is a primary view.

1. Bridges which carry highways are seen by roadway travelers from afar, in elevation, and while traveling on the bridge deck. Modifications should be made with this in mind.

2. Where circumstances are such that the primary view is from below the bridge, such as an overpass, modifications should be made accordingly.

ii. Modifications should be so designed that there is the least possible loss of historic material, and so that the character-defining features are not obscured, damaged, or destroyed.

iii. Structural modifications, or helping structures, should be clearly differentiated from the historic bridge. The design should be compatible in terms of mass, materials, scale, and detail.

iv. Traffic railings, or safety barriers, should be designed to meet requisite load requirements, and at the same time should be designed and installed so that character-defining features of the bridge are not obscured or damaged.

v. Deteriorated structural elements should be replaced in kind or with a material which duplicates the visual appearance of the original element.

II. Geometric Modifications

a. Evaluate the geometric constraints of the bridge in the context of the overall highway network. Determine realistic needs for geometric parameters in light of connecting highways, projected traffic volumes, accident history, and the proposed nature of future traffic needs.

b. Explore passive (off-bridge) solutions.

i. Adjust alignment of the approaches, restrict the bridge to one-way traffic, or both.

1. Create holding lanes for traffic at the approaches to a one-lane bridge with appropriate provisions for safety.

2. Leave the historic bridge in place for one-lane traffic and move a visually compatible historic bridge to an adjacent site to carry the second lane.

3. Leave the historic bridge in place for one-lane traffic and construct a visually compatible new bridge on an adjacent site to carry the second lane.

ii. The flow of approaching traffic should be adjusted by restricting vehicles, restricting speed, or installing signs and traffic signals.

iii. Provide sidewalks external to the bridge for pedestrian safety.

iv. The bridge should be widened by cantilevering a new deck from either side of the existing structure, where structurally feasible and aesthetically and historically appropriate.

v. Alter the geometric configuration of the bridge to remedy geometric deficiencies.

1. To increase the vertical clearance on through bridges, the depth of the portal frames and sway frames should be reduced with minimum possible destruction of historic fabric.

2. To increase the vertical clearance on grade-separation structures, the superstructure should be raised or the roadway lowered.

3. To increase the roadway width, some types of structures can be modified (e.g., multigirder, some concrete and stone bridges).

Modifications should be designed to be compatible with the original structure.

III. Materials Repair and Maintenance

a. Identify features that are important in defining the overall historic character of the bridge.

b. Historic materials should be repaired, if possible. If replacement of a feature is necessary, it should be replaced in kind or with a compatible substitute material.

i. Masonry Superstructure and Substructure

1. Drainage and vegetation

a. Provide proper deck drainage systems which do not damage or promote deterioration of the superstructure or substructure.

b. Remove vegetation growing on bridge superstructure or substructure.

2. Cleaning

a. Clean masonry only when necessary to halt deterioration or to remove heavy soiling.

b. Clean masonry with the gentlest method possible.

c. Use cleaning method on test patches to determine long-range detrimental effect of cleaning.

3. Repointing

a. Remove deteriorated mortar by carefully hand-raking the joints to avoid damaging the masonry.

b. Duplicate old mortar in strength, composition, color, and texture.

c. Duplicate old mortar joints in width and joint profile.

4. Repair of deteriorated sections

a. Replace extensively deteriorated or missing features in kind or with a compatible substitute material.

b. Replace masonry sections that are not repairable, in kind, using the same materials or compatible substitute materials. Dismantle deteriorated sections by hand, and with care.

c. Do not apply non-historic coatings, such as stucco, gunite, and sealants, to masonry surfaces as a substitute for repointing and masonry repairs.

ii. Metals

1. Cleaning

a. Identify metal prior to cleaning and test for gentlest possible cleaning method.

b. Use the gentlest possible cleaning methods for cast iron, wrought iron, and steel (structural metals found on historic bridges) to remove paint buildup and corrosion. If hand scraping and wire brushing prove ineffective, low pressure dry grit or walnut shell blasting may be used as long as it does not abrade or damage the surface. Test patches should be cleaned to determine damage.

2. Repaint with colors that are appropriate for the historic bridge.

3. Replace deteriorated or missing decorative elements in kind or with a compatible substitute material.

iii. Wood

1. Repair historic wood features by patching or reinforcing, using recognized preservation techniques.

2. Replace in-kind historic wood features which need to be replaced. If replacement in- kind is not possible, substitute materials that are compatible in texture and form, and that convey the same visual appearance as the original.

IV. Removal to a Less Demanding Site

a. If possible, seek a less demanding site on the existing transportation system.

b. If possible, find a new owner for the historic bridge among public agencies such as state parks and recreation departments, or county or municipal parks departments, or state tourism agencies.

c. If a new owner cannot be located in the public sector, an owner in quasi-public or nonprofit groups should be sought.

d. If no recipient can be found in public or quasi-public groups, an owner in the private sector may be sought.

e. Ensure that the recipient of the bridge is prepared to maintain it, and rehabilitate it if necessary. A preservation covenant or restriction may be necessary to ensure this.

f. When possible, undertake the selection and preparation of a relocation site in the proximity of the original site.

g. Prior to removal, make a complete and comprehensive inventory of all bridge parts. The parts should be carefully numbered and referenced to the inventory for identification.

h. If possible, remove the bridge without disassembling.

i. If disassembly is necessary, disassemble the bridge in such a manner as to allow for its reassembly.

j. Reassemble the bridge to duplicate its original configuration.

k. Do any required cleaning or repair of the bridge in conformance with previously stated guidelines as appropriate.

### *CONTINUED USE FOR NON-VEHICULAR PURPOSES*

If it is not feasible to continue a historic bridge in service for vehicular purposes, priority shall be given to continued use for non-vehicular purposes, at an existing site or at a new site. Preference shall be given to transportation-related uses of the historic bridge. Non-vehicular uses of a historic bridge may include:

1. Transportation-Related Functions

    a. Where feasible the bridge should be retained in a transportation or transportation-related function.

        i. While the most feasible transportation use may be to leave the bridge in place as a bicycle or pedestrian crossing, or to move it to a public park or recreation area for the same purpose, other uses and other locations should not be precluded, including ones that involve private ownership.

        ii. Adaptive use *in situ* will often be the only alternative for masonry or concrete bridges because of their nature or size. However, others are movable, particularly metal and timber trusses. In instances where the features in the immediate vicinity of the bridge have an associative value, preference should be given to adaptive use *in situ*. This is particularly important where the bridge is located within the boundaries of a historic district, or is clearly associated with contemporary transportation or industrial features.

        iii. In choosing among alternatives, greater consideration should be given to those factors that will enhance or protect the historic bridge than to the specific nature of the adaptive use or its location. Such factors include: provision for maintenance; protection from vandalism; accessibility to the public; and opportunities for interpretation.

        iv. While an adaptive use may reflect a reduced level of loading, structural adequacy for the new use must still be determined, and rehabilitation undertaken when appropriate.

v. The selection and preparation of an alternative site should be undertaken with sensitivity to the historical use and siting of the bridge.

1. A bridge that has distinctive features that link it with a particular use should be used in its historical context.

2. Bridges should not be placed where they are clearly too long or too short for the obstruction that they span, and skews generally should be avoided. New abutments should be of compatible design and clearly distinguishable from the historic bridge.

vi. Consistent with safety considerations, the structure itself should be returned to its historic configuration by removing visually obtrusive, non-character-defining elements that may have been added to permit the bridge to serve its present function, but which are not required for the new function. These might include elements added to enhance stiffness or load capacity, or secondary features, such as modern decks and guardrails.

vii. Elements which have been added to the bridge over the course of its history and which are determined to be character-defining should not be removed.

viii. Missing nonstructural elements of the bridge, including decorative features, that are distinctive of the style, type, or period in which the bridge was built should be replaced if they can be replicated from similar elements that survive on the same or a similar bridge.

2. Non-Transportation-Related Functions

a. If it is not feasible to retain the bridge in a transportation-related function, consideration should be given to non-transportation-related uses including public recreational uses, use as interpretive sites or museums, or architectural adaptations that could provide residential, commercial, or educational space.

i. In such instances, the adaptive use should not obscure or alter the essential elements of the structure that impart its identity and significance as a bridge.

ii. If the bridge is to remain or be moved within a historic district, careful consideration should be given to the compatibility of the proposed use with the architectural and historical character of the historic district.

iii. Items a.i, a.ii, and a.viii above are equally applicable to architecturally adaptive uses.

3. Adaptive Re-Use

a. If an adaptive use cannot be found, consideration should be given to retaining the bridge either in place or at an alternative location as a historical ruin or monument.

### *REPLACEMENT WITH MITIGATION*

When alternatives for continued use of a historic bridge for vehicular or non-vehicular uses have been considered and determined to be not feasible or prudent, and the historic bridge must be removed from its site, replacement with mitigation is the remaining alternative. Historic bridges which are scheduled for demolition, or alteration which destroys historic integrity, are documented to mitigate the adverse effect of demolition or alteration. Such documentation should be prepared for inclusion in the HAER collection in the Library of Congress. Additional mitigation options include storage and/or salvage of all or parts of a bridge, an alternative generally applicable to metal bridges. Mitigation options may include:

### DOCUMENTATION

The primary criterion in documenting historic bridges is whether the bridge can reveal information critical to understanding and interpreting bridge design, fabrication, engineering, and technology. Documenting bridges can contribute to understanding the development of transportation systems in the United States. Moreover, documentation provides information on the lives and works of individuals and engineers who contributed to advancing bridge technology. The following guidelines are recommended for documentation of historic bridges:

1. When a bridge has been determined to be eligible for the NRHP and all alternatives for preservation are exhausted, the federal and state agencies involved should consult with the appropriate Regional Office of the National Park Service (Western Regional Office in San Francisco) to determine the documentation level required. Generally, the levels of documentation correspond to the level of significance of the bridge as follows:
    a. Documentation Level I for bridges of national significance requires:
        i. Measured drawings,
        ii. Large-format contemporary photographs,
        iii. Photocopies of selected existing drawings (when available),
        iv. Historic photographs and illustrations, and
        v. Written data.
    b. Documentation Level II for bridges of state significance requires:
        i. Large-format contemporary photographs,
        ii. Photocopies of selected existing drawings (when available),
        iii. Historic photographs and illustrations, and
        iv. Written data.
    c. Documentation Level III for bridges of local significance requires:
        i. Dimensioned sketch plans and elevations showing bridge configuration,
        ii. Large-format contemporary photographs, and

iii. Written data.

2. Individuals compiling documentation should be professionally qualified with demonstrable experience in bridge history and in documenting historic bridges.
3. Documentation should focus on the existing bridge and should be an accurate record of existing conditions supplemented by information obtained from reliable secondary sources with documentary limitations clearly stated.
4. Documentation should be prepared in such a manner as to permit the independent verification of information.
5. Documentation should be prepared on materials that are readily reproducible, durable, and of standard sizes that meet accession and archival requirements of the Library of Congress.
    a. Documentation should be clearly and concisely presented.

### STORAGE AND/OR SALVAGE

If storage and/or salvage are part of the mitigation required for the bridge, additional consideration is necessary after documentation, as noted above, has been completed.

1. The goal of salvaging parts or all of the historic bridge should be identified in order to determine appropriate treatment.
2. If future use of the bridge is anticipated, a comprehensive inventory of all bridge parts should be completed. The bridge parts should be carefully numbered and referenced to the inventory for identification.
3. If future use of the entire bridge is anticipated, the bridge should be dismantled with care in such a way as to allow reassembly. The bridge parts should be stored in a place where they will be protected from deterioration.
4. If only portions of the bridge will be salvaged, those portions should be removed with care and stored or delivered to the new owner.
5. Removal to a Less Demanding Site may be applicable.

### SPECIAL CONSIDERATIONS FOR BRIDGES LOCATED IN HISTORIC DISTRICTS

Bridges located within the boundaries of designated historic districts may contribute to, or detract from, the overall character of the historic district. Treatment of an existing historic bridge, a replacement bridge, or a new bridge within a historic district should take into consideration the character of the historic district. Considerations for a bridge located within a historic district may include:

1. Consultation – In consultation with the SHPO, designated historic districts and their important characteristics should be identified.
    a. Identify which features are important in defining the overall historic character of the district.

b. Identify character-defining features of the historic bridge and is relationship to the buildings, streetscapes, and landscapes in the historic district.

2. Treatment – The treatment to be given historic bridges should be established with reference to the Priority Levels presented in the section on Standards and Guidelines for the Treatment of Historic Bridges.

    a. If the bridge is a historic bridge and/or contributing structure within the designated historic district, rehabilitation options may include:

        i. Priority I: Continued Use for Vehicular Purposes, or

        ii. Priority II: Continued Use for Non-Vehicular Purposes

    b. When the bridge cannot be upgraded adequately for continued vehicular use and the site precludes other uses, the historic bridge may need to be replaced. This alternative may require replacement with mitigation, including documentation.

    c. In addition to the evaluation of appropriate treatments for the historic bridge, the design of the replacement bridge should include consideration of the new bridge's compatibility within the historic district.

3. New Bridges – New bridges built in existing historic districts, whether replacement bridges or not, should be designed to be compatible with the character of the historic district in which they are located.

    a. The design and construction of the new or replacement bridge should be compatible with the bridge site and the historic character of the district in terms of size, scale, design, materials, color, and texture.

    b. The design of the new or replacement bridge should preserve the historic relationship between the bridge, its site, and the buildings adjacent to it.

    c. The design of the new replacement bridge should retain the historic relationship between the overall bridge siting and streetscape and landscape features in the district.

    d. If the historic substructure is sound, the replacement bridge should incorporate it as part of the new bridge.

## ADDITIONAL RESOURCES

*Flexibility in Design: A Guide for Achieving Flexibility in Highway Design* ©2004 American Association of State Highway and Transportation Officials.

*NCHRP Document 189: Design and Management of Historic Roads* (Web-Only) National Cooperative Highway Research Program (NCHRP), Transportation Research Board of the National Academies. Prepared by: Mary E. McCahon, Larry Sutherland, and Steven Shaup / TranSystems, Inc. January 2012.

*NCHRP Document 742: Communicating the Value of Preservation: A Playbook* National Cooperative Highway Research Program (NCHRP), Transportation Research Board of the National

Academies. Prepared by: Joe Crossett and Kyle Schneweis / High Street Consulting Group in association with Burns & McDonnell, Parris Communications, and CDM Smith © 2012 National Academy of Sciences.

*Guidelines for Historic Bridge Rehabilitation and Replacement* American Association of State Highway and Transportation Officials (AASHTO) Standing Committee on the Environment. Prepared by: J. Patrick Harshbarger, Mary E. McCahon, Joseph J. Pullaro, and Steven A. Shaup / Lichtenstein Consulting Engineers, Inc. in association with Parsons Brinckerhoff Quade & Douglas, Inc. March 2007.

*Best Practices and Lessons Learned on the Preservation and Rehabilitation of Historic Bridges*. American Association of State Highway and Transportation Officials (AASHTO) Standing Committee on the Environment. Prepared by: Parsons Brinckerhoff, Inc. in association with TranSystems, Inc. and Brelend C. Gowan, JD. July 2012.

*The Preservation Office Guide to Historic Roads: Clarifying Preservation Goals for State Historic Preservation Offices, Establishing Preservation Expectations for State Transportation Departments* Written by: Paul Daniel Marriott, with the generous underwriting of The James Marston Fitch Charitable Foundation June 2010.

*The Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges* Prepared by: Office of Engineering, Bridge Division, Bridge Management Branch December 1995.

*Context Sensitive Solutions* U.S. Department of Transportation, Federal Highway Administration http://contextsensitivesolutions.org.