

THE PRESERVATION OF HISTORIC,
SINGLE-LANE, METAL TRUSS BRIDGES
IN HUNTERDON COUNTY, NEW JERSEY:
ISSUES, CONCERNS, AND TECHNIQUES

A THESIS

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TABLE OF CONTENTS

Acknowledgments	iii
Table of Figures	iv
1.0 INTRODUCTION	1
2.0 LITERATURE REVIEW	8
3.0 METHODOLOGY	20
4.0 BRIDGE TYPES AND SIGNIFICANCE	24
4.1 BRIDGE PRINCIPLES	24
4.2 STONE ARCH	26
4.3 TRUSS	28
4.3.1 <i>Wood Truss</i>	30
4.3.2 <i>Metal Truss</i>	34
5.0 ISSUES	40
5.1 IMPORTANCE OF HISTORIC BRIDGES	40
5.2 HISTORIC BRIDGE LOSS AND REPLACEMENT	43
5.3 POLICIES AND PROGRAMS	46
5.4 INFRASTRUCTURE	57
5.5 MODERN HIGHWAY DESIGN	61
6.0 CONCERNS	67
6.1 SAFETY	67
6.2 LIABILITY	75
6.3 MAINTENANCE	79
6.4 FUNDING	83
7.0 TECHNIQUES	90
7.1 PRESERVATION METHODS	90
7.1.1 <i>Stabilization</i>	93
7.1.2 <i>Rehabilitation</i>	94
7.1.3 <i>Adaptive Reuse</i>	96
7.1.4 <i>Replacement</i>	96
7.1.5 <i>Bridge Park</i>	98
7.1.6 <i>Documentation</i>	99
7.2 Discussion	100

8.0 HISTORY AND BACKGROUND	103
8.1 EARLY COUNTY HISTORY	103
8.2 AGRICULTURAL / RURAL IMPORTANCE	108
8.3 LOCAL TRANSPORTATION HISTORY	114
8.3.1 Hamden Fink Truss Bridge	121
9.0 CASE STUDIES	128
9.1 CATEGORY 1 BRIDGES	131
9.2 CATEGORY 2 BRIDGES	159
9.2.1 White Bridge Controversy	172
9.3 CATEGORY 3 BRIDGES	176
10.0 CONCLUSION	189
10.1 CONTINUE PRESERVATION PRACTICES AND COMMUNITY INVOLVEMENT	190
10.2 PRESERVE COMMUNITY PRIDE AND RURAL ATMOSPHERE	196
10.3 PRESERVE THE SPIRIT OF BRIDGE BUILDING	202
10.4 MANAGE DEVELOPMENT	205
Bibliography	207
Appendix A: Additional Photographs	215
Appendix B: Bridge and Engineering Terms.....	236
Appendix C: HAER Diagrams.....	250
Appendix D: Historic Bridge Significance Chart	253
Appendix E: Survey Questions and Answers	260

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Table of Figures

The maps in this thesis were developed using Hunterdon County, New Jersey, Geographic Information System digital data, but this secondary product has not been verified by Hunterdon County and is not county-authorized.

All maps were designed by Matthew Kriegl.

All photographs were taken by Matthew Kriegl unless otherwise noted.

The bridge diagrams present throughout this thesis were extracted from a poster produced for the Historic American Engineering Record (HAER) in a poster titled “Trusses: A Study by the Historic American Engineering Record.” The complete poster can be seen in Appendix C.

Figure 1: Hunterdon County and Vicinity.	7
Figure 2: Hunterdon County Rural Farmscape.	113
Figure 3: Hamden Fink Truss Bridge.	123
Figure 4: Collapsed Hamden Fink Truss Bridge.	124
Figure 5: Map of Case Study Bridges.	130
Figure 6: Location of Category 1 Bridges.	132
Figure 7: Location of Hollow Brook Bridge.	133
Figure 8: Photograph of Hollow Brook Bridge.	133
Figure 9: Location of the Old Hamden Bridge.	137
Figure 10: Photograph of the Old Hamden Bridge.	137
Figure 11: Location of the Lower Lansdowne Bridge.	142
Figure 12: Photograph of the Lower Lansdowne Bridge.	142
Figure 13: Location of the Rosemont-Raven Rock Bridge.	146
Figure 14: Photograph of the Rosemont-Raven Rock Bridge.	146
Figure 15: Location of Stanton Staton Bridge.	150
Figure 16: Photograph of Stanton Station Bridge.	150
Figure 17: Location of the Locktown-Flemington Bridge.	154
Figure 18: Photograph of the Locktown-Flemington Bridge.	154
Figure 19: Location of Category 2 Bridges.	160
Figure 20: Location of Pine Hill Bridge.	161
Figure 21: Photograph of Pine Hill Bridge.	161

Figure 22: Location of the York Street Bridge.	165
Figure 23: Photograph of the York Street Bridge.	165
Figure 24: Location of the White Bridge.	168
Figure 25: Photograph of the White Bridge.	168
Figure 26: Photograph of the White Bridge.	172
Figure 27: Map of Category 3 Bridge Locations	177
Figure 28: Location of the New Hamden Bridge.	178
Figure 29: Photograph of the Replaced New Hamden Bridge	178
Figure 30: Location of the Potterstown Bridge.	182
Figure 31: Photograph of the Replaced Potterstown Bridge.	182
Figure 32: Location of Valley Station Bridge.	185
Figure 33: Photograph of the Replaced Valley Station Bridge.	185

1.0 INTRODUCTION

The preservation of bridges in the United States is commonly overlooked. Society and transportation officials tend to undervalue these structures and simply view them as a part of transportation infrastructure, otherwise paying little attention to them. However, many of the nation's bridges hold historic significance and help create and retain local character in addition to acting as vital links across rivers.

Through neglect and perceived inadequacy, these bridges are falling into disrepair and being replaced with more modern structures. All across the country, hundred year old craftsmanship and design is being replaced by streamlined, unadorned, structures that weigh heavily on safety, functionality, cost, and ease of construction. Not much consideration is usually given to aesthetics, setting, or historic context.

Nowhere is this more evident than on rural America's less traveled rural roadways. Here, single-lane bridges that have been in place for over a century, comprising of hundreds of designs, varying lengths, and materials, are regarded as outdated relics that pose serious safety hazards to those traveling over their road decks.

In a broad sense, a dichotomy exists between the government and the public on this issue, setting up a complex situation. On one side is the government, interested in safety and liability, and on the other, local residents. Some residents identify the bridges with local character and history of the community's past, advocating preservation. Others see historic bridges as inconvenient, outdated, unsafe, maintenance intensive money pits, favoring replacement. The answer to a bridge's viability lies, not on one side or the other, but somewhere in the middle. Safety and maintenance concerns need to be addressed, but not at the expense of losing a valuable historic and cultural resource.

Whereas in the recent past, these structures were wantonly torn down and replaced, new ideas and attitudes about historic bridges, their preservation, and their role in today's transportation network are now beginning to be developed and more widely accepted. Some states and communities, as long as thirty years ago, began to embrace and value their historic resources (including bridges) putting in place strong preservation programs to ensure the longevity of these structures. Yet there is still a long way to go.

At the crux of the matter are government policies, established and set at the federal level and passed down to the state and local levels. Initially, rigidly set policies all but encouraged single-lane historic bridges to be replaced due to safety concerns and road-bridge geometry and alignment problems. More recently, after examination by transportation officials, engineers, and preservationists, these policies have been amended to allow for greater flexibility and interpretation.

But these advances aside, various policies, funding, and liability concerns continue to riddle the case for preserving rusting and rotting rural bridges. Usually rated

and looked at as functionally obsolete, this is especially true for single-lane bridges. Various contradicting public views of cost, safety, inconvenience, and preservation further compound the situation. However, these rural single-lane bridges serve a significant historic and cultural value and are highly regarded by communities and the residents who live near them.

The value and local respect that these structures garner plays a large role in preventing their demise. Preservation of historic bridges can only successfully occur when the local community understands that these structures inherently hold cultural value and character and retain historic fabric of the community's past. In conjunction, government must also be willing to understand that these are unique structures that help identify local communities in an age filled with modernity and must cultivate and work with new views and ideas of how to retain these structures while ensuring their safety.

As of 2010, there were over 600,000 bridges across the United States of America, new and old, ranging from the grandest examples of suspension bridges to the simplest examples of narrow back country bridges.¹ At almost 450,000 strong, rural bridges make up about three quarters of our nation's total bridges.² Because of their sheer numbers, rural bridges have the greatest impact on the general public. These bridges arguably have the most character, most historic significance, and best retain an area's heritage. But safety has not come in numbers, as rural bridges are also the most overtly threatened. Rural bridges are in a state of (in a sense) preservation by neglect, walking a thin line between remaining intact and collapsing into the water flowing beneath them. While

¹ Better Roads, "Better Bridges 2010 Bridge Inventory: The State of Your Bridges," 2010. <http://www.betterroads.com/category/bridge-inventory/> (accessed February 7, 2011).

² American Society of Civil Engineers, "Report Card for America's Infrastructure: Bridges," 2010. <http://www.infrastructurereportcard.org/fact-sheet/bridges> (accessed February 7, 2011).

heavy focus (and funding) has generally been on interstate and other high profile, high capacity bridges, preservation of rural bridges have mostly remained under the radar, resulting in many being demolished and replaced. Because of the large numbers and types of rural bridges throughout the United States, this thesis seeks to examine just a small portion, focusing on New Jersey.

New Jersey is home to many bridges; some relatively old as this state, along with other states located on the eastern seaboard, was once part of the original thirteen colonies and had been occupied by Europeans beginning in the mid-1600s. Many of the original bridges, however, no longer exist, and as of 2010, New Jersey had 6,493 bridges.³ Nestled in rural northwestern New Jersey along the Delaware River is Hunterdon County. Hunterdon County has a strong historic past revolving around the American Revolution, agriculture, and other events. The county's location, squeezed between New York City and Philadelphia, creates a fierce preservation ethic and awareness for history and rural character in the face of ever encroaching suburbanization.

Hunterdon County contains many examples of different types of bridges of varying lengths, designs, and materials, including arch and truss bridges constructed from brick, stone, cast- and wrought-iron, steel, and wood, as well as other modern materials. With a wide ranging use of materials and designs, all necessitating somewhat differing techniques, this thesis will focus on the preservation of single-lane, metal truss bridges of Hunterdon County.

³ Better Roads, "Better Bridges 2010 Bridge Inventory: The State of Your Bridges," 2010. <http://www.betterroads.com/category/bridge-inventory/> (accessed February 7, 2011).

In a traditionally agricultural and rural county, its rolling hills and fields of corn countering many of the well-entrenched views of New Jersey, preservation has hit relatively few snags. Although there have been some major preservation failures in the past, land and development pressures due to suburbanization are beginning to threaten the county's rural character and historic fabric. Hunterdon County residents and local governments alike have made decisions which seem to favor preservation of both the rural landscape and historic structures, but increasing development pressure is creating difficulty in this endeavor.

This thesis will investigate the importance of retaining historic, single-lane, metal truss bridges by focusing on the issues, concerns, and techniques of both preservation and transportation. Preservationists often do not understand the history or technology of bridges, and this really hurts the cause. It is hard to preserve things when why they are important is not clearly understood. Therefore, this thesis will begin by investigating the issues of historic bridge importance, loss, and replacement; policies; infrastructure; as well as modern road and bridge designs. It will then discuss safety, liability, maintenance, and funding concerns involving the preservation of these structures while ensuring that they remain in use. Lastly, preservation techniques will be addressed and reinforced through the use of case studies.

Additionally, in order to help facilitate context, bridge types and their accompanying historic significance will be described. County and local background information on history, agriculture, and transportation will also be discussed. Hunterdon County's attempt to successfully understand and address these issues and concerns highlight how the county and community act together in order to achieve somewhat

different goals in the preservation of bridges; resulting in the retention of community character, heritage, and historic fabric. The case studies will also show the difficulties involved in bridge preservation and the different, and sometimes controversial, solutions taken in order to find satisfactory resolutions.

The case studies are intended to show how it is possible to mitigate these issues and concerns and strike a balance between safety and preservation in regards to bridges. Moreover, they show that historic, single-lane bridges do not necessarily need to be replaced. The case studies also argue that these bridges are not simply structures but play a wider role, by inherently containing cultural value and community identity, and that replacing them may result in cultural and social implications.



Figure 1: Location of Hunterdon County in relation to other New Jersey counties, major cities, and adjacent states

2.0 LITERATURE REVIEW

Bridges are important resources that serve important functions, such as connecting communities and crossing geographic divides. Many bridges are also of a historic nature and feature unique in their design and craftsmanship seldom seen today. As a result, the preservation of such a fundamental piece of infrastructure is, at times, difficult. This thesis looks at preservation efforts of historic, single-lane, metal truss bridges in Hunterdon County, New Jersey. Preservation issues and concerns of historic transportation resources, here and elsewhere, must be set against the issues and concerns of road and bridge engineers and transportation design guidelines, standards, and policies.

Because bridges are generally owned by governmental entities (this is especially true in New Jersey), much of the information available concerning bridges is geared toward state and local government engineers, who have the responsibility of maintaining these structures. As a result, this information seems very technical to those who are not engineers. In addition, much of this information also comes in the form of legislation, which is also tends to be technical and convoluted to those who are not proficient in law.

When it comes to transportation in the United States, there are three major players: The United States Department of Transportation (USDOT), the American Association of Highway Transportation Officials (AASHTO), and the Federal Highway Administration (FHWA). Much of the literature and publications are geared toward or written by these agencies and groups.

Although the USDOT's main goal is transportation safety, they have also been charged to preserve the environment, scenery, and historic resources when involved in transportation related projects. In 1966, the Department of Transportation Act was signed into law. A major part of this act included the Section 4(f) process. This process, which has been deemed "one of the nation's most stringent environmental laws," essentially forces transportation projects to protect public parks, recreation areas, waterfowl and their habitat, and historic sites.⁴ Unfortunately, although extremely strict and overarching, Section 4(f) does not technically apply to bridges since they are already part of the transportation network. However, there are other federal policies that must be followed during transportation projects. These include the National Environmental Protection Act (NEPA) and the Section 1006 process of the National Historic Preservation Act of 1966.

AASHTO has published several guides, through their Center for Environmental Excellence, to help transportation practitioners wade through this technical and legal information. Three of these guides pertain to efforts of bridge preservation. The first is the "Practitioner's Handbook: Complying with Section 4(f) of the U.S. DOT Act." In

⁴ Center for Environmental Excellence, "Practitioner's Handbook: Complying with Section 4(f) of the U.S. DOT Act," AASHTO. <http://environment.transportation.org/pdf/programs/pg11-1%20lowres.pdf> (accessed October 4, 2010), 1.

this handbook, AASHTO thoroughly describes the Section 4(f) process and how to identify and evaluate Section 4(f) properties. It also contains a list and description of good practices when carrying out the different steps of the Section 4(f) process.

The second handbook deals with the Section 106 process. This book is called “Consulting under Section 106 of the National Historic Preservation Act.” As with the “Practitioner’s Handbook: Complying with Section 4(f) of the U.S. DOT Act,” this book clarifies what steps need to be taken in order to mitigate negative impacts on historic resources. Although this handbook begins with the basics, it is “not intended to serve as a *beginner* introduction to the Section 106 process, nor is it intended to be an exhaustive technical guide for Section 106 practitioners.”⁵ While this handbook, along with the handbook on the Section 4(f) process, is rather technical, helps spell out step by step the processes that need to be followed in order to successfully and legally fulfill the intent of the programs.

Lastly, ASSHTO’s Center for Environmental Excellence has lots of information available about NEPA. Like all transportation projects, bridge projects must be environmentally sensitive, whether constructing a new bridge or rehabilitating an existing structure. Although historic bridges are already in place (and have been for some time) steps must be taken to mitigate harmful environmental effects, such as the removal of lead paint from a bridge, or the repainting a structure.

AASHTO literature, such as its numerous guides are important sources to understand for any transportation related project. Although bridges may be historic, they

⁵ Center for Environmental Excellence, “Practitioner’s Handbook: Consulting Under Section 106 of the National Historic Preservation Act,” AASHTO, <http://environment.transportation.org/pdf/programs/PG06.pdf> (accessed October 4, 2010), 2.

still must meet modern needs. Therefore, modern highway design guidelines must be followed. Over the years, AASHTO has become more sensitive to historic preservation concerns, especially when concerning historic bridges. AASHTO's *Guidelines for Geometric Design of Very Low-Volume Local Roads (ADT<400)* and *A Policy on Geometric Design of Highways and Streets* as well as the National Cooperative Highway Research Program's (NCHRP) publication *Cost-Effective Practices for Off-System and Local Interest Bridges* have been cited numerous times in multiple readings, and although not exclusive to bridges, these publications encompass a greater understanding of how the importance of historic preservation can be better balanced within a perfectly engineered world. These guidelines have been emulated in various ways by multiple states including Indiana, Minnesota, Virginia, Montana, and Texas.

AASHTO also was partially responsible for the report "Guidelines for Historic Bridge Rehabilitation and Replacement." In this 2007 report, prepared by Lichtenstein Consulting Engineers, Inc., historic bridge preservation steps, techniques, and guidelines are examined in great detail and depth. The report acknowledges that although there are "nationally applicable processes for considering preservation or replacement of historic bridges, there is no corresponding protocol that ensures a nationally consistent approach to determining which bridges should be rehabilitated or replaced."⁶ The goal of the report was to "use existing information to the greatest extent possible and then synthesize it (1) to identify effective practices, (2) to provide an accurate assessment of the state of the practice of historic bridge "rehabilitation-versus-replacement" decision making

⁶ American Association of State Highway Transportation Officials, *Guidelines for Historic Bridge Rehabilitation and Replacement*, AASHTO: Washington, D.C., 2008, 1.

among state and local transportation agencies, (3) to identify approaches for consistent and balanced decision making, and (4) to understand if historic bridge “issues” delay projects.”⁷ This report is invaluable for this thesis, bridge engineers, and the preservation community.

In addition to the literature produced by AASHTO and the NCHRP, the FHWA provides a wealth of information related to all aspects of transportation. Located under the USDOT, the FHWA works closely with bridge preservation issues. Most notable are the agency’s efforts in regards to design guidelines, which in many ways mirror AASHTO recommendations. Much of the information is accessible on the internet and includes design standards as well as their application. There are also sections on flexibility in highway and bridge design, the bridge inspection program, and safety devices (guardrails), as well as context sensitive solutions.

The FHWA also discusses specific bridge legislation and policies, including the Highway Bridge Replacement and Rehabilitation Program. (HBRRP), the Surface Transportation and Uniform Relocation and Assistance Act (STURAA), the Highway Bridge Program (HBP), the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU), the National Highway System Program (NHSP), the National Historic Covered Bridge Program (NHCBP), and the Surface Transportation Program (STP) among numerous others. Various funding matters are also examined and discussed at length.

⁷ Ibid., 4.

Issues concerning the crumbling state of the nation's infrastructure were also investigated. Much of this information was supplied by the American Society of Civil Engineers (ASCE). Their website discusses the dismal state of our infrastructure, including bridges, and the associated costs it will take for improvement. These concerns are echoed in "Better Bridges 2010 Bridge Inventory: The State of Your Bridges" by *Better Roads*, and AASHTO's report entitled "Rough Roads Ahead: Fix it Now or Pay for it Later."

Since this thesis focuses on bridges in New Jersey, research into the policies, practices, and publications of the New Jersey Department of Transportation (NJDOT) and other state agencies was undertaken and has yielded numerous important resources. In light of the tragic collapse of the I-35 bridge in Minneapolis in 2007, the NJDOT, evaluated the condition of bridges statewide and published their findings in a report titled, "Highway Carrying Bridges in New Jersey: Final Report." This report illustrates what has been done and what still needs to be done to the state's bridges to ensure their safety. The report breaks down the bridges into multiple categories including state bridges, local bridges, toll authority bridges, and New Jersey Transit bridges, and then discusses size, age, type, and condition. It further breaks down the costs for maintaining these structures on a county-by-county basis and the money needed to eliminate all structurally deficient bridges. The report ends with a series of recommendations, most of which involve increased funding.

New Jersey also has the Historic Bridge Preservation Program which is designed to provide funding for minor repair and enhanced maintenance projects to prolong the

lifespan of New Jersey's historic bridges.⁸ This program was put into place to help counties take care of the state's historic transportation resources.

The NJDOT also had all bridges in the state built before 1947 that are longer than 20 feet surveyed. This information is located in the *New Jersey Historic Bridge Data* publication. Of the 2,064 bridges surveyed more than 250 were deemed eligible to the National Register.⁹ This list was compiled on a county by county basis and describes why each structure may or may not be eligible for listing on the National Register of Historic Places. It also gives a description of the structure along with technical details. This survey was compiled to better understand the historic bridge resources located throughout the state.

One of the most important sources is a report from 2003 that discusses the very issues of preserving historic bridges in America. "Historic Bridges: A Heritage at Risk, A Report on a Workshop on the Preservation and Management of Historic Bridges," by Eric DeLony and Terry H. Klein and funded by the Federal Highway Administration's Office of Project Development and Environmental Review, discusses in extreme depth the issues surrounding the preservation efforts of historic bridges. There is background information followed by recommendations on what to do. The recommendations were formulated in part by a survey compiled in June 2001 by Mead & Hunt and Allee King Rosen & Fleming, Inc. (AKRF), as part of a contract to survey historic bridges and

⁸ New Jersey Department of Transportation, "Local Aid and Economic Development: Program Description and Procedures for Historic Bridge Preservation," State of New Jersey, <http://www.state.nj.us/transportation/business/localaid/documents/HistoricBridgePreservationProgram.pdf> (accessed February 20, 2011).

⁹ Federal Highway Administration, "Historic Bridges," <http://environment.fhwa.dot.gov/histpres/bridges.asp> (accessed March 19, 2010).

develop a management plan for New York State. Nine states (CT, GA, MT, NJ, OH, PA, TX, VT, VA) were queried as part of their study.¹⁰

The report also goes into the policy that the American Society of Civil Engineers have for the rehabilitation of historic bridges.¹¹ The report discusses the reasons that historic bridges are preserved and the forces behind the bridge preservation movement.¹² The report also mentions funding issues and the disconnect between environmentalists, transportation officials, and preservationist.¹³ An interesting note is also made about lawsuits that are filed because of injury on historic bridges.¹⁴ This is an important resource based on the players in transportation, engineering, preservation, environmental arenas.

Richard L. Cleary's book, *Bridges*, takes a more historical look at bridges in the United States. It is comprised of hundreds of historic bridge photographs and technical specifications along with descriptions and Historical American Engineering Record (HAER) drawings of bridges from all across country. In a couple instances, several Hunterdon County bridges are featured in this book including the West Main Street Bridge¹⁵ in Clinton, NJ, and the Raritan River (Hamden) Fink truss bridge (now replaced by a pedestrian bridge (and later discussed in this thesis))¹⁶. This is an immensely important source as it contains so much information on historic bridges. In fact, it also

¹⁰ Eric DeLony and Terry H. Klein, "Historic Bridges: A Heritage at Risk; A Report on a Workshop on the Preservation and Management of Historic Bridges" (Rio Rancho, NM: SRI Foundation, 2004), 2.

¹¹ Ibid., 25.

¹² Ibid., 22.

¹³ Ibid., 21.

¹⁴ Ibid., 21-22.

¹⁵ Richard L. Cleary, *Bridges* (New York: W.W. Norton & Company, 2007), 198.

¹⁶ Ibid., 236.

includes a foreword entitled, “A Call for Preservation,” which expresses concern that America’s historic bridges are being lost.

In his book *Bridges*, David J. Brown also discusses the many different types of bridges, and connects modern structures with the basic earlier principles of bridge design. In the chapter entitled, “New World, Old and New Ideas,” Brown discusses the different truss types that developed in the early- to mid-1800s, such as the Burr arch/truss, the Town Lattice truss, and the Long truss.¹⁷ These are some of the designs that will be investigated. Brown also mentions some basic bridge principles that will be necessary for the understanding of historic bridge construction.

The book, *A Bridge Worth Saving: A Community Guide to Historic Bridge Preservation*, by Mike Mort, lays out the plan of action that needs to be taken in order have a chance of successfully trying to preserve historic bridges. In a step-by-step process, he describes that you need to understand what you are trying to save, how to gain community support, how to raise money for your effort, hiring a consultant or engineer, assessing the values of the bridge, moving it and then repairing it. Although he talks about all the preservation options a bridge has, a big focus is on moving and relocating the historic resource.

Mort puts fourth five alternatives that may be used in trying to save a bridge. The first is to “live and let live,” this means to leave a small bridge in a hardly traveled area alone (as long as it is still structurally sound and all safety issues have been met); the second is “living side by side,” this means to leave the bridge alone and reroute traffic around it on a new bridge that would have been built anyway (limited availability of

¹⁷ David J. Brown, *Bridges* (New York: Mac Millan Publishing Company, 1993), 77-78.

lands makes this option less likely); “rehabilitate for original use” means to keep the bridge as it was meant to be (i.e. a walking bridge); “relocate” the structure to another area (usually demolition costs are equivalent to what it would cost to move the structure); and if it has to be torn down, take good documentation of it.¹⁸ This book also contains case studies and descriptions of historic bridge types, information that is important to understanding the historic bridge preservation movement.

David Fischetti’s book, *Structural Investigation of Historic Buildings: A Case Study Guide to Preservation Technology for Buildings, Bridges, Towers, and Mills*, consists of several case studies that focus on the engineering aspects of historic preservation. While many of the case studies focus on buildings, bridges and their methods of preservation are occasionally mentioned. Unfortunately, Fischetti highlights mostly wooden and timber structures, but many of the core principles are similar. In addition, the beginning chapters discuss the role of the engineer in historic preservation projects and explain the issue of liability during these projects.

Two reports written on behalf of Hunterdon County discuss the topic of bridges. The first report, by Thomas Boothby, Cecilia Rusnak, John Hawkins, and Ageliki Elefteriadou entitled “Stone Arch Bridge Inventory, Phase II: Hunterdon County, New Jersey,” discusses the high number and distinct variations of stone arch bridges throughout Hunterdon County. The report also addresses these structures’ importance in respect to commerce and settlement patterns. The second report, “A Plan for the Reconstruction of the Historic Hamden Fink Suspension Truss,” by A.G. Lichtenstein &

¹⁸ Mike Mort, *A Bridge Worth Saving: A Community Guide to Historic Bridge Preservation* (East Lansing: Michigan State University Press, 2008), 42-47.

Associates, Inc., and Dr. Emory Kemp, discusses the tragic loss of one of the oldest truss bridges in America and the plans of trying to reconstruct it.

In order to get a deeper understanding of the county's history, as well as the important role transportation and bridges played, county history books and articles were examined. George Motts's, *The First Century of Hunterdon County, State of New Jersey*, written in 1878, gives an overview of the important issues and events that took place in early Hunterdon County. This includes accounts of the settling of the area and the Revolutionary War. For a more in depth analysis of local historic issues, academic articles written for the county's 275th anniversary were consulted. Topics included early settlement, agriculture, and transportation. Further research on state and county transportation history was found as part of the state sponsored *New Jersey Historic Bridge Data* survey publication. Again, like the data collected on the individual bridges, the historic transportation background information found in these sources proved to be invaluable for understanding the historical transportation context of the area.

To better understand the historic significance, history, and context of particular bridge types, the report "A Context for Common Historic Bridge Types," by Parsons Brinckerhoff and Engineering and Industrial Heritage is very helpful. This report features drawings, photographs, and descriptions of dozens of different bridge designs and types. In addition it contains simple diagrams to be used in order to help with bridge identification in the field. A chart of bridge type, significance, and a discussion of issues and recommendations makes this report a great resource on historic bridges and their importance.

Despite the myriad of sources that span architectural and engineering specifications and plans, to ideas, policies, and recommendations on how to preserve historic bridges, not too much has been written specifically on single-lane bridges. It may be that these bridges are usually deemed obsolete then demolished and replaced rather than trying to expand them, or by expanding them, their historic fabric and character would be altered beyond acceptable limits, or preservation efforts would require an unreasonable amount of money.

Safety is also a big concern, with heavier, wider cars posing as potential detriment to both the bridge and the driver. This being said however, there are still single-lane bridges around and they do occasionally show up in the literature. In any case, historic single-lane bridges are an important historic resource and attempts should be made to protect them and preserve them whenever appropriate.

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3.0 METHODOLOGY

The goal of this thesis is to give a better understanding of the issues and concerns surrounding the preservation of historic single-lane, metal truss bridges. In order to help combat the many misconceptions that hamper the preservation of these structures, this thesis seeks to systematically address and discuss different preservation and transportation related topics in a logical progression. It will then explore different bridge preservation techniques. A series of case studies will follow, examining how different preservation techniques have been employed by the engineering department of Hunterdon County, New Jersey. The case studies will then be analyzed, highlighting the complex and sometimes controversial aspects of implementing and applying these preservation techniques.

This topic of preserving single-lane, metal truss bridges was chosen because of the alarming rate at which these particular historic resources are being lost. Hunterdon County was chosen as the case study location because of my familiarity with the area as well as abundance of single-lane bridges available for research. Although Hunterdon County has the highest concentration of stone arch bridges in North America, much

research has already been conducted on this type of resource. As a result, the decision was made to focus on single-lane, metal truss bridges, in hopes that the preservation efforts here can be used to help preservation efforts elsewhere.

The thesis will be divided into six major components. In many of these components, focus will be geared toward transportation related concepts. These concepts are important to understand before any serious preservation plans can be successfully realized. It is essential to comprehend that preservation is not a standalone concept. Preserving a house, or other building, involves not only knowing how to do traditional carpentry, but also involves building codes and zoning. The same is true for preserving historic transportation resources, like bridges. The preservation of bridges cannot only be looked at from a preservation perspective, but needs to be seen from an engineering and transportation perspective as well.

The first chapter will address bridge types and their historic significance. Beginning with the evolution of bridge design, the discussion will highlight stone arch, wood truss, and metal truss bridges, along with their impact and historic significance. This chapter will also provide a better understanding for the following preservation techniques and case study chapters.

The next two chapters of this thesis will discuss preservation and transportation issues and what concerns have to be addressed in order to help alleviate these problems. The issues that I have identified include the importance of historic bridges, preservation and transportation policies and programs, infrastructure problems, and modern highway design. These issues are affected in a large part by concerns such as safety, liability,

maintenance, and funding. Without clearly understanding these concerns, it is unlikely that many preservation projects will be able to reach their full potential. A lack of understanding can also lead to unrealistic expectations from the transportation official, engineer, or preservationist.

The fourth component will focus on different types of preservation techniques. The methods that will be highlighted in this section include stabilization and rehabilitation. Following the discussion of these two methods will be a focus on what I shall show to be less desirable methods which include adaptive reuse, the bridge park idea, and replacement. In addition, the historic significance of specific bridge members and components will be explained, followed by a general discussion of when the rehabilitation or preservation of a bridge is warranted and justified.

The fifth chapter will address local history and context. This will include vignettes of early Hunterdon County history, the agricultural and rural importance, and the history of county transportation. This chapter will help provide context for the case studies.

The sixth component involves case studies of historic single-lane, metal truss bridges in Hunterdon County, New Jersey. Thirteen bridges, divided into three categories, will be examined. The categories include bridges that are eligible for listing on the National Register, bridges that are not eligible for listing on the National Register, and bridges that have been replaced. The case studies will be supplemented with interviews from county engineers, site visits, and other supporting documentation. The case studies will be used to demonstrate how preservation techniques are carried out in the field as well as how complex logistical situations are overcome.

All of this research will then be wrapped up in a conclusion. This chapter will tease out the important observations that have been gleaned from the research. The conclusion will also tie all of the research together. The case studies will be analyzed to see what techniques were used as well as the concerns and issues that had to be surmounted.

This research should make the county's decision making process appear clearer. It should also demonstrate how important active citizen participation is in the preservation of historic resources. The conclusion will also address the benefits and needs for continuing a strong bridge preservation program for single-lane, metal truss bridges as well as the importance of a sensitive historic bridge replacement program. Lastly, the county's need for potential development growth management strategies and an investigation of how planning decisions affect the retention of historic transportation resources, such as bridges, will also be addressed in the conclusion.

4.0 BRIDGE TYPES AND SIGNIFICANCE

4.1 Bridge Principles

There are many different types of bridges throughout the United States. These structures range in age, type, design, material, and size. These differences result from varying situations and locations as well as the use of advancing technologies.

Regardless of the design or other advances, all bridges are still bound to the laws of physics and gravity. As a result, all bridges have four forces they must contend with: the forces of tension, compression, shear, and torsion. Tension pulls apart, compression pushes together, while shear cuts and torsion twists. For bridges, these forces are generated in three ways. This is known as *load*. The bridge's own weight is referred to as the *dead load*. This includes the structural members, road deck, and other components such as guard rails. Traffic traveling over the bridge is referred to as the *live load*. This includes anything that enters onto the bridge and then exits off, such as cars, trucks, school busses, tractors, horses, carts, bikes, and people. The last load is based on surrounding environmental pressures and is referred to as the *environmental load*. This

includes wind, earthquakes, ice and snow, floods, river currents, and debris.¹⁹ These loads generate forces which creates stress on the structure. The ability for a bridge to cope with these stresses is known as its strength.

Bridges of all designs must be sufficiently strong to handle the different types of stresses in order to be successful. Knowledge of the qualities and capabilities of a bridge's materials and components along with the abilities and understanding of different designs allow engineers to construct bridges that best fit particular situations. For example, stone possesses compressive strength but lacks tensile strength, while different varieties of timber vary greatly in both tensile and compressive strength.²⁰

Stone and wood are also both vulnerable to shear and torsion. In addition, the use of iron and steel, during and after the Industrial Revolution, outpaced the use of other materials due to its relative superiority in all four strengths.²¹ Early on, cast-iron was used for its compressive strength, while wrought-iron was used for its tensile strength.

Engineers took advantage of these two different materials' attributes, designing them to work together in order to make exceptionally strong bridges. After its development, steel, which contains both tensile and compressive strength, began to be used exclusively for both bridge and building construction. In addition, different bridge designs are able to better handle different situations.

¹⁹ David J. Brown, *Bridges* (New York: MacMillan Publishing Company, 1993), 14.

²⁰ Ibid.

²¹ Ibid.

4.2 Stone Arch

Stone arch bridges can be traced back millennia and are usually credited to ancient Rome. Rome's use of stone arches is prevalent in monumental aqueduct, bridge, and building designs. Many of these structures are still in existence. During the Middle Ages, stone arch bridges continued to be built, and improved, and many of England's stone arch bridges can be dated to this period.²² "By the time of the colonization of North America, the art of building stone arch bridges had matured over more than a millennium."²³

The oldest surviving stone arch bridge in North America is the Frankford Avenue Bridge in Philadelphia, dating to 1697, while the oldest stone arch bridge in New Jersey is the Stony Brook Bridge in Princeton Township, dating to 1792.²⁴ Although, there are and have been large stone arch bridges in North America, their designs were never as refined as their contemporary European counterparts, which were comprised of monumental, large, multiple spans.²⁵

However, during the turnpike building projects of the late 18th and early 19th centuries, significant numbers of new stone arch bridges were constructed across the eastern portion of the country. The turnpike bridges, along with other stone arch bridges being built at the time, became an important part of the nation's infrastructure "in providing safe, reliable, and durable means of crossing streams and rivers."²⁶ No more

²² Thomas E. Boothby et al., "Stone Arch Bridge Inventory, Phase II: Hunterdon County, New Jersey" (University Park, PA: The Pennsylvania State University, 1998), 1.

²³ Ibid.

²⁴ Ibid.

²⁵ Ibid., 1-2.

²⁶ Ibid., 3.

would bridges be logs haphazardly placed over a creek; now more permanent stone structures were built.

The toll roads corporations, although financially struggling, built large numbers of stone arch bridges in the early 1800s.²⁷ Ironically, many of these bridges have been lost due to the later success of the alignment of the now defunct toll roads. Over time, these roads necessitated widening, and as a result, the old stone arch bridges were replaced. These early turnpike bridges were relatively large, usually over twenty feet in length, with some over a hundred feet. From the mid- to late-1800s, other stone bridges were built as portions of canals and the railroads and featured both cut and engineered stones designs. The New Jersey Historic Bridge Survey has identified 13 remaining large stone arch bridges in Hunterdon County with spans over 20 feet, the highest number in the state.²⁸

Yet these larger bridges only account for a small portion of the stone arch bridges located throughout Hunterdon County. The majority of county's stone arch bridges are small scale with 10-20 foot long spans and are commonly known as 'country bridges.' Throughout the county, there are over 100 of these structures, making Hunterdon the largest concentration of stone arch bridges in North America.²⁹ According to the report "Stone Arch Bridge Inventory, Phase II: Hunterdon County, New Jersey," which was produced for Hunterdon County, these bridges are "rustic in location, being on farm to market roads off the major through routes, rustic in construction, being built crudely from locally available materials and following simple patters for the configuration of the

²⁷ Ibid., 18.

²⁸ Ibid., 18.

²⁹ Ibid., 18.

structures' elements."³⁰ In addition, the report notes, "nearly all of them date from the period between the end of the civil war to the turn of the century, or shortly thereafter; in transportation history from the beginning of the good roads movement in 1876 to the establishment of the federal aid system in 1916."³¹

4.3 Truss

Truss bridges are some of the most recognized structures across the United States. These types of structures were ubiquitous and used for everything from pedestrian to railroad to highway. Since the early beginnings of the United States through the 1950s, and even today, truss bridges have remained an important fixture in the nation's past, present, and future transportation system.

According to the report "A Context for Common Historic Bridge Types," prepared by the firms Parsons Brinckerhoff and Engineering and Industrial Heritage, "Truss bridges may be built as simple spans, with abutments or piers at either end, or as continuous spans, with intermediate piers, bents or columns supporting the superstructure."³² Trusses are referred to as the bridge's superstructure and support the road deck. The earliest forms of truss bridges were constructed from wood. Later, certain wood structural elements were replaced by metal, such as cast- or wrought-iron. Eventually, most truss bridges were completely constructed from metal, usually iron and later steel. Much advancement made in truss technology and design resulted from the

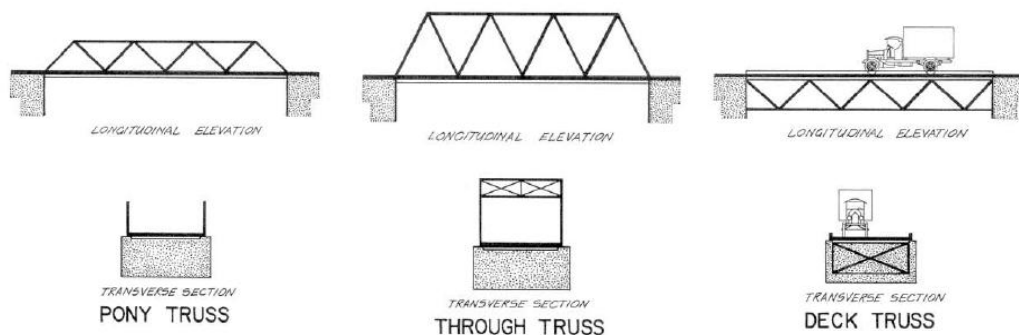
³⁰ Ibid., 20.

³¹ Ibid., 20.

³² Parsons Brinckerhoff and Engineering and Industrial Heritage, "A Context for Common Historic Bridge Types: NCHRP Project 25-25, Task 15," http://onlinepubs.trb.org/onlinepubs/archive/NotesDocs/25-25%2815%29_FR.pdf (accessed August 5, 2010), 63.

necessities of the railroads, which warranted stronger bridges to support their larger trains and heavier loads.

Truss bridges are distinguished by three types: pony truss, through truss, and deck truss. A pony truss is designed to carry light live loads. The design entails a road deck supported on either side by trusses. A through truss is designed for heavy live loads. As the name suggests, a through truss consists of a road deck supported with trusses on either side along with overhead lateral bracing. Through trusses are usually longer than pony trusses, some reaching 400 feet in length.³³ A deck trusses can also carry heavy live loads and can be long in length, however, the trusses are located under the road deck. Much of the further discussion will only involve the pony and through truss types.



In addition to the truss types listed below, it should be noted that there are numerous others, both wooden and metal. Some of the others are variations on the more common types described here, while others are one-of-a-kind or uniquely distinct. Remember that this was a time of experimentation and hundreds of designs, some more successful than others, were undoubtedly developed. The most well known examples are patented, and therefore, more easily researched.

³³ Ibid.

The advances leading to the all-iron truss bridge, and its wooden predecessor, is a testament to 19th century American civil engineers who set the world-wide standards of bridge building technology. Truss bridges retain the history of America's engineering legacy, and these resources are slowly being whittled away, replaced by more modern structures that lack the character or innovative spirit that fueled the truss building century of the 1800s.

4.3.1 Wood Truss

Beginning around the last two decades of the 18th century, bridges were constructed not of stone, like those of Europe, but of wood, which was abundantly more plentiful, and were usually constructed as part of a turnpike or other trading route. Immediately prior to and during the industrial revolution, the need for convenient river crossings combined with plentiful lumber set off an explosion in the construction of wooden bridges. Initially, these bridges had open decks, but the need to protect the wooden support structure from the elements necessitated the bridges being enclosed, and as David Brown, in his book, *Bridges*, notes, "The creaking, dark, mossy tunnels became one of the earliest characteristics of rural pre-industrial America."³⁴

Covered bridges are uniquely American and have no traces back to Europe, and although promoting images of rural simplicity and quaintness, these structures were technologically advanced and always being improved.³⁵ There are five major truss types

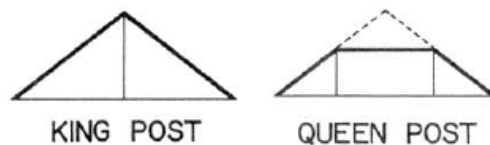
³⁴ David J. Brown, *Bridges* (New York: MacMillan Publishing Company, 1993), 77.

³⁵ Robert Fletcher and J. P. Snow, "History of the Development of Wooden Bridges," In *American Wooden Bridges*, by American Society of Civil Engineers, 28-69, (New York: American Society of Civil Engineers, 1976), 37-39.

that are commonly present in American wooden covered bridges: king post truss, queen post truss, Burr arch truss, Town lattice truss, and Howe truss.³⁶

The king post truss is the oldest and simplest truss design, dating back from before the Middle Ages. Triangular in shape, it was commonly used as a roof truss, and also widely used in covered bridges. It is also derivative of most other truss designs.³⁷ According to the National Park Service, “Simple king post trusses were used only to span very short distances up to about 30 feet, but occasionally a series of king post trusses were combined to form a long timber bridge.”³⁸ Early examples of wooden king post truss bridges, dating from the 1840s-50s, are very rare and therefore hold great historical significance.

Queen trusses are similar to the king post truss. They, too, are one of the earliest and simplest truss types and used to span short distances. In shape, they are elongated king post trusses with a rectangular panel in between two angled members. Generally, due to their rarity, queen post truss bridges are considered historically significant.³⁹



The Burr arch truss was a major advance in bridge truss design. Designed by Theodore Burr in 1804, this type of bridge was essentially a series of king post trusses

³⁶ Parsons Brinckerhoff and Engineering and Industrial Heritage, “A Context for Common Historic Bridge Types: NCHRP Project 25-25, Task 15,” http://onlinepubs.trb.org/onlinepubs/archive/NotesDocs/25-25%2815%29_FR.pdf (accessed August 5, 2010).

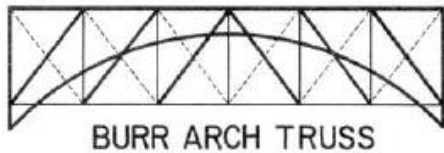
³⁷ Ibid., 66.

³⁸ Ibid., 66.

³⁹ Ibid., 70.

strengthened by an arch. Although other truss types were used, the arch feature is the signature characteristic of the Burr arch truss bridge and contributed to its stiffness.⁴⁰

This arch element allowed Burr arch truss bridges to span up to 120 feet in length. Burr's masterpiece bridge, connecting Waterford and Lansingburg over the Hudson River in



New York, was destroyed by fire in 1909.⁴¹

According to the report "A Context for Common Historic Bridge Types," the "The Burr arch is

considered amongst the highest developed of all-wood bridge types," and is common throughout the county, especially in the northeastern states.⁴² Nineteenth century Burr arch bridges are considered historically significant if they retain their character-defining features.⁴³

The Town lattice truss was another advance in bridge truss design. Created by Ithiel Town in 1820, "This type of truss has intersecting diagonals forming a web



between the top and bottom chord with no verticals or posts. The diagonals act in compression and in tension."⁴⁴ This type of

truss was fairly simple and easy to construct and allowed bridges to reach lengths of over 200 feet, and as a result, was extensively used. Wooden Town lattice trusses dating from the 1840s to immediately following the Civil War are historically significant if they

⁴⁰ Ibid., 72.

⁴¹ Ibid., 72.

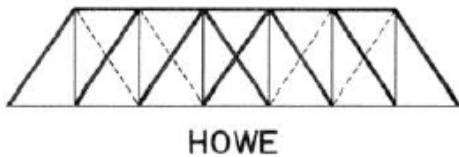
⁴² Ibid., 72.

⁴³ Ibid., 72.

⁴⁴ Ibid., 74.

retain their character-defining features.⁴⁵ Metal Town truss bridges were also constructed and are also of significance.

The Howe truss was designed and patented by William Howe in 1840. This type of truss combined the use of wood and metal by featuring “heavy wood diagonal



members in compression and lighter, vertical iron members in tension.”⁴⁶ Commonly used as

railroad bridges, the Howe truss became the most

popular and profitable of the wood truss designs. In addition, it is considered “crowning achievement of the wood bridge era” by bridge scholars.⁴⁷ It was also the first wooden bridge to incorporate metal components and ushered in the iron age of bridges. In general, wooden Howe truss bridges are considered historically significant.

Wooden bridges began to reach new lengths during the first quarter of the 19th century, with some bridges exceeding 350 feet. However, with the development of the Howe truss, the golden years of wooden covered bridges were over. In the years following the Civil War, wooden bridges began to fall out of favor, their popularity displaced by iron truss bridges.

Unfortunately, relatively few of these wooden structures survive today. Although plentiful in numbers during their time, they were vulnerable to the elements and susceptible to rot and fire. Many of the truss designs developed for the wooden covered bridges were later advanced and adapted for use in iron truss bridges which were to

⁴⁵ Ibid., 75.

⁴⁶ Ibid., 77.

⁴⁷ Ibid., 78.

follow. Hunterdon County contains the last remaining covered bridge in New Jersey. The Green Sergeant's Covered Bridge, a Howe truss covered bridge, constructed in 1872 on 1750 stone abutments, carries County Road 604 over the Wickecheoke Creek in Delaware Township.⁴⁸

4.3.2 *Metal Truss*

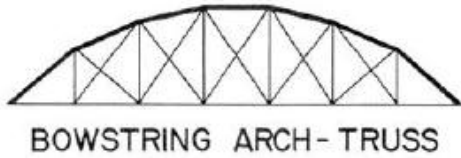
During the 1860s, metal truss bridges began to be developed after failed attempts in converting the wooden Howe truss system into an iron truss system. These advances led to eight distinct metal truss types: the metal bowstring arch truss, the Pratt truss, the Whipple truss, Baltimore truss, Parker truss, Pennsylvania truss, and the Warren truss. With these different bridge designs, engineers tried to achieve longer, stronger bridges using less material. In the late-1800s, “bridge prices were usually driven by the weight of the materials used to construct the superstructure,” so anything that would cut down on material weight was looked at favorably and usually became the popular design of choice.⁴⁹ Although few iron truss bridges were in existence before the 1850s, they flourished from the period following the Civil War to the onset of World War II.

The metal bowstring truss bridge was developed by Squire Whipple in 1840, the same year the Howe truss was patented. His bridge over New York’s Erie Canal in Utica was the second all iron bridge constructed in the United States and was 82 feet in

⁴⁸ A. G. Lichtenstein & Associates, Inc. and the New Jersey Department of Transportation, “The New Jersey Historic Bridge Database: Hunterdon,” 1994 (modified 2001), <http://www.nj.gov/transportation/works/environment/HistBrIntro.shtm> (accessed February 20, 2010), 56.

⁴⁹ Parsons Brinckerhoff and Engineering and Industrial Heritage, “A Context for Common Historic Bridge Types: NCHRP Project 25-25, Task 15,” http://onlinepubs.trb.org/onlinepubs/archive/NotesDocs/25-25%2815%29_FR.pdf (accessed August 5, 2010), 93.

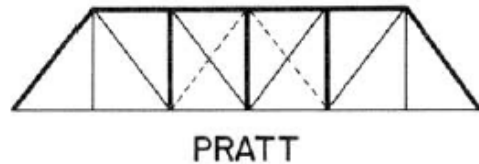
length.⁵⁰ It was comprised of both cast- and wrought-iron members, cast-iron for the primary compression members and wrought-iron for the vertical and diagonal tension rods. This type of truss was very popular and was used for a variety of different



structures including train sheds and barns, in addition to bridges. In fact, “During the last quarter of the nineteenth century, it was one of

the most generally adapted truss forms in bridge design.”⁵¹ According to the report “A Context for Common Historic Bridge Types,” “The bowstring arch truss is one of the more important nineteenth century bridge forms and dates primarily from the 1870s and 1880s.”⁵² These are of highest significance, while more modern steel versions are not.

The Pratt truss, developed by Thomas Pratt in 1842, is a more commonly known truss type. Originally, this type of truss was the reverse of the Howe truss and used vertical compression members of wood with wrought iron diagonals in tension.⁵³ This design was originally expensive to construct because of the amount of expensive metal required in comparison to the Howe truss.



However, it became incredibly popular when the railroad realized the strength benefits of an all iron bridge. In the eyes of railroad officials, “not only was the design simple, relatively economical, and easily erected in the field, it was also more trustworthy

⁵⁰ Ibid., 81.

⁵¹ Ibid.

⁵² Ibid., 82.

⁵³ Ibid., 84.

than the Howe,” and “as an iron or steel bridge, the Pratt truss became the most popular span in America in lengths of less than 250 feet for highways and railroads.”⁵⁴

The Pratt truss remained popular until the Warren truss was developed. The report “A Context for Common Historic Bridge Types” notes that “When fabricated entirely of iron, and later steel, with riveted connections, the Pratt truss became the American standard for bridges of moderate spans well into the 20th century.”⁵⁵ Although these bridges were numerous, they represent an important phase in the evolution of bridge development and advancement, and as a result, early examples are considered significant. Both pony and through Pratt truss bridges were constructed.

In 1847, Squire Whipple designed a second type of truss, which he called the “trapezoidal truss” which is similar to the Pratt truss and sometimes referred to as a “double-intersection Pratt.”⁵⁶ In this more complex design, Whipple extended the diagonals over two panels, thereby maintaining the correct angles, and allowing the length of the structure to be increased.⁵⁷ When constructed all from wrought-iron, this type of bridge is also known as a Murphy-Whipple bridge, named after John Murphy who first used wrought iron for both tension and compression members on a Whipple truss bridge in Pennsylvania, making the bridge more reliable.⁵⁸ Whipple truss bridges are rare and considered highly historically significant. Whipple truss bridges were constructed as through trusses.

⁵⁴ Ibid., 84.

⁵⁵ Ibid., 84.

⁵⁶ Ibid., 87.

⁵⁷ Ibid., 87.

⁵⁸ Ibid., 87.

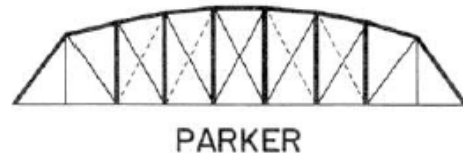
The Baltimore truss was developed for the use of heavy locomotives in the 1870s. Shortly after, it was used for highway bridges with steel versions used up until the



1920s.⁵⁹ Its unique design reduced both weight and cost while maintaining strength. The Baltimore truss is most well known as a railroad bridge, and early examples of this design for

railroad use are significant. Baltimore truss highway bridges are also considered significant due to their rarity.

The Parker truss was patented by Charles Parker in 1870. It can be described as a Pratt truss with an inclined top chord, and as a result the Parker truss, “uses less metal than a parallel chord Pratt truss of equal length, and the longer the span the greater the economy of materials.”⁶⁰ This equated to a



cheaper construction cost, and as a result, became extremely popular and built all across the country. A variation of the Parker truss is the camelback truss. Early examples of the Parker truss are considered historically significant, with examples from the 20th century less so. The Parker truss can be seen in both pony and through truss types.

⁵⁹ Ibid., 91.

⁶⁰ Ibid., 93.

The Pennsylvania truss was a combination of the Baltimore truss and the Parker truss. It was developed for railroad use in 1875 and was used for long span railroad

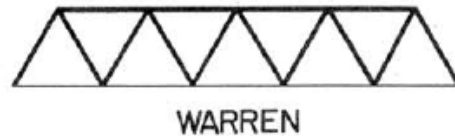


bridges, but also became common for short span rail bridges.⁶¹ Like the Parker truss it has an inclined top chord, making it more economical than the Baltimore truss. It was also adapted for

highway use and like the Baltimore truss was used until the 1920s. Both, early examples of iron railroad and highway bridges are considered to have historic significance.

Another well known truss design is the Warren truss, developed by Belgian engineer Neville and a British engineer named Francis Nash.⁶² The design of a Warren truss is comprised of multiple triangles and

includes no vertical members. Due to this design, “In the Warren truss, every part of the



truss equally bears its share of the stresses.”⁶³ Very few early Warren trusses are still in existence making them historically significant, especially examples constructed by state highway departments according to standardized plans.⁶⁴ Those built after the 1920s have a low historic significance. Both pony and through Warren trusses were constructed.

The bridge diagrams presented in this and other chapters of this thesis were extracted from a poster produced for the Historic American Engineering Record (HAER)

⁶¹ Ibid., 96.

⁶² Ibid., 98.

⁶³ Ibid., 97.

⁶⁴ Ibid., 98.

titled “Trusses: A Study by the Historic American Engineering Record.”⁶⁵ A copy of the complete poster is located in Appendix C.⁶⁶

Table 14-1 from the report “A Context for Common Historic Bridge Types,” which details the historic significance of these and other bridge types found throughout the United States in further depth, can be referenced in Appendix D.⁶⁷

⁶⁵ Historic American Engineering Record, National Park Service, Arnold David Jones, 1976. Library of Congress, Prints & Photographs Division, HAER, LC-USZ62-119864.

⁶⁶ The poster, “Trusses: A Study by the Historic American Engineering Record,” is also available from the National Park Service at: <http://www.nps.gov/history/hdp/samples/HAER/truss.htm>.

⁶⁷ Parsons Brinckerhoff and Engineering and Industrial Heritage, “A Context for Common Historic Bridge Types: NCHRP Project 25-25, Task 15,” http://onlinepubs.trb.org/onlinepubs/archive/NotesDocs/25-25%2815%29_FR.pdf (accessed August 5, 2010), 4-2–4-7.

5.0 ISSUES

5.1 Importance of Historic Bridges

Truss bridges have become emblematic of America's past. These structures, gracefully aging in the woods along less traveled roads, at times seem out of place, but usually pleasantly surprise travelers, and, with their rural setting, bring feelings of nostalgia. It is not hard to envision what traveling over these same routes and bridges over a hundred years ago was like, because in many locations, not much has changed. The bridges and landscapes seem unspoiled and untouched by more recent intrusions that permeate everyday lives, and despite a century or more of advancements, remain mostly the same.

What does historic mean? To be considered 'officially' historic, a bridge must meet the eligibility requirements of the National Park Service. This means that the bridge must be listed or eligible to be listed on the National Register of Historic Places. In order to be listed, the bridge has to be fifty years of age or older or hold exceptional importance. The bridge must also be significant under one or more of the National Register of Historic Places criteria of eligibility.

The report “A Context for Common Historic Bridge Types” by Parsons Brinckerhoff and Engineering and Industrial Heritage discusses these eligibility criteria. There are four criteria including Criterion A: a bridge associated with events that have made a significant contribution to the broad pattern of our history; Criterion B: a bridge associated with the lives of persons significant in our past; Criterion C: a bridge that embodies the distinctive characteristics of a type, period, or method of construction, or represents the work of a master or possesses high artistic values; and Criterion D: a bridge that has yielded, or may be likely to yield, important information in history or prehistory.⁶⁸ In most cases, a bridge falls under Criterion C and sometimes Criterion A. In addition, the bridge must retain its historic integrity, as defined by the National Park Service which includes location, design, setting, materials, workmanship, feeling, and association.⁶⁹

However, the fact that a bridge may not meet National Register eligibility requirements in no way lessens its importance. Non-eligible bridges are not eligible to be listed on the National Register. Although these structures may have significant age, they have usually been greatly altered, and as a result, have lost a significant portion of their historic integrity. A bridge may also be considered non-eligible if the structure is one of many other similar structures that are well represented in a given area. Many states and local governments also have their own criteria for evaluating and determining historic significance. However, in any case, bridges reminiscent of another era retain charm,

⁶⁸ Parsons Brinckerhoff and Engineering and Industrial Heritage, “A Context for Common Historic Bridge Types: NCHRP Project 25-25, Task 15,” http://onlinepubs.trb.org/onlinepubs/archive/NotesDocs/25-25%2815%29_FR.pdf (accessed August 5, 2010), 23-24.

⁶⁹ Ibid., 24-25.

craftsmanship, and character may be important to the community, regardless of eligibility or listing.

Bridges should not be looked at as only a link between one side of a river and another (or other divides). They should be looked at more in-depth as a record of our engineering past and collective heritage. These structures are quite complex, and their designs, no matter how simple they look, were the result of centuries of trial and error that culminated into what people see and use today. Unfortunately, this historic record is being destroyed at an alarming rate due to misconceptions about safety, progress, and funding.

Historic bridges have a sense of utilitarian simplicity to them. That their combinations of geometric patterns are anything more than necessary structural components intrigues. The designs of these bridges employed inventiveness and innovation, crafted with techniques that have been more or less neglected in our modern time. Historic bridges are portals to the past. A time when Americans used the materials found around them (local materials) and embraced every new advancement that came their way, developing designs and using materials in ways that sustained the expansion and building of a nation. Advancement in bridge engineering was represented not only in the bridges of the densely populated cities, but also in the sparsely populated countryside, commonly connecting dirt roads to modern iron marvels.

There is importance in retaining these structures. Their materials, their techniques, and their designs are reminiscent of past values, goals, and ideals. If these structures are lost, they can never really be fully reconstructed, and a bit of the past would be lost with them. Hopefully through community involvement and government

cooperation, these structures will be maintained and preserved for future generations to cherish in more than just photographs, putting a stop to the demolition and destruction of our engineering and transportation history as well as a part of our national heritage.

5.2 Historic Bridge Loss and Replacement

Time has not treated the bridges in the United States well. Many of the nation's bridges have fallen into disrepair and are in severe need of maintenance. This is especially true for historic bridges. Until quite recently, within the past twenty to thirty years, the situation in which a deteriorating bridge would simply be replaced was commonplace. As new technologies were developed, outdated bridges would be replaced with newer ones. As more roads were built and car speed increased, along with traffic volume, engineers and the public wanted newer, more modern structures that instilled an increased sense of safety and progress.

Unfortunately, as a result, many historic bridges have been lost. Beginning in the 1980s, however, new views about historic bridges began to take hold, spawning different approaches of how they should be handled and treated. The first major step in this reevaluation of historic transportation resources came in 1987, with the Surface Transportation and Uniform Relocation Assistance Act (STRURAA).

The Historic Bridge Program, enacted under STRURAA, required each state (through the county) to conduct a survey of bridges in order to identify potential historic structures. This data would then be used to determine what bridges would be eligible for listing on the National Register of Historic Places. This preliminary process became the groundwork of research and analysis for any future potential bridge preservation program

and activity. A few years later, in 1991, federal transportation policies were enhanced to provide for greater flexibility with the Intermodal Surface Transportation Efficiency Act (ISTEA). This act was to allow greater flexibility in the use of federal funds and (in theory) could be used to help offset the cost of rehabilitating historic bridges.

Unfortunately, since these Acts were passed in the early 1990s, the demolition and replacement of historic bridges has continued, at times, seemingly unabated. In 2003, it was noted that “half, if not more, of our Nation’s historic bridges have been lost in the last twenty years.”⁷⁰ Almost another decade has passed, and historic bridges are still being lost in unacceptable numbers.

There is now a renewed preservation mentality and preservation groups focused on retaining rural landscapes, lifestyles, and history have joined the fight in order to help save these historic structures. Support for these important records of the engineering past has never been stronger than it is today. National groups such as the Historic Bridge Foundation and the National Trust for Historic Preservation along with local groups like Rural Awareness of Franklin Township (Hunterdon County) have been able to garner and achieve popular public support in order to demonstrate the value of historic bridges and their importance for national identity, local community character, and overall historic heritage.

Not all news is good. Historic bridges did not escape the effects of the current negative economic climate. Over \$48.1 billion, or about half of the money in the federal American Recovery and Reinvestment Act (ARRA) of 2009, went to transportation

⁷⁰ Eric DeLony and Terry H. Klein, “Historic Bridges: A Heritage at Risk; A Report on a Workshop on the Preservation and Management of Historic Bridges” (Rio Rancho, NM: SRI Foundation, 2004), 4.

related projects.⁷¹ In 2010, Governor David Paterson of New York allotted \$4.1 million in federal ARRA money to demolish and replace the County Route 39 bridge over the Grasse River in Louisville, St. Lawrence County.⁷² This stone arch bridge is to be removed and replaced by a new steel structure. A plaque with the original bridge's history will be installed and a retaining wall built from the demolished bridge's stones will also be incorporated into the project. Along with this bridge, the Caretaker Road Bridge, over the Walloomsac River in Hoosick, Rensselaer County, will also be replaced at a cost of \$1.4 million of ARRA money.⁷³ This bridge was constructed in 1900, and if not replaced, would be closed to traffic, inconveniencing motorists who would have to take a lengthy detour and would increase response times for local emergency service providers.⁷⁴ Both projects are expected to be completed by the end of 2011.

New York is not alone in its use of ARRA funds to demolish historic bridges, and it is probably fair to say that every state has or will use ARRA funds in some way that would affect historic bridges. Not all of the ARRA funded programs, however, are detrimental. For example, "Pennsylvania is investing more than \$1 billion in upgrading 438 bridges and improving 780 miles of roads through 293 projects."⁷⁵ While some funds are

⁷¹ Federal Transit Administration, "The American Recovery & Reinvestment Act (ARRA)," Department of Transportation, http://www.fta.dot.gov/index_9440.html (accessed February 12, 2011).

⁷² NY Works, "Governor Paterson Announces \$94.9 Million in Stimulus Funding for Transportation Projects Around the State," New York State, <http://www.recovery.ny.gov/news/press061109-1.htm> (accessed February 12, 2011).

⁷³ Ibid.

⁷⁴ Ibid.

⁷⁵ Commonwealth of Pennsylvania, "Recovery Act Citizens' Update," http://blair.pacounties.org/AntisTwp/Documents/10_09_stimulus_citizens_update.pdf (accessed February 12, 2011), 2.

being used for bridge demolition and replacement, some of the money is going towards bridge preservation efforts.

Other government programs have an unintended detrimental effect on historic bridges. The Federal Highway Administration (FHWA) is responsible for running the National Historic Covered Bridge Preservation Program. Although this program is extremely beneficial for the preservation of wooden covered bridges, it provides no protection to other types of bridges, leaving arch and truss bridges, for example, completely vulnerable. Additionally, the issue that preservationists often do not understand the history or technology of bridges really hurts the cause. It is hard to preserve things when why they are important is not understood.

Although, there have been recent strides in preserving historic bridges, but too many still succumb to needless replacement. According to the National Trust for Historic Preservation, “Our nation's historic bridges are being destroyed at the alarming rate of one every two or three days. Lack of maintenance and a knee-jerk preference for replacement often counters the directive of Congress that historic bridges be preserved whenever possible.”⁷⁶

5.3 Policies and Programs

There are multiple policies and numerous programs which pertain to the preservation of historic transportation resources. These official policies and programs, in addition to recommendations (such as those by groups like AASHTO) play an extremely

⁷⁶ National Trust for Historic Preservation, “11 Most Endangered Historic Places: Memorial Bridge,” <http://www.preservationnation.org/travel-and-sites/sites/northeast-region/memorial-bridge.html> (accessed on February 12, 2011).

important role in maintaining historic resources, such as single-lane bridges, in a modern and safe context. Many of the policies mentioned here are discussed in further depth in other portions of this thesis.

Transportation policies were put into place in order to create a system in which it would be relatively simple to build a safe and efficient highway and road network. This ease came with a price however. Rigid rules forced the demolition of many historic resources. Highways were built through downtowns, dividing neighborhoods. Roads were widened, necessitating the demolition of buildings traditionally built along the roads and bridges deemed too narrow. Roads were also straightened in the name of safety, and the new alignments usually meant replacing bridges that were historically built at skewed angles.

These policies worked in creating an extremely efficient highway system, a model that was replicated around the world. Unfortunately, these policies were also extremely efficient at destroying neighborhoods, cultural fabric, and historic resources. As time progressed and a new ethic towards preservation became stronger, standard policies were hard pressed to remain static.

One of the earliest policies that benefitted historic bridges was the Highway Bridge Replacement and Rehabilitation Program. (HBRRP). A program under the Surface Transportation Assistance Act (STAA) of 1978, HBRRP created a way to rate the conditions of bridges on a common scale throughout the country. The ratings were used to determine whether a bridge was structurally deficient or functionally obsolete

based on its geometry and capacity.⁷⁷ This program awarded federal money to be used on deficient structures.

About a decade later, the Surface Transportation and Uniform Relocation and Assistance Act (STURAA) was signed into law. Passed in 1987, STURAA was a major step in the process of bridge preservation nationwide. The Act's main focus was on the Interstate Highway System, which by this time was almost complete. With the last remaining sections of the system embroiled in controversy, STURAA was "widely seen in Congress and the transportation community as the last authorization bill of the Interstate era."⁷⁸ The Act required (among numerous other things) that each state conduct a survey of bridges in order to identify potential historic structures.⁷⁹ This preliminary process became the groundwork of research and analysis for any and all future potential bridge preservation program and activity. STURAA also became important in the Section 106 and Section 4(f) review processes which will be discussed below.

As a result of STURAA, bridges in Hunterdon County (as well as the entire state) longer than 20 feet and constructed before 1964 were surveyed to create the Historic New Jersey Bridge Database. This survey was originally conducted in September 1994 and later modified in 2001. This database was compiled based on survey data and recommendations in cooperation with consultants, the New Jersey Department of

⁷⁷ Eric DeLony, *Landmark American Bridges* (New York: American Society of Civil Engineers, 1993), 9.

⁷⁸ Federal Highway Administration, "President Ronald Reagan and the Surface Transportation and Uniform Relocation Assistance Act of 1987," Department of Transportation, <http://www.fhwa.dot.gov/infrastructure/rw01e.cfm> (accessed March 21, 2011).

⁷⁹ A.G. Lichtenstein & Associates, Inc., "The New Jersey Historic Bridge Survey," 1994, http://www.nj.gov/transportation/works/environment/pdf/Survey_Doc.pdf (accessed February 20, 2010), 4.

Transportation (NJDOT), the Federal Highway Administration (FHWA), and the New Jersey Department of Environmental Protection (NJDEP), and the State Historic Preservation Office (SHPO).

In 1991, the Intermodal Surface Transportation Efficiency Act (ISTEA) was signed into law, replacing STURAA. This Act fundamentally changed the way federal funds were distributed to states. According to an article by Ellen Schweppe, a writer for the FHWA bimonthly magazine, *Public Roads*, ISTEA was “envisioned as landmark legislation that would launch America into the post-interstate era.”⁸⁰ This would be enormous change that could carry equally enormous benefits for transportation, the environment, local communities, and historic preservation.

One of the major points that ISTEA contained was an emphasis on intermodalism. This meant the integration between rail, air, and sea travel, in ways that were not previously possible. But the law’s greatness involved the concepts of “flexibility,” “innovation,” “involvement,” and “collaboration,” which “transformed the relationship between the federal government and states and localities in terms of funding transportation projects,” and “gave state and local governments greater flexibility in determining transportation solutions.”⁸¹ ISTEA also created a greater ability for public involvement relating to transportation projects (such as local bridge preservation).

This was a huge step forward, and took the importance away from the Interstate System. In exchange, it focused only on emphasizing preventative maintenance on the Interstate System while directing attention (and federal money) to a newly created

⁸⁰ Ellen Schweppe, “Legacy of a Landmark: ISTEA After 10 Years,” Federal Highway Administration, <http://www.fhwa.dot.gov/publications/publicroads/01novdec/legacy.cfm> (accessed February 17, 2011).

⁸¹ Ibid.

National Highway System (NHS). The National Highway System includes the interstate highways as well as other roads vital to the nation's economy, defense, and mobility.⁸²

However, the major impact was the new relationship forged between the federal government and the states (and by extension, county and local governments). With the creation of Surface Transportation Program (STP), federal funding became more flexible, as did the programs that were eligible. Again, the focus was not solely on highways, but more broadly included funding for “bridges on public roads, transit capital projects, car-pooling projects, safety improvements, bicycle and pedestrian facilities, and transportation control measures.”⁸³ According to Richard Osborne, Transportation Specialist in FHWA's Office of Legislation and Strategic Planning, “States now have a lot more flexibility in deciding how to use funds.”⁸⁴

This new flexibility in ISTEA now allowed transportation funding to go to the rehabilitation of historic bridges, the creation of scenic byways, the restoration of train stations, as well as archeological planning and research. When ISTEA expired it was amended and replaced with the Transportation Equity Act (TEA-21) in 1998, and when that expired it was amended and replaced with the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) in 2005.

Under SAFETEA-LU there are a variety of programs that allow funding to go towards the historic preservation of bridges. These programs include Highway Bridge Program (HBP), the National Highway System Program (NHSP), the National Historic

⁸² Federal Highway Administration, “Application of Design Standards, Uniform Federal Accessibility Standards, and Bridges,” U.S. Department of Transportation, <http://www.fhwa.dot.gov/design/0625sup.cfm> (accessed February 17, 2011).

⁸³ Ibid.

⁸⁴ Ibid.

Covered Bridge Program (NHCBP), and the Surface Transportation Program (STP). Since these are basically funding programs, they are discussed at further length in the section on funding.

The Highway Bridge Program (HBP) has a section that deals exclusively with historic bridges, Title 23 of the United States Code 144 section (n). Subsection (1) requires that states “implement the programs described in this section in a manner that encourages the inventory, retention, rehabilitation, adaptive reuse, and future study of historic bridges,” while subsection (2) requires states to “complete an inventory of all bridges on and off Federal-aid highways to determine their historic significance.”⁸⁵ In addition, subsection (4) asks states to seek out a new owner for the historic bridge if it determined that it is to be demolished.⁸⁶ Section (m) is the program for bridges not on federal-aid highways (off-system), which is where single-lane truss bridges are usually located, and section (o) states that bridges on non-federal aid highways “shall be designed, constructed, operated, and maintained in accordance with State laws, regulations, directives, safety standards, design standards, and construction standards.”⁸⁷

In addition to the HBP and other policies which will be discussed in further chapters and sections, historic bridges may fall under the category of Projects with Historic and Scenic Impacts or Values (Title 23 U.S.C. 109(q)).⁸⁸ Rural, historic, single-

⁸⁵ Cornell University Law School, “U.S. Code: Title 23, Chapter 1, § 144. Highway Bridge Program,” Legal Information Institute, http://www.law.cornell.edu/uscode/uscode23/usc_sec_23_00000144----000-.html (accessed March 21, 2011).

⁸⁶ Ibid.

⁸⁷ Ibid.

⁸⁸ Federal Highway Administration, “Application of Design Standards, Uniform Federal Accessibility Standards, and Bridges,” U.S. Department of Transportation, <http://www.fhwa.dot.gov/design/0625sup.cfm> (accessed February 17, 2011).

lane truss bridges are usually located in scenic areas and generally contribute to enhance a location's scenic qualities. As such, this could allow engineers to consider greater flexibility in their designs of roads and bridges in order to maintain their scenic and historic qualities. In addition, the preservation of historic bridges may also fall under Transportation Enhancement (TE) Activities. This allows funding for projects within twelve eligible categories, including the acquisition of scenic or historic easements and sites as well as historic preservation.⁸⁹

The two policies that have the largest impact on historic transportation resources, however, are Section 106 of the National Historic Preservation Act (NHPA) and Section 4(f) of the Department of Transportation Act, both signed into law in 1966.

Section 106 (as it is regularly called) insists that federal agencies be held accountable for actions that impact historic resources. The Section 106 review process encompasses four steps: (1) initiating consultation, meaning that all appropriate and interested parties must be identified and asked to participate in the process; (2) identifying historic resources, meaning all historic resources in a proposed project area of potential effect (APE) which are listed or are eligible to be listed on the National Register of Historic Places must be identified; (3) determining whether there will be an adverse effect, meaning will the federal project pose an adverse or negative effect to the identified historic resources in the APE; and (4) resolving the adverse effects, meaning that after an

⁸⁹ Federal Highway Administration, "Transportation Enhancement Activities," U.S. Department of Transportation, <http://www.fhwa.dot.gov/environment/te/index.htm> (accessed February 17, 2011).

adverse effect is identified, what steps could be taken to rectify the situation.⁹⁰ A Section 106 review must also be initiated if federal money is used on any project impacting historic resources, whether as part of a governmental or private undertaking.

Unfortunately, the Section 106 review process is just procedural, and the outcome could result in the demolition of an historic building or replacement of an historic bridge—if no prudent or feasible option is identified. It is a process that is used to help identify and potentially mitigate adverse effects on historic resources with the ultimate goal of preservation. However, adverse impacts are not always avoidable and mitigation efforts are not always feasible. In these cases, the historic resource is well documented before it is removed or altered.

While Section 106 is commonly used for all types of historic resources and properties, Section 4(f) process only applies to agencies within the Department of Transportation, such as the Federal Highway Administration. The intent of Section 4(f) is to protect public parks, recreation areas, waterfowl and their habitat, and historic sites (whether public or private).⁹¹ It has been noted that Section 4(f) “compliance is often difficult and ... has been described by courts as one of the nation’s most stringent environmental laws.”⁹² Section 4(f) applies to even very small amounts of use or

⁹⁰ Center for Environmental Excellence, “Practitioner’s Handbook: Consulting Under Section 106 of the National Historic Preservation Act,” AASHTO, <http://environment.transportation.org/pdf/programs/PG06.pdf> (accessed October 4, 2010), 5.

⁹¹ Center for Environmental Excellence, “Practitioner’s Handbook: Complying with Section 4(f) of the U.S. DOT Act,” AASHTO. <http://environment.transportation.org/pdf/programs/pg11-1%20lowres.pdf> (accessed October 4, 2010), 1.

⁹² Ibid.

disturbance of an identified site even for temporary use. In addition, it is not limited to physical use, but also proximity effects, such as noise, smells, and visual impacts.⁹³

Even though the Section 4(f) process has been recently slightly altered and streamlined, prohibition of DOT use of an identified site will continue to be upheld unless: (1) there is “no feasible and prudent alternative” other than the site in question; and (2) that all possible actions and planning and mitigation actions have been taken in order to eliminate or minimize all adverse effects.⁹⁴ While recent amendments have allowed the Section 4(f) process to be more flexible, the process is still very effective in protecting environmental, recreational, and historic features. Unlike Section 106, which is procedural (meaning after the process, the project may still move forward), Section 4(f) offers substantive protection, meaning the outcome of the process could prohibit the DOT from using the site.

Although Section 4(f) is meant to protect historic transportation facilities and properties such as train stations, there is no mention of historic roads or bridges which are actively serving as part of the functioning transportation network.⁹⁵ As a result, the Federal Highway Administration (FHWA) has determined that “Section 4(f) would apply only when an historic bridge or highway is demolished, or if the historic quality for which the facility was determined to be eligible for the National Register is adversely affected by the proposed improvement.”⁹⁶ In addition, new bridges constructed near historic bridges left in place are exempt from Section 4(f) review if “its historic value will

⁹³ Ibid.

⁹⁴ Ibid.

⁹⁵ Federal Highway Administration. “FHWA Section 4(f) Policy Paper.” U.S. Department of Transportation. <http://www.environment.fhwa.dot.gov/projdev/4fpolicy.pdf> (accessed March 21, 2011), 15.

⁹⁶ Ibid.

be maintained, and the proximity impacts of the new bridge do not result in a substantial impairment of the historic bridge.”⁹⁷

Transportation projects are also subject to the National Environmental Policy Act (NEPA), signed into law in 1970. NEPA, like the Section 106 process, is procedural, and “requires federal agencies to consider the potential environmental consequences of their proposals, to consult with other interested agencies, to document the analysis, and to make this information available to the public for comment before the implementation of the proposals.”⁹⁸ This is generally important when a bridge is undergoing a major rehabilitation, being repainted, or being replaced. It only applies when federal money is being used (which is usually the case with bridges, due to their high costs of design, construction, and maintenance) or federal permitting is required. Numerous states have their own similar processes which apply when state money is used or when state permits are required.

In addition to the policies described above, there are numerous programs, organizations, agencies, and groups that support historic preservation and the preservation of historic transportation resources. On a national level is the National Trust for Historic Preservation (NTHP), the Advisory Council on Historic Preservation (ACHP), and the National Park Service (NPS). National programs geared towards bridge preservation include the National Historic Covered Bridge Preservation Program

⁹⁷ Ibid.

⁹⁸ Center for Environmental Excellence, “NEPA Process,” AASHTO, http://environment.transportation.org/environmental_issues/nepa_process/ (accessed October 4, 2010).

(NHCBP), the Historic Bridge Foundation, the Department of Transportation (DOT), the Federal Highway Administration (FHWA), the National Cooperative Highway Research Program (NCHRP) and the American Association for Highway Transportation Officials (AASHTO). Websites that advocate for the preservation of historic bridges include HistoricBridge.org and BridgeHunter.com.

New Jersey state programs, organizations, agencies, and groups geared toward preservation include the New Jersey Historic Preservation Office (NJHPO), the New Jersey Department of Environmental Protection (NJDEP), the New Jersey Department of Transportation (NJDOT), the New Jersey Cultural Trust, the New Jersey Historic Trust, and Preservation New Jersey. In addition, there are local entities like Rural Awareness, local historians, and the county government.

There are numerous other groups (public and private) which provide support for preservation efforts of all types of historic resources. These groups, whether acting on a national scale or more locally, help advocate for historic preservation and transportation policies. In some cases these groups offer funding, much of the time through matching grant programs. They also help craft guidelines, regulations, and laws focused on transportation design standards and historic preservation issues. They push for policy changes and encourage public involvement. These groups consist of preservationists, local residents, engineers, academics, and others, and encompass government, private and non-profit agencies and organizations. These groups have proven to be an invaluable asset in the preservation and maintenance of historic transportation resources.

5.4 Infrastructure

With over 600,000 bridges across the United States, there are many different structures to look after and maintain.⁹⁹ It is possibly for this reason that they are *not* adequately maintained. This lack of maintenance has not only impacted bridges, but has impacted dams, drinking water, levees, roads, rails, aviation, transit, energy supply and transmission, and schools, among others. The infrastructure of the United States is not being adequately maintained. This has led to a crumbling national infrastructure that needs more than just a few repairs.

In fact, bridges rank relatively high on the American Society of Civil Engineers (ASCE) Report Card for America's Infrastructure for 2009, although its grade is still dismal. Bridges have attained a letter grade C, the second highest grade achieved by any form of infrastructure, with only solid waste ranking higher at a C+.¹⁰⁰ The average grade for America's infrastructure is D, with wastewater, levees, drinking water, inland waterways, and roads, scoring lowest at a D-. The five-year funding requirement necessary to improve just the nation's roads and bridges is estimated at \$930 billion, and with only \$380.5 billion budgeted, there is a \$549.5 billion shortfall.¹⁰¹ The estimated five year investment needed to improve the nation's entire infrastructure network rests at more than \$2.2 trillion.¹⁰²

⁹⁹ Better Roads, "Better Bridges 2010 Bridge Inventory: The State of Your Bridges," 2010. <http://www.betterroads.com/category/bridge-inventory/> (accessed February 7, 2011).

¹⁰⁰ American Society of Civil Engineers. "Report Card for America's Infrastructure: 2009 Grades." <http://www.infrastructurereportcard.org/> (accessed February 7, 2011).

¹⁰¹ American Society of Civil Engineers, "Report Card for America's Infrastructure: Bridges," 2010. <http://www.infrastructurereportcard.org/fact-sheet/bridges> (accessed February 7, 2011).

¹⁰² American Society of Civil Engineers. "Report Card for America's Infrastructure: 2009 Grades." <http://www.infrastructurereportcard.org/> (accessed February 7, 2011).

Although this report may be startling, just take a drive on almost any road or highway and try not to hit a pothole. Road conditions are abysmal and lead to hundreds of dollars in vehicle maintenance a year per driver. According to an American Association of State Highway and Transportation Officials (AASHTO) report, the average driver spends an additional \$355 a year in vehicle maintenance due to poor road conditions, and urban drivers may pay up to an additional \$746.¹⁰³ With more heavy vehicles on the road, and greater traffic volume in general, roads and bridges must contend with stress like never before, for which they were either not intended or they cannot support in their present forms.

Needless to say, maintenance of our national infrastructure is the key to its sustainability. In the AASHTO report, Michigan Department of Transportation Director, Kirk L. Steudle, emphasizes that “spending \$1 to keep a road in good condition prevents spending \$7 to reconstruct it once it has fallen into poor condition.”¹⁰⁴ But costs are high and state budgets are at all time lows. For example, the ASSHTO report indicates how dire the maintenance problem is across the Unites States. As of 2009, Oregon needs \$200 million over the next ten years to maintain its roads at current levels—it only has \$130 available; during this same time, Texas needs \$73 billion over the next 22 years but only has \$900 million available a year; Rhode Island needs \$640 million a year, but only has access to \$354 million; and Pennsylvania needs a staggering \$2.19 billion a year to maintain its current road network.¹⁰⁵ The stimulus money from the American Recovery

¹⁰³ American Association of State Highway Transportation Officials, “Rough Roads Ahead: Fix it Now or Pay for it Later,” http://roughroads.transportation.org/RoughRoads_FullReport.pdf (accessed February 12, 2011), 5.

¹⁰⁴ Ibid., viii.

¹⁰⁵ Ibid., viii, 13.

and Reinvestment Act (ARRA) has been used to try and gap these budget shortfalls, but this has not been enough. All states have to contend with dwindling resources for transportation programs and maintenance in some form or another, and the longer this maintenance is deferred, the worse the problem gets.

With all the maintenance concerns, states focus a significant amount of their resources on the Interstate System.¹⁰⁶ This is because this system sees the highest volumes of traffic in comparison to other portions of the road network. This focus leaves rural roads and bridges even more vulnerable to major structural issues. As a reference point, there are 55,000 interstate bridges, most around 40-50 years old. The majority of structures this old requires “substantial rehabilitation,” and in another 20-30 years will need to be replaced.¹⁰⁷ Some rural bridges have barely been touched for nearly a century.

Bridge and road maintenance sadly became the center of national focus in August 2007 when the I-35 Mississippi River Bridge (Bridge 9340) collapsed in Minneapolis, Minnesota, killing 13 people and injuring over 100.¹⁰⁸ This incident shed new light on the appalling lack of maintenance to transportation infrastructure and forced the government to reevaluate the state of its bridges. This tragic event began to highlight the many issues concerning these aging, sometimes vital, transportation links.

The I-35 Mississippi River Bridge was not a small back county bridge, but bridge on an interstate highway, the type of structures focused on in funding and maintenance programs. There are hundreds of thousands of bridges across the United States. And of

¹⁰⁶ Ibid., 20.

¹⁰⁷ Ibid., 19.

¹⁰⁸ National Transportation Safety Board, “Collapse of I-35 Highway Bridge, Minneapolis, Minnesota, August 1, 2007: Accident Report,” <http://www3.nts.gov/publictn/2008/HAR0803.pdf> (accessed March 26, 2011), xiii.

this amount, almost 140,000 bridges, both major and minor, are considered functionally obsolete or structurally deficient.¹⁰⁹ Of this amount, perhaps hundreds if not thousands are in a desperate need of immediate repair.

Our infrastructure should be looked at as an investment for the future. The AASHTO “Rough Roads” report notes on the cost of maintenance as “pay me now or pay me lots more later.”¹¹⁰ The report continues, stating, “Maintaining a road in good condition is easier and less expensive than repairing one in poor condition. Costs per lane mile for reconstruction after 25 years can be more than three times the cost of preservation treatments over the same 25 years and can extend the expected service life of the road for another 18 years.”¹¹¹ This is even truer for bridges which inherently incur higher costs in design, maintenance, and replacement.

In fact, when New Jersey received its almost \$2 billion in ARRA money in 2009, more than half, \$1.05 billion, went to transportation projects, including \$469 million used to repaint bridges in order to “reduce future maintenance costs.”¹¹² This is similar to another preservation issue: maintaining an historic house costs less than building a new one. The same goes with roads and bridges. Maintaining the nation’s stock of historic and non-historic bridges will allow them to safely remain in service for future generations, staving off costly repairs and replacements while retaining historic character.

¹⁰⁹ Better Roads, “Better Bridges 2010 Bridge Inventory: The State of Your Bridges,” 2010. <http://www.betterroads.com/category/bridge-inventory/> (accessed February 7, 2011).

¹¹⁰ American Association of State Highway Transportation Officials, “Rough Roads Ahead: Fix it Now or Pay for it Later,” http://roughroads.transportation.org/RoughRoads_FullReport.pdf (accessed February 12, 2011), 27.

¹¹¹ Ibid.

¹¹² Rudy Larini, “Majority of Stimulus for N.J. will go for Transportation Projects,” *Star-Ledger* (Newark, NJ), March 12, 2009.

5.5 Modern Highway Design

The road network in the United States is divided into two systems: on-system and off-system. On-system roads include the Interstate Highway System and the National Highway System. Off-system roads include state roads not on the National Highway System along with county and local roads. These different systems have different design standards and funding requirements which affect road and bridge projects and preservation efforts.

Modern road and bridge projects can be divided into four categories: new construction; reconstruction; resurfacing, restoration, rehabilitation (3R); and maintenance.¹¹³ Although these project types differ, the main focus of highway and traffic engineers is remains the same—safety. Safety may seem beneficial, and it generally is, but, the overarching premises surrounding safety in relation to road design may cause unintended detrimental effects for historic structures, scenery, and the environment. In general, safety in road design equates to flat, wide, and straight.

The guide that is most commonly referenced regarding road and bridge design is *A Policy on the Geometric Design of Highways and Streets*, last updated in 2004. This guide, more commonly known as the Green Book, was created by AASHTO and is used by federal, state, and local engineers. The Green Book's recommendations are not to be mistaken for a national standard of practices or actual policies, which they are not. It is to act as a guide.

¹¹³ Federal Highway Administration, "Flexibility in Highway Design: Highway Design Guidelines," U.S. Department of Transportation, <http://www.fhwa.dot.gov/environment/flex/ch02.htm> (accessed February 13, 2011).

However, many states, as well as the federal government, have adopted most aspects of the Green Book and in conjunction with various specific modifications, have established the Green Book as transportation policy. The New Jersey Department of Transportation (NJDOT) *Design Manual for Bridges and Structures* notes in the introduction, “The following publications, as modified in this Manual, govern the design of bridges and structures.”¹¹⁴ It then lists 15 separate AASHTO publications, including *A Policy on Geometric Design of Highways and Streets*, *AASHTO LRFD Bridge Design Specifications*, and *AASHTO Manual for Bridge Evaluation*. It concludes with, “The above publications are approved references to be used in conjunction with this Manual.

Primarily they set forth minimum nationwide requirements which are consistent with current practice, but require modifications to suit local conditions. In the event of conflict in the requirements, the instructions in this Manual shall govern.”¹¹⁵ The Federal Highway Administration has adopted the Green Book as the national standard for the National Highway System.¹¹⁶

Until 1991, most states were strongly encouraged to use the AASHTO Green Book as the basis of their transportation manual. However, after the passage of ISTEA, states were allowed more freedom in determining their own transportation standards.¹¹⁷ Many states decided to continue following Green Book recommendations, but a few states took this opportunity to enact a new set of standards for their roads. One important

¹¹⁴ New Jersey Department of Transportation, *Design Manual for Bridges and Structures: Fifth Edition*, 2009 (Trenton, NJ: State of New Jersey, 2009), 1-1.

¹¹⁵ Ibid.

¹¹⁶ Federal Highway Administration, “Flexibility in Highway Design: Highway Design Guidelines,” U.S. Department of Transportation, <http://www.fhwa.dot.gov/environment/flex/ch02.htm> (accessed February 13, 2011).

¹¹⁷ Ibid.

example is Rhode Island, which the Federal Highway Administration notes, “has decided that, because it has historic, scenic, and cultural resources along many of its roads, it would be inappropriate to make major changes to the geometry and alignments that would negatively affect these resources.”¹¹⁸ They continues to note that “This new approach will help to preserve the resources along many of Rhode Island's older roads and help engineers maintain the roads in a way that the public feels is appropriate for the communities.”¹¹⁹ Other states have followed suite as have local governments.

Bridges are more complex to design than roads, and because they are expensive to construct and maintain, are expected to perform better and longer. Historic bridges create even more complex problems. There are two major issues that must be addressed in dealing with historic bridge designs, the first is width and the second is weight (and sometimes height).

Historic bridges are already in place and have certain widths. Since some of these bridges were built in a time before automobile traffic, they were designed for pedestrians, horses, and carts, not cars. Therefore, these bridges tend to be narrow. Secondly, for the same reasons above, they were not built to sustain modern traffic loads, and require posted weight limits to prevent collapse.

Historic bridges also serve as aesthetic, scenic, historic, and cultural resources for communities in which they are located, and as such, great care should be taken to preserve them. The FHWA and AASHTO agree. Since this thesis deals with rural single-lane historic bridges, a focus on AASHTO recommendations for local roads will

¹¹⁸ Ibid.

¹¹⁹ Ibid.

be examined. The ASSHTO guidelines are dependent on the average daily volume of traffic that travels over the bridge. If the volume is 400 or less cars a day, then the width should be the traveled way with an additional 0.6 meters on each side. If the volume is between 400 and 2,000 cars a day, then the width should be the traveled way with an additional 1.0 meters on each side. If the volume is greater than 2,000 cars a day, then the width should equal the approach roadway width.¹²⁰

Sometimes historic bridge widths are not wide enough and there is little that can be done. In these situations, ASSHTO “recognizes that those that tolerably meet the criteria may be retained,” and that it is important to consider “each aesthetically and historically significant bridge on a case by case basis, before deciding to demolish and replace it.... Only after careful analysis and consultation with the community, should a determination be made.”¹²¹ The FHWA notes that, “In many instances, particularly for bridges of historic or aesthetic value, the rehabilitation of the bridge is the preferred solution, rather than total replacement. This option is not always feasible, but should be pursued as much as possible.”¹²²

¹²⁰ Federal Highway Administration, “Flexibility in Highway Design: Bridges and Other Major Structures,” U.S. Department of Transportation, <http://www.fhwa.dot.gov/environment/flex/ch07.htm> (accessed February 13, 2011).

¹²¹ Ibid.

¹²² Federal Highway Administration, “Flexibility in Highway Design: Highway Design Guidelines,” U.S. Department of Transportation, <http://www.fhwa.dot.gov/environment/flex/ch02.htm> (accessed February 13, 2011).

The NJDOT *Design Manual for Bridges and Structures* also acknowledges historic bridges and indicates that it:

Shall be determined if the existing bridge is either on or eligible for the National Register of Historic Places or a contributing element of an historic district. If this is the case, the method of preservation is to be evaluated and a corresponding rehabilitation scheme must be considered. Also, if the bridge is on the National Register then Sections 106 and 4(f) requirements are to be considered in the project development.¹²³

The NJDOT *Design Manual for Bridges and Structures* also discusses bridge width, which is an important issue concerning single-lane bridges because of their narrowness. The manual states that, “the minimum roadway width shall conform to the appropriate AASHTO/NJDOT standards or meet the approach roadway width, whichever is greater (provided the approach roadways are not excessively wide).¹²⁴ The manual also notes that context sensitive solutions may be considered.¹²⁵ Context sensitive solutions generally give engineers more flexibility in their design and allows their designs to be accommodating and to more appropriately blend into their surroundings.

AASHTO also recognizes other components of historic bridges, such as guardrails and pedestrian access, all which they deem important. AASHTO, along with county engineers, have stated that all attempts should be made to ensure that people in the vehicles traveling over a bridge should be able to see water or landscape below and should not have their views blocked by guardrails or other devices. This being said, guardrails on bridges are absolutely required and are especially important on historic bridges. The guardrails are designed to take the brunt force of a crash so that the bridge’s

¹²³ New Jersey Department of Transportation, *Design Manual for Bridges and Structures: Fifth Edition, 2009* (Trenton, NJ: State of New Jersey, 2009), 12-2.

¹²⁴ Ibid.

¹²⁵ Ibid.

superstructure is not compromised, which could lead to collapse. The FHWA indicates that there are over 60 different types of approved guardrails and that “bridge designers should consult the community when considering the type of railing to be used.”¹²⁶

Another issue dealing with historic bridges is geometrics, which includes the road alignment in the approach to the bridge. Many bridges were built in this manner because it was a simpler and cheaper road design. Mike Mort, in his book, *A Bridge Worth Saving: A Community Guide to Historic Bridge Preservation* explains:

Transportation routes evolved to follow good ground lines—the natural contours of the land often associated with high ground or the course of a river. Metal was money, and building a bridge across the river in the shortest distance (at right angles to the bank) was the ideal. Therefore, many old bridges have approaches that abruptly turn into the bridge. This would not be a problem for a horse-drawn wagon, as they did not go very fast. Today’s traffic, though, requires a little more advance notice.¹²⁷

In many cases, these approaches do not meet AASHTO guidelines because there is a sharp curve or a steep vertical grade right before entering onto the bridge. This leads to traffic blind spots and could potentially lead to accidents. However, because of Right-of-Way issues it is usually very hard to realign the road. In cases where the road is realigned, bridges may lose some of their historic integrity or may have to be replaced altogether.

¹²⁶ Federal Highway Administration, “Flexibility in Highway Design: Bridges and Other Major Structures,” U.S. Department of Transportation, <http://www.fhwa.dot.gov/environment/flex/ch07.htm> (accessed February 13, 2011).

¹²⁷ Mike Mort, *A Bridge Worth Saving: A Community Guide to Historic Bridge Preservation* (East Lansing: Michigan State University Press, 2008), 52.

6.0 CONCERNS

6.1 Safety

Bridges carry their own special sets of safety concerns. Since these structures must cope with variable stresses due to the vehicles traveling over them and handle large volumes of people each day, inspections are vital for their continuing functionality. There are many different types of safety concern that relate to bridges. Some of them are more obvious than others. Structural safety is the number one concern, but weight restrictions, width and height restrictions, road and bridge geometry, and environmental safety concerns (such as with lead paint) also pose problems.

In 1969, two years after the collapse of the Silver Bridge (connecting Ohio and West Virginia) over the Ohio River made it clear that the nation's bridges and public roads were critically deficient., the United States Congress passed the National Bridge Inspection Standards (NBIS).¹²⁸ This was added to the Code of Federal Regulations and is known as 23CFR650.

¹²⁸ Hojjat Adeli, ed., *Historic Bridges: Evaluation, Preservation, and Management* (Boca Rotan, FL: CRC Press, 2008), 62.

Initially, this inspection procedure was solely aimed at federal-aid highway system bridges, located under the Federal Aid Highway act of 1968. In 1978, under the Surface Transportation Assistance Act (STAA), the inspection program was expanded to include all bridges of 20 feet in length or more. The program was once again expanded in 1987 under the Surface Transportation and Uniform Relocation Assistance Act (STURAA).

The NBIS dictates that, that in general, bridges carrying the nation's traffic must be inspected once every two years.¹²⁹ Some bridges, however, are inspected every four years, when justifiable conditions allow, while others, usually bridges with known problems, are inspected yearly. The deficient bridges are then placed into one of two categories: (1) Structurally Deficient or (2) Functionally Obsolete. A bridge is considered structurally deficient if significant load-carrying elements have significantly deteriorated or been damaged. A bridge is considered functionally obsolete if the geometrics of the bridge no longer conform to current or accepted design standards.

During the inspection, a bridge is given a sufficiency rating, and based on this rating, the bridge passes or is categorized as structurally deficient or functionally obsolete. Usually, bridges determined to be eligible for federal funds must be reconstructed or rehabilitated to meet the new transportation bridge safety guidelines, and the resulting structure must be removed from the deficient list.

Since its inception, the NBIS program has managed to rehabilitate or replace thousands of bridges across the United States. As of 2010, approximately 140,000

¹²⁹ Federal Highway Administration, "Structures: Compliance with the National Bridge Inspection Standards," U.S Department of Transportation.
<http://www.fhwa.dot.gov/bridge/0650csup.cfm> (accessed February 28, 2011).

bridges are still categorized as either functionally obsolete or structurally deficient.¹³⁰

This accounts for approximately 23 percent of the entire bridge inventory (consisting of 21 percent interstate and state structures and 25 percent of city/township/county structures).¹³¹ Although this encompasses a large number of bridges, it represents a five year low point in obsolete or deficient bridges.¹³² Over the past five years, as the number of bridges as been incrementally rising, the number of bridges that were either functionally obsolete or structurally deficient, has steadily dropped. But there is still much work to be done.

In the case study state of New Jersey, data was collected in 2007, after the I-35 bridge collapse in Minneapolis. This was done in order to assess and report on the state of its bridges. This study categorized the bridges by owner, with 2,579 bridges controlled by the state, 2,557 bridges under county and municipal control, and 1,311 bridges controlled by other entities.¹³³ Although the state may control about the same number of bridges as counties, state bridges are significantly larger, accounting for 34,248,171 square feet of bridge deck area, in contrast to the 7,947,229 square feet of county controlled bridge deck area.¹³⁴

Another big difference between state and county bridges is age distribution. While 45 percent of bridges in both categories fall between 0 and 40 years of age, 40 percent of state bridges are between 41 and 75 years, with only 15 percent at 75 years of

¹³⁰ Better Roads, “Better Bridges 2010 Bridge Inventory: The State of Your Bridges,” <http://www.betterroads.com/category/bridge-inventory/> (accessed February 7, 2011).

¹³¹ Ibid.

¹³² Ibid.

¹³³ New Jersey Department of Transportation, “Highway Carrying Bridges in New Jersey: Final Report,” <http://www.state.nj.us/transportation/refdata/bridgereport102007.pdf> (accessed February 17, 2011), 5.

¹³⁴ Ibid.

age or older. This is switched with county bridges, with only 24 percent falling between ages 41 and 75 years, and 31 percent being more than 75 years of age.¹³⁵ This disparateness may be accounted for in the more recent addition of bridges to the Interstate System as well as a greater emphasis on replacing (or rehabilitating) state and Interstate System bridges first. State bridges have always needed to be widened and strengthened to accommodate ever growing volumes of traffic, while less traveled county and local roads did not see such increases until more recently.

A correlation can be seen with age distribution and bridge condition between state and county bridges. This correlation equates to volume increases in the transportation network that are absorbed by county roads and bridges but max out at the state level. Although 31 percent of county bridges are over 75 years of age, only 12 percent are considered structurally deficient and 19 percent, functionally obsolete. Compared to county bridges, state percentages are approximately the same, with 13 percent structurally deficient and 22 percent functionally obsolete, even though there is a significant decrease in amount of bridges over 75 years of age.¹³⁶

These inspections lead to a safe road network that is able to handle the massive amounts of traffic throughout New Jersey. This includes the New York City and Philadelphia metropolitan areas, which is comprised of some of the heaviest traffic volumes and most congested travel corridors in the nation. However, this assurance comes at a steep price tag. Almost \$22 million is spent annually for the state's bridge inspection program, including \$12 million for state bridges and \$6 million for county

¹³⁵ Ibid., 6.

¹³⁶ Ibid., 8.

bridges.¹³⁷ But New Jersey feels that the high cost of the program is warranted, claiming, “We feel that the cost of a high quality inspection program is justified by providing for the identification of deterioration at a point where it can be repaired before it results in the loss of use of our highway system and the potential loss of life that could result.”¹³⁸

Unfortunately, funding problems threaten to slow this progress of making New Jersey’s bridges, and those of the nation, safer. Infrastructure improvements are costly, and the construction and rehabilitation of bridges is no exception. It is estimated that New Jersey would have to spend over \$13.5 billion dollars to eliminate all structurally deficient and functionally obsolete bridges in the state.¹³⁹ Of this amount, more than half would go to state bridges (\$7.8 billion) with \$1.5 billion for county use. In the case study county of Hunterdon, it is estimated that \$74 million will be required to eliminate all structurally deficient and functionally obsolete bridges.¹⁴⁰

It is important to understand that just because a bridge is classified as structurally deficient or functionally obsolete does not mean that the structure is unsafe and is about to collapse. A bridge may be rated structurally deficient if it is weight restricted while a bridge may be rated functionally obsolete because of height and width restrictions. None of these reasons explicitly make the bridge unsafe for use. However, these ratings do indicate that the bridge may need a further, more in-depth investigation to better understand its condition. Unfortunately, many states use the functionally obsolete condition of their bridges as a basis for necessary removal.

¹³⁷ Ibid.

¹³⁸ Ibid., 10.

¹³⁹ Ibid., 13.

¹⁴⁰ Ibid., 14.

Weight, width, and height restrictions have posed special burdens for single-lane bridges more recently. Although these structures were state of the art during the time they were constructed, they are generally not compatible with today's modes of transportation. Horses and carts of crops exerted little stress on these metal structures, as did early automobiles and farming equipment. However, with advancements in automobiles and other vehicles, these bridges can no longer efficiently perform as designed.

Vehicles have become larger and heavier, and some bridges may not be able to accommodate these vehicles. A major issue arises concerning emergency vehicles. Ambulances and fire trucks, especially pumper trucks, have exceptional weights. Iron truss bridges built in the late-1800s usually have restricted weights ranging from 4 to 6 tons. An average fire truck can weigh up to 14 tons, and pumper trucks can weigh up to 28 tons. If these vehicles were to cross a historic bridge, the potential for collapse is great, effectively demolishing the bridge, destroying the fire truck, and possibly causing serious injury to the firefighters. In addition, narrow single-lane bridges may not be able to safely accommodate these wider emergency vehicles, and if the bridge is a through truss, tall emergency vehicles may have difficulty crossing due to height limitations. Preventing fire trucks or ambulances from crossing a bridge, forces emergency vehicles to find another route, losing precious time needed to put out a fire or transport someone to the hospital.

School busses run into this problem as well. Ranging in weight from 11 to 14 tons, school busses are also prevented from crossing weight restricted historic bridges. A bridge collapsing under the weight of a school bus filled with children could be

catastrophic. The same goes with delivery trucks, concrete trucks, and modern day farm equipment. Heavy vehicles that consistently pass over the bridge may cause metal fatigue, leading the bridge to deteriorate and fail more quickly than expected or planned.

In general, at least in Hunterdon County, there is an effort to make weight restricted historic bridges accept a 15 ton load or more. The loading rates that can be used as a general rule of thumb are as follows: H-15 (15 tons); HS-15 (27tons) allows for a typical farm vehicle, school bus, loaded garbage truck, and single-unit fire engine; HS-20 (36 tons) allows for all of the H-15 and HS-15 vehicles plus pay-loaded ready-mix concrete truck, and tractor-apparatus fire engine.¹⁴¹

In a rural area like Hunterdon County, farming is important. Yet a farmer may not be able to easily get his tractor or other farm implements to all of his fields because it is too heavy to go over weight restricted bridges. In addition, tractors, fire trucks, and other large vehicles may be too wide or too tall to fit through single-lane truss bridges, necessitating lengthy detours.

Geometric problems also cause safety concerns because the alignment of the road in relation to the bridge. Roads traditionally follow rivers in a parallel fashion, but bridges cross rivers and must be perpendicular to them as well as the road. This forms a 90 degree angle, creating blind spots and eliminating useful sightlines. Bridges are also slightly elevated in order to prevent washing-out during a flood event. This too creates a

¹⁴¹ The Indiana Association of County Highway Engineers and Supervisors, “Indiana Design Manual Section 72-7.0: Treatment of Historic Bridge on Low-Volume Local Road (Analysis of Comments: March 21, 2007),” <http://www.iaches.org/PDF/Draft%20and%20Final%20Section%2072-7.02.pdf> (accessed February 20, 2011), 6.

hazardous condition, preventing the drivers from seeing one another until they are both facing each other on the bridge deck.

Although these bridges are usually located on narrow rural roads with relatively low speed limits, a vehicle must slow upon entering the bridge (due to its 90 degree slightly elevated entrance), stop to make sure other cars are not crossing, and then slowly proceed to other side, where (usually) another corresponding sharp turn must be navigated. As a result, many of these historic bridges act as traffic calming devices.

Another safety concern is bridge paint. Bridges were, and continue to be, painted to prevent the structure from rusting and deteriorating. Historic bridges were originally painted with lead based paints, making them highly toxic. When the bridges are repainted, the old paint must be stripped. Environmental permits and a myriad of safety features and devices are then installed to prevent the lead paint flakes from contaminating the surrounding area. The bridge is then painted with a non-toxic paint. Due to its labor intensity, bridge painting is costly and time consuming, but is invaluable in preventing accelerated deterioration and further safety concerns.

Other devices, mainly guardrails, are also extremely important for the structural integrity and safety for both bridges and drivers. This is especially true of historic bridges which are made from materials such as cast-iron which could sheer apart on impact, immediately compromising the structure and leading to failure. Guardrails must be strong enough to absorb the impact while transferring as little of the impact to the super structure as possible. All attempts should be made to protect the bridge's superstructure from collision. As mentioned previously, guardrails should not prevent views and can be aesthetically pleasing. There are over sixty different types of guardrails

that have been crash tested and approved by the FHWA of different materials and styles.¹⁴² Guardrails, when properly positioned and installed, allow historic bridges to safely remain in service, protecting the bridges, the vehicles, and the people traveling over them.

6.2 Liability

Liability is a major concern in any transportation related project. Relating to safety, transportation facilities are generally designed to mitigate many perceived future liability concerns. On the one hand, this gives the impression that the road is safe (within the control of certain other variables, mainly speed). On the other hand, this usually leads to over-design of the facility.

The over-design of roads and bridges regularly results in using, or attempting to use, interstate design concepts for all roads, including less traveled rural routes. These major concepts incorporate wide, straight roads with ample space for shoulders. Usually this design is incompatible with current rural road alignments and existing bridges. It may also lead to other concerns such as promoting speeding and other reckless driving behavior.

The use of these designs are usually result from abstract ideas about potential accident spots and government liability for allowing such a ‘dangerous’ road or bridge to remain in place ‘unchecked.’ The thought of lengthy and costly lawsuits compels local governments to fix these concerns according to acceptable AASHTO and state

¹⁴² Federal Highway Administration, “Flexibility in Highway Design: Bridges and Other Major Structures,” U.S. Department of Transportation, <http://www.fhwa.dot.gov/environment/flex/ch07.htm> (accessed February 13, 2011).

recommendations and standards, sometimes without considering other concerns such as character, historic integrity, the environment, and setting.

Fears of tort litigation are well founded, but usually over exaggerated. Lawsuits against engineers and road departments have indeed been on the increase, according to the FHWA, a result of no longer allowing design immunity for highway agencies in almost all states.¹⁴³ In response, transportation officials at all levels have turned to AASHTO's Green Book as a way to claim that they exercised 'due care' and have adhered to the accepted standards and practices for their road and bridge designs. Although this is done in an attempt to defend themselves from lawsuits, it is not always successful.

The FHWA notes that strict adherence to ASSHTO recommendations does not automatically prevent engineers and transportation departments from being sued, and conversely, not adhering to ASSHTO's recommendations does not automatically establish negligence.¹⁴⁴ In all cases, common sense should be used in design and the implementation of transportation projects. The rationales for the design should always be thoroughly and thoughtfully justified, whether or not the project meets ASSHTO's recommendations, and all decisions should be well documented.

Liability is also a real concern for historic structures and those charged with their responsibility. According to David C. Fischetti, P.E., structural engineers are reluctant to

¹⁴³ Federal Highway Administration, "Flexibility in Highway Design: Highway Design Guidelines," U.S. Department of Transportation, <http://www.fhwa.dot.gov/environment/flex/ch02.htm> (accessed February 13, 2011).

¹⁴⁴ Ibid.

become involved with historic preservation projects because of liability concerns.¹⁴⁵

There are just too many unknowns and potential complications that could occur. By providing a structural evaluation the engineer may become the ‘engineer of record’ and therefore hold a brunt of the responsibility for the integrity of the structure and project.¹⁴⁶

This is can lead to litigation, it is believed, because historic buildings and structures were not built to modern standards. At the time these structures were built, there were usually no ways to test or analyze the structures or the materials from which they were constructed. For example, the configuration of wood beams in a building was based on a guess rather than the weight the beams could actually support. The same was true for bridges, where iron beams had no real way of being strength tested before design or assembly, and the metal crafting process (cast- or wrought-iron) was an imperfect science that generally did not yield consistent results.

As such, there is a real concern that these structures may contain hidden flaws, leading to collapse. If these flaws are not caught and remedied, this could lead to potential litigation. As a result, many engineers do not participate in historic preservation projects, as stated above, or require adequate compensation (sometimes charging hefty fees) to protect themselves in the case of any potential complications or lawsuits.¹⁴⁷

Although the fear of litigation hangs over engineers who inspect and do work on these structures, as well as the governments responsible for them, this fear, at least in regards to historic bridges, is mostly unfounded. According to a survey conducted for a

¹⁴⁵ David C. Fischetti, *Structural Investigation of Historic Buildings: A Case Study Guide to Preservation Technology for Buildings, Bridges, Towers, and Mills*, (Hoboken, NJ: John Wiley & Sons, Inc., 2009), 3.

¹⁴⁶ Ibid.

¹⁴⁷ Ibid., 4.

workshop on the preservation and management of historic bridges, “Historic Bridges: A Heritage at Risk,” in 2003, which included responses from the Department of Transportation of thirty-six states and the District of Columbia, tort liability may be more of an imagined concern than reality.¹⁴⁸

According to the survey, fifteen states identified tort liability being cited most frequently as the reason for not rehabilitating historic bridges.¹⁴⁹ However, when a follow-up question asking how many lawsuits involving historic bridges have been successfully brought against their agency over the past five years, “No state could identify a single instance when it was sued because someone lost a life, personal property or experienced an injury due to a deficient historic bridge.”¹⁵⁰ The report further states that “Tort liability will always be a concern, but this survey brings into question the use of tort liability as a reason for not rehabilitating an historic bridge.”¹⁵¹ As the FHWA notes, tort liability, real or imagined, may lead to the avoidance of “innovative and creative approaches to design problems,” and that “avoiding unique solutions is not the answer.”¹⁵² Nowhere is this a more true statement than in the attempts to persevere transportation resources such as historic bridges, where unique solutions are the key, not the impediment, to their future sustainability.

¹⁴⁸ For the complete survey, see Appendix E.

¹⁴⁹ Eric DeLony and Terry H. Klein, “Historic Bridges: A Heritage at Risk; A Report on a Workshop on the Preservation and Management of Historic Bridges” (Rio Rancho, NM: SRI Foundation, 2004), 24.

¹⁵⁰ Ibid.

¹⁵¹ Ibid.

¹⁵² Federal Highway Administration, “Flexibility in Highway Design: Highway Design Guidelines,” U.S. Department of Transportation, <http://www.fhwa.dot.gov/environment/flex/ch02.htm> (accessed February 13, 2011).

6.3 Maintenance

There is nothing more important than maintenance. Maintenance is imperative for making sure bridges of all ages, from the oldest to the newest, successfully perform and last. Bridges are costly to maintain, but even more costly to construct, therefore it is wise to construct a sound bridge that will be able to successfully last a long time with the minimal amount of required maintenance.

One of the biggest concerns with historic, metal truss bridges is rust. These structures are metal and metal rusts. Fortunately, metal structures from the mid- to late-1800s were comprised of iron. Early iron bridges were not as susceptible to rusting as more modern structures are. This is because the early metal contained a high-level of phosphorous (an impurity which inhibited rust).¹⁵³ Unfortunately, by the 1930s, phosphorous was removed from steel in order to make it more ductile.¹⁵⁴ This is why so many older truss bridges are still around, in relatively good shape, they do not rust as easily as modern metal bridges and as a result, needed less maintenance from cash strapped roads departments.

Generally, maintenance performed on a bridge is designed to prevent larger problems from occurring at a later date and “preventative maintenance such as routine cleaning and inspection is the key component to any bridge maintenance program.”¹⁵⁵

There are five areas of concern that should be part of every bridge maintenance program:

¹⁵³ Mike Mort, *A Bridge Worth Saving: A Community Guide to Historic Bridge Preservation* (East Lansing, MI: Michigan State University Press, 2008), 48.

¹⁵⁴ Ibid.

¹⁵⁵ National Cooperative Highway Research Program, *Cost-Effective Practices for Off-System and Local Interest Bridges* (Washington, D.C.: Transportation Research Board, 2004), 28.

the traveled surface, the structural decks, the superstructure, the substructure, and the watercourse and embankments.¹⁵⁶

According to a survey of bridge engineers and administrators, bridge decks pose the greatest number of problems, mainly dealing with the winter season and the use of road salts. Potholes, spalling, punch throughs, and other deck failures result from aging materials, harsh weather conditions, and higher traffic volumes. Superstructure ailments are also a result of age and the environment, with paint failure near speeds up corrosion of the metal components. Narrow bridges also suffer from vehicle collisions, highlighting the importance and necessity of adequate guardrails. Substructure, like the superstructure deteriorates because of the effects of nature. However in this case, the failures are harder to catch and includes localized footing scour and scour holes which can be catastrophic to the bridge. Both superstructure and substructure deterioration can be difficult to repair and cost prohibitive.¹⁵⁷ However, researchers found that a large percentage of bridge problems could be solved using repair, rehabilitation, and retrofitting procedures.¹⁵⁸

Within these five areas of concern, maintenance is required of various bridge features. These features not only include parts of the bridge but also include objects attached to the bridge like signs and safety devices as well as the area over, under, and around the structure. According to the National Cooperative Highway Research Program

¹⁵⁶ Ibid., 29.

¹⁵⁷ Ibid., 37.

¹⁵⁸ Ibid., 32.

(NCHRP), in their report, *Cost-Effective Practices for Off-System and Local Interest*

Bridges, other features and areas that require maintenance include:

- Signs and energy absorbing devices
- Approaches
- Substructures (concrete abutments and piers, timber piles and abutments, steel piling, concrete piling, and stone masonry abutments and piers)
- Trusses, truss members, and connections
- Beam spans (timber stringers—treated or untreated, steel stringers and girders, concrete girders, bearings, and expansion joints)
- Decks (timber, concrete, steel, curbs, and sidewalks)
- Railings (concrete, steel, timber, and masonry)
- Waterways
- Culverts and related appurtenances
- Cleaning and painting¹⁵⁹

Making sure that the proper maintenance is performed in these five areas maximizes a bridge's service life.

A topic that is related to maintenance concerns the bridge's life-cycle. According to AASHTO, "Life-cycle costs are one of the most frequently used factors in decision making. Agencies have limited resources, amid choices must be made whether to utilize them on old bridges."¹⁶⁰ Although, the large metropolitan bridges are continuously rehabilitated and maintained, smaller rural bridges compete for funds, and as a result, maintenance is not always properly carried out. In these cases, where the maintenance costs of old bridges consume valuable money, the temptation is to replace the old structure with new structures that are less maintenance heavy. AASTO comments that "It is for these structures where initial construction and long-term maintenance costs are

¹⁵⁹ Ibid., 29.

¹⁶⁰ American Association of State Highway Transportation Officials, *Guidelines for Historic Bridge Rehabilitation and Replacement* (AASHTO: Washington, D.C., 2008), 36.

vitally important and often the deciding factor. Additionally, a bias that new is better than old often factors into decisions.”¹⁶¹

Although there is no standard of when a bridge should be replaced (because every situation is different), AASHTO has come up with a rough guideline. According to AASHTO, “if the cost of rehabilitation is less than the cost of replacement, if the life-cycle costs are approximately equal to that of a new bridge, and if the life of the rehabilitation is on the order of 25 years, then rehabilitation can be easily justified even though a new bridge may have a life of 50 years or more.”¹⁶² AASHTO continues, claiming that “even if the cost of rehabilitation approaches the cost of replacement, as long as the cost of maintenance and the rehabilitation life remains reasonable, rehabilitation of the historic bridge is justified.”¹⁶³ It is only when the costs of maintenance is high and life-cycle of the maintenance is short when replacement should be pursued.¹⁶⁴

Proper maintenance allows a bridge to have a long life-cycle, saving money by thwarting the need to design and construct a costly new bridge. Currently, technologies are being developed to extend the life-cycle of bridges while at the same time reducing the amount of time needed for maintenance. These technologies allow bridge deviancies to be corrected using methods that do not require constant maintenance.¹⁶⁵ In addition, new epoxies and specially coated metal parts extend the life-cycle of bridge components

¹⁶¹ Ibid.

¹⁶² Ibid.

¹⁶³ Ibid.

¹⁶⁴ Ibid.

¹⁶⁵ Ibid.

while the bridge deck's life-cycle can be extended by yearly scrubbing to remove road salts and other debris.¹⁶⁶

Metal truss bridges' number one defense against the elements is paint. Unfortunately, historic bridges were painted with lead paint. Lead paint causes a maintenance and environmental nightmare and "the increasing costs of lead paint removal and repainting have become a significant burden for bridge owners."¹⁶⁷ The cost of the lead paint removal and related hazardous waste is consuming maintenance budgets. Fortunately, once the lead paint is removed from the structure, the bridge is painted with a non-toxic, lead-free alternative paint.

Maintenance slows the rate of deterioration, extending the life of the bridge. However, the decision by some state and local governments to use deferred maintenance as a way to save funds is counterintuitive. This process ends up costing more money in the long run through larger, more costly repair or reconstruction projects at a later date. Deferred maintenance has also been a prime contributor to the appalling state of the current bridge population.¹⁶⁸ In order to save a few dollars, bridges were left to languish in the harsh elements without the proper care that is necessary for their continuing safe functionality.

6.4 Funding

Funding for all (public) bridge projects in the United States originates in three places: the federal government, the state government, and local government. Usually,

¹⁶⁶ National Cooperative Highway Research Program, *Cost-Effective Practices for Off-System and Local Interest Bridges* (Washington, D.C.: Transportation Research Board, 2004), 38.

¹⁶⁷ *Ibid.*, 34.

¹⁶⁸ *Ibid.*, 36.

this money originates at the federal level, and then makes its way down to the local level through various programs.

Taking care of bridges is a costly endeavor, and as such, much of the cost of rehabilitation, restoration, reconstruction, and new construction comes from, in some fashion, the federal government. Funds get distributed to the states from the United States Department of Transportation (USDOT) and the Federal Highway Administration (FHWA). These funds are used by the states or distributed to counties or local municipalities offset the cost of interstate highway construction, public transportation projects, bridge building and repair, and safety measures like traffic signals and signs.

The use of certain federal funds is dependent on whether the historic structure is located on- or off-system. Federal funding is offered through a variety of federal programs, a majority of which is made available through the Safe Accountable Flexible Efficient Transportation Equality Act-Legacy for Users (SAFETEA-LU). These programs include the Surface Transportation Program (STP), the Highway Bridge Replacement and Rehabilitation Program (HBRRP), and National Highway System funds.

One bridge funding program of SAFETEA-LU is the Surface Transportation Program (STP). STP funds allow flexibility in deciding how the money states receive is to be spent. The funds are distributed to each state based on a variety of factors including total lanes of federal-aid highways, vehicle miles traveled on federal-aid highways, and

the estimated contributions to the state's Highway Account Trust Fund.¹⁶⁹ These funds can then be used by the state, or redistributed to local municipalities for their use. STP money can be used for, among other things, bridge projects on any public road.¹⁷⁰

The Highway Bridge Replacement and Rehabilitation Program (HBRRP) is another funding program of SAFETEA-LU that can be used for bridges. This program, now called the Highway Bridge Program (HBP), allows funds to be used for the replacement, reconstruction, or rehabilitation of bridges in order to improve the structure's condition. HBP funds can also be used for preventative maintenance, and at least fifteen percent of a state's HBP funds must be used for non federal-aid highway bridges.¹⁷¹

National Highway System (NHS) funds are another SAFETEA-LU bridge funding program. NHS funds go towards improvements to rural and urban roads that are part of the NHS, including the Interstate System.¹⁷² Although this program has been successful in the rehabilitation of many bridges (some historic), states are only able to use NHS funds for road and bridge projects that are on the National Highway System. Single-lane bridges are generally not located on this system, and therefore would not qualify for use of HBP funds.

¹⁶⁹ Federal Highway Administration, "Fact Sheets on Highway Provisions: SAFETEA-LU (Surface Transportation Program)," U.S. Department of Transportation, <http://www.fhwa.dot.gov/safetealu/factsheets/stp.htm> (accessed February 20, 2011).

¹⁷⁰ Ibid.

¹⁷¹ Federal Highway Administration, "Fact Sheets on Highway Provisions: SAFETEA-LU (Highway Bridge Program)," U.S. Department of Transportation, <http://www.fhwa.dot.gov/safetealu/factsheets/bridge.htm> (accessed February 20, 2011).

¹⁷² Federal Highway Administration, "Fact Sheets on Highway Provisions: SAFETEA-LU (National Highway System Program)," U.S. Department of Transportation, <http://www.fhwa.dot.gov/safetealu/factsheets/nhs.htm> (accessed February 20, 2011).

An important component to transportation preservation is the National Historic Covered Bridge Preservation Program (NHCBPP) of SAFETEA-LU. This program enables states to use funds in order to preserve and rehabilitate historic wooden covered bridges that are eligible for listing on the National Register of Historic Places.¹⁷³ Although this program funds historic bridges specifically, it only applies to wooden covered bridges. Metal truss and other type of bridge are ineligible to receive funding from this program. There is no other exclusive federal historic bridge preservation funding program that helps preserve metal truss bridges.

The first three programs (STP, HBP, and NHS) all have a federal share of eighty percent (subject to sliding scale adjustment), leaving the state to cover only twenty percent of the cost project cost. These programs make large amounts of money available to the states for bridge preservation and other transportation improvement projects. These programs are also highly successful and imperative to the states in offsetting the enormous costs of infrastructure maintenance. But in addition to federal programs, states have their own programs by which they fund bridge and preservation projects.

Many states have historic bridge preservation programs. Since the focus of this thesis is New Jersey, state programs of New Jersey will be examined more in-depth than programs of other states. New Jersey has the Historic Bridge Preservation Program. Through this program, The New Jersey Department of Transportation (NJDOT) provides

¹⁷³ Federal Highway Administration. "Fact Sheets on Highway Provisions: SAFETEA-LU (National Historic Covered Bridge Preservation)." U.S. Department of Transportation. <http://www.fhwa.dot.gov/safetealu/factsheets/histcovbridges.htm> (accessed February 20, 2011).

funding and technical assistance towards the preservation and rehabilitation of off-system historic bridges.¹⁷⁴

The New Jersey Historic Bridge Preservation Program allows counties to obtain state funds to rehabilitate historic bridges through preventative maintenance and other minor repairs in order to “prolong the life span of New Jersey's historic bridges.”¹⁷⁵ The program does not, however, fund major projects such as structural, safety, and geometric upgrades.¹⁷⁶ In addition, the program covers 100 percent of approved project costs.¹⁷⁷ In 2007, Hunterdon County received part of a \$588,000 grant slated for historic bridge preservation. Through these grants, counties will receive the “resources to preserve the integrity and safety of these historic bridges, thereby ensuring their use by future generations of New Jerseyans,” exclaimed NJDOT Commissioner Kris Kolluri.¹⁷⁸ The county accepted the \$140,000 award and used it to repair the bearings and chords of various metal truss bridges throughout Hunterdon County.¹⁷⁹

¹⁷⁴ New Jersey Department of Transportation, “Local Aid and Economic Development: Program Description and Procedures for Historic Bridge Preservation,” State of New Jersey, <http://www.state.nj.us/transportation/business/localaid/documents/HistoricBridgePreservationProgram.pdf> (accessed February 20, 2011), 2.

¹⁷⁵ New Jersey Department of Transportation, “Local Aid and Economic Development: Historic Bridge Preservation,” State of New Jersey, <http://www.state.nj.us/transportation/business/localaid/historic.shtm> (accessed February 20, 2011).

¹⁷⁶ New Jersey Department of Transportation, “Local Aid and Economic Development: Program Description and Procedures for Historic Bridge Preservation,” State of New Jersey, <http://www.state.nj.us/transportation/business/localaid/documents/HistoricBridgePreservationProgram.pdf> (accessed February 20, 2011), 2-3.

¹⁷⁷ New Jersey Department of Transportation, “Local Aid and Economic Development: Historic Bridge Preservation,” State of New Jersey, <http://www.state.nj.us/transportation/business/localaid/historic.shtm> (accessed February 20, 2011).

¹⁷⁸ Ibid.

¹⁷⁹ New Jersey Department of Transportation, “NJDOT awards grants to preserve historic county bridges,” New Jersey Department of Transportation News Release, October 23, 2007.

Another important funding program in New Jersey was the Statewide Transportation and Local Bridge Bond Act of 1999. This program created a special fund of \$250 million for NJDOT and NJ TRANSIT (the statewide public transportation authority) transportation projects and another \$250 million to be distributed to the counties for local bridge projects.¹⁸⁰ As of 2007, sixty-three percent of the local bridge project money had been spent.¹⁸¹ Through this program, Hunterdon County was able to perform maintenance and rehabilitation measures on eleven bridges throughout the county, including one that will be further discussed in the case studies chapter. In all, the state granted Hunterdon County over \$7 million dollars for the preservation of county bridges.¹⁸²

Funding is a complex issue when it pertains to preserving and rehabilitation historic bridges. Some funds come with rules and stipulations that go along with the money. For example, single-lane historic bridges, in many cases, are too narrow to meet modern design standards for a two-lane road (and sometimes too narrow for a single-lane road). As a result, county engineers design bridges with wider decks, to accommodate newer road and bridge standards. This scenario puts funding, engineers, preservationists, and residents at odds with one another, but is common place.

Building and maintaining transportation infrastructure is costly. Historic preservation is equally costly. That is why the government gives tax credits and

¹⁸⁰ New Jersey Department of Transportation, “1999 Bridge Bond spending plan released, stressing bridge and road maintenance, operational improvements and transit,” New Jersey Department of Transportation News Release, October 22, 1999.

¹⁸¹ New Jersey Department of Transportation, “Statewide Transportation and Local Bridge Bond Act of 1999: Status Report May 2007” (Trenton, NJ: New Jersey Department of Transportation, 2007) 2.

¹⁸² Ibid, 4.

incentives to preserve buildings and why the government offsets the costs of transportation projects. Together, trying to preserve a single-lane historic bridge can turn out to be an expensive endeavor, especially for a local or county government that does not have deep coffers. County engineers and officials have to make tough decisions, usually driven by financial options. On one hand, they can maintain and perform proper upkeep on historic structures, expending their money and time. Or, on the other, they can let historic bridges languish, receive federal and state government money, and build a new structure.

The arguments are not as black and white as written above, but money and funding concerns are affecting the very existence of single-lane bridges. By their very nature, they are functionally obsolete (they are only one-lane wide on two-lane wide roads). Many are also structurally deficient. If the bridge needs to be fixed (or replaced), and there are funds available, taking the funds may lead to the destruction of a historic resource. Supposedly, by accepting the money and updating the bridge to modern standards, the bridge becomes safer. But is a wide bridge on a rural back road really safer than a narrow bridge?

7.0 TECHNIQUES

7.1 Preservation Methods

Bridge preservation methods vary widely depending on the type of structure, location of the structure, and condition of the structure. The historic significance of the bridge also impacts the methods employed. It should be emphasized that creative solutions to bridge preservation problems are always encouraged. Many communities have been able to retain their historic bridges by conceiving and developing solutions that maintain their bridges' structural and historic integrity. This is done through utilizing creative design and contextual solutions.

While not all methods work for all structures, great effort should be put forth in investigating any and all options before considering replacement. In addition, every effort should be made to ensure that the bridge remains in transportation service.¹⁸³ In order to attain these goals, there are two main methods of bridge preservation: stabilization and rehabilitation. The adaptive reuse of bridges should be considered if the

¹⁸³ Virginia Transportation Research Council, "A Management Plan for Historic Bridges in Virginia: Final Report," (Charlottesville, VA: University of Virginia, 2001) <http://www.virginiadot.org/programs/resources/01-r11.pdf> (accessed February 19, 2011), 18.

first two methods are deemed not viable. Replacement should only be used as a last resort and should only follow after thorough documentation of the structure. What is important to understand is that, as AASHTO notes, “Some deficiencies are easily corrected while others require more effort to bring a historic bridge into conformance with engineering standards.”¹⁸⁴ The key is finding the balance between rehabilitation and replacement and usually that balance concerns funding.

The methods available are not limited to the options presented here. These options are, in the broadest terms, the most heavily relied upon methods of bridge preservation. They can also serve as a starting point when determining what actions should be taken. However, before any steps are taken towards the preservation or replacement of metal truss bridges, AASHTO’s *Guidelines for Historic Bridge Rehabilitation and Replacement* recommends that certain questions should first be asked and considered. Questions to consider about rusting and deterioration include:

- Can a deteriorated or cracked member be replaced in kind?
- Can a deteriorated or cracked member be repaired with additional material bolted to it?
- Can members be added to supplement deteriorated or undersized ones?
- Will applying a coating system arrest corrosion?
- Can an auxiliary structural system be installed?¹⁸⁵

Questions to consider about load-carrying capacity include:

- Can dead load be reduced by replacing the deck with a lighter one?
- Can material be added to individual members to increase capacity?
(This includes installing high-strength rods as well as plates)

¹⁸⁴ American Association of State Highway Transportation Officials, *Guidelines for Historic Bridge Rehabilitation and Replacement* (AASHTO: Washington, D.C., 2008), 18.

¹⁸⁵ *Ibid.*, 25.

- Can deteriorated members or sections of members be replaced in kind to restore structural integrity and/or increase capacity?
- Can use of the bridge be restricted?¹⁸⁶

Geometry problems are serious concerns with rural, single-lane bridges. Because they were built in a time before heavy, high speed vehicles were developed, they are usually narrow and have poor sight distances across the bridge and at the approaches.

Important concerns to consider before making any major rehabilitation decisions include:

- Can a bridge be widened without adversely affecting its scale?
- Can the vertical clearance be increased to remain in scale with the bridge and not have an adverse effect?
- Can signals or signage be installed to control alternating flow of traffic on a low-volume road?
- When the proposed improvement is for a highway or street that is already substandard, can minimally acceptable standards/guidelines be used?
- Can the scale and proportions of a bridge contributing to a historic district be maintained by a new replacement bridge and have no adverse effect to the district?¹⁸⁷

One of the first through trusses in the Mid-Atlantic region to be widened was the Califon Main Street Bridge over the South Branch of the Raritan River in Hunterdon County.¹⁸⁸ This bridge, constructed in 1887 and identified as historically significant, is individually eligible and listed as part of the Califon Historic District. It was widened from 17 feet to 24 feet in 1985 with portions of the superstructure being spliced and replaced in kind. In addition, the bridge's trusses and all other decorative details remained intact. As a result of this meticulous rehabilitation and preservation effort, the bridge was allowed to retain its individual eligibility for listing. This was a major step in

¹⁸⁶ Ibid., 28.

¹⁸⁷ Ibid., 31.

¹⁸⁸ The Califon Main Street Bridge is officially known as structure # 100J001.

bridge preservation in Hunterdon County as well as one of the first major bridges actively preserved. Upon the successful rehabilitation of this structure, people in the county, and elsewhere began to refer to this technique as ‘Califonication.’¹⁸⁹

7.1.1 Stabilization

Stabilization is generally the least labor intensive and least costly option available in order to preserve a historic bridge. In this scenario, the bridge is maintained and left alone. If only a minimal amount of repair work is required and the road is hardly traveled, stabilization may be the proper action to take. However, this option is not prudent to use on most bridges because of safety and other concerns, and is only available to those bridges that are the least traveled and that would rarely, if ever, encounter heavy vehicles, such as school busses and delivery or construction trucks. Mike Mort notes “As long as safety issues have been addressed and the bridge is fundamentally sound, simply leaving it alone is a preservation option in itself.”¹⁹⁰

Sometimes this method of preservation is chosen by default. If a rehabilitation or replacement plan cannot be decided upon or funding issues prevent plans from going forward, maintenance and safety concerns are addressed but the bridge is otherwise left alone. This method is also commonly used for listed or eligible bridges while rehabilitation or replacement plans are being discussed and finalized. If the bridge poses no imminent safety risks for the motorists, it is better to leave the bridge alone while an appropriate action plan for its preservation is developed.

¹⁸⁹ Dennis Heil and John Glynn of the Hunterdon County Department of Roads, Bridges, and Engineering, interviewed by author, Flemington, NJ, January 5, 2011.

¹⁹⁰ Mike Mort, *A Bridge Worth Saving: A Community Guide to Historic Bridge Preservation* (East Lansing, MI: Michigan State University Press, 2008), 42.

7.1.2 Rehabilitation

When stabilizing a bridge is not deemed practical, bridges may be rehabilitated. The decision to rehabilitate a bridge is complex. Although this method is successful in retaining historic fabric while strengthening the bridge for modern use, it is also the most labor intensive and difficult method of preservation available because of all the different variables that need to be addressed. However, it can also be the most successful method employed, ensuring that the bridge remains in service for decades to come. AASHTO notes that “If a bridge can be improved to an acceptable level in a feasible and prudent manner without destroying what makes it historic, then it is generally a viable candidate for rehabilitation.”¹⁹¹

Generally, listed or eligible bridges are often rehabilitated. This is because all efforts must be taken to mitigate any action that may harm the bridge’s historic integrity while helping it reach current bridge standards. Rehabilitation allows a bridge to maintain its historic integrity while simultaneously being retrofitted for service in the 21st century. In his book, *A Bridge Worth Saving: A Community Guide to Historic Bridge Preservation*, Mike Mort explains why this method of preservation is so difficult noting that, “Not only must the bridge be repaired, its rust removed, its damaged members fixed, its camber restored, and all of its metal primed and painted, but it must also be brought up to code.”¹⁹² He continues, “Heavier guardrails may be needed. The truss itself may require reinforcement with extra diagonals or subtrusses and ties. Stronger material may

¹⁹¹ American Association of State Highway Transportation Officials, *Guidelines for Historic Bridge Rehabilitation and Replacement* (AASHTO: Washington, D.C., 2008), 15.

¹⁹² Mike Mort, *A Bridge Worth Saving: A Community Guide to Historic Bridge Preservation* (East Lansing, MI: Michigan State University Press, 2008), 44.

need to be used for the deck. Load levels may need to be posted.”¹⁹³ In addition, single-lane bridges are often too narrow, complicating the rehabilitation process.

As previously indicated, if a bridge is going to be rehabilitated, the rehabilitation must correct the deficient bridge, rendering it non-deficient. Width and weight limitations are the largest impedances in trying to get the bridge to meet current requirements. Height limitations may also exist for through trusses. In order to maintain historic integrity, certain aspects of the bridge are considered historically significant and should be altered or changed as little as possible. AASHTO’s *Guidelines for Historic Bridge Rehabilitation and Replacement* identifies these aspects as:

- Technologically significant components or details
- Particular configurations of truss design
- Completeness of early examples of common bridge types
- Scale of bridges located in historic districts¹⁹⁴

However, in contrast, AASHTO’s guidelines also notes bridge components that are generally not considered significant and that may be altered. These include:

- Decks
- Substructure units
- Stringers and floorbeams
- Rivets
- Exact dimension and strength of structural steel
- Location of metal truss bridges
- Bearings¹⁹⁵

¹⁹³ Ibid.

¹⁹⁴ American Association of State Highway Transportation Officials, *Guidelines for Historic Bridge Rehabilitation and Replacement* (AASHTO: Washington, D.C., 2008), 17.

¹⁹⁵ Ibid., 9.

7.1.3 Adaptive Reuse

The adaptive reuse of bridges should only occur when rehabilitation is deemed infeasible. This can occur because of excessive costs related to the rehabilitation process, or, in the case of listed or eligible bridges, the rehabilitation will either damage too much of the bridge's historic integrity or will not be able to rectify the bridge's deficiencies adequately. Bridges are usually then deconstructed, cleaned, primed and painted, and then reassembled in another location. A new bridge is then designed and constructed as a replacement.

Although moving and repurposing a bridge allows the structure to remain intact, the bridge loses its sense of place and its context; both considered part of its historic integrity. However, this outcome is better than losing a historic resource altogether, and as such, before a bridge is demolished, efforts should be made to see if the structure could be used for other transportation and non transportation related applications. In some cases, bridges are moved from high volume roads to lower volumes roads, continuing to function as part of the transportation network. Bridges may also be sold for private use, usually for residential driveways. In other cases, the bridge may be relocated to a park where it can serve as part of a bike path or as a pedestrian foot bridge.

7.1.4 Replacement

Rural, single-lane bridges are generally considered functionally obsolete because of their width restrictions and are also usually structural deficient because of their weight restrictions, but this does not necessarily mean they need to be replaced. Larger bridges are rehabilitated all the time. Some of the most well-known bridges across the country

such as the Golden Gate Bridge in California and the Brooklyn Bridge in New York can be considered functionally obsolete but have been rehabilitated to accommodate modern traffic conditions. Historic bridges such as these are less costly to rehabilitate than to replace, and engineers generally turn to rehabilitation when dealing with large structures. However, this thinking is reversed with smaller bridges.

The immense cost of replacing a large bridge is often offset by the relatively low cost of proper maintenance. Conversely, smaller, shorter spans suffer from relatively high maintenance costs and safety concerns. As a result, “Owners and managers often decide to replace shorter bridges that have structural, functional and/or safety problems rather than consider rehabilitation based on the proven long-term cost effectiveness of replacement for short and single-span bridges.”¹⁹⁶

Replacing a bridge should be considered the last resort. Unfortunately, this option still occurs more commonly than necessary. Although discouraged today, this was a common method of the past and many of our nation’s historic bridges have been lost due to the erroneous belief that a new bridge would be better and safer than maintaining the old structure. Many of the issues leading to the replacement of historic bridges have already been addressed above. Funding and liability top this list of concerns, although in many cases it may cost the same or be cheaper to rehabilitate a bridge than to construct a new one, and, as mentioned previously, the liability argument is often more of a fear than fact.

¹⁹⁶ American Association of State Highway Transportation Officials, *Guidelines for Historic Bridge Rehabilitation and Replacement* (AASHTO: Washington, D.C., 2008), 9.

It should be understood that not all bridges can be saved. On-system bridges are located on major arteries and carry high volumes of traffic. In many cases historic bridges are no longer suited for this type of environment. This is especially true with single-lane bridges. There is a real safety concern in these situations, and as a result, many of these bridges have already been replaced. However, off-system bridges can usually be managed without having to be replaced. These bridges are less traveled and can usually be successfully rehabilitated. Nevertheless, there are times when even off-system bridges are too far gone and rehabilitation becomes impracticable. In these situations, the bridge may need to be replaced.

7.1.5 Bridge Park

In addition to the preservation techniques described above, a new bridge preservation technique is beginning to take hold—the bridge park. Although a relatively new concept, the idea of an historic bridge park has begun to catch on in places where historic bridges are exceptionally threatened. Located in Calhoun County, Michigan, near Battle Creek, is a five acre county park, known as the Calhoun County Historic Bridge Park.¹⁹⁷ This park, free of charge and open to the public, houses six historic bridges, including five metal truss bridges that were no longer sufficient in their original location. The sixth bridge is a stone arch railroad bridge that is still in use. All of the bridges have been rehabilitated and are from locations around Michigan.

¹⁹⁷ For more information about the Calhoun County Historic Bridge Park, please visit: <http://www.historicbridges.org/info/bridgepark/>

The idea of a bridge park is spreading. John Glynn, the director of the Hunterdon County Department of Roads, Bridges, and Engineering, mentioned how a bridge park would be beneficial for not only Hunterdon County but other places as well. His rationale was that historic bridges may no longer be suited for service on the transportation network, but that does not mean they should be discarded. He noted the craftsmanship and story that each bridge can tell through its design.¹⁹⁸ To lose these stories and a record of the nation's engineering past could be prevented by the creation of other bridge parks throughout the country.

Although these bridges will be moved to a park like setting from various locations (losing their historic context), citizens, engineers, and students would be able to learn about and study historic bridges and their components. The concept of a bridge park is simple enough. Counties already have both parks and bridges. If a historic bridge was going to be replaced, the structure could easily be disassembled and later reconstructed in a park, saving history and creating a unique public repository for people to enjoy.

7.1.6 Documentation

When all else fails, and there is no way to preserve the bridge (either by rehabilitation or adaptive reuse or through any other means), the bridge should be thoroughly documented before it is demolished. Documentation is required if federal money is being used in the demolition.¹⁹⁹ The documentation should follow the Historic American Engineering Record (HAER) guidelines established by the National Park

¹⁹⁸ Dennis Heil and John Glynn of the Hunterdon County Department of Roads, Bridges, and Engineering, interviewed by author, Flemington, NJ, January 5, 2011.

¹⁹⁹ Mike Mort, *A Bridge Worth Saving: A Community Guide to Historic Bridge Preservation* (East Lansing, MI: Michigan State University Press, 2008), 46.

Service. A HAERs report requires a written narrative and visual records including sketches, photographs, and measured drawings. If done properly, and accepted, the HAER document will be retained at the Library of Congress with copies at other local institutions.

In general, it is also a good idea, and sometimes required, to document the condition of the bridge no matter which technique is ultimately decided upon. Any changes should be noted so that it could be referenced for future investigation and research.

7.2 Discussion

AASHTO's *Guidelines for Historic Bridge Rehabilitation and Replacement* creates six groups based on the adequacy or inadequacy of a given bridge's geometry, load-carrying capacity, and superstructure/substructure condition in order to determine the bridge's rehabilitation potential. It is safe to say that a majority of the single-lane truss bridges across the country would fall into Group IV. This group possesses adequate superstructure/substructure condition but has inadequate load-carrying capacity and geometry. In addition, issues concerning geometrics and load-carrying capacity are some of the most difficult bridge deficiencies to address through rehabilitation.²⁰⁰ The majority of the case study bridges fall into this category.

According to the guidelines, Group IV bridges were designed for lighter and smaller vehicles with lower average daily traffic (ADT).²⁰¹ These types of bridges were designed as two -lane bridges, but because of the size of today's vehicles, act as a two-

²⁰⁰ American Association of State Highway Transportation Officials, *Guidelines for Historic Bridge Rehabilitation and Replacement* (AASHTO: Washington, D.C., 2008), appendix B-6.

²⁰¹ Ibid., 40.

way, single-lane bridge. Many of these bridges also suffer from poor geometry and were constructed on sharp curves with resulting sight distance problems. ASSHTO notes that these structures are good candidates for rehabilitation and preservation “if widening and improving the deficiencies can be accomplished without destroying what makes the bridge historic in a manner that is feasible and prudent....”²⁰² In regards to weight limitations, ASSHTO notes that “Those bridges that can be strengthened to increase load-carrying capacity without destroying what it is that makes it historic in a manner that is feasible and prudent have preservation potential.”²⁰³

In both cases, ASSHTO’s *Guidelines for Geometric Design of Very Low-Volume Load Roads (ADT <400)* can be used to help determine specific design features. In general, these guidelines usually allow a functioning bridge with poor geometry to remain in place if the recorded accident rate is low and the structure meets traffic volume and load-carrying capacity minimums. In addition, many states have their own written or unwritten policies on how to handle very low-volume roads and bridges.

In the end, it comes down to the individual agency or department responsible for these structures to make the decision for rehabilitation or replacement. Many states and local governments take different approaches regarding bridge preservation, reflecting the culture of each responsible agency.²⁰⁴ And these cultures vary greatly.

According to an ASHTO survey, out of 21 respondents, ten felt that their agency was proactive in the rehabilitation of historic bridges citing state encouragement of rehabilitation and relocation of historic bridges, pride in heritage resulting in efforts

²⁰² Ibid., 39.

²⁰³ Ibid., 39.

²⁰⁴ Ibid., 14.

aimed to avoid replacement of historic bridges, and the number of successfully rehabilitated bridges.²⁰⁵ On the other side however, agencies that did not feel that they were proactive cited a preference for replacement bridges, financial considerations, and that rehabilitation is only considered when public input demands it (showing how important public participation is in preservation).²⁰⁶

The complex issues and concerns surrounding the rehabilitation and replacement of historic bridges can seem daunting at times. Many different variables must be considered including money and funds, safety, maintenance, historic significance, and public opinion. In most cases, the answers are not easy to discern and historic resources can be lost. There is no simple solution and every bridge has a different set of circumstances that must be looked at on an individual basis. Options are also not limited to those noted above, and other creative solutions (by preservationists, residents, and engineers) have been employed and are encouraged. Efforts should be made to help retain historic bridges, especially those located on the rural back roads of America. It is understandable that not every bridge can be saved, but lessons should be learned from the bridges that have been lost so that future decisions can be better made

²⁰⁵ Ibid., appendix B.

²⁰⁶ Ibid.

8.0 HISTORY AND BACKGROUND

8.1 Early County History

Hunterdon County was born from two major rivers which gave access to the interior of New Jersey. These rivers were the Raritan River and the Delaware River. According to George S. Mott in his account of the first one hundred years of Hunterdon County, these rivers “opened the avenues for up along fertile valleys until, in Hunterdon County, they approached at the nearest points within twenty miles of each other, and there the tributaries of each drain the same hills.”²⁰⁷ As early as the late 1600s, settlers from the New York vicinity recognized western New Jersey’s importance, and as Mott notes, “Some of these settlers, and many of their children found their way to the richer lands of Hunterdon.”²⁰⁸

In another account of the first settlers into Hunterdon, he writes, “The district, lying between the confluence of the branches of the Raritan and the Delaware [R]iver,

²⁰⁷ George S. Mott, *The First Century of Hunterdon County, State of New Jersey* (Flemington, NJ: E. Vosseller, Bookseller and Stationer, 1878), 3.

²⁰⁸ *Ibid.*, 9.

soon became known; and its natural advantages attracted the attention of both Jerseys.”²⁰⁹

This area of land, between the Raritan and Delaware Rivers, will comprise the bulk of modern Hunterdon County and this account highlights the important role rivers have played in the history and development of the county.

The area which is now Hunterdon County was originally inhabited by the Leni Lenape People. Many of the place names, topographic features, as well as river and stream names, come from the Leni Lenape. The Leni Lenape created many of the original paths that were to become roads and villages which were to become colonial settlements.

Colonists began to arrive in the 1600s. The Dutch were the first to settle the Mid-Atlantic region around New York City. In 1664, before the Dutch were to lose New Amsterdam to the British, the land that is now the state of New Jersey was given to Sir George Carteret and Lord Berkley, by the English Duke of York.²¹⁰ Lord Berkley sold his portion to Quakers John Fenwicke and Edward Byllinge. Byllinge turned over management of his half of New Jersey to a group of Quaker Trustees, including William Penn. In 1676, the province of New Jersey was split into East Jersey and West Jersey. At this point, 4,600 square miles of West Jersey was open for settlement, and in 1680, the Quakers were given the rights to govern their land.²¹¹

The territory of West Jersey was divided into one hundred shares or proprietaries, which were then further divided into one hundred lots. The inhabitants were then able to

²⁰⁹ Ibid., 10.

²¹⁰ Norman C. Wittwer, “The Dawn of Hunterdon County,” In *The First 275 Years of Hunterdon County: 1714-1989* (Flemington, NJ: Hunterdon County Cultural and Heritage Commission, 1989), 6.

²¹¹ Ibid.

select commissioners who would further divide the land “as occasion shall require.”²¹² By 1700, West Jersey consisted of about 8,000 inhabitants.²¹³ The inhabitants were almost all English Quakers.

Most development occurred in the south and central portion of West Jersey, around present-day Trenton and Burlington, which was the capital (but not located in present-day Hunterdon). Settlement north of Trenton was slow. It was not until around 1704 when settlers began arriving to these northern regions. As the English Quakers slowly moved north, the Dutch began to arrive from the east via the Raritan River.²¹⁴ Southern portions of present-day Hunterdon County were settled first including areas around present-day Lambertville, Stockton, the Amwells, and Ringos. As time progressed, tracts of land in the northern wilderness areas were divided, including portions of present-day Franklin, Alexandria, Tewksbury, Kingwood, Clinton, Union, and Raritan Townships. This land was frequently obtained through negotiated treaties with Native Americans.

The influx of people into this northern area began to create a difficult governing situation. With the seat of county government located at Burlington, in the southern portion of the county, it became an inconvenience and even a danger for the inhabitants to make the long journey from the northern settlements southward for official business and government transactions.²¹⁵ In 1712, it was suggested to create an upper county in the West Jersey province.

²¹² George S. Mott, *The First Century of Hunterdon County, State of New Jersey* (Flemington, NJ: E. Vosseller, Bookseller and Stationer, 1878), 5.

²¹³ *Ibid.*, 6.

²¹⁴ *Ibid.*, 9.

²¹⁵ *Ibid.*, 23-24.

In 1714, the County of Hunterdon was created, honoring Governor Robert Hunter.²¹⁶ This included the area of present-day Hunterdon County along with portions of Mercer, Warren, Sussex, and Morris Counties. By 1722, the county had grown to five townships, with only one, Amwell, being located within the present boundaries. By 1726, the population grew to 3,236 people.²¹⁷

During this time, Mott notes that “the political institutions were so liberal in their character, that those who appreciated civil and religious liberty were attracted. And thus it came to pass, that no county in the State had so mixed a population composed, as it was, Huguenots, Hollands, Germans, Scotch, Irish, English, and [N]ative Americans.”²¹⁸ This was a prosperous time in the county and Quaker meeting houses, churches, mills, and small villages began to dot the countryside along the riverbanks and valleys, taming and transforming the once heavily forest wilderness into prime agricultural land.

In 1738, due to similar distance issues as noted previously, the northern portion of the county was split off, forming what are now Morris and Warren Counties. This however did not stall the county’s growth, and “Although thus shorn off[f] more than half its territory,” Mott notes, “Hunterdon soon became the wealthiest and most populous of all counties.”²¹⁹

The county was prosperous due to three main reasons. The first was the county’s strong population growth, stimulated by its attractiveness which lured people to settle

²¹⁶ Norman C. Wittwer, “The Dawn of Hunterdon County,” In *The First 275 Years of Hunterdon County: 1714-1989* (Flemington, NJ: Hunterdon County Cultural and Heritage Commission, 1989), 9.

²¹⁷ George S. Mott, *The First Century of Hunterdon County, State of New Jersey* (Flemington, NJ: E. Vosseller, Bookseller and Stationer, 1878), 24.

²¹⁸ Ibid., 11.

²¹⁹ Ibid., 31.

within Hunterdon's boundaries. The second was the vast amount of wheat and flour produced in the county. Wheat became the principle crop, and due to the numerous winding rivers and streams flowing throughout the county, mills were situated almost at every river bend. In fact, these mills were so ubiquitous that it is noted that in "no part [of the state] were they so numerous as in this county."²²⁰ These mills produced copious amounts of flour for both the Philadelphia and New York markets.²²¹ The third reason was industry. Iron deposits that were abundant in central Hunterdon provided raw materials that could be used in the manufacturing of tools and other farm implements. Both wheat production and the iron industry became even more important during the American Revolution because the wheat was milled into flour for the Continental Army, and the iron was forged into cannonballs.

When the American War for Independence was fought, Hunterdon generally sided strongly with the patriots.²²² Although there were loyalist movements, the patriot cause seemed to have strong support from county residents. In fact, Hunterdon County provided more soldiers than any other county in New Jersey.²²³ The period surrounding the American Revolution was extremely tumultuous, and seemed hopeless before General George Washington crossed the Delaware River from Pennsylvania in a successful surprise attack on Hessian soldiers quartering in Trenton.²²⁴ Many battles and skirmishes occurred within the county and county militia fought in battles both in and out of New Jersey.

²²⁰ Ibid.

²²¹ Ibid.

²²² Ibid., 41.

²²³ Ibid., 44-45.

²²⁴ Ibid., 42.

After the war ended, and New Jersey became a state, Hunterdon County, like all other locations in the newly formed country suffered rampant economic instability and inflation. These uncertain and unstable economic conditions lasted into the 1800s.²²⁵ In 1785, the county seat was moved to Flemington due to its central location within the county. Flemington continues to serve as the county seat. In 1790, the county boasted 20,153 residents, the highest out of the twelve counties in the state during this time.²²⁶

8.2 Agricultural / Rural Importance

In the late 1600s, when first settled by Europeans, the area that now comprises Hunterdon County was almost completely forested. By the mid 1700s, however, from this forest covered, rugged, wilderness, small farms began to be carved out. Early farms were sold as “Field Tracts” and consisted of approximately 103 acres of land.²²⁷ These relatively small parcels were not conducive to the development of large estates, but became the backbone of family farms.²²⁸ In fact, it was been noted that, “only those who did not have much ambition were unable to become farm owners, even though they started as tenants.”²²⁹

As a result of its isolated wilderness location, many of the county residents became farmers. Initially, farming in the back woods of western New Jersey was extremely inefficient and wasteful. However, as new farm technology and techniques

²²⁵ Ibid., 47.

²²⁶ Ibid., 48.

²²⁷ Bernard F. Ramsburg, “Agriculture,” In *The First 275 Years of Hunterdon County: 1714-1989* (Flemington, NJ: Hunterdon County Cultural and Heritage Commission, 1989), 1.

²²⁸ Ibid.

²²⁹ Ibid.

began to slowly make their way into Hunterdon, especially when dealing with early fertilizers, efficiency increased, as did production.²³⁰

Early settlers built their dwelling from squared logs, a technique copied from the Swedes who resided in southern New Jersey.²³¹ As saw mills were developed, a transition into modest sized wood framed houses occurred, relegating the log structures for use as barns. Stone houses were also common early on, with many still standing. Brick houses were generally not constructed, simply due to the lack of brick availability. Barns were very important in Hunterdon County, and it should be mentioned that “some early observers noted that many Hunterdon farmers preferred having large, well-constructed barns to having substantial homes.”²³² Some of these early barns can also still be spotted around the county.

The first crop to be grown in early Hunterdon County was corn. Other early crops included wheat, oats, and rye. Hay was also cultivated from native grasses, clover, and timothy, and in the closing decade of the 1700s, alfalfa was planted but was not successful.²³³ Early livestock in the county included cattle, horses, swine, and sheep: cattle for milk, horses for work, swine for food, and sheep for wool.²³⁴ Early animals were left to roam free in the mostly unfenced, wooded countryside, and it was not until the mid-1800s when advancements in livestock and breeding took place.

Prior to the mid-1800s, most farm work was done by hand. This changed with the invention of the Deats plow in 1828, by John Deats of Stockton, in southern Hunterdon

²³⁰ Ibid.

²³¹ Ibid., 2.

²³² Ibid., 3.

²³³ Ibid., 6.

²³⁴ Ibid., 7.

County.²³⁵ Although this was an improvement over other plows at the time, its use did not catch on until after 1850. Other farm implement advances took place throughout the county as well, but again, it was not until 1850 when the mechanization of farming practices took hold.

By the mid-1800s, corn planters, grain drills, and mowing machines became commonplace on farms.²³⁶ With these advancements came the introduction of soybeans, potatoes, and tomatoes as commercial crops.²³⁷ Peach and apple orchards were ubiquitous on virtually every farm in the county and produced countless bushels of fruit. During this time, the peach industry boomed, and in the years following the Civil War, special trains were dispatched specifically for the peach crop. On a single day in 1882, 64 carloads of peaches were shipped from the county to city markets.²³⁸ By 1889, there were over two million peach trees in Hunterdon County.²³⁹

By the late-1800s, stream powered threshing machines and tractors began to replace the use of horses.²⁴⁰ The late-1800s brought further advancement in fertilizers; the use of which became more scientific, being based on soil composition tests.²⁴¹ Soil erosion problems and other issues that have been plaguing farmers early on were also finally coming under scrutiny.

At the close of the 1800s, soybeans fell out of favor, but an explosion in the cultivation of potatoes and tomatoes rose to the forefront of importance in county crop

²³⁵ Ibid., 4.

²³⁶ Ibid., 4.

²³⁷ Ibid., 6.

²³⁸ Ibid., 7.

²³⁹ Ibid.

²⁴⁰ Ibid., 5.

²⁴¹ Ibid., 2.

production. Canneries were opened and tomato production skyrocketed throughout the county, fueled by the New York market. In 1891, *The Business Review of the Counties of Hunterdon, Morris and Somerset, New Jersey*, stated that potatoes ranked next to peaches in importance in Hunterdon County.²⁴²

The first few decades of the twentieth century brought with it a major agricultural shift to Hunterdon County. The use of gasoline powered trucks and tractors made hay cultivation, which was used to feed work horses, unnecessary and the county hay industry all but collapsed.²⁴³ The San Jose scale and other fruit diseases and pests decimated the peach trees and crop, making peach cultivation no longer viable.²⁴⁴ In addition, electric power started to become available during the 1920s and 30s, changing drastically, the way farms were run.

This decrease in agricultural cultivation, created a greater interest in the production of dairy products.²⁴⁵ With electricity becoming more widely available, automatic milking machines were developed. This greatly increased dairy productivity, especially after World War II.²⁴⁶ Dairy cooperatives and groups began to form and these groups worked to open markets in the Philadelphia and New York areas as well as negotiated better prices for county dairy products.

Along with a new importance in dairy farming, the twentieth century brought interest in poultry farming, and throughout the first half of the 1900s, Hunterdon was a

²⁴² Ibid., 6.

²⁴³ Ibid.

²⁴⁴ Ibid., 7.

²⁴⁵ Ibid., 9

²⁴⁶ Ibid., 5.

leading county in New Jersey poultry production.²⁴⁷ Again, much of the county poultry industry was a result of, and dependent on, the New York market, which had a growing voracious appetite, and the advent of newer technologies allowed not only agricultural fruits and vegetables to be shipped by rail to the large cities of New York and Philadelphia, but dairy products, poultry, and eggs as well.

By the 1930s, new methods of sustainable farming, such as crop rotation, soil conservation, and better farming practices in general were developed.²⁴⁸ New scientific breakthroughs and the establishment of the County Board of Agriculture and the Agricultural Extension Service produced hybrid species of corn, tomatoes, and other fruits and vegetables that could better withstand the conditions in Hunterdon County.²⁴⁹ As these new practices took hold, they allowed greater efficiency and productivity.

Oddly enough, agricultural development in Hunterdon County has come full circle. The mid-1960s was the apex of an over 300 year growth of the traditional agricultural backbone of Hunterdon County. Dairy and poultry farms reigned supreme. However, in the 1970s, the number of farms sharply declined. It was the end of an era. Although, farms did not vanish from the county, they reverted back to the small farms of the past. Large dairy and poultry farms were converted to “cash grain” farms, or “gentlemen farms,” producing wheat, soybeans, and corn with few employers and heavily mechanized.²⁵⁰

²⁴⁷ Ibid., 10.

²⁴⁸ Ibid., 2.

²⁴⁹ Ibid., 5-6.

²⁵⁰ Ibid., 15.

In the mid-1980s, under pressure from residential development, property values soared and farms consolidated and intensified production. New farms known as “specialty farms” or “boutique farms” which offer fruit, berry, and vegetable products (many with a pick-your-own option) were established, and the number of wholesale nurseries and greenhouses increased.²⁵¹ More recently, horse farms, which fell out of favor after the invention of mechanical tractors and the automobile, have also risen in popularity.



Figure 2: Hunterdon County rural farmscape.

Modern county farms are now almost always supplemented with non-farm income, relegating farming to only a part-time enterprise. A new awareness of the importance of agriculture in Hunterdon County, as well as New Jersey, has led to the establishment of the State Agriculture Development Committee and County Agriculture Development Boards, which help retain state and county farmland through the Farmland Preservation and Open Space programs. Although the area has remained thoroughly

²⁵¹ Ibid.

agricultural, these measures have become an integral part in maintaining Hunterdon County's strong rural and agricultural heritage and character in spite of encroaching development pressures and suburban sprawl.

8.3 Local Transportation History

Early roads in colonial New Jersey were primitive and downright terrible in anything but perfect weather, and sometimes even then. This was sparsely settled wilderness and there were very few amenities to be had. Roads were not an early luxury. As many of the original inhabitants arrived in western New Jersey via the rivers, colonial roads to this location were basically not established and early settlers were initially dependant on Native American paths carved through the landscape. As was true with other places around this time, these paths were eventually widened to accommodate more than just foot traffic, and over time, basically became the system and network of roads present today.²⁵²

The early road system of Hunterdon County is similar to many other road systems that were present in the original thirteen colonies, especially New England. These roads were not grid based, but followed the contours of the land, an issue that would be 'corrected' in more western states with the Congressional Land Survey system started in 1785. Sometimes these early roads helped alleviate logistical and physical problems and obstacles such as elevation, ruggedness, topography, rivers, and streams, but this usually lead to winding, circuitous paths that were inefficiently long.

²⁵² Frederick Stothoff, "Transportation," In *The First 275 Years of Hunterdon County: 1714-1989* (Flemington, NJ: Hunterdon County Cultural and Heritage Commission, 1989), 1.

One of the first main roads developed in the county was known as the Old York Road. This road was part of a Native American path network that started across the Delaware River in Pennsylvania and crossed into Hunterdon near Lambertville. The path then passed through Mt. Airy, Ringos, and Reaville on its way to Newark. The road was never officially surveyed and was (is) also known as the King's Highway and York Road.²⁵³ This road is currently still in existence and was the old route between Philadelphia, PA, and Newark, NJ. It is now New Jersey State Road 179. Another early road went from Trenton to the Delaware Water Gap meandering through present-day Flemington, Cherryville, Pittstown, and Hampton on its way north.²⁵⁴

Early roads such as these now consist of many different names and numbers. This is due to the winding nature of the early roads being incorporated with the straighter modern roads. In some cases, the path of an early road has been integrated into a dozen or more different streets, roads, and highways, but generally retains its historic course.

Again, these early roads were nothing more than widened paths through the woods and crossed rivers and streams with simple log bridges crafted from the surrounding forest. These early bridges were not very technologically advanced, but simply designed for functionality, ease, and efficiency. Traffic did not pose a significant issue either, and as such, these roads did not necessitate any elaborate crossings or major improvements.

No major road improvements were undertaken until after the American Revolution. During the Revolution, the transport of goods and troops must have been

²⁵³ George S. Mott, *The First Century of Hunterdon County, State of New Jersey* (Flemington, NJ: E. Vosseller, Bookseller and Stationer, 1878), 10.

²⁵⁴ Frederick Stothoff, "Transportation," In *The First 275 Years of Hunterdon County: 1714-1989* (Flemington, NJ: Hunterdon County Cultural and Heritage Commission, 1989), 1.

extremely difficult. Heavy cargo, weapons, and wagons would have most likely sunk into the dirt and mud paths, creating large ruts, damaging the road system even further. Spring and summer rains would make the roads virtually impassable, and with no snow plows, feet of heavy winter snow and drifts would leave the roads buried, standing people and cutting off villages and towns from one another. However, this also led to awareness of the importance of a good road network in order to allow for the easy transportation of agricultural goods throughout the county and state and to the city markets of New York and Philadelphia.

The turn of the 19th century was a boom time for infrastructure building all across the fledgling nation. Hunterdon County was no exception. In 1806, the New Jersey Turnpike was constructed, crossing the northern portion of New Jersey from New Brunswick, NJ, to Easton, PA.²⁵⁵ However, the idea of a toll road did not sit well with Hunterdon residents, most of who despised turnpikes and often created “shunpikes” as a way to bypass the tolls.²⁵⁶ After thirty years, the Turnpike turned over the road to the county’s municipalities.²⁵⁷

The rise and fall of other turnpike providers around the county and state did more than just irritate local farmers; they were advancing road technology throughout the east coast. County historians note that “Too many turnpikes were built in sparsely settled regions in anticipation of traffic that never materialized. Profits were lacking, and the

²⁵⁵ Ibid., 2.

²⁵⁶ A.G. Lichtenstein & Associates, Inc, “The New Jersey Historic Bridge Survey,” 1994, http://www.nj.gov/transportation/works/environment/pdf/Survey_Doc.pdf (accessed February 20, 2010), 168.

²⁵⁷ Frederick Stothoff, “Transportation,” In *The First 275 Years of Hunterdon County: 1714-1989* (Flemington, NJ: Hunterdon County Cultural and Heritage Commission, 1989), 2.

tolls received were never enough to maintain the roads.”²⁵⁸ But even though these turnpikes failed, the roads were improved, and advancements to counter the harsh winter climate, with macadam pavements and drainage systems, “represented a significant improvement over the muddy, rutted farm roads available at the time.”²⁵⁹

Canals and railroads also began to play a large role in 19th century Hunterdon County. Although Hunterdon County borders the Delaware River, the river featured rapids in various locations making the river treacherous and hard to navigate. In 1834, the construction of a feeder canal to the Delaware & Raritan (D&R) Canal (which stretched between Bordentown, and New Brunswick, NJ) generally alleviated the risky trips down the Delaware. The canal also was responsible for opening up markets and stimulating development throughout the region.²⁶⁰

Railroads were another improvement to the transportation system of the Nation, state, and county. Hunterdon farmers could now easily and quickly transport good to large regional market areas and to cities like New York, Philadelphia, and Trenton. Numerous rail lines crossed the county by the 1870s, bringing increased commerce, population, and communication into the rural county.

The introduction and success of canals and the railroads had great impacts on the county road and bridge network. Stagecoach and wagon routes connected towns with the canal and rail stations, carrying ever heavier loads which could now more easily and

²⁵⁸ Ibid., 2.

²⁵⁹ Thomas E. Boothby et al., “Stone Arch Bridge Inventory, Phase II: Hunterdon County, New Jersey” (University Park, PA: The Pennsylvania State University, 1998), 2.

²⁶⁰ A.G. Lichtenstein & Associates, Inc, “The New Jersey Historic Bridge Survey,” 1994, http://www.nj.gov/transportation/works/environment/pdf/Survey_Doc.pdf (accessed February 20, 2010), 168.169.

efficiently be transported. However, these loads put additional stresses on local bridges and the already dismal roads.

Beginning as early as 1757, it was determined that local roads were to be managed by townships while bridges were to be managed by the counties.²⁶¹ This is still the case today. The first bridge built in present Hunterdon County was constructed in 1785. In 1795, the Freeholders (as county administrators are referred to in New Jersey) began levying taxes towards the construction of bridges over inland creeks.²⁶² In 1830, about \$6,500, a third of the county budget, was being spent on building and repairing bridges, and by 1860, this amount had risen to over \$25,000.²⁶³

The earliest existing bridges in Hunterdon County are stone arch examples from the 1840s. While a couple of large structures can be found, the vast majority are generally small in size. Wooden covered bridges, although known to be numerous throughout the county, are represented in the county with New Jersey's last remaining covered bridge, the Greene-Sergents Bridge in Delaware Township. Hunterdon County began building iron truss bridges as early as 1858, many built to replace the aging wooden covered bridges.²⁶⁴

Hunterdon County's impressive collection of bridges is renowned. Not only for possessing the only remaining covered bridge in the state, but it also because the county has the largest concentration of stone arch bridges in North America. In addition, Hunterdon has one of the finest collections of metal truss bridges not only in New Jersey, but in the nation.

²⁶¹ Ibid., 170.

²⁶² Ibid.

²⁶³ Ibid.

²⁶⁴ Ibid., 59.

Thanks to an economic decline after the Civil War that lasted until after the Great Depression, and a later found appreciation of these disappearing structures, Hunterdon County has more surviving metal truss bridges than any other county in the state.²⁶⁵ As a result, “Hunterdon County presents an almost encyclopedic array of metal truss bridges that chronicle the development and standardization of the bridge type.”²⁶⁶

The reasons behind the high number of metal truss bridges have not really changed through all of these years. In general, it is due largely to the rural location of the county along with a slow growth in population and highway development which made replacing old bridges unnecessary. Without the traffic of other areas, Hunterdon County bridges were able to remain safely in place. Another reason was the resistance of county residents to help fund local road and bridge improvements, deeming them “too costly.”²⁶⁷

As mentioned previously, Hunterdon County’s collection of truss bridges can be seen as an historic engineering record of truss design. The county has 63 metal truss bridges, with 32 dated before 1901.²⁶⁸ The technology that was employed in the design of these bridges runs from the most technologically advanced for its time to simple experimental configurations, some the only example ever seen.

Many of the bridges are not only rare in a national sense, but like the Green Sergeant covered bridge, are the only existing examples in the state. These include, The Old Hamden Bridge, the Lower Lansdowne Bridge, and the Rosemont-Raven Rock Bridge. Other unique bridges include the Hollow Brook Bridge and the Stanton Station Bridge. A further discussion of these bridges is included in the case study portion of this

²⁶⁵ Ibid., 171.

²⁶⁶ Ibid.

²⁶⁷ Ibid.

²⁶⁸ Ibid.

thesis. Hunterdon County also has an abnormally high number of multi-span pony truss bridges.²⁶⁹ Although multi-span through truss bridges are common, pony truss configurations are usually limited to single spans. However, numerous examples are present in Hunterdon County.

Hunterdon County's truss bridges are not all unique however, and the collection includes numerous examples of both the popular Pratt and Warren truss structures. While these are more numerous and common, the examples in Hunterdon County are "remarkably well-preserved."²⁷⁰ An interesting fact concerns New Jersey's truss bridge distribution. Although northern New Jersey possesses numerous examples of 19th century metal truss bridges, focused on Hunterdon and neighboring Somerset Counties, there are no surviving examples in the southern half of the state.²⁷¹

In the 1920s and 30s new bridge designs began to be developed taking advantages of new materials and building techniques, such as reinforced concrete. This halted the construction of truss bridges across the country. However, Hunterdon County continued on, constructing over ten truss bridges well into the 1940s.²⁷²

It should be noted that as early as 1912, New Jersey had a reputation of very good stewardship, management, and design of bridges. Bridge designs here were standardized as early as 1913. The "Golden Age" of highway construction (1921-1936) saw an

²⁶⁹ HistoricBridges.org, "Hamden Road Bridge," <http://www.historicbridges.org/newjersey/lowerlandsdown/> (accessed September 4, 2010).

²⁷⁰ A.G. Lichtenstein & Associates, Inc, "The New Jersey Historic Bridge Survey," 1994, http://www.nj.gov/transportation/works/environment/pdf/Survey_Doc.pdf (accessed February 20, 2010), 168.173.

²⁷¹ Ibid., 59-60.

²⁷² Ibid., 175.

enormous amount of financial resources devoted solely to bridges, and in 1925, “nearly half the total amount of state and federal funds expended that year was for bridges.”²⁷³

In 1925, Morris Goodkind, a Columbia University graduate, became the State Bridge Engineer. During his tenure, he insisted that all state designed bridges exceed ASSTHO standards and emphasized bridge aesthetics. Many of these extraordinary bridges still remain and although some structures have been damaged and altered, many still have remains of “well proportioned concrete balustrade, faience tile characters identifying route and date set in the end posts, tile mosaics and borders, and incised decoration on abutments common.”²⁷⁴

This is important because bridges on local and county roads are subject to state standards for bridge design and construction. Many of the aesthetic elements that Goodkind promoted were copied on a local level, which is why replacement county bridges go to great expense for stone veneers, carved bridge plaques, and a continuation of truss themes.

8.3.1 Hamden Fink Truss Bridge

When Hunterdon County residents are asked about historic local bridges, most instantly identify the old Hamden Fink Truss Bridge. In 1978, this bridge collapsed dramatically into the South Branch of the Raritan River after one of the bridge’s vertical columns was struck by a vehicle. In an instant, the community and nation lost an

²⁷³ Ibid., 49.

²⁷⁴ Ibid.

engineering landmark. Nevertheless, this event also initiated Hunterdon County's first real foray into historic transportation preservation.

In early 1857, the existing bridge over the South Branch of the Raritan River near Hamden needed to be replaced. The design for the new bridge was to be a wooden truss bridge featuring three relatively short spans (none longer than 40 feet). It has been noted in the report, "A Plan for the Reconstruction of the Historic Hamden Fink Suspension Truss," that considering "covered wooden bridges were being routinely built of spans in excess of 100 feet this proposal seems very conservative and certainly not the harbinger of a whole new tradition in bridge building for public roads."²⁷⁵

Over the next few months, however, a complete reversal occurred, and after numerous meetings between county officials and iron bridge advocates, the Hunterdon County Board of Chosen Freeholders unanimously approved a new "revolutionary" all-iron bridge design.²⁷⁶ This new design was to be a Fink truss, originally developed only a few years earlier by German immigrant Albert Fink.

The Fink truss is unique, but similar to the Bollman truss, in that it acts somewhat like a suspension bridge. These types of bridges are commonly called suspension trusses and are "not true triangular trusses, but rather elaborations



FINK

²⁷⁵ A.G. Lichtenstein & Associates, Inc., and Dr. Emory L. Kemp, "A Plan for the Reconstruction of the Historic Hamden Fink Suspension Truss," (A.G. Lichtenstein & Associates, Inc.: Fair Lawn, NJ, 1979), 8.

²⁷⁶ Ibid.

on a simple trussed beam.”²⁷⁷ Suspension trusses were deemed too flexible for railway use, and with the development of other stronger triangular trusses, the use of the Fink truss for bridges was phased out by the late-1870s.

The Hamden Fink Truss Bridge, located between Franklin and Clinton Townships, was constructed by the Trenton Locomotive and Machine Manufacturing Company and completed in 1858. Crossing the South Branch of the Raritan River, the structure was comprised of eight-panels and was 100 feet in length. The bridge was mainly constructed from cast-iron (which is very brittle when subjected to lateral forces) with wrought-iron diagonal tension members.



Figure 3: Hamden Fink Truss Bridge. Photocopy of Historic Photograph, Office of Hunterdon County Engineer, Flemington, NJ, ca. 1940-50. Photographer unknown. Library of Congress, Prints & Photographs Division, HAER NJ, 10-CLIN.V, 1-1.

²⁷⁷ Ibid., 6.

The original design remained in service since the date of its construction in relatively pristine condition. Its deck, which was probably originally constructed from wood, was replaced several times, most drastically in 1956, when the deck was replaced with metal planking which was then paved.²⁷⁸

In 1974, the bridge's historic significance was recognized and it was listed on the National Register of Historic Places. It was also listed on the State Register the same year. At the time of its listing, it was one of only two Fink truss bridges still in existence in the United States as well as the oldest metal truss bridge in the nation.²⁷⁹ Four years later, on October 2, 1978, a vehicle struck the bridge, cracking a cast-iron vertical member. The entire structure failed, collapsing into the river below.²⁸⁰



Figure 4: Collapsed Hamden Fink Truss Bridge. Photograph provided by the Hunterdon County Department of Roads, Bridges, and Engineering, Flemington, NJ.

²⁷⁸ *Ibid.*, 9.

²⁷⁹ *Ibid.*, 2.

²⁸⁰ For additional photographs of the collapsed bridge, see Appendix A.

This was not to be the end of the story for the Hamden Fink Truss Bridge, however. The bridge's local and national importance drew a spotlight on Hunterdon County, and every effort was considered for its preservation and potential return to service.

After the bridge's collapse, all of the parts were moved to a location where the structure could be more easily studied and examined. The first step involved investigation. Each member of the structure was examined for evidence of failure using chemical and physical testing. The results of the testing were disturbing. Every failed member contained large voids, a result of the original casting process, which at the time was an imperfect science.

Cast-iron of the mid-1800s was also notoriously brittle especially in long, straight, slender pieces (such as is necessary for bridges). Many bridges, the Hamden Fink Truss Bridge included, thereby only used cast-iron components in direct compression (with wrought-iron members for tension). This was based on the fact that given a bridge's design, cast iron members would not be subjected to lateral bending or stresses under normal conditions. When the vehicle struck the bridge, the lateral stress fractured the cast-iron vertical member, setting off a progression of failures in other cast-iron components that ultimately caused the bridge to fail and collapse.

As a result, one of the main reconstruction issues was how to deal with the vulnerable cast iron members. In addition, although the wrought-iron tension members did not fail, they were "a twisted mass of iron, rather like a large plate of spaghetti," and many had to be cut in order to remove the tangled mess from the site, rendering them un-

useable “without a great deal of re-working of the iron.”²⁸¹ A sample of the original cream colored paint was preserved for future reference.

The second step involved recording. The pieces were laid out for proper measurements to be taken. The parts were also thoroughly documented and photographed for future restoration purposes and as a permanent archival record.²⁸² The bridge, in addition to being listed on the National Register, was also thoroughly documented for the Historic American Engineering Record (HAER) and was nominated as an American Society of Civil Engineer (ASCE) national landmark.

After the investigative and documentation process was completed, a decision had to be made on what to do with the bridge. Several options were discussed. These included reconstructing the bridge with its original components in the same location, replicating the old bridge with newly cast components, and reconstructing the bridge in another area for non-transportation use such as in a park. Restoring the bridge using much of the original fabric proved to be non-feasible. According to the report, “Neither welding, brazing or gluing would insure the necessary strength and have the safety necessary for a functioning bridge, even for pedestrian use.”²⁸³ The components not destroyed in the collapse were poorly cast and brittle and another accident on the restored bridge might lead the bridge to collapse once again.

As a result, it was decided that an exact replica of the bridge be constructed. Casts would be made from the original components. These exact replica components would be made from ductile iron and mild steel (instead of cast-and wrought-iron) for

²⁸¹ Ibid., 16.

²⁸² Ibid., 17.

²⁸³ Ibid., 18.

added strength. The replica bridge was supposed to be such an accurate replica (even with the new ductile iron members) that it was believed that only through a chemical analysis would it be possible to distinguish the materials.²⁸⁴ The bridge deck was also going to be restored with timber floor beams. These beams would be laminated and pressure treated for fire and fungus protection. The abutments were then to be repaired and the bridge painted in its original cream color.

It was also suggested that an interpretive display be installed at the site, complete with the original bridge's history and the restoration/replication process. In addition, it was recommended that the original bridge components be given to a state or local museum or even to the Smithsonian Institute. The total cost of the project was estimated at \$385,000.²⁸⁵ Additional expenses were also anticipated for other engineering and legal costs.

Unfortunately, none of these recommendations were heeded, and the jumble of bridge parts were left to languish outside behind the Hunterdon County Government Complex. The bridge was never restored or never replicated. The road remains closed to through traffic. A new bridge was eventually built, but it is only for pedestrian use. The original rusting bridge parts were eventually recycled, despite their national historic importance. The bridge's memory remains only as a series of photographs, measured drawings, and documents in the Library of Congress as part of the Historic American Engineering Record (HAER).²⁸⁶

²⁸⁴ Ibid., 19.

²⁸⁵ Ibid., 22.

²⁸⁶ This documentation is also available at <http://loc.gov/pictures/item/nj0143/>.

9.0 CASE STUDIES

In an attempt to show the approaches that can be taken to preserve historic single-lane bridges, thirteen case studies from around Hunterdon County, New Jersey, are presented in order to exemplify one county's quest to retain their historic fabric and character. All of the bridges in these case studies are metal truss bridges of various design and both through and pony truss types are represented. Many have been repaired, some heavily, while others have been completely replaced. A majority, but not all the structures, are eligible for listing on the National Register of Historic Places. All of the bridges were constructed between the close of the Civil War and the first decades of the 20th century.

Much of the background information used for the case studies was supplied by "The New Jersey Historic Bridge Database" which was compiled based on information and recommendations from *The New Jersey Historic Bridge Survey*. Both documents were prepared by A. G. Lichtenstein & Associates, Inc. in consultation with the New Jersey Department of Transportation (DOT), the New Jersey Department of Environmental Protection (NJDEP), the State Historic Preservation Office, and other

agencies. The creation of this type of database, one which identifies a state's collection of historic bridges for preservation purposes, was required under the 1987 Surface Transportation and Uniform Relocation and Assistance Act (STURAA). The information found in this survey and database proved to be invaluable for this investigation. To supplement this background data, other research, including field-truthing (visiting and photographing the sites) and interviews with Hunterdon County officials and engineers was conducted. The people interviewed include John Glynn (director of the Hunterdon County Department of Roads, Bridges, and Engineering) and Dennis Heil (a Hunterdon County bridge engineer).

The case studies will be divided into three categories. The first category includes bridges that are eligible for National Register status. The second category includes bridges that are not eligible for National Register status. The third category includes bridges that have been replaced by new metal truss structures. By investigating the bridges in these three categories, and the work done in order to maintain them, a clearer picture emerges in how county engineers, officials, and local residents view these important, and yet sometimes overlooked, structures.

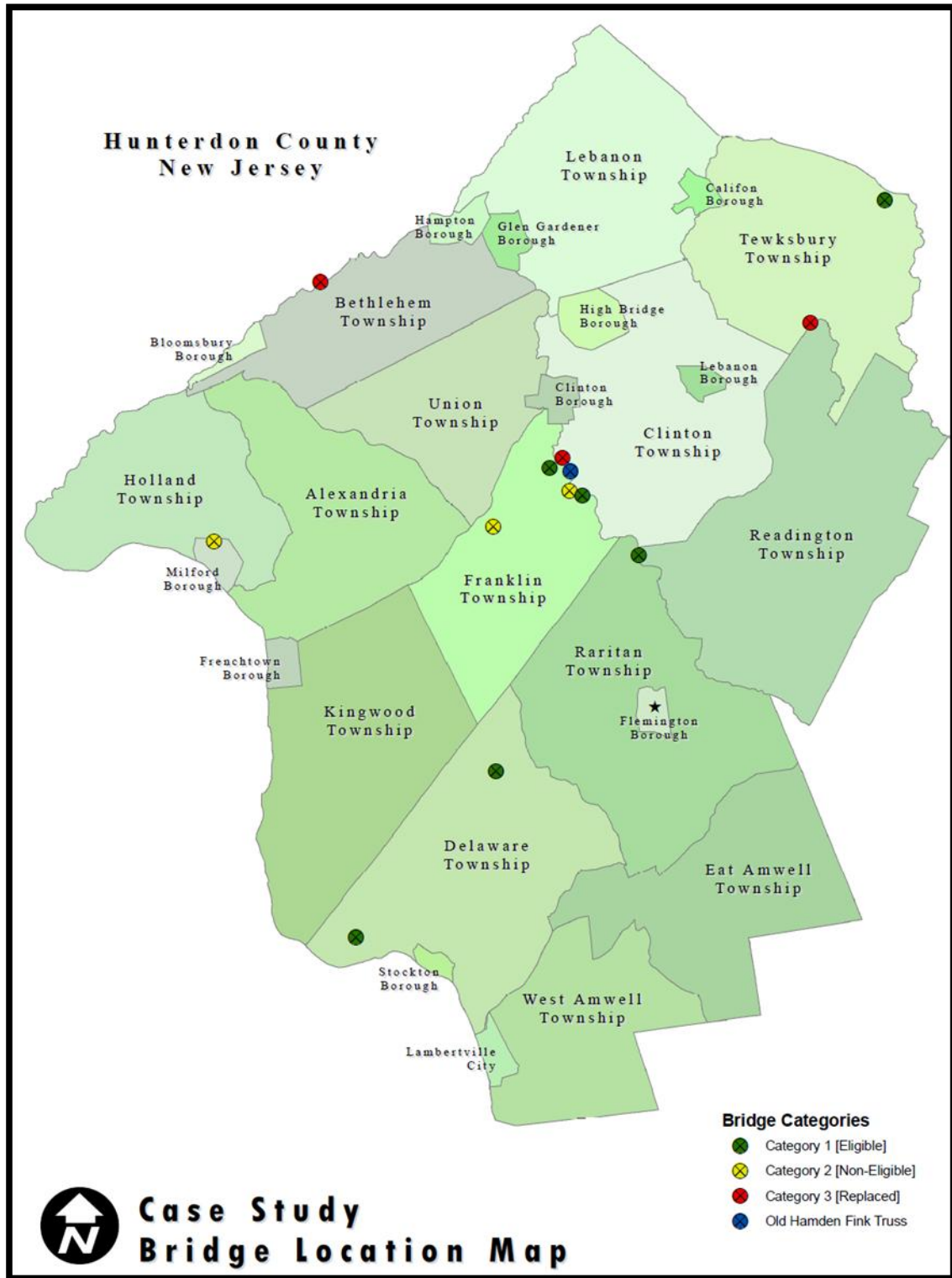


Figure 5: Map of Case Study Bridges.

9.1 Category 1 Bridges

[Listed or eligible to be listed on the National Register of Historic Places]

The first category is comprised of six case study bridges. These structures are usually the most impressive, but sometimes looks can be deceiving. Located throughout the county and running the range from grand through truss examples to simple creek straddling structures, these bridges are important both locally and nationally in the engineering record of the nation's transportation past.

Category 1: Bridge Location Map

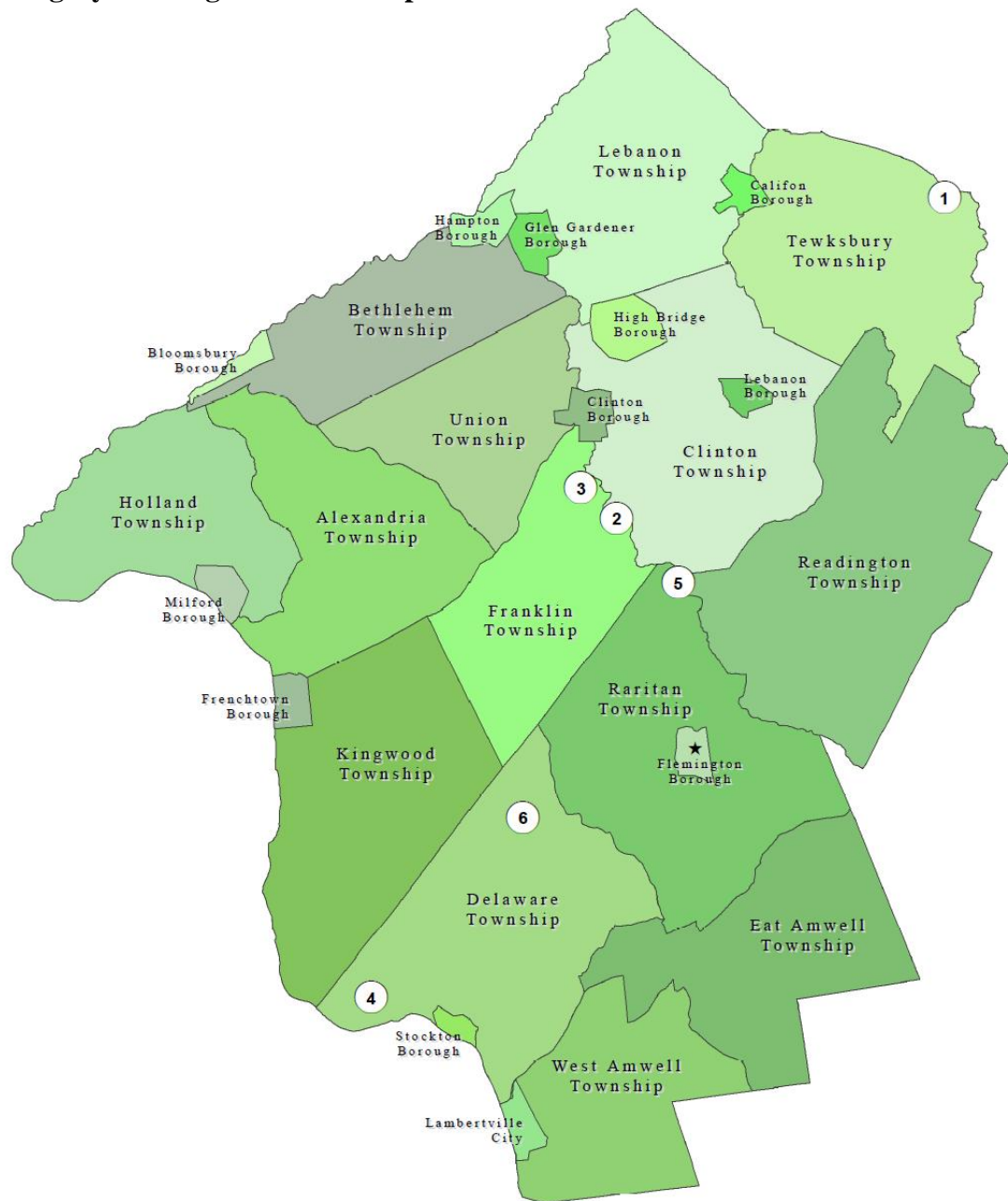


Figure 6: Location of Category 1 Bridges.

1. Hollow Brook Bridge, Tewksbury Township
2. Old Hamden Bridge, Franklin Township-Clinton Township
3. Lower Lansdowne Bridge, Franklin Township
4. Rosemont-Raven Rock Bridge, Delaware Township
5. Stanton Station Bridge, Raritan Township-Readington Township
6. Locktown-Flemington Bridge, Delaware Township

Hollow Brook Bridge

Hollow Brook Road: Tewksbury Township

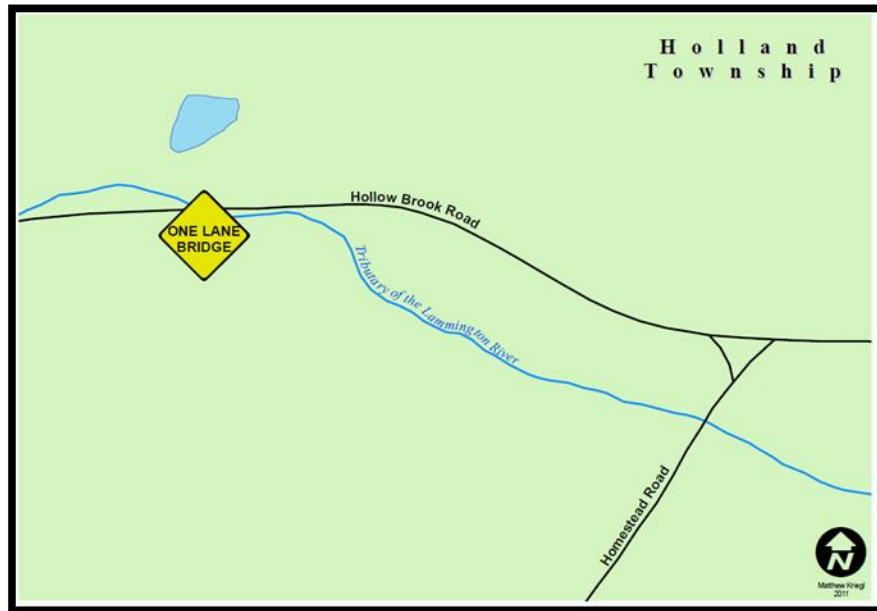


Figure 7: Location of Hollow Brook Bridge.



Figure 8: Photograph of Hollow Brook Bridge.

Hollow Brook Bridge²⁸⁷

Located on a back-country, barely paved, narrow road that can be easily mistaken for a driveway, a small unassuming structure crosses a tributary stream of the Lamington River. This is the Hollow Brook Bridge, and hidden in its unassuming form is a historic relic of the past.

Hollow Brook Bridge is located in a rural, wooded portion of Tewksbury Township in northern Hunterdon County. Although the date of construction and builder is unknown, it is estimated to have been built in the early 1880s. Hollow Brook Bridge is a 16.5 foot wide, two-panel, single-span, pin connected, steel pony truss bridge, and at only 33 feet in length, is one of the shortest spans investigated. Despite its meager stature, it is brimming with historic significance.

According to “The New Jersey Historic Bridge Database,” this structure “is the sole known example of its type in the county.”²⁸⁸ Hollow Brook Bridge also has a unique truss system. This is a Fink-like Bollman truss, in which “the floor beams are supported by a pair of diagonals that span from end of span to end of span.”²⁸⁹ The Bollman truss was developed in the 1850s and allowed for longer spans. It was originally designed for the combination of wood and iron, but quickly fell out of favor due to its lack of rigidity and advances in other types of trusses.²⁹⁰ “The New Jersey Historic Bridge Database” notes that Hollow Brook Bridge “is historically and technologically significant as a rare

²⁸⁷ Hollow Brook Bridge is officially known as structure #100T022 or within the county as T-22.

²⁸⁸ A.G. Lichtenstein & Associates, Inc. and the New Jersey Department of Transportation, “New Jersey Historic Bridge Data: Hunterdon County,” 1994 (modified 2001) http://www.nj.gov/transportation/works/environment/pdf/Historic_BR_Hunterdon.pdf (accessed February 20, 2010), 117.

²⁸⁹ Ibid.

²⁹⁰ Ibid.

and fairly complete survivor of the pre-Civil War bridge technology.”²⁹¹ Its complete rural setting along with its engineering significance has enabled Hollow Brook Bridge to be individually eligible for the National Register.

The bridge’s rural location has generally shielded it from adverse effects that impact other bridges. Hollow Brook Road is very lightly traveled. This lack of traffic prevents the bridge from enduring excessive stresses. The lack of neighboring residences also allows the bridge to escape most delivery truck traffic that could further stress the structure while its out of the way location and narrowness prevents this road from being a cut-through route, again, limiting traffic stresses.

Hollow Brook Bridge’s rural location has also allowed it to maintain its narrow width. Although not meeting accepted standards for a two-way street, the 16½ foot width is acceptable on a road with such little traffic volume. All of these factors have helped the bridge maintain its integrity for more than a century. However, the bridge was weight restricted at 6 tons and this posed a problem, especially for heavily laden garbage trucks, which would routinely cross the structure.

Over the years, the bridge has been maintained and repaired. “The New Jersey Historic Bridge Database,” notes, “The top chord, end posts, and one vertical appear to be original, although repaired several times.”²⁹² Nevertheless, due to the age of the bridge and unknown quality of the material from which the structure was constructed, the county was worried about it collapsing and a major rehabilitation ensued.

²⁹¹ Ibid.

²⁹² Ibid.

During past rehabilitation efforts, galvanized stringer beams were laid from abutment to abutment to help take pressure off the trusses. However, to help maintain the bridge's high historic integrity, fabric, and appearance, slender beams were used which deflected a bit too much (as per the rehabilitation design). As a result, the trusses are still in play. Although it can be considered a stringer bridge, Hollow Brook Bridge is still technically a truss structure. The open grid system road deck was also replaced with a solid road deck. The bridge is now considerably stronger and is no longer weight restricted, which removed it from the structurally deficient category. However it remains functionally obsolete due to its width.²⁹³ Despite these repairs, the bridge retains its historic integrity.

²⁹³ New Jersey Department of Transportation, "New Jersey Highway Carrying Bridges: Attachment #1-Bridge Condition Inventory (All Bridges)," State of New Jersey, <http://www.state.nj.us/transportation/refdata/attachment1highwaycarryingbridges.pdf> (accessed March, 27, 2011), 70.

Old Hamden Bridge

Hamden Road: Franklin Township-Clinton Township



Figure 9: Location of the Old Hamden Bridge.



Figure 10: Photograph of the Old Hamden Bridge.

Old Hamden Bridge²⁹⁴

As Hamden Road winds its way parallel to and along the South Branch of the Raritan River, it makes an abrupt sharp turn, crossing the river via the Old Hamden Bridge, before once again returning to its parallel course. Located amidst the fields and forests of rural Franklin Township, among early 19th century homes, the Old Hamden Bridge seems to blend seamlessly with both nature and history.

Not to be confused with the Hamden Fink Truss Bridge discussed above, the Old Hamden Bridge was constructed in 1885 by Dean and Westbrook, of New York City, and retains both a sense of place and time. The bridge is a 15.6 foot wide, two-span, pin connected, cast- and wrought-iron, Pratt pony truss bridge spanning 162 feet in length.²⁹⁵ Sitting on stone abutments as well as a stone mid-stream pier, this bridge is an example of a multi-span pony truss. Although Hunterdon County has a high number of these multi-span pony trusses, they are generally rare in other parts of the country, with most multi-span bridges being through trusses.²⁹⁶

According to “The New Jersey Historic Bridge Database,” the Old Hamden Bridge “survives in a remarkably complete state of preservation,” retaining the original and unaltered truss and floor beams and contains “no apparent welded repairs or

²⁹⁴ Old Hamden Bridge is officially known as structure # 10XXF65 or within the county as F-65

²⁹⁵ A.G. Lichtenstein & Associates, Inc. and the New Jersey Department of Transportation, “New Jersey Historic Bridge Data: Hunterdon County,” 1994 (modified 2001) http://www.nj.gov/transportation/works/environment/pdf/Historic_BR_Hunterdon.pdf (accessed February 20, 2010), 178.

²⁹⁶ HistoricBridges.org, “Hamden Road Bridge,” <http://www.historicbridges.org/newjersey/lowerlandstown/> (accessed September 4, 2010).

alterations.”²⁹⁷ In addition, all bridge components are stamped with the order number, verifying that these are the bridge’s original parts.²⁹⁸ The bridge also retains its identification plaques.

An important feature of this bridge is its inclusion of Phoenix columns, the use of which “represents a transitional stage where the Phoenix truss system was being simplified to be competitive with ‘standard’ pin connected trusses of built-up members.”²⁹⁹ According to “The New Jersey Historic Bridge Database,” only four Phoenix-section pony truss spans exist in New Jersey, with the Old Hamden Bridge being the only documented 2-span example.³⁰⁰ The Phoenix column was developed in 1864 by David Reeves at the Phoenixville Iron Company in Phoenixville, Pennsylvania. It is comprised of multiple (usually no less than four) cylindrical wrought-iron hollow segments that, when fastened together, possesses great compressive strength and is relatively light in weight (as compared to a solid wrought-iron column).³⁰¹ Other case study bridges also possess Phoenix columns.

The Old Hamden Bridge retains its historic fabric in a way most bridges usually do not—in its entirety. This is a testament to historic craftsmanship and durability, and demonstrates how a historic bridge can remain a functional piece of infrastructure into the 21st century. This bridge’s significant, impeccable lifespan can be credited to several factors. The foremost of these factors is the location of the bridge. This is not a heavily

²⁹⁷ A.G. Lichtenstein & Associates, Inc. and the New Jersey Department of Transportation, “New Jersey Historic Bridge Data: Hunterdon County,” 1994 (modified 2001) http://www.nj.gov/transportation/works/environment/pdf/Historic_BR_Hunterdon.pdf (accessed February 20, 2010), 178.

²⁹⁸ Ibid.

²⁹⁹ Ibid.

³⁰⁰ Ibid.

³⁰¹ Ibid., 181.

traveled area and is relatively far from any major roads. As of 2009, average daily traffic crossing this structure was only 158 vehicles.³⁰²

In addition, the lack of traffic contributes to this bridge's survival. Careful maintenance, in this case a focus on painting to prevent rust, has allowed the structure to remain virtually intact for over 125 years. Surprisingly, despite its slender members, this bridge is seemingly well built and little other work has been done. There is not a lot of rusting, the deck pans are in fairly good shape, and, after over 100 years of service, the bolts have been tightened probably as much as possible. In addition, to make sure that the nuts and bolts do not rotate on their own, they have been tack welded in place. This bridge was last painted by the county in 2007 and there are no plans to replace the current structure.³⁰³

Because of the immaculate condition of the Old Hamden Bridge, its local and state uniqueness and rarity, structural qualities and engineering significance, along with its pristine setting, this bridge is individually eligible for National Register listing. Although eligible, it has yet to be listed on the National or State Register. It was granted a Certificate of Eligibility in 1999 by the New Jersey State Historic Preservation Officer. HistoricBridges.org gives the Old Hamden Bridge national significance of nine out of 10 and a local significance of eight out of ten.³⁰⁴

However, this bridge does face challenges. Even though it has remained intact for all these years, its narrowness does not comply with accepted road and bridge design

³⁰² BridgeHunter.com, "Hamden Road Bridge," <http://bridgehunter.com/nj/hunterdon/10XXF65/> (accessed September 4, 2010).

³⁰³ Dennis Heil and John Glynn of the Hunterdon County Department of Roads, Bridges, and Engineering, interviewed by author, Flemington, NJ, January 5, 2011.

³⁰⁴ HistoricBridges.org, "Hamden Road Bridge," <http://www.historicbridges.org/newjersey/lowerlandsgdown/> (accessed September 4, 2010).

standards. Fortunately, the lack of traffic on Hamden Road may be able to mitigate this issue for the time being. The larger issue revolves around the bridge's weight limit.

Currently, this structure is posted at 4 tons. This is not sufficient for today's modern traffic such as trucks, emergency vehicles, school busses, and some large farm equipment and therefore is considered to be structurally deficient.³⁰⁵ Although, the bridge seems in good structural shape, not heeding the posted weight limit (either intentionally or unintentionally) could result in this structure being damaged and collapsing into the river below. Safety concerns such as this may force engineers to strengthen the bridge in the future, possibly harming its historic integrity, but this has yet to be seen. Currently, regular maintenance checks and inspections favor keeping the Old Hamden Bridge as it is.

³⁰⁵ New Jersey Department of Transportation, "New Jersey Highway Carrying Bridges: Attachment #1-Bridge Condition Inventory (All Bridges)," State of New Jersey, <http://www.state.nj.us/transportation/refdata/attachment1highwaycarryingbridges.pdf> (accessed March, 27, 2011), 74.

Lower Lansdowne Bridge
Lower Lansdowne Road: Franklin Township

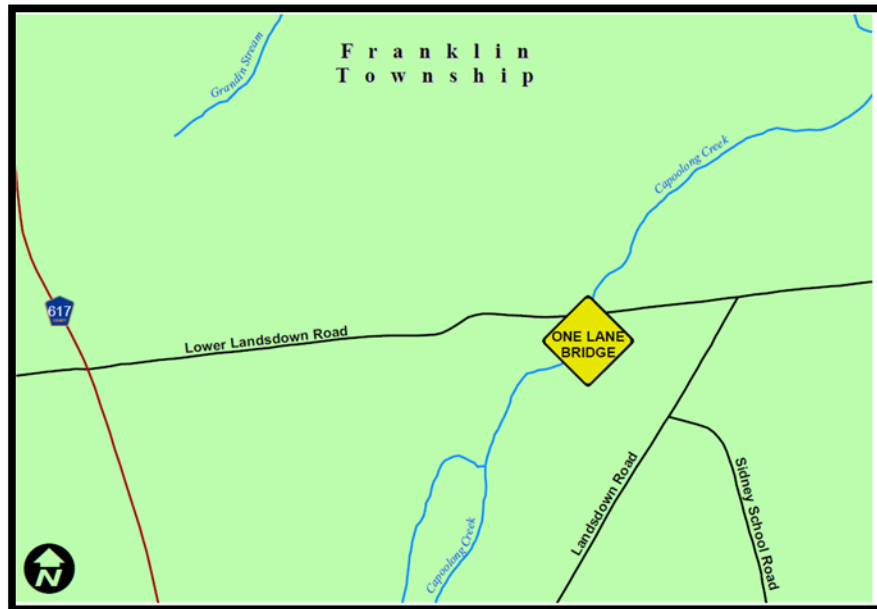


Figure 11: Location of the Lower Lansdowne Bridge.



Figure 12: Photograph of the Lower Lansdowne Bridge.

Lower Lansdowne Bridge³⁰⁶

Nestled in the woods of Franklin Township along Lower Lansdowne Road and crossing the Capoolong Creek is a unique 19th century remnant. Constructed in 1885 by Dean and Westbrook, of New York City, the Lower Lansdowne Bridge is a 15.4 foot wide, five-panel, single-span, pin connected, cast- and wrought-iron, Pratt through truss bridge, spanning 92 feet in length.³⁰⁷ Like several other bridges investigated, the Lower Lansdowne Bridge retains its identification plaques and all components are numbered, verifying the original parts. The bridge rests on random rusticated ashlar masonry abutments with flared wingwalls.

There are two important features that this bridge possesses. The first is that it was designed by the Phoenix Bridge Company, incorporating Phoenix columns. The second is that this is a skewed bridge, which means, in plan view, the bridge is not constructed at right angles and resembles a parallelogram. Together, this makes the Lansdowne Bridge the only skewed Phoenix bridge in New Jersey.³⁰⁸

This bridge is somewhat complex due to its skewed design. Many of the components had to be different sizes in order to be compatible with the offset resulting from the bridge's skew. "The New Jersey Historic Bridge Database" notes that, "on this bridge the incline of the portals were kept parallel and the end panel of the top chords are

³⁰⁶ Lower Lansdowne Bridge is officially known as structure # 10XXF82 or within the county as F-82.

³⁰⁷ A.G. Lichtenstein & Associates, Inc. and the New Jersey Department of Transportation, "New Jersey Historic Bridge Data: Hunterdon County," 1994 (modified 2001) http://www.nj.gov/transportation/works/environment/pdf/Historic_BR_Hunterdon.pdf (accessed February 20, 2010), 181.

³⁰⁸ Ibid.

of unequal length.”³⁰⁹ In addition, “All floor beams are perpendicular to the bridge centerline.”³¹⁰

The use of Phoenix columns allows the bridge to be extremely strong and relatively light. According to HistoricBridges.org, “The true strength of the Phoenix column is evident in this bridge, since it clearly is a much less massive bridge than the traditional Pratt truss.... In fact, this bridge is so lightweight that it appears to defy physics....”³¹¹

The Lower Lansdowne Bridge is “historically and technologically significant as a well-preserved example of 19th-century bridge technology in both its design and its construction details,” according to “The New Jersey Historic Bridge Database.”³¹² Along with its well-preserved state, its unique skewed design, use of Phoenix columns, setting, and rarity within New Jersey, this bridge is eligible to be individually listed on the National Register. It was subsequently listed on the National Register as well as the State Register in 1979.

Maintenance and repairs have taken place with the Lansdowne Bridge, with the most major changes occurring over half a century ago in 1958. “The New Jersey Historic Bridge Database” indicates that the stringers and deck were replaced with longitudinal laminated timber.³¹³ In 2008, a new guardrail was installed. Other than numerous patches and hidden repairs (such as strengthening members by inserting pipes into hollow

³⁰⁹ Ibid.

³¹⁰ Ibid.

³¹¹ <http://www.historicbridges.org/newjersey/lowerlandsdown/>

³¹² A.G. Lichtenstein & Associates, Inc. and the New Jersey Department of Transportation, “New Jersey Historic Bridge Data: Hunterdon County,” 1994 (modified 2001) http://www.nj.gov/transportation/works/environment/pdf/Historic_BR_Hunterdon.pdf (accessed February 20, 2010), 181.

³¹³ Ibid.

cavities), little else has been done to alter this bridge. Due to its age and slender cast-iron components, this bridge has caused all types of problems and requires a lot of maintenance. However, as of yet, the patches and other maintenance efforts have not harmed the historic integrity of the structure. HistoricBridges.org rates this bridge's national significance as an eight out of ten while its local significance is a nine out of ten.³¹⁴

Unfortunately, this bridge has a posted 6 ton weight limit and is not wide enough to accommodate two lanes of traffic. As a result, it is considered structurally deficient.³¹⁵ However, its location and low traffic volume on Lower Lansdowne Road may allow this single-lane bridge to remain intact. Weight limit issues may necessitate future shoring up of the structure. However, a single-lane bridge down the road (the New Hamden Bridge (discussed below)) was recently replaced with a two-lane solution. Hopefully, the historic integrity of the Lower Lansdowne Bridge will allow it to stave off future replacement.

³¹⁴ HistoricBridges.org, "Lansdowne Bridge," <http://www.historicbridges.org/newjersey/lowerlandsdown/> (accessed September 4, 2010).

³¹⁵ New Jersey Department of Transportation, "New Jersey Highway Carrying Bridges: Attachment #1-Bridge Condition Inventory (All Bridges)," State of New Jersey, <http://www.state.nj.us/transportation/refdata/attachment1highwaycarryingbridges.pdf> (accessed March, 27, 2011), 74.

Rosemont-Raven Rock Bridge

Rosemont-Raven Rock Road: Delaware Township

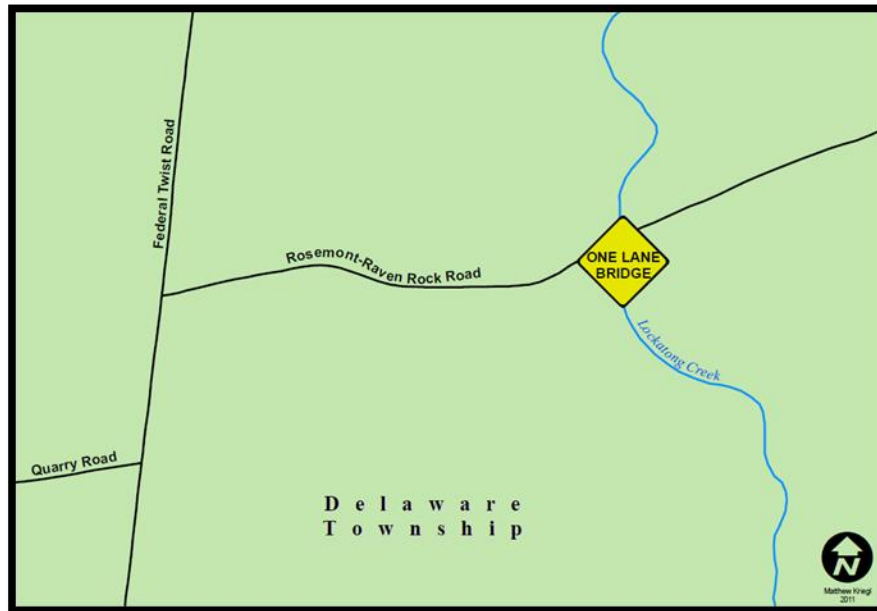


Figure 13: Location of the Rosemont-Raven Rock Bridge.



Figure 14: Photograph of the Rosemont-Raven Rock Bridge.

Rosemont-Raven Rock Bridge³¹⁶

Located in a scenic and rural portion of Delaware Township, on a very lightly traveled road is the impressive Rosemont-Raven Rock Bridge. Surrounded by fields, forests, and clearings, this bridge enjoys a setting near two historic farms and a nature preserve. The Lockatong Creek flows beneath this notable 129 foot long wrought- and cast-iron through truss bridge.

Designed and built by Lambertville Iron Works in 1878, this single-span, 15.6 foot wide, pin-connected, 9-panel Pratt bridge “ranks as one of the most important [through] truss bridges in the state based on its age, nearly complete state of preservation and use of Phoenix columns for the compression members.”³¹⁷ The bridge also retains almost all of its decorative features, including cast-iron filigree at the corners of the portal openings, lattice railings, and elaborate ball and spire finials.

Although some work has been done to maintain the structure’s integrity, much of it has been minimal, non-intrusive, and concealed. Portions of the bridge decking and steel stringers are modern. According to “The New Jersey Historic Bridge Database,” besides a few welds and strengthening components, the majority of the structure is in its original condition.³¹⁸ HistoricBridges.org gives the Rosemont-Raven Rock Bridge a national and local significance rating of nine out of ten.³¹⁹ Like many of the other

³¹⁶ Rosemont-Raven Rock Bridge is officially known as structure # 10XX300 or within the county as D-300.

³¹⁷ A.G. Lichtenstein & Associates, Inc. and the New Jersey Department of Transportation, “New Jersey Historic Bridge Data: Hunterdon County,” 1994 (modified 2001) http://www.nj.gov/transportation/works/environment/pdf/Historic_BR_Hunterdon.pdf (accessed February 20, 2010), 167.

³¹⁸ Ibid.

³¹⁹ HistoricBridges.org, “Raven Rock Bridge,” <http://www.historicbridges.org/newjersey/ravenrock/> (accessed September 4, 2010).

structures already mentioned, its superb condition results, in large part, from its out of the way location and low traffic volume. As of 2009, average daily traffic was sparse at 240 vehicles.³²⁰

This bridge is considered extremely rare because of its age and condition. It is also significant because it was designed and built by a local company, the Lambertville Iron Works. This company, run by William Cowin, was the fabricator of the most important 19th century bridges in the region.³²¹ According to “The New Jersey Historic Bridge Database,” the numerous cast iron elements, which serve both utilitarian and decorative purposes, displays an excellent representation of the skill of the 19th-century iron worker.³²² Because of this bridge’s condition and state of preservation along with its highly decorative motifs and connection to a local company, the Rosemont-Raven Rock Bridges is eligible to be individually listed on the National Register. Although this bridge is highly significant, to date it has not been listed on the National Register. However, it was granted a Certificate of Eligibility by the New Jersey State Historic Preservation Officer in 1999.

Because Rosemont-Raven Rock Bridge is considered to be structurally deficient, it has been identified by the state to be rehabilitated.³²³ Since the bridge is of great

³²⁰ BridgeHunter.com, “Raven Rock Road Bridge,” <http://bridgehunter.com/nj/hunterdon/10XX300/> (accessed September 4, 2010).

³²¹ A.G. Lichtenstein & Associates, Inc. and the New Jersey Department of Transportation, “New Jersey Historic Bridge Data: Hunterdon County,” 1994 (modified 2001) http://www.nj.gov/transportation/works/environment/pdf/Historic_BR_Hunterdon.pdf (accessed February 20, 2010), 167.

³²² Ibid.

³²³ New Jersey Department of Transportation, “New Jersey Highway Carrying Bridges: Attachment #1-Bridge Condition Inventory (All Bridges),” State of New Jersey, <http://www.state.nj.us/transportation/refdata/attachment1highwaycarryingbridges.pdf> (accessed March, 27, 2011), 74.

historic importance, options on how to rehabilitate the structure are limited. The North Jersey Transportation Planning Authority (NJTPA), of which Hunterdon County is a member of, has designated this bridge as part of its Transportation Improvement Program for fiscal years 2010-2013. As of 2010, \$1.250 million of New Jersey STP funds were allocated to the county to investigate and perform rehabilitation alternatives for the structure. The total cost of the project, which is not fully underway as of yet, is estimated at \$1.784 million.³²⁴

³²⁴ North Jersey Transportation Planning Authority, “Transportation Improvement Program, Fiscal Years 2010-2013: Hunterdon County,” <http://www.njtpa.org/Project/TIP/documents/REVISEDhunterdonPROJECTS102011Element.pdf> (accessed February 8, 2011), 5.

Stanton Station Bridge

Stanton Station Road: Raritan Township-Readington Township



Figure 15: Location of Stanton Staton Bridge.



Figure 16: Photograph of Stanton Station Bridge

Stanton Station Bridge³²⁵

Situated in a rural wooded area straddling the South Branch of the Raritan River between Readington and Raritan Townships is Stanton Station Bridge. Within a mile of the bridge is the 19th century village of Stanton and scattered modern subdivision houses. The bridge is also located adjacent to railroad tracks and a park. The location of the bridge instills a serene sense of tranquility and peace, and it seems as if not much has changed since the late-1800s.

Constructed by the Cleveland Bridge and Iron Company in 1880, this 103 foot long, 15.7 foot wide through truss bridge is one of the earliest metal truss bridges in the country.³²⁶ The iron, single span, eight-panel, pin-connected Pratt through truss bridge is ornately ornamented and well preserved. Much of the original bridge remains intact with few alterations. The bridge is significant in several ways: first, its early date of construction; second, its well preserved condition; and third, its unique construction details. The bridge sits on random ashlar abutments.

Being constructed in 1880, this is the second oldest metal through truss bridge that exists in the country.³²⁷ In addition to being old, this structure is in remarkably good condition. The bridge is also complete and many of the members retain their shop numbers. The Stanton Station Bridge also made use of a unique type of deck

³²⁵ Stanton Station Bridge is officially known as structure # 10XX179 or within the county as RQ-179.

³²⁶ A.G. Lichtenstein & Associates, Inc. and the New Jersey Department of Transportation, "New Jersey Historic Bridge Data: Hunterdon County," 1994 (modified 2001) http://www.nj.gov/transportation/works/environment/pdf/Historic_BR_Hunterdon.pdf (accessed February 20, 2010), 164.

³²⁷ Ibid.

construction known as “fish-belly” which is a special type of built up flooring system, with each floorbeam acting as an individual truss.³²⁸

In the bridge’s more than 130 years in service, only one of the beams ever needed to be replaced.³²⁹ Other than the replaced floor beam, there have not been too many additional alterations other than some replaced stringers and railing system. Some decorative lattice work was unfortunately removed from the structure in the past; however the bridge is still highly decorated.

This bridge is extremely significant on both a national and local level. Not only is this one of the oldest truss bridges in the country, but according to “The New Jersey Historic Bridge Database,” it documents “the evolution and application of metal truss bridge technology in Hunterdon County,” while demonstrating “how those bridges were built.”³³⁰ Because of this great significance, Stanton Station Bridge is eligible to be individually listed on the National Register. It has not been listed but was granted a Certificate of Eligibility in 1999 by the New Jersey State Historic Preservation Officer.

Similar to the situation with the Rosemont-Raven Rock Bridge, Stanton Station Bridge is considered structurally deficient and has been identified for rehabilitation.³³¹ Since the bridge is also of great historic importance, options on how to rehabilitate the

³²⁸ HistoricBridges.org, “Stanton Station Bridge,” <http://www.historicbridges.org/newjersey/stanton/> (accessed September 4, 2010). A.G. Lichtenstein & Associates, Inc. and the New Jersey Department of Transportation, “New Jersey Historic Bridge Data: Hunterdon County,” 1994 (modified 2001) http://www.nj.gov/transportation/works/environment/pdf/Historic_BR_Hunterdon.pdf (accessed February 20, 2010), 164.

³³⁰ Ibid.

³³¹ New Jersey Department of Transportation. “New Jersey Highway Carrying Bridges: Attachment #1-Bridge Condition Inventory (All Bridges).” <http://www.state.nj.us/transportation/refdata/attachment1highwaycarryingbridges.pdf> (accessed March, 27, 2011), 73.

structure are limited. The NJTPA has designated this bridge as part of its Transportation Improvement Program for fiscal years 2010-2013. As of 2010, \$330,000 of New Jersey STP funds was allocated to the county to investigate historic preservation alternatives for the structure.³³² An additional \$310,000 is slated for 2011 and another \$1.540 million slated for 2012.³³³ The total cost of the project is estimated at \$2.449 million.³³⁴

³³² North Jersey Transportation Planning Authority, "Transportation Improvement Program, Fiscal Years 2010-2013: Hunterdon County," <http://www.njtpa.org/Project/TIP/documents/REVISEDhunterdonPROJECTS102011Element.pdf> (accessed February 8, 2011), 7.

³³³ Ibid.

³³⁴ Ibid.

Locktown-Flemington Bridge
Locktown-Flemington Road: Delaware Township

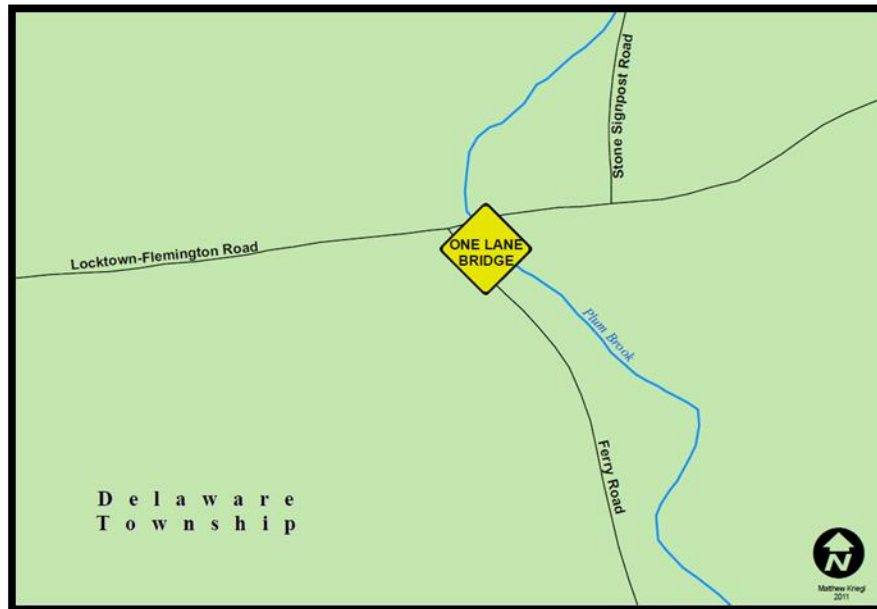


Figure 17: Location of the Locktown-Flemington Bridge.



Figure 18: Photograph of the Locktown-Flemington Bridge.

Locktown-Flemington Bridge³³⁵

Situated in a rural wooded area of Delaware Township is one of the shortest bridges examined. Crossing over the Plum Brook, the Locktown-Flemington Bridge spans only 29 feet. Although the current structure maintains its original length, its original width of 13.7 feet has recently been significantly increased.

Despite being part of a widening project, the bridge's trusses were retained. According to "The New Jersey Historic Bridge Database," this single-span, 2-panel pony truss bridge is a hybrid modified Warren design with predominantly riveted connections.³³⁶ The original design, as well as the lattice ornamentation of the trusses remains mostly intact. The original structure was locally designed by J.E. Bowne and built by J.W. Scott, locally of Flemington, in 1900.³³⁷ The bridge sits on fieldstone abutments.

The Locktown-Flemington Bridge is considered technically significant because of its experimentation with the combination of different truss designs. It is also considered significant as one of only two examples of this design (the other being located the next street over). This bridge is noteworthy because it represents "the variety and idiosyncrasy of bridge designs that characterize the heyday of the metal truss bridge

³³⁵ Locktown-Flemington Bridge is officially known as structure # 100D388 or within the county as D-388.

³³⁶ A.G. Lichtenstein & Associates, Inc. and the New Jersey Department of Transportation, "New Jersey Historic Bridge Data: Hunterdon County," 1994 (modified 2001) http://www.nj.gov/transportation/works/environment/pdf/Historic_BR_Hunterdon.pdf (accessed February 20, 2010), 97.

³³⁷ Ibid.

era.”³³⁸ As a result of its rarity and local importance, this bridge has been deemed individually eligible to be listed on the National Register.

Originally a narrow, single-lane structure, the Locktown-Flemington Bridge was recently realigned and widened. The original bridge was taken down, new abutments and footings were constructed, and the alignment was slightly improved. New galvanized stringers were added to relieve the stress on the trusses. The original trusses were then attached to the new structure. Six-inch stone veneer was added to the new abutments finishing up the project.

Although the end product looks a bit awkward and out of scale, with its wide road deck, the bridge was in dire need of rehabilitation and increased traffic on the road had made the narrow bridge with its skewed alignment even more dangerous. Additionally, the original abutments were virtually nonexistent, leading Dennis Heil, an engineer for Hunterdon County, to describe the bridge as a “rust bucket” with “rusty floorbeams, rusty stringers on a pile of rocks.”³³⁹ The bridge was in such bad shape that every time a fire truck crossed the bridge, county engineers would have to go out and inspect the structure.³⁴⁰

The new bridge was completed in 2005 and is now essentially a stringer bridge. Because neighboring residents opposed the new two-lane structure, for fear it would increase traffic, the original trusses were used to help quell the opposition and to “give a flavor of the old [bridge].”³⁴¹ Stone veneer was also incorporated, at great expense, to

³³⁸ Ibid.

³³⁹ Dennis Heil and John Glynn of the Hunterdon County Department of Roads, Bridges, and Engineering, interviewed by author, Flemington, NJ, January 5, 2011.

³⁴⁰ Ibid.

³⁴¹ Ibid.

help retain the original bridge's character. Additionally, new massive guardrails were also installed. These guardrails add to the safety of the structure, but, unfortunately, obscure much of the historic trusses. A plaque denotes the date of the original bridge and completion date of the new structure, along with the bridge number. Since its rehabilitation, this bridge is no longer considered obsolete or deficient.³⁴²

When it comes to the bridges in Category 1, Hunterdon County should be commended for their active role in bridge preservation. A lot of effort has been put forward in order to maintain these bridges, even when replacing the historic bridge would lessen the burden of constant repairs. The state, of course, is half responsible (through the State Historic Preservation Office), as it dictates what historic components must be preserved and maintained, and if the historic structure can even be replaced at all.

In general though, the repairs have maintained much of the historic fabric in many of the county's most historically significant bridges. The county's high levels of active maintenance should also be commended. Many of these structures, although over a century in age, are in almost pristine condition with minor alterations, a testament to the county's understanding of the importance of proper maintenance.³⁴³

It is through a combination of a rural setting, low traffic volumes, and persistent maintenance that these bridges have been able to survive in such a complete state. It is

³⁴² New Jersey Department of Transportation, "New Jersey Highway Carrying Bridges: Attachment #1-Bridge Condition Inventory (All Bridges)," State of New Jersey, <http://www.state.nj.us/transportation/refdata/attachment1highwaycarryingbridges.pdf> (accessed March, 27, 2011), 71.

³⁴³ For additional photographs of these structures, see Appendix A.

also because of sensitive preservation and strengthening techniques that these structures will be able to remain in place even longer.

Of the six bridges examined in this first category, all but the Locktown-Flemington Bridge remained mostly untouched, unaltered, or sensitively rehabilitated. The extreme deterioration of the Locktown-Flemington Bridge necessitated extreme actions, and although the majority of the bridge was replaced, the historic trusses were retained and reinstalled (even though they no longer function as such). The rehabilitation of this structure could have been a bit more sensitive to the original historic bridge, but due to all the issues and constraints surrounding this structure, the end result turned out relatively well.

9.2 Category 2 Bridges

[Not eligible to be listed on the National Register of Historic Places]

The second category is comprised of three case study bridges. These structures, although they may not be eligible to be listed on the National Register, are still important to the historic engineering record. Many of these bridges retain much of their original material but have been too heavily altered and are no longer pristine specimens, while other bridges in this category are one of many similar examples located throughout the county.

Category 2: Bridge Location Map

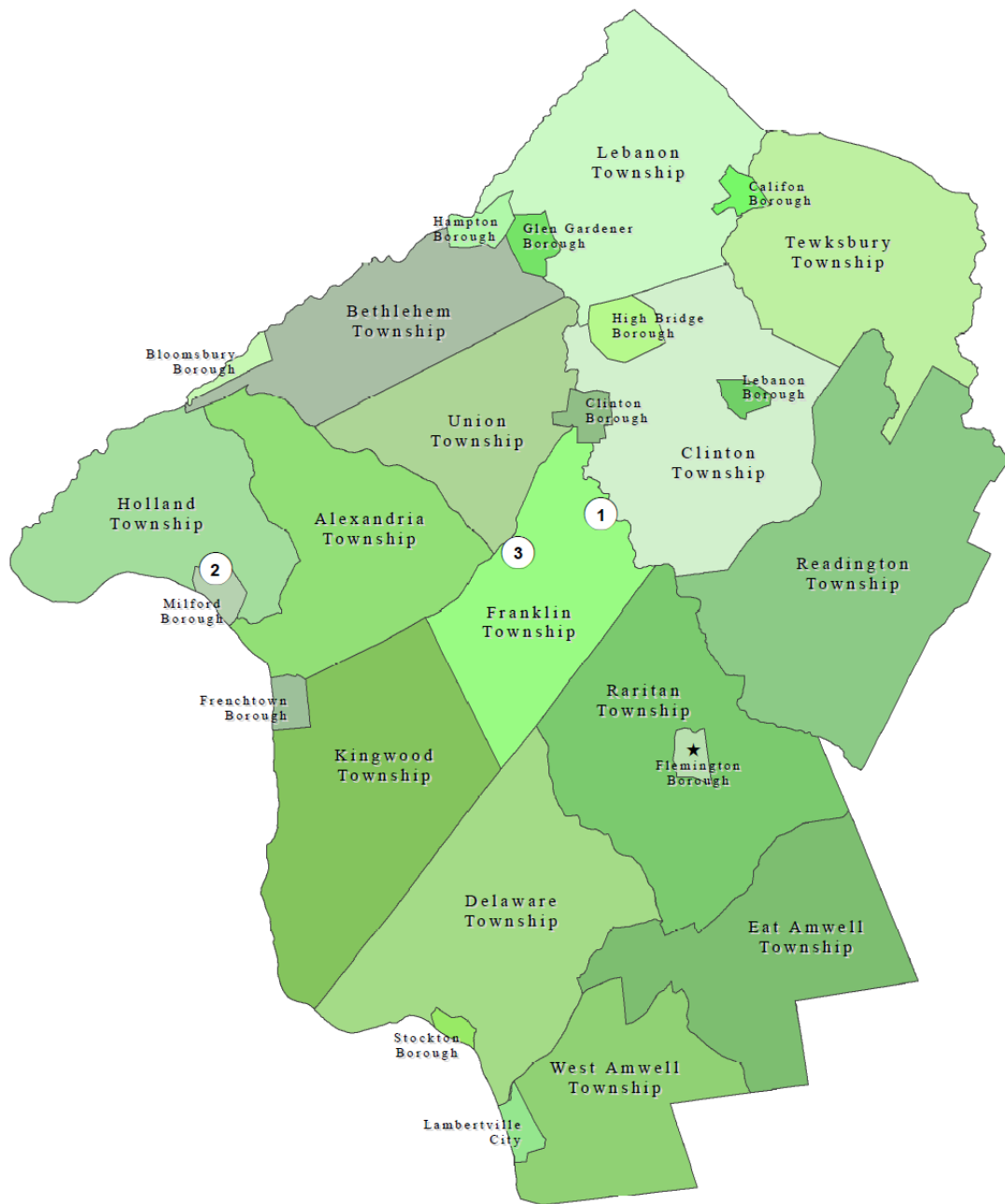


Figure 19: Location of Category 2 Bridges.

1. Pine Hill Bridge, Franklin Township-Clinton Township
2. York Street Bridge, Milford Borough
3. White Bridge, Franklin Township

Pine Hill Bridge

Pine Hill Road: Franklin Township-Clinton Township

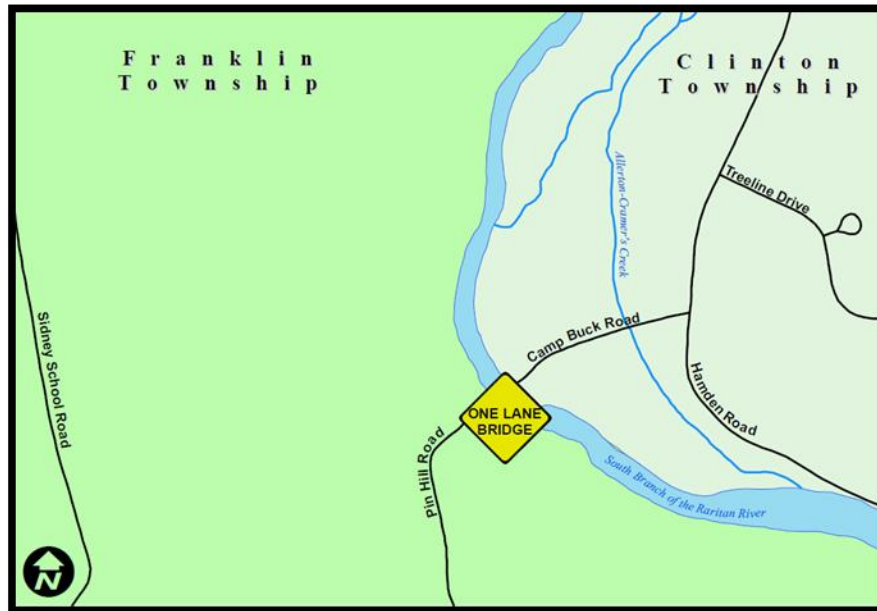


Figure 20: Location of Pine Hill Bridge.



Figure 21: Photograph of Pine Hill Bridge.

Pine Hill Bridge³⁴⁴

Located on a lightly traveled, rural road on the border between Franklin and Clinton Townships is the Pine Hill Bridge. This bridge crosses the South Branch of the Raritan River (which forms the township boundaries) in a forested area between a nature preserve and a camp. The area is relatively pristine in character and only the modern weight limit signs betray the fact that this is not the late 1800s.

This low-slung pony truss bridge, constructed around 1900 by an unknown builder, is comprised of multiple spans. As mentioned above, multi-span pony truss bridges are not common outside of Hunterdon County. Although the bridge spans 92 feet in length, it is one of the narrowest examined with a width of only twelve feet.³⁴⁵ The steel structure is a pin-connected, half hip Pratt pony truss with two spans, each containing four panels.³⁴⁶ Much of the decorative lattice work remains intact and the bridge sits on stone abutments as well as a stone mid-stream pier.

Unfortunately, this bridge has been heavily modified over the years, although it may not be evident without close inspection of the structure. It was last heavily modified in the early 1980s. “The New Jersey Historic Bridge Database” notes that “Welded additions include plates at panel points, reinforcing of the lower chords, repair plates on diagonals, and outriggers.”³⁴⁷ Because of these significant alterations, the bridge was deemed to be not eligible for listing on the National Register. HistoricBridges.org rates

³⁴⁴ Pine Hill Bridge is officially known as structure # 100FC80 or within the county as FC-80.

³⁴⁵ A.G. Lichtenstein & Associates, Inc. and the New Jersey Department of Transportation, “New Jersey Historic Bridge Data: Hunterdon County,” 1994 (modified 2001) http://www.nj.gov/transportation/works/environment/pdf/Historic_BR_Hunterdon.pdf (accessed February 20, 2010), 106.

³⁴⁶ Ibid.

³⁴⁷ Ibid.

this bridge's national significance as a six out of ten while its local significance is a four out of ten.³⁴⁸

The approach to the bridge is geometrically challenged and the structure is both functionally obsolete and structurally deficient. Upon entering the bridge from the east, a steep vertical ramp-like approach prevents the driver from seeing oncoming traffic. In addition, according to a county engineer, the bridge deck is way too narrow to safely handle modern traffic. The bridge also possesses one of the lowest weight limits of the bridges examined, rated at only 4 tons. The bridge is also not elevated high enough, and there is concern that at some point the bridge could be washed away during a flooding event. Due to these conditions, in addition to its narrow width, this bridge is conceded to be structurally deficient.³⁴⁹

Although a few rehabilitation efforts have been performed to shore up the structure, it remains in bad shape, which is exacerbated by its location. It is severely weight restricted, located in a flood plain, and its awkward alignment makes it difficult to simply replace. According to Dennis Heil, the structure is “a rust bucket and a half.”³⁵⁰ He also noted that both the substructure and superstructure are not doing too well, adding “the question is which is going to fail first.”³⁵¹

³⁴⁸ HistoricBridges.org, “Pine Hill Road Bridge,”

http://www.historicbridges.org/newjersey/pinehill_campbuck/ (accessed September 4, 2010).

³⁴⁹ New Jersey Department of Transportation. “New Jersey Highway Carrying Bridges: Attachment #1-Bridge Condition Inventory (All Bridges).”

<http://www.state.nj.us/transportation/refdata/attachment1highwaycarryingbridges.pdf> (accessed March, 27, 2011), 74.

³⁵⁰ Dennis Heil and John Glynn of the Hunterdon County Department of Roads, Bridges, and Engineering, interviewed by author, Flemington, NJ, January 5, 2011.

³⁵¹ Ibid.

In this case, the county has very limited options. One option would be to replace the superstructure, but this is unlikely because of the poor condition of the substructure. If nothing structural is done soon, the bridge may be closed to vehicular traffic, remaining open only for pedestrians. A new vehicular bridge in this area may never come to fruition. As Dennis Heil alludes, the county keeps putting off the replacement of this bridge and it is “probably not going to be addressed in our lifetimes.”³⁵² It should also be noted that although this bridge is not in good shape, it is not in danger of collapsing as long as drivers heed all warnings and restrictions. Despite all major issues, Pine Hill Bridge currently retains much of its historic character in its quiet setting.

³⁵² Dennis Heil and John Glynn of the Hunterdon County Department of Roads, Bridges, and Engineering, interviewed by author, Flemington, NJ, January 5, 2011.

York Street Bridge
York Street: Milford Borough



Figure 22: Location of the York Street Bridge.



Figure 23: Photograph of the York Street Bridge.

York Street Bridge³⁵³

Located on a lightly traveled road at the edge Milford Borough, near the boundary with Holland Township, is a small bridge, crossing the Hakihoake Creek. Located in a village setting surrounded by fields and forests, the York Street Bridge was constructed in 1901 by an unknown builder. This steel structure is a pin connected, three-panel, Pratt half hip pony truss bridge. It spans 42 feet in length and is 14.6 feet wide. The bridge sits on stone abutments. In 1976, the east abutment was encased in concrete.³⁵⁴

This bridge has been heavily modified over the years leading to numerous welded repairs and reinforcing. Both the diagonals and floorbeams are replacements. Because of these significant alterations and because there are better examples of similar bridges throughout the county, the bridge was deemed to be not eligible for listing on the National Register.

Recently, in 2008, this bridge has undergone a major rehabilitation.³⁵⁵ During the rehabilitation, the superstructure was disassembled and work was done on the west stream bank abutment. The abutment was strengthened with a massive concrete cap that is designed to prevent the bridge from going out of plumb when heavy vehicles cross. It will also help prevent the creek from scouring and damaging the abutment during a high water event.

³⁵³ York Street Bridge is officially known as structure # 1000096 or within the county as M-94.

³⁵⁴ A.G. Lichtenstein & Associates, Inc. and the New Jersey Department of Transportation, "New Jersey Historic Bridge Data: Hunterdon County," 1994 (modified 2001) http://www.nj.gov/transportation/works/environment/pdf/Historic_BR_Hunterdon.pdf (accessed February 20, 2010), 46.

³⁵⁵ For detail photographs of the rehabilitation, see Appendix A.

After work on the west stream bank and abutment was completed, work on the superstructure commenced. This work entailed a series of stringer beams connected to the abutments in order to take the pressure off the trusses. These beams also allowed the bridge to be widened. The trusses were then reassembled onto the new structure and the road deck was paved. These alterations have allowed the structure to better accommodate today's vehicles and the bridge is no longer weight restricted.

Technically this bridge is no longer dependent on its trusses and would be considered a stringer bridge. However, the alterations are not that noticeable without climbing under the structure. As a result, the York Street Bridge retains much of its historic character despite being heavily retrofitted for modern traffic. Additionally, after the rehabilitation, the bridge is no longer structurally deficient, but remains functionally obsolete, due to its width.³⁵⁶

³⁵⁶ New Jersey Department of Transportation. "New Jersey Highway Carrying Bridges: Attachment #1-Bridge Condition Inventory (All Bridges)." <http://www.state.nj.us/transportation/refdata/attachment1highwaycarryingbridges.pdf> (accessed March, 27, 2011), 74.

White Bridge

White Bridge Road: Franklin Township



Figure 24: Location of the White Bridge.



Figure 25: Photograph of the White Bridge.

White Bridge³⁵⁷

Crossing the Capoolong Creek in Franklin Township and situated in a shallow wooded valley surrounded by farmland sits a unique bridge. The bridge, at the end of a sharp curve and overlooked by a farmstead constructed in the late 17th century, has an idyllic setting for seemingly being the most contentious bridge in Hunterdon County. The White Bridge Road Bridge is a skewed five-panel, pin connected, Pratt half-hip, pony truss bridge. It was constructed in 1900 by an unknown builder from a ferrous material.³⁵⁸ The bridge spans 80 feet in length and is 13.8 feet wide, resting on ashlar abutments.

The White Bridge Road Bridge has been heavily modified and includes outriggers welded to floorbeams and plates welded to panel points and end posts.³⁵⁹ Because of these extensive modifications, the bridge was deemed to be not eligible for listing on the National Register. Another interesting aspect of this bridge is that it does not seem to be sited correctly. In fact, upon further investigation, according to “The New Jersey Historic Bridge Database,” it was determined that the span is too long for the crossing, and suggested that the bridge was moved here from elsewhere.³⁶⁰ Franklin Township historian, Lora Jones, has noted that the original 1886 wooden bridge over the Capoolong

³⁵⁷ White Bridge is officially known as structure # 100XXF45 or within the county as F-45.

³⁵⁸ A.G. Lichtenstein & Associates, Inc. and the New Jersey Department of Transportation, “New Jersey Historic Bridge Data: Hunterdon County,” 1994 (modified 2001) http://www.nj.gov/transportation/works/environment/pdf/Historic_BR_Hunterdon.pdf (accessed February 20, 2010), 173.

³⁵⁹ Ibid.

³⁶⁰ Ibid.

Creek was replaced in 1930 by a white steel truss bridge moved from nearby Frenchtown.³⁶¹

The bridge is functionally obsolete due to its narrow width and has a weight limit of 15 tons, usually the minimum acceptable rating. The road on which this structure is located, White Bridge Road, is not heavily traveled, but has relatively more volume than other bridges examined and has been increasing. The sharp curve on the southern end of the bridge and the ascending hill located to north creates a geometric and road alignment problem. The bridge also shows visual signs of deterioration, including rust and bent components.

Being so heavily modified and possibly even moved, the White Bridge Road Bridge hardly seems like a probable candidate for the fervent preservation campaign that has continuously been brewing over the past decade. An in depth account of this controversy is written below.

The NJTPA has designated this bridge as part of its Transportation Improvement Program for fiscal years 2010-2013. As of 2010, \$330,000 of New Jersey STP funds was allocated to the county to “replace the existing structure with a 26-foot wide new bridge.”³⁶² The new bridge will have two 12-foot wide lanes and two one-foot shoulders on each side. In addition a sidewalk will be attached to one side and the approach geometry will be improved. The total cost of the project is estimated at \$2.205 million. The plans are still in the design and permitting stages.

³⁶¹ David Giambusso, “A bridge too wide? Foes: New span would ruin town’s charm,” *The Star-Ledger* (Newark, NJ), May 31, 2009.

³⁶² North Jersey Transportation Planning Authority, “Transportation Improvement Program, Fiscal Years 2010-2013: Hunterdon County,” <http://www.njtpa.org/Project/TIP/documents/REVISEDhunterdonPROJECTS102011Element.pdf> (accessed February 8, 2011), 10.

When it comes to the bridges in Category 2, Hunterdon County should be generally commended for their restraint in wantonly replacing obsolete and deficient structures. Much effort goes into trying to retain the character of these bridges, even though they are not eligible for listing on the National Register.

These three examples highlight the difficulties with trying to maintain safe bridges. In some cases, such as in the Pine Hill Bridge scenario, the best course of action is to maintain the structure as is, monitor it, and then leave it alone. The York Street Bridge highlights how a bridge can be properly rehabilitated, widened, and strengthened, while retaining much of its original character. The White Bridge Road Bridge example demonstrates the difficult decisions county engineers have to make, especially in the face of rampant opposition.³⁶³

Although all bridges cannot be saved, a great effort is put forth in order to retain rural character and the original structures when at all possible. Even if not historically significant, these truss bridges are aesthetically pleasing and garner strong community support. In many cases, residents have installed hanging baskets and placed flags on these bridges to help incorporate these structures into the community. In response, the county makes efforts to accommodate bridge designs and repairs that do not significantly harm or alter these structures while balancing the need for safety.

³⁶³ For additional photographs of these structures, see Appendix A.

9.2.1 *White Bridge Controversy*

Beginning in 2009, the residents of Franklin Township, in central Hunterdon County, became enraged when the county decided to replace the single-lane bridge located on White Bridge Road. This was the culmination of a ten year process in which the county was finally able to secure federal funds in order to replace the aging structure.



Figure 26: Photograph of the White Bridge.

The bridge is functionally obsolete and structurally deficient and the approaches feature road geometry problems with sharp curves. All the way back in 1990, John Glynn, director of the County Roads, Bridges, and Engineering Department, said the bridge had structurally failed and declared it “one of the worst in New Jersey at the

time.”³⁶⁴ Since then, numerous discussions flared up every couple of years over the bridge’s ultimate fate.

In 2009, with the funding secured, the county began moving swiftly towards replacement. In response the community started a petition, garnering 275 signatures trying to prevent the county from replacing the one-lane bridge with a new two-lane structure. Multiple township and county meetings were held for residents to discuss their opinions on replacing the old bridge. A majority of those attending were adamantly against the proposal of a new two-lane structure.

The county however held their position claiming that a two-lane bridge was necessary to meet federal guidelines which is required when using federal funds. Erin Phalon, a Department of Transportation spokeswoman further explained the situation. “The bridge is currently functionally obsolete, because the roadway leading to the bridge is two lanes and the bridge is one lane. In order to use federal funds, the owner must replace the bridge with a bridge that is not functionally obsolete, and therefore the new bridge must feature two lanes.”³⁶⁵ The county also contends that the existing structure is dangerous to hikers who cross it while following an adjacent trail.

At the crux of the matter is whether a two-lane bridge would destroy the rural, bucolic landscape of the area. White Bridge Road connects two historic villages, Pittstown and Quakertown, in an area of New Jersey that is known for its historic farms and rolling hills in a state that is generally perceived as overly congested and urbanized. Residents claim that replacing the bridge with a wider structure would create greater

³⁶⁴ Warren Cooper, “White-Bridge Group Loses 1-Lane Battle,” *Hunterdon County Democrat* (Flemington, NJ), July 16, 2009.

³⁶⁵ David Giambusso, “One-lane bridge in Franklin causes controversy,” *The Star-Ledger* (Newark, NJ), July 12, 2009.

volumes of traffic which would travel at higher speeds, leading to new developments and strip malls. They believe that “a two-lane bridge is the first step in a wider pattern of unwanted traffic, development and modernization of the area.”³⁶⁶

While the residents felt as if their opinions and suggestions had been largely ignored and that the county is endangering the safety and rustic character of the area, the county claimed that a wider bridge is warranted because of safety concerns and an increasing traffic volume, which is already estimated at between 850-900 vehicles per day. A new bridge would also be able to accommodate school busses and fire trucks.

By mid-July, after county meetings between residents, engineers, and officials tried to hash out their differences over the project, it was ultimately determined that the bridge would be replaced with a new two-lane structure. In addition, residents would be able to have some input on various design decisions. However, this did not sit well with residents, one of which, Terry Schultz, said, “You should have told us at the first meeting that the bridge was designed and signed off on and that the only choices open to us was to pick out colors and a little latticework. You should have been honest with the public and not waste a lot of people’s time.”³⁶⁷ As a counter, the county stated that over the years, the concerns of the residents have indeed altered the design of the bridge. Originally slated to be 35-feet in width with straighter approach geometry, the current design was reduced to 32-feet, and then further reduced to 26-feet with the current approach geometry kept intact based on community concerns.

³⁶⁶ David Giambusso, “A bridge too wide? Foes: New span would ruin town’s charm,” *The Star-Ledger* (Newark, NJ), May 31, 2009.

³⁶⁷ Warren Cooper, “White-Bridge Group Loses 1-Lane Battle,” *Hunterdon County Democrat* (Flemington, NJ), July 16, 2009.

In an effort to partially address residents' fears about speeding along the road, county engineers suggested that a number of measures could be taken. In addition to leaving existing road geometrics, special pavement treatments that make the two-lane structure look narrower could be applied, as could painting a crosswalk or installing stop signs. In addition, the township may consider restricting the road to local traffic and limiting the road to 4- or 5-tons. Residents contend however that there is no better way to slow traffic than a one-lane bridge.

Although the residents and community members were adamant about keeping their single-lane bridge in place, they were skeptical that the county would change its position, especially once they were given federal money for the project. To keep the bridge in place, or replace it with another single-lane bridge, would have forced the county to give up its federal funds and repay what had already been spent on the design process, in addition to all future maintenance costs on the structure. Laura Jones, Franklin Township historian, in regards to the negotiation process between the county and residents, said it best, "If you negotiate between a one-lane bridge and a two-lane bridge, what do you get?"³⁶⁸

The new bridge, as mentioned previously, is currently in the design and permitting stages and the total cost of the project is estimated at \$2.205 million.³⁶⁹

³⁶⁸ David Giambusso, "A bridge too wide? Foes: New span would ruin town's charm," *The Star-Ledger* (Newark, NJ), May 31, 2009.

³⁶⁹ North Jersey Transportation Planning Authority, "Transportation Improvement Program, Fiscal Years 2010-2013: Hunterdon County," <http://www.njtpa.org/Project/TIP/documents/REVISEDhunterdonPROJECTS102011Element.pdf> (accessed February 8, 2011), 10.

9.4 Category 3 Bridges

[Structures that have been replaced]

The third category is also comprised of three case study bridges. These structures were replaced because the original bridges were deemed by the county to be too far deteriorated or unsafe to be kept in service. None of the replaced structures were eligible for listing on the National Register for Historic Places.

Category 3: Bridge Location Map

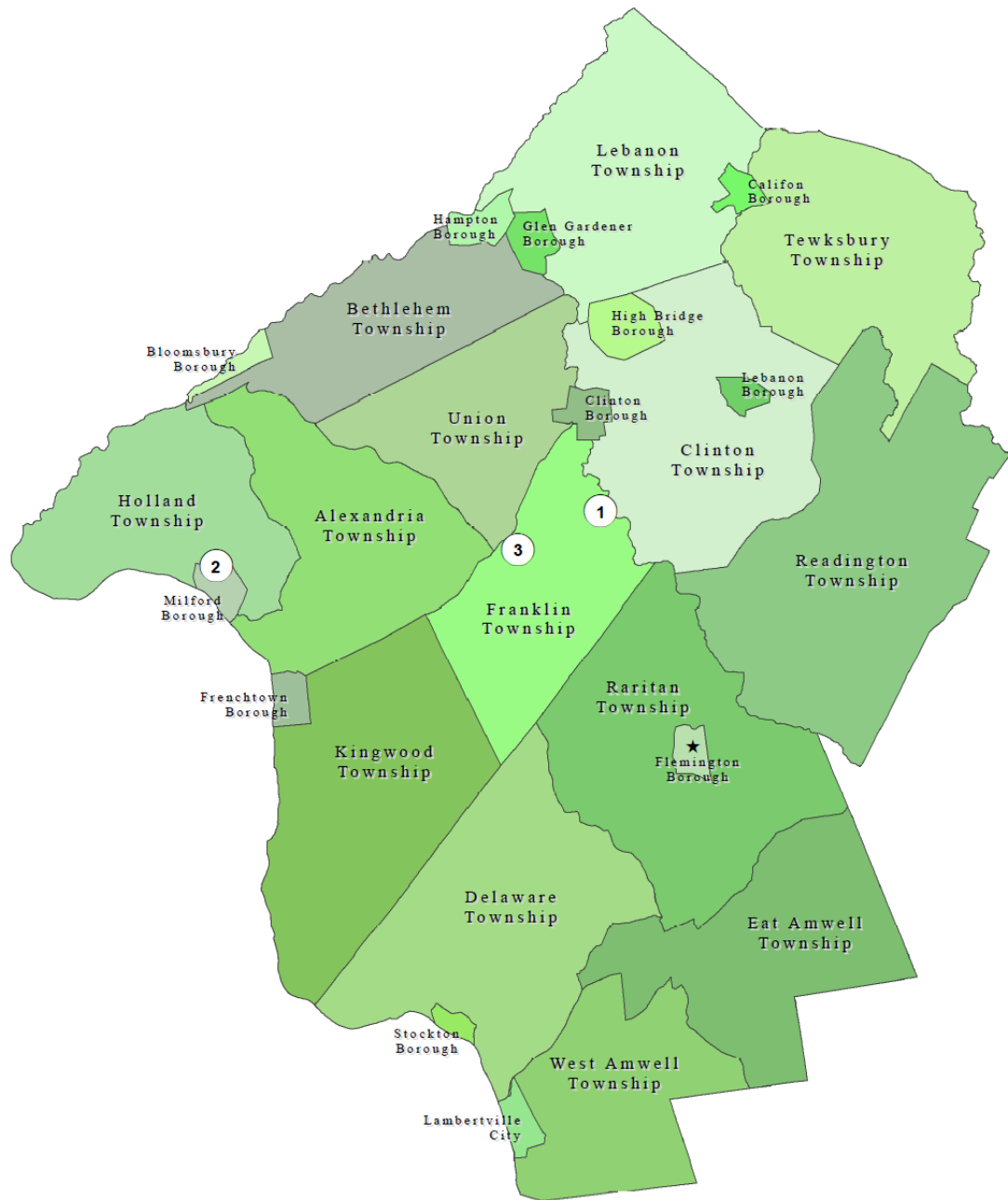


Figure 27: Map of Category 3 Bridges

1. New Hamden Bridge, Franklin Township-Clinton Township
2. Potterstown Bridge, Tewksbury Township
3. Valley Station Bridge, Bethlehem Township

New Hamden Bridge

Hamden Road: Franklin Township-Clinton Township



Figure 28: Location of the New Hamden Bridge.



Figure 29: Photograph of the replaced New Hamden Bridge

New Hamden Bridge³⁷⁰

Located about a mile northeast from the Lansdowne Bridge is the New Hamden Bridge (not to be confused with any of the Hamden bridges previously mentioned). This bridge crosses the South Branch of the Raritan River and is situated between Franklin and Clinton Townships (the river forms the boundary). This bridge is one of two bridges that were located on this section of Hamden Road. As previously noted, the other bridge (one of the last remaining examples of a Fink truss) was taken down after a vehicular accident severely compromised the structure in the 1970s. That bridge has been replaced with a pedestrian bridge and has been closed to traffic. Located on Hamden Road and situated in an area of open fields adjacent to a wooded nature preserve, this bridge is a replacement structure built in 2005.

The original bridge, constructed around 1900, was a single-lane steel structure spanning 152 feet with a 15 foot width. It was a two-span, skewed, pin-connected, five-panel Pratt pony truss bridge.³⁷¹ The bridge sat on stone abutments as well as a stone mid-stream pier. It had been altered and was not considered historically or technologically distinctive and therefore was deemed to be not eligible for listing on the National Register.

The narrow bridge was classified as functionally obsolete and its low weight limitations made it structurally deficient. The bridge began to fall apart and its deck pan began to rust out. In light of increasing traffic volumes, the county decided that instead

³⁷⁰ New Hamden Bridge is officially known as structure # 10XXF62 or within the county as F-62.

³⁷¹ A.G. Lichtenstein & Associates, Inc. and the New Jersey Department of Transportation, "New Jersey Historic Bridge Data: Hunterdon County," 1994 (modified 2001) http://www.nj.gov/transportation/works/environment/pdf/Historic_BR_Hunterdon.pdf (accessed February 20, 2010), 177.

of putting money into something that was “too narrow for the traffic out there,” that they were better off replacing the existing bridge with a new wider structure.³⁷²

In 2006, the bridge was totally replaced with a new wider, two-lane structure. In addition, the new bridge has an unrestricted weight limit and is no longer functionally obsolete or structurally deficient. The replacement of this bridge was funded by the New Jersey Statewide Transportation Bridge Bond act of 1999. Through this program, \$1 million dollars was expended to facilitate the design and construction of this new bridge.³⁷³

Although the new bridge is wider than its original predecessor, the county did a good job of trying to keep the bridge’s character. The new structure imitates the original structure in variety of ways. To begin with, the new structure is a two-span, five-panel pony truss bridge. However, the designers of the new bridge opted to use a Warren truss with verticals and not the Pratt truss that was present in the original structure. There are several examples of this truss design throughout Hunterdon County, most notably the Kiceniuk Bridge. It is an interesting design to replace a bridge from 1900, since the Warren design seems to have been popular beginning in the mid-1920s.

The new bridge spans 163 feet in length and is 30 feet wide. Additionally, the stone abutments were extended as was the midstream pier, not only to accommodate a wider bridge, but to make room for an additional 6 foot wide sidewalk, which is attached

³⁷² Dennis Heil and John Glynn of the Hunterdon County Department of Roads, Bridges, and Engineering, interviewed by author, Flemington, NJ, January 5, 2011.

³⁷³ New Jersey Department of Transportation, “Statewide Transportation and Local Bridge Bond Act of 1999: Status Report May 2007” (Trenton, NJ: New Jersey Department of Transportation, 2007), 52.

to the east side of the new bridge. The total contracted cost of the replacement structure was \$1,843,542.³⁷⁴

In general, the bridge accomplishes its goal of matching the character of the area. Unfortunately, the bridge looks a bit out of scale. The entire superstructure looks thick. This is possibly exaggerated by the wide road and narrow guardrails (the bridge deck is wider than the existing road). The attached sidewalk component also does not help, making the bridge seem even more massive. Although this structure seems like it matches the character of a late-1800s pony truss bridge, it does not match the scale.

³⁷⁴ Department of Roads, Bridges, and Engineering, “Road and Bridges Summary: 2005” (Flemington, NJ: County of Hunterdon, 2005) <http://www.co.hunterdon.nj.us/pdf/roadsandbridges/2005Summary.pdf> (accessed February, 17, 2011), 27.

Potterstown Bridge

Potterstown Road: Tewksbury Township

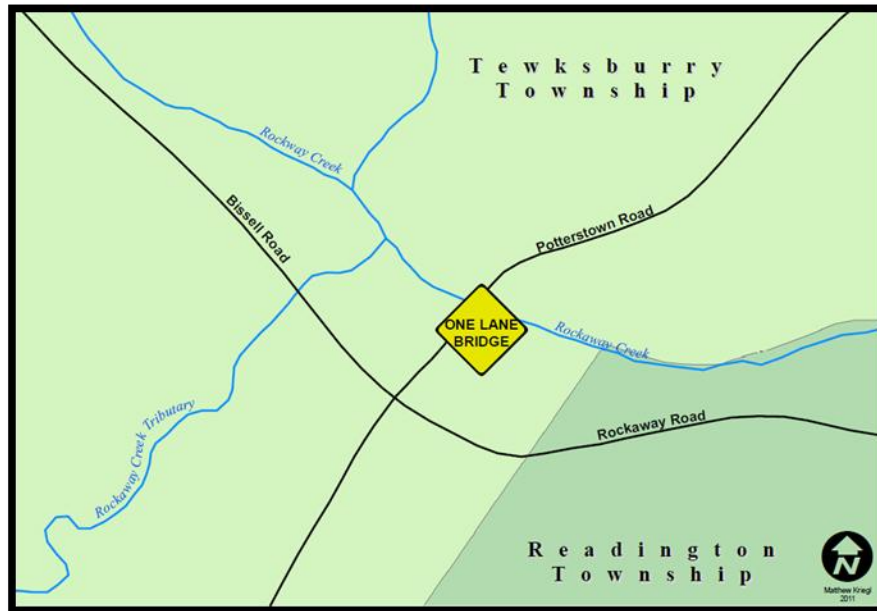


Figure 30: Location of the Potterstown Bridge.



Figure 31: Photograph of the replaced Potterstown Bridge.

Potterstown Bridge³⁷⁵

Situated in a park-like meadow setting in a lightly wooded area of rural Tewksbury Township and crossing the Rockaway Creek is the Potterstown Bridge. Major developments have been constructed in the vicinity, but none can be seen from the bridge. The bridge is also located near the nationally and locally identified Taylor's Mill Historic District (designated 1992). The current bridge completely replaces the original steel bridge constructed in 1901 by the American Bridge Company.

The 1901 bridge spanned 65 feet in length and had a width of 15.3 feet. This structure was a single-span, four-panel, Pratt half hip pony truss bridge. The bridge had been significantly altered with major modifications occurring in 1945 and 1988.³⁷⁶ Because of the alterations, the original bridge was deemed to be not eligible for listing on the National Register. The replacement bridge was completed in 2006.

By the time this bridge was slated to be replaced it had been heavily rehabilitated on four previous occasions. As a result, the original structure was hidden behind a wall of welds and patchwork repairs. This prevented engineers and inspectors from seeing the original bridge members and knowing what shape they were actually in.³⁷⁷ The bridge was deemed functionally obsolete and structurally deficient. Because of the bridge's unknown true condition, the structure was given a weight limit of 3 tons, the lowest

³⁷⁵ Potterstown Bridge is officially known as structure # 100T061 or within the county as T-61.

³⁷⁶ A.G. Lichtenstein & Associates, Inc. and the New Jersey Department of Transportation, "New Jersey Historic Bridge Data: Hunterdon County," 1994 (modified 2001) http://www.nj.gov/transportation/works/environment/pdf/Historic_BR_Hunterdon.pdf (accessed February 20, 2010), 118.

³⁷⁷ Dennis Heil and John Glynn of the Hunterdon County Department of Roads, Bridges, and Engineering, interviewed by author, Flemington, NJ, January 5, 2011.

weight restriction a bridge can have. Still, whenever cars passed over its deck, the bridge shook.

The bridge became so untrustworthy that the fire department could not travel over the bridge for fear of collapsing the structure and losing a truck. As a result, fire trucks were forced to take long detours around the weight restricted bridge, endangering people's lives.

In 2006, the entire bridge was replaced with a new truss structure that spans 65 feet, maintaining the original length, with a width of 24 feet. The design of the new bridge is similar to the original, in that it retains its single-span pony truss configuration. The new truss seems to be a variation of a Warren truss design. Although the original structure had four panels, the new bridge contains five with the center panel accented with an 'X.' In order to add a sense of historic design, latticework was installed on the verticals. In another nod to the past, a plaque was installed on the new bridge in order to commemorate the original 1901 structure built by the American Bridge Company. The total contracted cost of the replacement structure was \$681,450.³⁷⁸

This new bridge fits in its context very nicely and does not look out of place or scale. The bridge can now accommodate two lanes of traffic and is no longer weight restricted. Fire trucks and other emergency vehicles can now also safely cross the Potterstown Bridge.

³⁷⁸ Department of Roads, Bridges, and Engineering, "Project Summary: 2006" (Flemington, NJ: County of Hunterdon, 2006) <http://www.co.hunterdon.nj.us/pdf/roadsandbridges/2006RoadsBridgesSummary.pdf> (accessed February 17, 2011), 30.

Valley Station Bridge

Valley Station Road: Bethlehem Township-Warren County

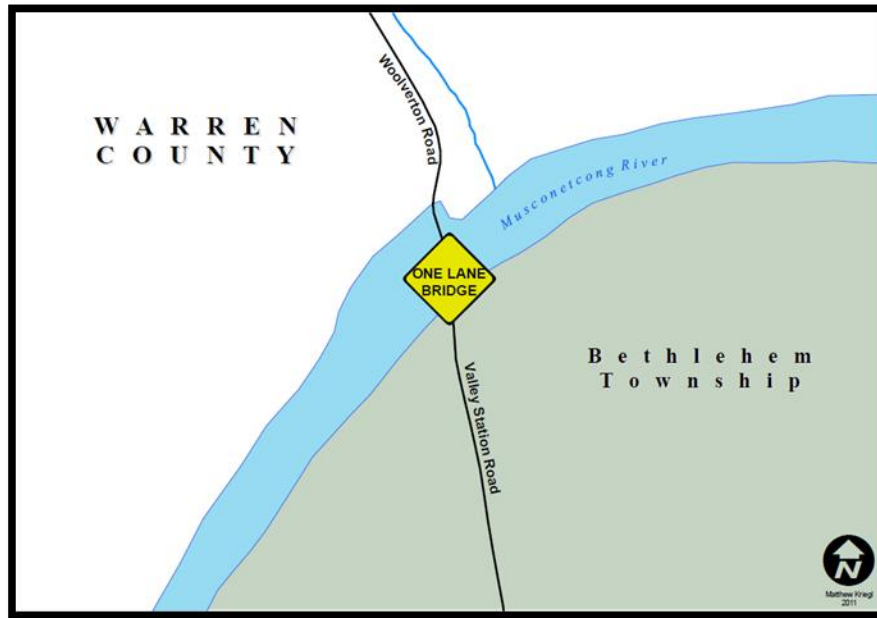


Figure 32: Location of Valley Station Bridge.



Figure 33: Photograph of the replaced Valley Station Bridge.

Valley Station Bridge³⁷⁹

Surrounded by fields and a few trees, Valley Station Bridge crosses the Musconetcong River connecting Bethlehem Township with Warren County. The surrounding rural area consists of mainly farmland and the bridge is lightly traveled. The existing bridge replaces the original 1901 steel structure.

Originally, the bridge spanned 117 feet in length with a width of 15.5 feet and was a pin-connected, Pratt half hip pony truss bridge featuring two spans, each with four panels.³⁸⁰ The bridge rested on stone abutments as well as a stone mid-stream pier, but over time portions of these abutments and pier were encased in concrete.

Major modifications in 1958 altered the bridge significantly, and later additions of safety equipment, such as guardrails and extra bracing, began to obscure the bottom half of the superstructure. By the early 2000s, portions of the bridge's superstructure were dented and bent out of shape and other visual signs of deterioration, including flaking paint and rust were evident. Because of the heavy alterations, the original bridge was deemed to be not eligible for listing on the National Register. A replacement bridge was completed in 2005.

Before the bridge was replaced, the original structure was categorized a functionally obsolete because of its narrow width and structurally deficient because of its five ton weight limit. Much of the bridge was also covered with patches, guardrails, and other welded plates, making it difficult to assess the bridge's true condition. When the

³⁷⁹ Valley Station Bridge is officially known as structure # 1000B5W or within the county as B-5W.

³⁸⁰ A.G. Lichtenstein & Associates, Inc. and the New Jersey Department of Transportation, "New Jersey Historic Bridge Data: Hunterdon County," 1994 (modified 2001) http://www.nj.gov/transportation/works/environment/pdf/Historic_BR_Hunterdon.pdf (accessed February 20, 2010), 78.

county took the bridge apart, it was evident that the correct decision was made, as many of the components were heavily corroded. The last major rehabilitation on the bridge occurred in 1958, and according to county bridge engineer Dennis Heil, the bridge should have been replaced then. But it was not, and the bridge continued to be patched for another 60 years.³⁸¹

The Valley Station replacement bridge is very similar to the New Hamden Bridge replacement structure. Like the New Hamden Bridge, this new structure is two-lanes wide and has an unrestricted weight limit. This new structure also imitates the original bridge in variety of ways, such as retaining its two-span, five-panel pony truss configuration. However, the designers of the new bridge opted once again to use a Warren truss with verticals and not the Pratt design which was present in the original structure. The stone abutments were repaired and extended as was the midstream pier to accommodate a wider bridge. The total contracted cost of the replacement structure was \$1,176,389 with Hunterdon County's cost being \$588,194, and the remainder paid by Warren County.³⁸²

Although this structure closely resembles the New Hamden Bridge replacement structure, this bridge does not look out of place. The Valley Station replacement bridge blends with the rural character of the area much better than the New Hamden Bridge. This could be because the bridge is slightly more narrow, but it is probably more likely

³⁸¹ Dennis Heil and John Glynn of the Hunterdon County Department of Roads, Bridges, and Engineering, interviewed by author, Flemington, NJ, January 5, 2011.

³⁸² Department of Roads, Bridges, and Engineering, "Road and Bridges Summary: 2005" (Flemington, NJ: County of Hunterdon, 2005) <http://www.co.hunterdon.nj.us/pdf/roadsandbridges/2005Summary.pdf> (accessed February, 17, 2011), 26.

due to the more wooded and hilly setting. Like the other new replacement bridges, all of the truss components were hot-dipped galvanized, ensuring that the bridges will remain relatively maintenance free for at least 35 years.

When it comes to the bridges in Category 3, Hunterdon County should be commended for their design of complementary bridges that are sensitive to the rural and historic context of the county.³⁸³ Although, like many local governments across the nation, they seem to have a need for wider, two-lane bridges, the county makes an effort to help retain the truss bridge tradition. It should be noted that although these are new structures, they are based on the same technology of earlier truss bridges, and designed to last as long.

Although it is unfortunate that these three original truss bridges were lost, they were replaced by bridges built in the same spirit. Hunterdon County designs bridges to last at least fifty years, and tries to build structures that will last 100 years or more.³⁸⁴ There is very little different between the old bridges lasting 100 years and the new bridges lasting 100 years. In 50 years time, these new truss bridges may be eligible for listing in the National Register. And while some the original bridges my still be around, nearing the 200 year mark, these new county bridges will be making their mark as a remnant of engineering past from the first decade of the 2000s.

³⁸³ For additional photographs of these structures, see Appendix A.

³⁸⁴ Dennis Heil and John Glynn of the Hunterdon County Department of Roads, Bridges, and Engineering, interviewed by author, Flemington, NJ, January 5, 2011.

10.0 CONCLUSION

Through an in-depth analysis of the many facets of historic bridge preservation, the challenges of retaining these structures have been shown to be great. As if the difficulties in maintaining newer portions of roads and more recently constructed bridges are not daunting enough, states and municipalities must also be able to step up and take care of the structures that they already have. The issues of safety, liability, and funding are large hurdles that must be further overcome to ensure that these historic pieces of infrastructure will be able to remain in place, as an active part of the nation's transportation network, for years and generations to come.

This thesis has uncovered four main points which pertain to the bridges of Hunterdon County but which also may be extrapolated to other communities. As it stands now, Hunterdon County does a relatively good job when trying to maintain its stock of bridges (both historic and non-historic structures). In some respects, it stands alone in this regard and has been recognized as being a leader in historic bridge preservation. Although the challenges of transportation resource preservation are ever

increasing, the county should continue to advance this preservation and maintenance practice in consultation with community members.

In addition, this thesis discovered that Hunterdon County residents place great value on these single-lane structures, not only because of their physical historic significance, but because of the connection with the past agrarian and rural way of life that seems to be quickly slipping away from the area and which is perceived to be embodied in these structures. As a third point, although some of these historic structures are being lost, their replacements are being planned and designed in the same spirit as the historic bridges that they are replacing. This will continue the practice of building truss bridges, employing newer technologies, and looking towards future development.

Fourth, the county officials and residents need to develop a type of growth management plan that will not only deal with the preservation of bridges for the bridges' sake, but a plan that could help curtail the influx of development that not only threatens these structures, but also threatens the rural atmosphere, historic fabric, and cultural characteristics of the area. This could be accomplished through wise planning decisions and policies.

10.1 Continue Preservation Practices and Community Involvement

The challenges are certainly great, especially now. Money and funding is tight. This comes at a particularly unfortunate time, a time when our infrastructure needs an infusion of money just to help it survive for another day. The nation's infrastructure, including dams, levees, bridges, roads, airports, and other structures, that we normally take for granted, is crumbling. We have let these structures languish, deferring

maintenance and patching and repairing only when absolutely necessary. This has led to a crippled patch-work system on which millions of people rely every day; from going to work to cooking dinner to watching television.

Bridges are suffering under the incessant stream of ever wider and heavier loads, while longer and wider highways are perpetually clogged with traffic. When we see these scenes of our crumbling, broken down infrastructure on the news we are horrified, but we are equally horrified at the cost of repair. There is an unfounded belief that if it costs \$3 million dollars to repair something, such as a bridge, and would cost the same \$3 million dollars to replace said structure; people tend to go with the replacement option, as though that is somehow a better deal. Is newer better? Is building a new bridge a better use of our collective tax money? In the end we will get a new bridge, but what do we lose in this process?

This belief is endemic to all forms of preservation and is not specific to transportation. However, it may be more pronounced in transportation resource preservation. As has been described above, engineers strive for the safest design possible for their projects. This of course is a noble ideal and works if nothing is in the way. But, in reality there is a natural and built environment. There are buildings and other existing structures that must be dealt with, as well as terrain. Widening and realigning roads is commonplace and generally disregards the surrounding area. Countless city blocks, neighborhoods, and bridges have been lost in this endeavor, not to mention the great environmental toll. But this does not have to be the case.

Preservationists were making great strides in arguing the case for rehabilitating historic bridges instead of replacing them during the early 2000s. Groups such as the SRI

Foundation, which “seeks to enrich society by fostering Historic Preservation,” held a conference on historic bridges, entitled *Historic Bridges: A Heritage at Risk*.³⁸⁵ During this conference, many of the nation’s top bridge researchers, historians, preservationists, engineers, and officials discussed the perilous state of these structures and developed recommendations for improving their situation. In addition, the American Society of Civil Engineers (ASCE) submitted a letter during this conference that affirmed their wholehearted commitment towards the retention of historic bridges.³⁸⁶ It was also during this time AASHTO and the NCHRP began researching historic bridges for their reports, the “Guidelines for Historic Bridge Rehabilitation and Replacement” and “Cost-Effective Practices for Off-System and Local Interest Bridges” respectively. Things began to look up. After decades of neglect and replacement, the nation’s stock of historic bridges was decimated. Was this to be a potential turning point?

Unfortunately, the answer was no. In 2007, the tragic collapse of the I-35 Bridge in Minneapolis refocused attention to our aging infrastructure, and particularly on bridges. States scrambled to re-inspect and reevaluate their bridges’ conditions in an effort to quell public concern and their own liability. To make matters worse, the economy began to collapse and in an effort to try and save jobs, the federal government began doling out billions of dollars through the American Recovery & Reinvestment Act (ARRA). Much of this money was being handed out to fund numerous transportation

³⁸⁵ SRI Foundation, “Homepage,” <http://www.srifoundation.org/> (accessed March 28, 2011).

³⁸⁶ Eric DeLony and Terry H. Klein, “Historic Bridges: A Heritage at Risk; A Report on a Workshop on the Preservation and Management of Historic Bridges,” (Rio Rancho, NM: SRI Foundation, 2004), 25.

projects at a time when national focus was on the deleterious condition of the nation's bridges.

As a result, state and local governments swiftly replaced numerous historic bridges because they were deemed to be inadequate and unfit for continued use. This is not to say all the money was spent on ripping apart the historic transportation fabric. As cash strapped states not only sought to replace its deficient structures, but also to repair and rehabilitate its historic bridges, millions of dollars were spent on preservation efforts.

Despite the great number of logistical challenges, there are also preservation challenges that plague historic bridge preservation. The NCHRP report, "Cost-Effective Practices for Off-System and Local Interest Bridges" states that "Historic bridges are one of the most challenging aspects of bridge rehabilitation and replacement."³⁸⁷ This challenge is even greater with single-lane bridges. Although becoming more flexible, modern road design guidelines tend to inhibit the preservation of these narrow structures, and are geared towards their replacement. In addition, Eric DeLony, in his article, "Save Our Span!," notes that "highway departments receive federal and state funding earmarked specifically for bridge replacement but little maintenance money that would extend the use of historic bridges."³⁸⁸ This goes back to the belief that newer is better.

Hunterdon County, however, stayed the course. There was not a need here to replace insufficient bridges, but to continue maintaining them. Strong community

³⁸⁷ National Cooperative Highway Research Program, *Cost-Effective Practices for Off-System and Local Interest Bridges* (Washington, D.C.: Transportation Research Board, 2004), 113.

³⁸⁸ Susan M. Zacher, "Driving a Call to Action for Pennsylvania's Historic Bridges," *Pennsylvania Heritage* 35, no. 1 (2009): 34.

opposition to bridge replacement has allowed county engineers to foresee future design and logistical issues before they ever come to the table. This is not to say that there are not problems or issues that arise. Sometimes community wants and desires are not justifiable or realistic. On the other side, at times, the same can be said about county decisions and plans. In order to resolve these conflicts a balance must be struck between the realistic wants and needs of both the community residents and county officials.

Hunterdon County engineers have continued to consistently design contextually sensitive replacement bridges and perform historically sensitive repairs and rehabilitations. This is important. It helps define the county and the communities located within it. The case studies have shown that sincere efforts are made by county engineers to retain historic and cultural fabric while allowing members of the community to have a strong input in what happens. Everyone has a stake in preservation. Although the bridges are owned by the county, who is charged with maintaining them and ensuring their safety, they truly belong to the people of the county. These structures are public property and the decisions that are made by the county not only affect the structures themselves, but the surrounding community as well.

The most important lesson that should be better understood when it comes to bridge preservation is balance. There needs to be balance between the goals of safely designing roads and bridges, the goals of historic preservation, and the goals of the county and residents.

Like many things, this is double-edged and can be interpreted in different ways. For example, the county claims that single-lane bridges are a safety hazard because of their alignment and narrowness. Local residents contend, that for those very same

reasons, these structures prevent cars from excessively speeding and act as a traffic calming device—in effect creating safer driving conditions. DeLony points to this as well, “Interestingly enough, residents increasingly want traffic-calming projects, reduced speed limits, and retention of narrower roads and bridges, to limit the speed and size of vehicles in their communities.”³⁸⁹

The case studies show that the county performs diligently when dealing with historic structures. The incident involving the Hamden Fink Truss Bridge from the 1970s and the ongoing situation with the White Bridge underscore the necessity for retaining an area’s historic and cultural fabric and the importance of public participation. Once again, DeLony strongly agrees. He states, “Experience has proven that historic bridges can only be save when someone cares about them.”³⁹⁰ Things are not going to fix themselves. In an absolute sense, road engineers would design everything to be as wide and as flat and as straight as they can; preservationists would save every building and structure. These two ideals are not compatible. Therefore a compromise must be made between them, a balance. This will only happen successfully when the community is actively involved.

In addition, the community has a certain attachment to these inanimate objects, both old and new. In this vein, the community fully embraces its bridges. During the holidays, decorations are hung on bridges around the county and flags are commonly seen on these structures throughout the year.

Of note are flower baskets that hang from the trusses of numerous bridges throughout the county. This is evidence of community pride in these structures, as

³⁸⁹ Susan M. Zacher, “Driving a Call to Action for Pennsylvania’s Historic Bridges,” *Pennsylvania Heritage* 35, no. 1 (2009): 34.

³⁹⁰ Ibid.

someone must tend to these plants to ensure their survival. In fact, at a meeting about the fate of the White Bridge, the director of the Hunterdon County Department of Roads, Bridges, and Engineering was asked about whether the new bridge was designed to have hooks so that flowers may be hung from the trusses. The director responded by saying, “bridges are personal to the people that use it.”³⁹¹ Additionally, during an interview, referring to a different bridge, Dennis Heil noted, “If they want to doll it up, be our guest.”³⁹² This too, shows an active understanding in the community’s stake in county bridge projects.

10.2 Preserve Community Pride and Rural Atmosphere

The White Bridge controversy may not end the way that many residents feel is acceptable, but they should not be discouraged. What they have accomplished for more than a decade is productive conversation with county engineers who will now take the lessons learned during this project and apply them to future ones. The community has also forced concessions from the county’s original ideas and designs and will get a narrower two-lane bridge designed to “act” as a single-lane bridge.

Community pride plays a big role in all types of preservation. In the case studies on Hunterdon County’s bridges, an understanding between the community and the engineers allows bridges to be maintained rather than replaced. There are of course exceptions, and sometimes structures must be replaced. However, the county generally tries to retain the character of its bridges. This can be seen in one of two ways, the first

³⁹¹ Warren Cooper, “White-Bridge Group Loses 1-Lane Battle,” *Hunterdon County Democrat* (Flemington, NJ), July 16, 2009.

³⁹² Dennis Heil and John Glynn of the Hunterdon County Department of Roads, Bridges, and Engineering, interviewed by author, Flemington, NJ, January 5, 2011..

being that the county is performing minimalist alterations to these structures because it is the will of the people that these historic bridges be retained, or that it is simply cheaper for the county to do minor maintenance work on a regular basis than it is to replace a bridge. In fact, historically, Hunterdon County has frequently chosen to strengthen existing metal bridges rather than construct new structures.³⁹³

No matter the reason, the end result is a spectacular collection of bridges. It should be emphasized that this does not only apply to officially historic bridges (those listed or eligible to be listed in the National Register) or to a particular type of bridge (arch, truss, etc.). As can be seen in the case studies, all bridges are generally treated in the same manner, although listed or eligible bridges are more highly regarded and are generally not replaced. Many of these bridges are additionally located in rural settings with little traffic, a fact which has also helps contribute to their preservation.

However, it seems that the truss structure and design is what is most important to the community. Moreover, it is the way the structure looks and functions rather than its actual historic significance. The White Bridge controversy is a case in point. This is not the original bridge, and in fact, is a bridge moved to that location from somewhere else. Yet the charm of having an “historic” bridge facilitates strong community backing in the “local history” of the area.

³⁹³ A.G. Lichtenstein & Associates, Inc, *The New Jersey Historic Bridge Survey*, (1994) http://www.nj.gov/transportation/works/environment/pdf/Survey_Doc.pdf (accessed February 20, 2010), 174.

But, if this is true, and historic significance is not the most important feature of these “historic” structures, then why are community members so adamant about keeping single-lane bridges?

New Jersey is a treasure trove of bridges, and they are coming under increasing attack. This is a result of not, only government policies or funding concerns but suburbanization. Historic preservation has often been described as anti-progress. These bridges are the literal embodiment of that statement. These are not houses blocking a development site from the construction of a new gleaming skyscraper. These bridges physically and literally block the flow of traffic, preventing, or significantly lowering, people’s ability to flow freely, thereby preventing, or slowing, actual progress.

Single-lane bridges do act as a block to progress by restricting the flow of people into an area. Some of the avid preservation efforts of single-lane bridges have to do with history, historic integrity, and the past, but much of it has to do with the future. No one is trying to prevent farmers or emergency vehicles from being able to safely cross the bridge. No one is arguing that the bridge not be repaired, maintained, or even replaced. The issue is that the residents do not want the bridge replaced by a modern two-lane structure. They want to keep the rural feel and character of the area. They want to preserve Hunterdon County’s rural community feel.

They feel that they are being misplaced by newcomers who arrive from cities, expecting all kinds of amenities, like wide road, street lights, and traffic signals. In essence, these newcomers leave more urban areas to escape to the country, only to bring, or expect, the urban environment with them, transforming sleepy towns into strip malls and highways. These folks do not want to take a 35-mph drive along a windy road

following a river, only to go even slower, or stop, in order to cross a single-lane bridge, wearily looking for potential oncoming traffic. They want to speed along new short cuts they found through the woods. Through routes that are half the distance but also half the speed, something that can be easily be compensated for when going twice the posted limit, roaring over wider bridges that have acted as choke points in the past. “We have the belief, you build it, they will come,” asserted Hunterdon County resident Kimberlee Goodwin.³⁹⁴ “How far do we go to allow people to ruin our county?”³⁹⁵

Yes, history too plays a large role in all of this. Hunterdon County began as a collection of rural farming communities, and because of being just far enough from the grasp of New York City and Philadelphia, has effectively preserved this rural charter—until now. Now, with better highway access and faster and more fuel efficient cars, this area is under assault. Not to say that there are no policy problems to blame. Communities trying to attract new residents have allowed developments to spring up around every bend, increasing traffic on roads barely traveled just five, ten, or twenty years ago.

Fast drivers, recklessly ignoring weight and speed limits crash into these structures; severely damaging, the bridge, their car, and sometimes themselves, because of our fast paced mode of modern living. Historic single-lane bridges slow this pace down. Back to a time when hay wagons and horses slowly trotted across these bridges, under the penalty of a fine. The bridges are important historic reminders of transportation evolution of how rural communities were connected to their city markets.

³⁹⁴ Warren Cooper, “White-Bridge Group Loses 1-Lane Battle,” *Hunterdon County Democrat* (Flemington, NJ), July 16, 2009.

³⁹⁵ Ibid.

Some bridges are intricately designed and are and considered something akin to a work of art, with their metal bracing, latticework, and tracery.

They represent a time when rural life was slower paced, and seemingly more simple. A time when the sound of water flowing under a bridge was not muffled by the sound of a car engine roaring down the road. A time that can only really be reenacted by walking along old country roads and crossing the bridge by foot, hearing the sounds of nature: bugs in the grass, wind in the trees, and water flowing below, only to have this contemplative moment dashed by the sound of a an approaching car. A time when neighbors talked to and trusted one another, not sitting solitarily in their oversized, out-of-scale house, complete with their three car garage, five cars, and un-landscaped, barren front yard. A time when the schools were not crowded, the streets were not crowded, and people were more respectful. This is what these bridges truly represent in both form and function. They represent the past and they embody the past. They give hope for the future, allowing a single generation to hang on just a bit longer to a way of life and character stretching back over 300 years. This is what is really trying to be preserved. It is not the bridges' purely historic connotations, but the connections that these structures embody, a dimly lit ember of the past, just barely able to hang on. These bridges represent a reprieve from rampant development, a breath of fresh air, and long ago memories just out of reach.

Much of this is romanticized of course, but there is still meaning. The county argues that this is not totally true and other people agree. But it is hard to imagine how a rural way of life and character could be sustained with wider roads, wider bridges, and other more 'modern' improvements that, by their very existence, invalidate the very

meaning of rural. A rural farming community does not consist of wide roads, ultra-modern bridges, and cars frantically speeding around from place to place. A rural farming community runs at a slower pace, with winding roads, old buildings, and bridges that time passed by.

All of these issues and feelings are touched upon in numerous letters to the editor concerning the replacement of the White Bridge. Over and over again, community members lament the passing of the rural farmscape, claiming, as resident John Drwal does, that this “simply is an issue of respecting the voice of a community and preserving one of the last rural areas of the state.”³⁹⁶ Drwal continues by stating “to preserve this quiet rural community there is really only one option, a one-lane bridge. Proposed speed bumps and signage to slow down traffic once the two-lane bridge is up can be changed by law over time. Only a one-lane bridge preserves this rural country road.”³⁹⁷

And yes, there are detractors too. Craig Turpin asks in a letter to the editor “who living in the 21st century would argue against the construction of a two-lane bridge?”³⁹⁸ He continues by claiming “it’s been argued that it would destroy the bucolic nature of the area. Any bridge does that!”³⁹⁹ “The real objection to the two-lane bridge,” he claims, “is the same for any other development in the area. It’s a vote against more people and growth of any kind. Make it too easy to drive here and more people will come. Make it too easy to build here and you’ll have too many neighbors. It’s a variation of NIMBY [Not

³⁹⁶ John Drwal (letter to the editor), “Do the right thing,” *Hunterdon County Democrat* (Flemington, NJ), May 28, 2009.

³⁹⁷ Ibid.

³⁹⁸ Craig Turpin, (letter to the editor), “He can’t escape from illogical views,” *NJ.com*, July, 9, 2009.

³⁹⁹ Ibid.

In My BackYard] thinking and it's widespread in Hunterdon. Bridges and roads are here for the common good and they should not be subject to the least development common denominator.”⁴⁰⁰

“Everything has a cost attached,” counters resident Brenda Sozanski, a lifelong resident of Hunterdon County who lives along White Bridge Road.⁴⁰¹ She notes that she will retain her “fond memories of the small country road and bridge,” but wonders “about the future of our youth and their memories. Yes,” she concedes, “change needs to happen, but at whose expense?”⁴⁰²

Resident Larry Potter best sums up the feelings of the community when he notes that preserving the existing structure would be in the “best interest of our community spirit, safety and good planning.”⁴⁰³ He then continues, stating that, “Our local bridges are the only public architecture we have that that connect to our past. White Bridge is one of a handful of local landmarks that give our town a singular identity. No, it's not state-of-the-art engineering; but every day it embodies local spirit by silently speaking to those who have lived before us.”⁴⁰⁴

10.3 Preserve the Spirit of Bridge Building

These bridges serve as a valuable connection to the past, not only in an engineering sense, but, in a cultural sense. Much has been written on the techniques

⁴⁰⁰ Ibid.

⁴⁰¹ Brenda Sozanski (letter to the editor), “Free money isn’t free,” *Hunterdon County Democrat* (Flemington, NJ), June 11, 2009.

⁴⁰² Ibid.

⁴⁰³ Larry Potter (letter to the editor), “Wants one-lane bridge,” *Hunterdon County Democrat* (Flemington, NJ), May, 21, 2009.

⁴⁰⁴ Ibid.

necessary for proper preservation, but less attention has been focused on the important cultural implication the loss of these structures pose.

In Hunterdon County, this is believed to be the abolition of community identity. A rural outpost under siege by modern encroachment, Hunterdon County seeks to place its collective rural history into these historic structures. The residents believe, earnestly, that this is the solution. That no matter how many housing developments are built and no matter how many people move in, everyone must stop at a single-lane bridge and check for oncoming traffic. Everyone must slow down around the sharp approach to the bridge.

While all the techniques discussed here are actively used or have been considered by Hunterdon County, there is an interesting question that should be posed. DeLony notes that, “lack of planning, and the replacement of historic bridges all contribute to a loss of character and undeniable sense of place.”⁴⁰⁵ But, if the preservation of historic bridges in Hunterdon County is not only about the actual structure, but the role that structure plays in retaining the historic atmosphere, could properly designed replacement bridges be an adequate, if not appropriate, solution that will be able to retain both these cultural and historic attributes?

Building bridges was, and remains, incredibly speculative. When many of the bridges examined in this thesis were built, in the late 1800 and early 1900s, the builders designed them anticipating future growth. They had to. Bridges are expensive to build today and they were expensive to build 100 years ago. This is why they were designed to

⁴⁰⁵ Susan M. Zacher, “Driving a Call to Action for Pennsylvania’s Historic Bridges,” *Pennsylvania Heritage* 35, no. 1 (2009): 34.

last 100 years. This is also why there are such mammoth bridges scattered across the countryside. Has anything really changed?

New bridges are built in the same spirit for the same reason. Bridges today are designed to long outlast the people who design and construct them. The average age of bridges in New Jersey is 50-75 years old. It is pretty impressive that these structures are still around, even more so for structures built over 100 years ago, in a time when cars were not even invented, these bridges were build so soundly that we are able, with very little modification, still use them today. Modern engineers look at bridges the same way today. Local communities and governments have limited funds. A new bridge costs anywhere between \$1.5 million to \$3 million or more. These are huge expenses especially for rural areas. As a result, bridges are designed to last a long time because \$3 million is not that much money when spread over 100 or more years.

This is another reason why maintenance is so important. Many of Hunterdon County's new bridges are hot-dipped galvanized, meaning that they do not need to be repainted for at least 35 years.⁴⁰⁶ This cuts down on maintenance costs. This is not to say that all functionally obsolete or structurally deficient bridges should be demolished and replaced with new structures, but it does mean that another look should be taken at local rural bridges. In a way, Hunterdon County is simply continuing a tradition of metal truss bridge construction and should not be chastised every time a bridge is lost at the hands of county engineers.

⁴⁰⁶ Dennis Heil and John Glynn of the Hunterdon County Department of Roads, Bridges, and Engineering, interviewed by author, Flemington, NJ, January 5, 2011.

This also does not mean that the county should not cherish and respect the historic bridges that it possesses. Like everything else, a balance must be made between original historic fabric and new (or future) historic fabric. Once a historic bridge is demolished, it can never be put back and a part of history is lost forever. But the preservation of history or culture should not come before the safety of people and so when a legitimate safety concern arises in a bridge it should be dealt with appropriately. If this means the bridge must be replaced, then the structure that replaces it should emulate and respect the character and culture of the past, present, and future, because this new structure will be around for a long time.

10.4 Manage Development

The article “Misunderstanding Historic Preservation,” by Johanna Hoffman, writing for the non-profit organization Next American City, “excellently points out, that historic preservation and preservationists should not be about preventing development and progress (as is commonly thought), but should actively find ways to better manage it.”⁴⁰⁷ In this way, progress towards the future can be better balance with the history of the past. This is the lesson that should ultimately be learned. That in looking to the past, a clearer path to the future emerges. The unknown needs for the future should be secured in the known footings of the past.

It is only through proper and wise planning that a rural landscape can be retained.

It is true that single-lane bridges slow progress and even can prevent it for some time.

⁴⁰⁷ Johanna Hoffman, “Misunderstanding Historic Preservation,” Next American City, http://americancity.org/buzz/entry/2936/?sms_ss=facebook&at_xt=4d8355a5d8441e94%2C0 (accessed March 18, 2011).

But in the end, it is appropriate planning that would have barred the need for bridges to become choke points to development in the first place. With proper planning, these bridges would have been more than sufficient to handle the low volumes of traffic. Management of future progress is imperative in maintaining the cultural and historic characteristics that these single-lane bridges currently represent and will also be the determinate for what new bridges are to be built in the future.

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Appendix A

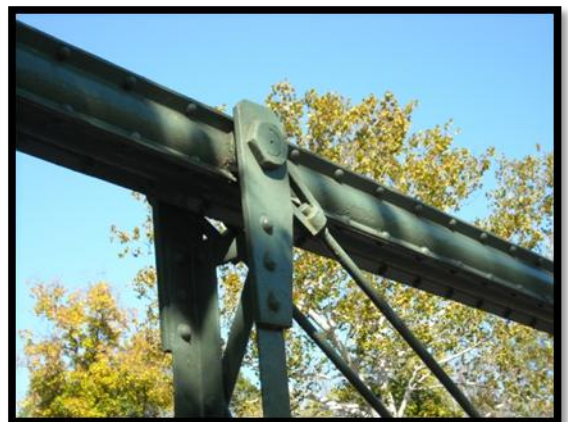
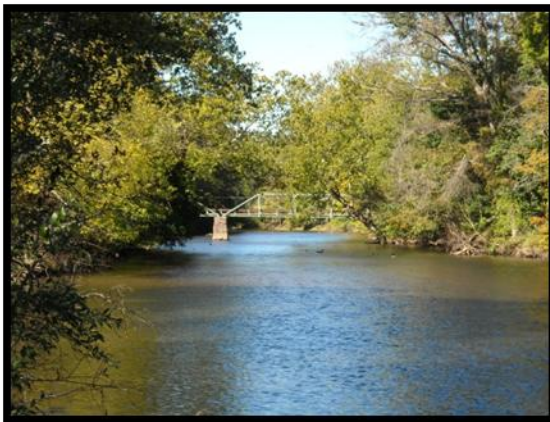
Additional Photographs

Appendix A: Additional Photographs

Hollow Brook Bridge



Old Hamden Bridge



Appendix A: Additional Photographs

Old Hamden Bridge (continued)



Appendix A: Additional Photographs

Lower Lansdowne Bridge



Appendix A: Additional Photographs

Rosemont-Raven Rock Bridge



Appendix A: Additional Photographs

Rosemont-Raven Rock Bridge (continued)



Appendix A: Additional Photographs

Stanton Station Bridge

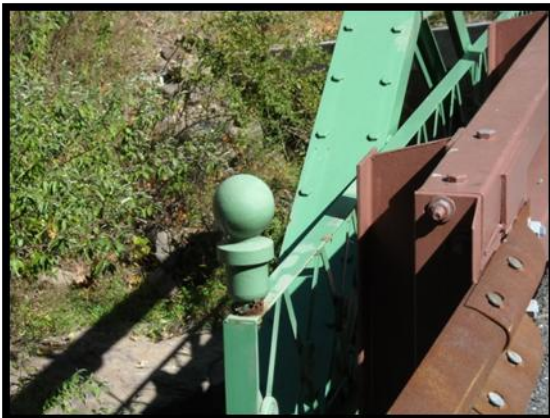


Appendix A: Additional Photographs

Stanton Station Bridge (continued)



Locktown-Flemington Bridge



Appendix A: Additional Photographs

Locktown-Flemington Bridge (continued)



Pine Hill Bridge



Appendix A: Additional Photographs

Pine Hill Bridge (continued)



York Street Bridge



Appendix A: Additional Photographs

York Street Bridge (continued)



Appendix A: Additional Photographs

Maintenance Repairs

York Street over Hakihoake Creek

Structure No. 1000-096 (M-94)

Completed: June 30, 2008 J. Srubjan / L. Bonham

June 30, 2008



West approach looking east



East approach looking west

Appendix A: Additional Photographs



Upstream looking south



Downstream looking north



Reconstruct west abutment, rip-rap south west stream bank stabilization.



General view of west abutment.

Appendix A: Additional Photographs



General view of underside of deck and west abutment.



General view of east abutment.

Appendix A: Additional Photographs



General view of north west rail.



General view of south east wing wall.

Photographs and information of the Maintenance Repairs of the York Street Bridge were supplied by the Hunterdon County Department of Roads, Bridges, and Engineering, Flemington, NJ.

Appendix A: Additional Photographs

White Bridge



Appendix A: Additional Photographs

New Hamden Bridge (replacement structure)

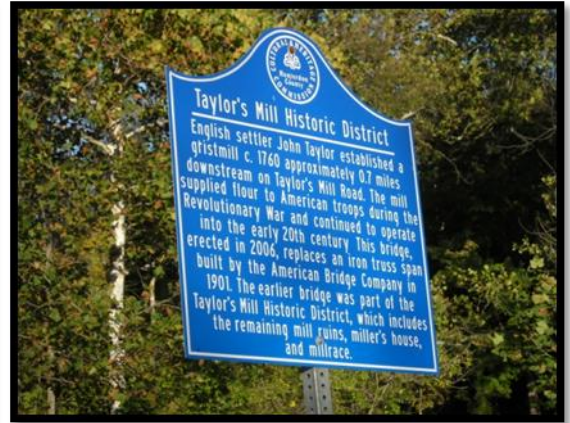


Potterstown Bridge (replacement structure)



Appendix A: Additional Photographs

Potterstown Bridge (replacement structure (continued))



Hunterdon County and Tewksbury Township dedication and opening ceremony of the replacement Potterstown Bridge.

Photograph: Hunterdon County Department of Roads, Bridges, and Engineering

Appendix A: Additional Photographs

Valley Station Bridge (replacement structure)



Hamden Fink Truss Bridge (collapsed)

Photographs courtesy of the Hunterdon County Department of Roads, Bridges, and Engineering



Appendix B

Bridge and Engineering Terms

Appendix B: Bridge and Engineering Definitions and Terms

Abutment-

Part of a structure which supports the end of a span or accepts the thrust of an arch; often supports and retains the approach embankment.

Alignment-

A ground plan of a railway or road. How a bridge layout interacts with the road configuration.

Anchor span-

Located at the outermost end, it counterbalances the arm of span extending in the opposite direction from a major point of support. Often attached to an abutment.

Anchorage-

Located at the outermost ends, the part of a suspension bridge to which the cables are attached. Similar in location to an abutment of a beam bridge.

Approach-

The course of the road or area located prior to entering or exiting the deck of the bridge.

Approach span-

A term to designate the spans located on either side of the main span; see main span.

Arch-

A curved structure which supports a vertical load mainly by axial compression.

Arch barrel-

The inner surface of an arch extending the full width of the structure.

Arch ring-

An outer course of stone forming the arch. Made of a series of **voussoirs**. An archivolt is an arch ring with decorating moldings.

Ballustrade-

A decorative railing, especially one constructed of concrete or stone, including the top and bottom rail and the vertical supports called ballusters. May also include larger vertical supports called **stanchions**.

Baltimore truss-

A subdivided Pratt truss commonly constructed for the Baltimore and Ohio Railroad. It has angled end posts and a top chord which is straight and horizontal. Compare to **camelback truss** and **Pennsylvania truss**.

Beam-

A horizontal structure member supporting vertical loads by resisting bending. A girder is a larger beam, especially when made of multiple plates. Deeper, longer members are created by using trusses.

Bearing-

A device at the ends of beams which is placed on top of a pier or abutment. The ends of the beam rest on the bearing.

Bent-

Part of a bridge substructure. A rigid frame commonly made of reinforced concrete or steel which supports a vertical load and is placed transverse to the length of a structure. Bents are commonly used to support beams and girders. An **end bent** is the supporting frame forming part of an abutment.

Each vertical member of a bent may be called a **column**, **pier**, or **pile**. The horizontal member resting on top of the columns is a **bent cap**. The columns stand on top of some type of foundation or footer which is usually hidden below grade.

A bent commonly has at least two or more vertical supports. Another term used to describe a bent is **capped pile pier**. A support having a single column with bent cap is sometimes called a "**hammerhead**" pier.

Bowstring truss-

A truss having a curved top chord and straight bottom chord meeting at each end.

Box girder-

A steel beam built-up from many shapes to form a hollow cross-section.

Brace-ribbed arch (trussed arch)-

An arch with parallel chords connected by open webbing.

Bridge-

A raised structure built to carry vehicles or pedestrians over an obstacle.

Buttress

A wall projecting perpendicularly from another wall which prevents its outward movement. Usually wider at its base and tapering toward the top.

Cable-

Part of a suspension bridge extending from an anchorage over the tops of the towers and down to the opposite anchorage. Suspenders or hangers are attached along its length to support the deck.

Cable-stayed bridge-

A variation of suspension bridge in which the tension members extend from one or more towers at varying angles to carry the deck. Allowing much more freedom in design form, this type does not use cables draped over towers, nor the anchorages at each end, as in a traditional suspension bridge.

Camber-

A positive, upward curve built into a beam which compensates for some of the vertical load and anticipated deflection.

Camelback truss

A truss having a curved top chord and straight bottom chord meeting at each end, especially when there are more than one used end to end. Compare to **Baltimore truss** and **Pennsylvania truss**.

Cantilever-

A structural member which projects beyond a supporting column or wall and is counterbalanced and/or supported at only one end.

Appendix B: Bridge and Engineering Definitions and Terms

Centering-

Temporary structure or falsework supporting an arch during construction.

Chord-

Either of the two principal members of a truss extending from end to end, connected by web members.

Compression-

A type of stress involving pressing together. It tends to shorten a member (the opposite of tension). Stress characterized by pressing together.

Column-

A vertical structural member used to support compressive loads. Also see **pier** and **pile**.

Continuous span-

A superstructure which extends as one piece over multiple supports.

Corbelled arch-

Masonry built over an opening by progressively overlapping the courses from each side until they meet at the top center. Not a true arch as the structure relies on strictly vertical compression, not axial compression.

Counter-

A truss web member which functions only when a structure is partially loaded.

Covered bridge-

An overhead truss system, primarily of timber, clad with wood sheathing and a roof to protect the wood superstructure/truss from the elements.

Cripple-

A structural member which does not extend the full height of others around it and does not carry as much load.

Crown-

On road surfaces, where the center is the highest point and the surface slopes downward in opposite directions, assisting in drainage. Also a point at the top of an arch.

Culvert-

A drain, pipe or channel which allows water to pass under a road, railroad or embankment.

Dead load-

The weight of the structure itself, independent of traffic or the environment, which must be supported by the structure. Compare to live load.

Deck-

The top surface of a bridge which carries the traffic.

Deck truss-

A truss which carries its deck on its top chord. Compare to **pony truss** and **through truss**.

Appendix B: Bridge and Engineering Definitions and Terms

Deflection-

The perpendicular distance a beam bends from straight, due to load and span.

Elliptical arch-

An arch formed by multiple arcs each of which is drawn from its own center. Compare to a roman arch which is a semi-circular arc drawn from a single centerpoint.

Embankment-

Angled grading of the ground.

End post-

The outwardmost vertical or angled compression member of a truss.

Expansion joint-

A meeting point between two parts of a structure which is designed to allow for movement of the parts due to thermal or moisture factors while protecting the parts from damage. Commonly visible on a bridge deck as a hinged or movable connection.

Extrados-

The outer exposed curve of an arch; defines the lower arc of a spandrel.

Eye bar-

A structural member having a long body and an enlarged head at each end. Each head has a hole through which a pin is inserted to connect to other members.

Falsework-

Temporary structure used as support during construction. Falsework for arch construction is called "centering."

Fill-

Earth, stone or other material used to raise the ground level, form an embankment or fill the inside of an abutment, pier or closed spandrel.

Finial-

A sculpted decorative element placed at the top of a spire or highpoint of a structure.

Fixed arch-

A structure anchored in its position. Compare to **hinged arch**.

Floor beam-

Horizontal members which are placed transversely to the major beams, girders, or trusses; used to support the deck.

Footing-

The enlarged lower portion of the substructure or foundation which rests directly on the soil, bedrock, or piles; usually below grade and not visible.

Force-

External influence on an object which tends to produce a change in its shape or causes movement.

Appendix B: Bridge and Engineering Definitions and Terms

Gabion-

A galvanized wire box filled with stones used to form an abutment or retaining wall.

Geometrics-

The characteristics and features of road and bridge design.

Girder-

A horizontal structure member supporting vertical loads by resisting bending. A girder is a larger beam, especially when made of multiple metal plates. The plates are usually riveted or welded together.

Grade separation-

A crossing of two highways, or a highway and a railroad, at different levels. The bridge that spans highways or railroad tracks (as in an overpass) is a grade separation structure.

Gusset plate-

A metal plate used to unite multiple structural members of a truss.

Half-hipped (Pratt)-

A Pratt with inclined end posts that do not horizontally extend the length of a full panel.

Haunch-

The enlarged part of a beam near its supported ends which results in increased strength; visible as the curved or angled bottom edge of a beam.

Hinged arch-

A two-hinged arch is supported by a pinned connection at each end. A three-hinged arch also includes a third pinned connection at the crown of the arch near the middle of a span. Compare to **fixed arch**.

Howe truss-

A type of truss in which vertical web members are in tension and diagonal web members in compression. Maybe be recognized by diagonal members which appear to form an "A" shape (without the crossbar) toward the center of the truss when viewed in profile. Compare to **Pratt truss** and **Warren truss**.

Humpback-

A description of the sideview of a bridge having relatively steep approach embankments leading to the bridge deck.

Impost-

The surface which receives the vertical weight at the bottom of an arch.

Intrados-

The interior arc of an arch.

Appendix B: Bridge and Engineering Definitions and Terms

Jersey barrier-

A low, reinforced concrete wall wider at the base, tapering vertically to near mid-height, then continuing straight up to its top. The shape is designed to direct automotive traffic back toward its own lane of travel and prevent crossing of a median or leaving the roadway. Commonly used on new and reconstructed bridges in place of decorative ballustrades, railings or parapets.

Keystone-

The uppermost wedge-shaped voussoir at the crown of an arch which locks the other voussoirs into place.

King Truss-

Two triangular shapes sharing a common center vertical member (king post); the simplest triangular truss system. Compare to **queen truss**.

Knee brace-

Additional support connecting the deck with the main beam which keep the beam from buckling outward. Commonly made from plates and angles.

Lag-

Crosspieces used to connect the ribs in centering.

Lateral bracing-

Members used to stabilize a structure by introducing diagonal connections.

Lattice-

An assembly of smaller pieces arranged in a gridlike pattern; sometimes used a decorative element or to form a truss of primarily diagonal members.

Lenticular truss-

A truss which uses curved top and bottom chords placed opposite one another to form a lens shape. The chords are connected by additional truss web members.

Live load-

The dynamic or moving weight, such as traffic, carried by a structure. Compare to **dead load**.

Load-

Weight distribution through a structure.

Low truss-

A truss that carries its traffic near its top chord but not low enough to allow cross bracing between the parallel top chords. The roadway is located between the load-carrying members. This arrangement is also called a pony truss.

Main span-

Longest span in the structure (can be simple or continuous support system).

Member-

One of many parts of a structure, especially one of the parts of a truss.

Moment-

The tendency of a force to cause a rotating motion.

Overhead truss-

In an overhead truss the roadway is located under and between the load-carrying members with traffic traveling through the truss. An overhead truss features lateral-bracing between the top chords over the deck. Also referred to as a through truss.

Parabola-

A form of arch defined by a moving point which remains equidistant from a fixed point inside the arch and a moving point along a line. This shape when inverted into an arch structure results in a form which allows equal vertical loading along its length.

Parallel-

Positioning of a member so that it is aligned with another in such a way that if extended the two members would not meet. Compare to **perpendicular** and **transverse**.

Parapet-

A low wall along the outside edge of a bridge deck used to protect vehicles and pedestrians.

Pennsylvania truss-

A subdivided Pratt truss invented for use by the Pennsylvania Railroad. The Pennsylvania truss is similar in bracing to a Baltimore truss, but the former has a camelback profile while the latter has angled end posts only, leaving the upper chord straight and horizontal. Compare to **camelback truss** and **Baltimore truss**.

Perpendicular-

Positioning of a member so that it projects out from or crosses another at a right angle. Compare to **parallel** and **transverse**.

Phoenix column-

Developed in 1864 by David Reeves at the Phoenixville Iron Company in Phoenixville, Pennsylvania. It is comprised of multiple (usually no less than four) cylindrical wrought-iron hollow segments that, when fastened together, possesses great compressive strength and is relatively light in weight (as compared to a solid wrought-iron column).

Pier-

A vertical structure which supports the ends of a multi-span superstructure at a location between abutments. Also see **column** and **pile**.

Pile-

A long column driven deep into the ground to form part of a foundation or substructure. Also see **column** and **pier**.

Pin-

A cylindrical bar which is used to connect various members of a truss; such as those inserted through the holes of a meeting pair of eyebars.

Pinned connections-

A connection type where a cylindrical bar is used to connect various members of a truss; such as those inserted through the holes of a meeting pair of eyebars. Introduced in the 1840s, pin connections are the earliest connection type and were commonly used for trusses built before 1910s. Pin connections allowed for easier erection of bridges, much of which could be completed offsite. Pin connections remained popular until the end of the nineteenth century when they were replaced by riveted connections.

Pony truss-

A truss which carries its traffic near its top chord but not low enough to allow crossbracing between the parallel top chords. Compare to **deck truss** and **through truss**.

Portal-

The opening at the ends of a **through truss** with forms the entrance. Also the open entrance of a tunnel.

Post-

One of the vertical compression members of a truss which is perpendicular to the bottom chord.

Posttension-

A type of **Prestressing** in which reinforcing tendons are fed through tubes which are covered by concrete poured into the form. Once the concrete cures and the forms are removed, the tendon is clamped on one end and jacked tighter on the other until the required tension is achieved. This produces a reinforced concrete beam with a positive camber which is able to withstand greater loads without deflection as compared to unreinforced beams of similar dimensions. Compare to **pretension**.

Pratt truss-

A type of truss in which vertical web members are in compression and diagonal web members in tension. Many possible configurations include pitched, flat, or camelback top chords. May be recognized by diagonal members which appear to form a "V" shape toward the center of the truss when viewed in profile. Variations include the **Baltimore truss** and **Pennsylvania truss**. Compare to **Warren truss** and **Howe truss**.

Prestressing-

Methods of increasing the load bearing capacity of concrete by applying increased tension on steel tendons or bars inside a beam. Types of prestressing include **posttension** and **pretension**.

Pretension-

A type of **prestressing** in which reinforcing tendons stretched to a desired tension and then covered by concrete poured into the form. Once the concrete cures and the forms are removed, the tension of tendon is transferred to the concrete increasing its compression and creating a positive camber. This produces a reinforced concrete beam which is able to withstand greater loads without deflection as compared to unreinforced beams of similar dimensions. Compare to **posttension**.

Also, cable hangers (or suspenders) used to support a bridge deck are commonly pretensioned before being attached to the deck.

Pylon-

A monumental vertical structure marking the entrance to a bridge or forming part of a gateway.

Queen Truss-

A truss having two triangular shapes spaced on either side of central apex connected by horizontal top and bottom chords. Compare to **king truss**.

Reinforcement-

Adding strength or bearing capacity to a structural member. Examples include the placing of metal rebar into forms before pouring concrete, or attaching gusset plates at the intersection of multiple members of a truss.

Revet-

The process of covering an embankment with stones.

Revetment-

A facing of masonry or stones to protect an embankment from erosion.

Rib-

Any one of the arched series of members which is parallel to the length of a bridge, especially those on a metal arch bridge.

Rigid frame bridge-

A type of girder bridge in which the piers and deck girder are fastened to form a single unit. Unlike typical girder bridges which are constructed so that the deck rests on bearings atop the piers, a rigid frame bridge acts as a unit. Pier design may vary.

Rise-

The measure of an arch from the spring line to the highest part of the intrados, which is to say from its base support to the crown.

Riveted connections-

A connection type using a metal shank with a large head on one end that forms its connection by passing the shank through aligned holes in the plates and hammering the second end to form a similar shape. Riveting is a common connection type for trusses and beam/girders.

Segmental arch-

An arch formed along an arc which is drawn from a point below its spring line, thus forming a less than semicircular arch. The intrados of a Roman arch follows an arc drawn from a point on its spring line, thus forming a semi-circle.

Shear-

Stress placed transversely on a member in opposite directions.

Simple span-

A span in which the effective length is the same as the length of the spanning structure. The spanning superstructure extends from one vertical support, abutment or pier, to another, without crossing over an intermediate support or creating a cantilever. (Superstructure is completely supported between two supports.)

Skew-

When the superstructure is not perpendicular to the substructure, a skew angle is created. The skew angle is the acute angle between the alignment of the superstructure and the alignment of the substructure.

Span-

The horizontal space between two supports of a structure. Also refers to the structure itself. May be used as a noun or a verb.

The **clear span** is the space between the inside surfaces of piers or other vertical supports. The **effective span** is the distance between the centers of two supports.

Spandrel-

The roughly triangular area above an arch and below a horizontal bridge deck. A **closed spandrel** encloses fill material. An **open spandrel** carries its load using interior walls or columns.

Splice plate-

A plate which joins two girders. Commonly riveted or bolted.

Springer-

The first voussoir resting on the impost of an arch.

Spring line-

The place where an arch rises from its support; a line drawn from the impost.

Stanchion-

One of the larger vertical posts supporting a railing. Smaller, closely spaced vertical supports are ballusters. Also see **ballustrade**.

Strain-

The deformation of an object caused by a force acting upon it. Compressive strain is the shortening of an object in compression. Tensile strain is the elongation of an object in tension. Shearing strain is a lateral deformation caused by a force which tends to move part of an object more than another. Compare to **stress**.

Steel I-beam-

Steel I-beams are rolled steel sections up to 36 inches in depth that support the deck and carry the load to the bearings located on the supports. The I-beam can be encased in concrete.

Stress-

The resistance of an object to external force. Compressive stress develops as an object in compression resists being shortened. Tensile stress develops as an object in tension resists being elongated. Shearing stress develops as an object subject to shearing forces resists deformation. Compare to **strain**.

Stiffener-

On plate girders, structural steel shapes, such as an **angle**, are attached to the **web** to add intermediate strength.

Stringer-

A beam aligned with the length of a span that usually extends between floor beams and assists in supporting the deck.

Strut-

A compressive member.

Structure-

A stable assembly of components which carries a load while resisting various applied stresses, and transfers the load through its foundation to the ground.

Substructure-

The portion of a bridge structure including abutments and piers which supports the superstructure.

Superstructure-

The portion of a bridge structure which carries the traffic load and passes that load to the substructure.

Suspended span-

A simple beam supported by cantilevers of adjacent spans, commonly connected by pins.

Suspenders-

Tension members of a suspension bridge which hang from the main cable to support the deck. Also similar tension members of an arch bridge which features a suspended deck. Also called hangers.

Suspension bridge-

A bridge which carries its deck with many tension members attached to cables draped over tower piers.

Tension-

Stress characterized by pulling apart.

Through truss-

A truss which carries its traffic through the interior of the structure with crossbracing between the parallel top and bottom chords. Compare to **deck truss** and **pony truss**.

Thrust-

A force caused by one part of a structure pushing outward against another. The thrust at the abutments of segmental arch is also called drift.

Tie-

A tension member of a truss.

Tied arch-

An arch which has a tension member across its base which connects one end to the other.

Tower-

A tall pier or frame supporting the cable of a suspension bridge.

Transverse

Positioning of a member so that it projects out from or crosses another, generally in a horizontal position. Compare to **parallel** and **perpendicular**. Also, describes a movement across the length of an object as opposed to along its length.

Trestle-

While **Bridge** is the more general term (which may be a single span or multi-span, typically one span is longer than the others), **Trestle** is a longer, multi-span structure -- a series of shorter spans in which most of the spans are of similar length. **Trestle** is a more common term in relation to railroads, while **viaduct** is a similar long, multi-span structure for streets. Neither term seems to be exclusive.

Although described as a single structure, the Ohio Connecting RR bridge over the Ohio River at Brunot Island could be described as a pair of bridges (one over each river channel) with a trestle at each approach and a trestle connection in the center. But more often, a long structure which does not have a predominantly larger span could be described as a trestle.

Truss-

A structural form that is made of a web-like assembly of smaller members usually arranged in a triangular pattern. A truss bridge uses diagonal and vertical members to support the deck loads. The diagonal and vertical members are joined with plates and fasteners (pins, rivets, or bolts) to create several rigid triangular shapes. This configuration allows relatively light units to be created for large spans. There are three basic arrangements of trusses – pony, through, and deck – and a wide variety of subtypes.

A structural form which is used in the same way as a beam, but because it is made of an web-like assembly of smaller members it can be made longer, deeper, and therefore, stronger than a **beam** or **girder** while being lighter than a beam of similar dimensions.

Trussed arch-

A metal arch bridge which features a curved truss.

Upper chord-

Top chord of a truss.

Vault-

An enclosing structure formed by building a series of adjacent arches.

Vertical lift bridge-

A movable deck bridge in which the deck may be raised vertically by synchronized machinery at each end. Compare to **swing bridge** and **vertical lift bridge**.

Voussoir-

Any one of the wedge shaped block used to form an arch.

Appendix B: Bridge and Engineering Definitions and Terms

Warren truss-

A type of truss in which vertical web members inclined to form equilateral triangles. May be recognized by diagonal members which appear to form a series of alternating "V" and "A" shapes (without the crossbar) along the length of the truss when viewed in profile. Often the triangles are bisected by vertical members to reduce the length of the members of the top chord. Compare to **Pratt truss** and **Howe truss**.

Web-

The system of members connecting the top and bottom chords of a truss. Or the vertical portion of an I-beam or girder.

Welded connections-

Introduced by 1930, welded connections are created by heating and melting two pieces of metal together to form a "bead" of molten steel. Used for trusses and beam/girder bridges.

Wing walls-

Extensions of a retaining wall as part of an abutment; used to contain the fill of an approach embankment.

Definitions and terms are adapted and conglomerated from:

Cridlebaugh, Bruce S. "Bridges and Tunnels of Allegheny County and Pittsburg, PA." August 8, 2010. <http://www.pghbridges.com/index.htm> (accessed March 28, 2011).

Cridlebaugh, Bruce S. "Terminology: Bridges." Bridges and Tunnels of Allegheny County and Pittsburg, PA. <http://www.pghbridges.com/termsBrg.htm> (accessed March 28, 2011).

Cridlebaugh, Bruce S. "Terminology: Engineering." Bridges and Tunnels of Allegheny County and Pittsburg, PA. <http://www.pghbridges.com/termsEng.htm> (accessed March 28, 2011).

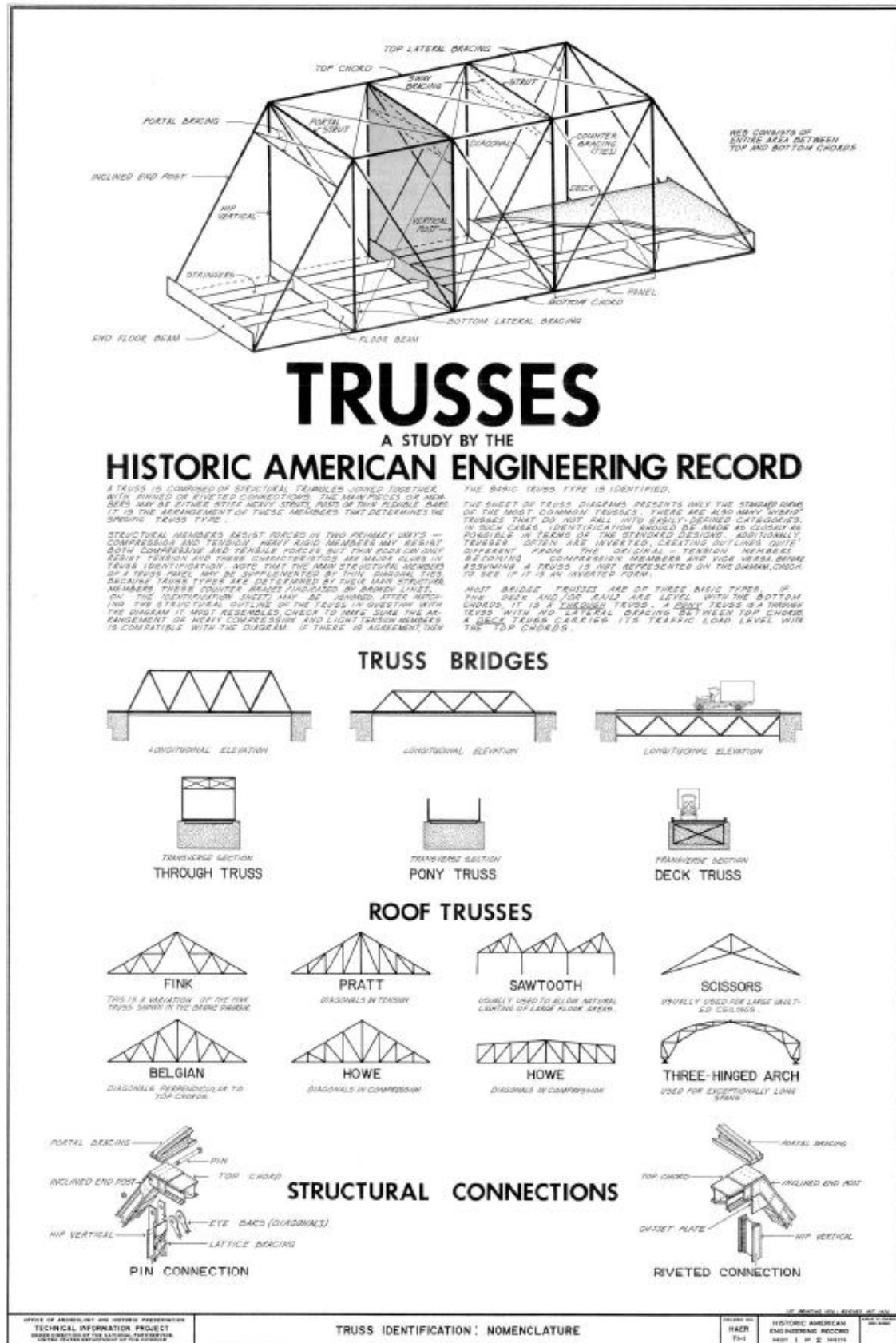
M&H Architecture, Inc. "Indiana Bridges Historic Context Study, 1830s-1965." February 2007. <http://www.in.gov/indot/files/INBridgesHistoricContextStudy1830s-1965.pdf> (accessed February 20, 2010).

Appendix C

Historic American Engineering Record Diagrams

United States Department of the Interior
National Park Service

Historic American Engineering Record. National Park Service. Arnold David Jones,
1976. Library of Congress, Prints & Photographs Division, HAER, LC-USZ62-119864.



[illegible]

Appendix D

Historic Bridge Significance Charts

The Transportation Research Board (TRB) through the National Academy of Sciences (NAS) grants permission to use Table 4-1. Summary of bridge type/subtype evaluations (p. 4-2) from Parsons Brinckerhoff and Engineering and Industrial Heritage, “A Context for Common Historic Bridge Types,” final report for NCHRP Project 25-25 (15), “Historic Bridges,” 2005 in this thesis.

Permission is given with the understanding that inclusion of the material will not be used to imply Transportation Research Board, AASHTO, Federal Highway Administration, Transit Development Corporation, Federal Transit Administration, Federal Aviation Administration, or Federal Motor Carriers Safety Administration endorsement of a particular product, method, or practice.

April 1, 2011

Source:

Parsons Brinckerhoff and Engineering and Industrial Heritage. “A Context for Common Historic Bridge Types: NCHRP Project 25-25, Task 15. 2005.”
http://onlinepubs.trb.org/onlinepubs/archive/NotesDocs/25-25%2815%29_FR.pdf
(accessed August 5, 2010).

Table 4-1. Summary of Bridge Type/Subtype Significance Evaluations

Truss Type	Highest Level of Significance Within Type	Subtypes with Highest Significance Level Within Type	Subtypes With Lower Significance Level Within Type
CATEGORY 1: TRUSS			
King Post Truss	Significant	Pre Civil War examples are of the highest significance.	Late 19 th century examples are significant and 20 th century examples are of moderate significance.
Queen Post Truss	Significant	Pre Civil War examples are of the highest significance.	Late 19 th century examples are significant and 20 th century examples are of moderate significance.
Burr Arch Truss	Significant	All 19 th century examples are considered significant.	N/A
Town Lattice Truss	Significant	Wood examples dating before 1870 and all metal railroad bridges of the 19 th century are of the highest significance.	N/A
Howe Truss	Highly Significant	Highly significant are the railroad bridges of the 1840s and 1850s.	Wooden Howe truss covered bridges from the 19 th century and 20 th century are significant.
Bowstring Arch Truss	Highly Significant	Whipple bowstring trusses are of the highest level of significance.	Non-Whipple bowstrings are highly significant, but less significant than the Whipples. An exception would be examples such as King Iron or Wrought Iron company-fabricated bowstrings, or rare one-of-kind examples such as the Avery-Bartholomew or Glass Reznor Schneider patented bowstrings.
Pratt Truss	Significant	Early examples (19 th century) are of the highest significance, especially multiple-span truss bridges spanning larger rivers.	Later examples are of moderate significance.

Table 4-1. Summary of Bridge Type/Subtype Significance Evaluations

Truss Type	Highest Level of Significance Within Type	Subtypes with Highest Significance Level Within Type	Subtypes With Lower Significance Level Within Type
Whipple Truss	Highly Significant	Whipples are relatively rare within the context of this study and are of the highest level of significance.	N/A
Baltimore Truss	Significant	Early examples associated with the B&O Railroad are of the highest significance.	Baltimore truss bridges on highways are not common and are considered significant.
Parker Truss	Significant	Pin-connected 19 th century examples are of the highest significance.	Twentieth century examples are of moderate significance.
Pennsylvania Truss	Significant	Early examples associated with the railroad are of the highest significance.	Pennsylvania truss bridges on highways are not common and are considered significant.
Warren Truss	Significant	Nineteenth century examples are of the highest significance.	Trusses built after ca. 1920 are of moderate significance.
Subdivided and Double-intersection Warren Truss	Highly Significant	All examples, as they are among the least common types in this study.	N/A
Lenticular Truss	Highly Significant	All examples, as they are among the least common types in this study.	N/A
CATEGORY 2: ARCH			
Stone Arch	Highly Significant	Late 18 th and early 19 th century examples are of the highest level of significance.	Bridges built under the Depression-era federal work programs are significant. Bridges associated with parks may also be significant.
Reinforced Concrete Melan/ von Emperger Arch	Highly Significant	Documented patented examples of the type are of the highest level of significance.	N/A
Reinforced Concrete Luten Arch	Significant	Documented patented examples of the type are of the highest level of significance.	N/A

Table 4-1. Summary of Bridge Type/Subtype Significance Evaluations

Truss Type	Highest Level of Significance Within Type	Subtypes with Highest Significance Level Within Type	Subtypes With Lower Significance Level Within Type
Reinforced Concrete Marsh or Rainbow (Through) Arch	Significant	Documented patented examples of the type are of the highest level of significance.	Rainbow arches that cannot be documented as patented are less significant, but still possess significance.
Reinforced Concrete Closed Spandrel Arch	Significant	Early examples and types built according to State DOT standardized bridge plans are of the highest level of significance.	Later examples are less significant, but still possess significance.
Reinforced Concrete Open Spandrel Arch	Significant	Early examples and types built according to State DOT standardized bridge plans are of the highest level of significance.	Later examples are less significant, but still possess significance.
Steel Tied Arch	Significant	Most examples will possess significance.	N/A
Reinforced Concrete Tied Arch	Significant	Most examples will possess significance.	N/A
Steel Hinged Arch	Highly Significant	Most examples will possess significance.	N/A
Reinforced Concrete Hinged Arch	Highly Significant	Most examples will possess significance.	N/A
CATEGORY 3: BEAM, GIRDER & RIGID			
Timber Stringers	Low Significance	Early examples and examples built according to State DOT standard plans are of the highest level of significance.	Timber stringers associated with parks may also possess significance.
Reinforced Concrete Cast-In-Place Slabs	Significant	Early examples and examples built according to early 20 th century State DOT standard plans are of the highest level of significance.	Examples from the 2 nd quarter of the 20 th century are less significant, but still may possess significance.

Table 4-1. Summary of Bridge Type/Subtype Significance Evaluations

Truss Type	Highest Level of Significance Within Type	Subtypes with Highest Significance Level Within Type	Subtypes With Lower Significance Level Within Type
CATEGORY 3: BEAM, GIRDER & RIGID, Continued			
Reinforced Concrete T-Beams	Moderate Significance	Early examples and examples built according to early 20 th century State DOT standard plans are of the highest level of significance.	Long examples (>30 feet) and examples with decorative features may also possess significance.
Reinforced Concrete Channel Beams	Low to Moderate Significance	Early 20 th century representative examples or those built according to early 20 th century State DOT standard plans are of the highest level of significance.	Examples with decorative features may also possess significance.
Reinforced Concrete Girders	Moderate Significance	Early examples and examples built according to early 20 th century State DOT standard plans, and through girders are of the highest level of significance.	Examples from the 2 nd quarter of the 20 th century are less significant, but still may possess significance.
Reinforced Concrete Rigid Frames	Significant	Early examples and those that can be documented as having been built according to State DOT standard plans are of the highest level of significance.	Also significant are examples built on parkway systems.
Reinforced Concrete Pre-cast Slabs	Low Significance*	The earliest examples of the type possess the highest level of significance.*	N/A*
Pre-stressed Concrete I-Beams	Significant*	Early 1950s examples of the type possess the highest level of significance.*	Other examples possess a low level of significance.*

Table 4-1. Summary of Bridge Type/Subtype Significance Evaluations

Truss Type	Highest Level of Significance Within Type	Subtypes with Highest Significance Level Within Type	Subtypes With Lower Significance Level Within Type
CATEGORY 3: BEAM, GIRDER & RIGID, Continued			
Pre-stressed Concrete Box Beams	Low Significance*	The earliest examples of the type possess the highest level of significance.*	N/A*
Metal Rolled Multi-Beams	Low Significance	Early examples of the type possess the highest level of significance.	Other examples that use innovative fabricating techniques may be significant.
Metal Fabricated Girders	Moderate Significance	Early 20 th century examples possess the highest level of significance.	First generation, welded steel girders that survive from the 1950s may also be significant.
Metal Rigid Frames	Significant	Early examples and those documented as having been built according to State DOT standard plans possess the highest level of significance.	Also significant are examples built on parkway systems.
CATEGORY 4: MOVABLE SPANS			
Center-bearing Swing Span	Highly Significant	Late 19 th and early 20 th century examples possess the highest level of significance.	Examples built late in the historic period (through 1955) may be significant or moderately significant.
Rim-bearing Swing Span	Highly Significant	Late 19 th and early 20 th century examples possess the highest level of significance.	Examples built late in the historic period (through 1955) may be significant or moderately significant.
Vertical Lift Span	Highly Significant	Most examples will possess significance.	N/A
Simple Trunnion (Milwaukee, Chicago) Bascule Span	Significant	Early examples and examples associated with the Chicago Department of Public Works.	Other examples are less significant, but still considered significant.

Table 4-1. Summary of Bridge Type/Subtype Significance Evaluations			
Truss Type	Highest Level of Significance Within Type	Subtypes with Highest Significance Level Within Type	Subtypes With Lower Significance Level Within Type
CATEGORY 4: MOVABLE SPANS, Continued			
Multi-trunnion (Strauss) Bascule Span	Highly Significant	Most examples will possess significance.	N/A
Rolling Lift (Scherzer) Bascule Span	Highly Significant	Of the highest significance are early examples of the type.	Most other examples will possess significance.
CATEGORY 5: SUSPENSION			
Monumental Suspension Bridges	Highly Significant	Most examples will possess significance.	N/A
Shorter-span and Vernacular Spans	Significant	Most examples will possess significance.	N/A
CATEGORY 6: TRESTLES AND VIADUCTS			
Trestles	Significant	Nineteenth century examples possess the highest level of significance.	Twentieth century examples are of moderate to low significance, but may possess significance for their great length or for solving a topographical problem.
Viaducts	Highly Significant	Stone railroad and other viaducts from the second quarter of the 19 th century are of the highest significance level.	Many viaducts should be evaluated within the bridge type that they fall under, e.g., girder, concrete arch.
CATEGORY 7: CANTILEVERS			
Cantilevers	Significant	Early examples and those of very long length are of the highest significance.	Twentieth century examples are of lower significance, unless they are very long in length or for solving a topographical problem.

*More modern types of bridges for which scholarship is just being developed.

Appendix E

Survey Questions and Answers
Historic Bridges: A Heritage at Risk
SRI Foundation

HISTORIC BRIDGES: A HERITAGE at RISK
A Workshop on the Preservation and Management of Historic Bridges
Washington, D.C., December 3-4, 2003
ANALYSIS OF QUESTIONNAIRE

Prior to the workshop, we sent out a questionnaire to obtain general information on the nation's historic bridges, and to get some sense of how state Departments of Transportation (DOTs) are dealing with them. The questionnaire was sent to all 50 state DOTs, several consulting engineers experienced in historic bridge rehabilitation, a couple of civil engineering educators interested in the subject, and several non-engineering preservationists and historic bridge scholars. Thirty-seven DOTs responded, including the District of Columbia. The intent of the questionnaire was to develop quantifiable information on the nation's historic bridges, confirm the issues enveloping historic bridges, and to help shape the agenda and discussion topics for the workshop. We were extremely gratified to hear back from so many respondents. While the responses confirm the threat to the nation's historic bridges, they also reveal several innovative approaches to saving these historic spans. The following is an analysis and interpretation of the questionnaire. Please take time to review this analysis. Your interpretation of the responses will contribute to the success of the workshop.

QUESTIONS & RESPONSES

- 1) Most states have completed statewide historic bridge inventories. Surface transportation legislation (STURAA) mandated completion of the inventories in 1987. How many bridges in your state are listed or have been determined eligible for the National Register?**

Most states completed their initial surveys in the early-1980s with the Commonwealth of Virginia leading the pack. Subsequently, most states completed "upgrades" in the late-1990s incorporating post-WW II and pre-interstate era bridges. According to the responding DOTs (37 including the District of Columbia), there are 1,668 bridges listed and 6,014 bridges determined eligible for the National Register.

[Note: The National Register's database shows 2,300 listed-bridges for all fifty states, including Guam, Puerto Rico and the District of Columbia, and 841 bridges that have been determined eligible. There are eleven (11) bridges designated as National Historic Landmarks. The National Register explains that since formal determinations of eligibility (DOEs) come to the National Register in all shapes and forms, data on DOEs are inaccurate. The National Register is comfortable, however, with the accuracy of the number of bridges actually listed. It should be noted that there are discrepancies between the number of National Register-listed bridges reported by the state DOT's on the questionnaire and the National Register's database. The reasons for these differences are not clear at this time.]

2) During a Colorado Preservation, Inc. conference two years ago, we learned that over half that state's historic bridges had been lost in the last twenty years.

To learn whether this alarming statistic was consistent with the other states, we asked respondents to tell us how many historic bridges have been destroyed over a similar period of time. It seems that the loss of historic bridges may not be as grave as originally anticipated. For those states that have good hard data, the rate of attrition is more like 25% rather than 50%. While most states have complied with STURAA, two states have no survey to date - Louisiana, and Utah, and the District of Columbia.

[Note: However, this percentage comes with several significant qualifications - one being that many of the earlier surveys only looked at state and federal-aid road bridges and not the locally and municipally owned bridges. Many of the unique, one-of-a-kind bowstring arches, metal trusses and early concrete spans are located on the secondary farm-to-market roads. Another reason to question this percentage is that many of the earlier surveys were "paper" inventories where the data were not tabulated in a computerized database. This is understandable since databases were not as sophisticated and user friendly twenty years ago as they are today. This brings into question the accuracy of data from some of the states. An illustration of this is that two of the states with significant populations of historic bridges - Pennsylvania and New York - cannot tell us how many historic bridges have been lost in the last twenty years. Both states have only completed comprehensive, computerized surveys in the last few years. Virginia has no data on the fate of its historic bridge before 1990. The survey suggests that better record keeping and more easily managed databases are key to managing historic bridges. Concerning the questionnaire, Jim Cooper, a bridge preservationist from Indiana, stated that in Indiana, "...[w]e have lost very few covered timber-truss structures in the last ten years (maybe 8 or 9 down to 92). We have lost probably two dozen National Register Eligible concrete structures in a decade. The rate is now accelerating. The losses are different for metal trusses: Over two-thirds of the metal bridges I surveyed in 1984 are now gone. ... I doubt that anyone at INDOT could, for example, report the data I have just provided here. No one there keeps track of such things..."]

3) Some states have implemented or are developing historic bridge management and preservation plans. Do you have a plan in place? Are you currently working on a plan?

Of the 37 states responding, 12 have management plans in place, and 14 are either working on or contemplating developing one. Wisconsin has a plan for its bascule bridges. Pennsylvania is working on a plan for its masonry arch bridges.

4) Does the plan include provisions for routine maintenance?

Thirteen (13) of the states responding include maintenance as part of the plan.

5) Several states have orphan bridge or adopt-a-bridge programs. If you have such a plan, how many bridges have successfully been saved or adopted on an annual basis since the program was implemented?

Twelve (12) states indicated that they have a marketing, orphan, or adopt-a-bridge program. Tennessee was one of the first to aggressively promote such a program and, over the last 22 years, has marketed 24 bridges. For the other states, the number of bridges marketed ranges from 3-4 per year to somewhere between 1-5 per decade. South Dakota and Pennsylvania have found that its marketing programs are not very successful.

6) To maintain its backcountry roads and New England townscapes, the state of Vermont has adopted in-state design standards for its roads and bridges. Does your state have in-state design standards?

Ten (10) of the 37 states noted that they have in-state standards. Three (3) states indicated they plan to develop such standards. Kentucky stated that it uses “context sensitive design” in dealing with historic bridges.

7) Do you provide any special assistance to counties responsible for historic bridges?

Fifteen (15) states indicated that they provided assistance to county entities. This question was included because many historic bridges exist on local and municipal roads not falling under direct state jurisdiction, and local and county engineer play a significant role in preserving these resources.

8) Most states adhere fairly closely to AASHTO standards. Does your state exercise any flexibility or have specific policies for dealing with historic bridges?

Responses indicate that a surprisingly high percentage (66%) of the states (23) stated that they exercise design flexibility in dealing with historic bridges. Oregon links design flexibility to bridges on scenic highways such as the Columbia River Gorge and Coastal Route 101.

9) In general, does bridge replacement occur more often than bridge rehabilitation?

As suspected, 25 of the 37 state DOTs, including the District of Columbia, say that replacement far outweighs rehabilitation. Indiana DOT says that more bridges are replaced when paid for by federal funds. Maryland says that while more bridges were replaced in the past, it feels more will be rehabilitated in the future. Again, many states were not able to answer this question definitively because they are unable to track past actions involving historic bridges.

10) Is there an engineer or staff within your agency who you would consider expert on rehabilitating historic bridges?

Twelve (12) states indicated that they have engineers or staff with expertise in historic bridges.

California - Dave Stow, PE

Connecticut - Timothy Fields, PE

Louisiana - Gill Gautreau, PE

Maryland - John Hudacek, PE

Michigan - Margaret Barondess

New Hampshire - Dave Powelson, PE

New Jersey - Lichtenstein Consulting Engineers

Oregon - Frank Nelson, PE

Texas - Charles Walker, PE

Vermont - Dave Hoyne, PE, Gilbert Newbury, PE

Virginia - Tom Lester, PE, Park Thompson, PE, Nick Nicholson, PE

West Virginia - Terry Bailey, PE

[Note: We would like to add two county engineers, to remind us of the role local engineers have in saving historic bridges: Frederick County, Maryland - Ken Harwood and Calhoun County, Michigan - Dennis Randolph, PE. Undoubtedly, there are more qualified individuals in both categories.]

11) Do you have an education/information outreach program informing citizens of the state's historic bridges - that is, a way to obtain citizen and community input into the proposed rehabilitation or replacement of an historic bridge?

Twenty-one (21) of the states noted they had some form of educational outreach pertaining to historic bridges. Kentucky responded that it relied on the State Historic Preservation Officer (SHPO) for these services. Others relied on web sites and the normal Section 106 consultation process. Indiana has a special program informing Hoosiers of the state's covered bridges.

12) Have you sponsored or funded the rehabilitation of an historic bridge in the last twenty years?

Every state that responded, with the exception of two (New Mexico and Utah), stated that they had rehabilitated an historic bridge sometime during the last twenty years. Few states could provide specifics on the costs or level of rehabilitation due to limited record keeping. States with significant populations of covered bridges specifically mentioned special programs dealing with these spans. The fact that most states have rehabilitated historic bridges indicates that some think that this is a viable engineering and economical alternative. Vermont stated that rehabilitation often resulted in substantial savings, as did the county engineer from Frederick County, Maryland.

Bridges rehabilitated ranged from massive structures such as the Cotter Bridge (1930) in

Arkansas to simple through trusses, concrete slabs and arches. Particularly notable is the rehabilitation work that Oregon DOT has done on the large coastal bridges designed by state bridge engineer Conde McCullough, bridges on the Columbia River Gorge Scenic Highway, the state's covered bridges, and some of the major moveable spans over the Willamette River in Portland.

[Note: It is clear that there is no shortage of outstanding examples of historic bridge rehabilitation throughout the country. However, there is a paucity of case studies outlining rehabilitation techniques and costs. FHWA contracted with the Louis Berger Group several years ago to produce a best practices handbook, but it has not been completed. Having case studies in-hand certainly would assist in and stimulate similar treatments in other parts of the country.]

13) Speaking with individuals in state DOTs, there is concern of a "disconnect" between environmental and engineering interests and disciplines. Could you characterize the relationship between these two disciplines in your agency?

This is a touchy issue confirmed by many equivocal responses from the state DOTs. Though many states indicated that relationships were improving, eight states responded that there was a "disconnect." In some states, environmental and preservation interests were still perceived as "scapegoats," something extra and not necessary. Other respondents cited different value systems between the two disciplines as one of the reasons for this disconnect.

Despite the prevalence of engineering interests and the lack of interest to pursue alternative or non-traditional methods, many respondents said that relationships were improving because of better understanding of the respective disciplines. Some of the reasons for improvement included the intervention or mediation by the FHWA division office, change of leadership within the agency, the attitude of individual project managers, context sensitive design, and the integration of environmental and engineering disciplines within the same office. Vermont claimed that its historic bridge program helped instill a measure of pride among the engineers on staff.

14) Funding, tort liability, and the lack of community interest have been cited as reasons for not rehabilitating historic bridges. Please confirm if these are true adding other reasons that have mitigated against preservation. Concerning liability, please differentiate between perception and actual cases where an historic bridge actually resulted in a successful law suit against the state or local authority.

14a) Which of the following has been cited most frequently in your state as the reason for not rehabilitating historic bridges. If more than one reason has been cited with equal frequency, please check all the reasons: funding, tort liability, lack of community interest, other (please describe).

Twenty-nine (29) of the states responded that funding is the primary reason that historic bridges are not rehabilitated. Fifteen (15) states cited tort liability as a reason, and eleven (11) the lack of community interest.

[Note: Preservationists working on the 10th Street Bridge in Great Falls, Montana discussed with Eric DeLony the problem associated with restrictions on the use of federal funds when restoring historic bridges. Though this issue was not on the questionnaire, it is a significant enough issue to include in this analysis. As noted on FHWA's *Re:NEPA* web page (this past spring), Federal funds may be utilized if the deficient aspects of the bridge are no longer deficient after the project. If the bridge is taken out of motorized vehicle use, funds up to the cost of demolition may be used for preservation (23 U.S.C. 144(o)).]

14b.) If you checked "tort liability," how many lawsuits involving historic bridges have been successfully brought against your agency over the past five years? Number of cases.

No state could identify a single instance when it was sued because someone lost a life, personal property or experienced an injury due to a deficient historic bridge. Tort liability will always be a concern, but this survey brings into question the use of tort liability as a reason for not rehabilitating an historic bridge.

Other reasons noted by the respondents included safety, capacity, service life, poor condition, functional and structural obsolescence, geometrics, AASHTO standards, maintenance, future costs, school buses, emergency and farm vehicles, and comparative costs between old and new structures.

15) On the other hand, what has been the fundamental reason(s) that historic bridges have been saved?

By far, community interest was the primary factor, noted by thirty-one (31) of the states. Thirteen (13) cited flexible design standards and three mentioned adopt-a-bridge programs. Nine (9) states cited their historic bridge management plans as the reason bridges were saved.

Many states cited the Section 106 compliance process. One reason cited for successful rehabilitation involved someone on the DOT staff or a focused, passionate citizen or citizen's group willing to make a conscience effort to save a bridge. Other reasons mentioned included SHPO interest, the availability of transportation enhancement funding, and the obvious cost effectiveness of rehabilitation.

Innovative Programs: Please provide any additional comments you may have on your bridge program. Does your state have a program that you would consider innovative in dealing with historic bridges? For example, Virginia and Texas have come up with specific bridge management plans that guarantee the preservation of selected bridges. Oregon DOT has an in-house SWAT team responsible for the inspection and maintenance of its legacy of Conde McCullough coastal bridges.

Arkansas has developed a GIS system to manage, market and mitigate impacts to its historic bridges. California cited its seismic retrofit programmatic agreement following the Loma Prieta earthquake. Rehabilitation of the fifteen City Beautiful bridges, designed by city engineer Merrill Butler, spanning the Los Angeles River in downtown Los Angeles is an outstanding example of this program. Connecticut has design guidelines that protect the rustic, Art Deco and Modern bridges on the Merritt Parkway. Georgia cited its covered bridge program; and this would probably hold true for other states with significant populations of covered bridges.

Though the Georgia program started before the National Covered Bridge Preservation Program went into effect three years ago, the national program has been extremely important for preserving the nation's covered bridges.

Michigan cited the Calhoun County Bridge Park, the first in the country. Ohio has one of the oldest historic bridge programs in the country, having initiated one twenty-six years ago in addition to having a programmatic agreement in place for the last ten years.

Oregon has its in-house SWAT team for historic bridge maintenance who are responsible for the cathodic protection of the McCullough coastal bridges, historic bridges on the Columbia River Gorge Scenic Highway and the state's covered bridge program.

Pennsylvania cited its stone-arch bridge program as a pilot for dealing with its other historic bridge types. Tennessee cited its twenty year old marketing program. Texas has developed an in-house Historic Bridge Team and has funded the rehabilitation of ten bridges. TxDOT has also produced an historic bridge manual, is exploring a scenic bypass program so that bridges can remain in vehicular use on scenic byways, and has a program that requires a maintenance agreement with bridge owners when a bridge is set aside for non-vehicular use.

Virginia has a comprehensive management plan for its sixty three (63) National Register listed and eligible bridges, and the plan includes regular maintenance. It also has a “RRR,” Rural Rustic Roads program, whereby minimal rehabilitation is done on rural bridges other than making sure the bridges are safe. The management plan constitutes a public statement of VDOT’s intentions to manage and preserve the state’s historic bridges. West Virginia cited its covered bridge program. Vermont has what is most likely the most comprehensive programmatic agreement and historic bridge management program in the country. Most states responding to the questionnaire (24), however, did not feel they had any innovative programs.

[Note: We should also mention that several counties have outstanding historic bridge management programs, such as Frederick County, Maryland; Calhoun County, Michigan; Hunterdon County, New Jersey; and Ashtabula County, Ohio. These are ones that are best known though there probably are others.]

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The full report can be found online at:
http://www.srifoundation.org/pdf/bridge_report.pdf

DeLony, Eric, and Terry H. Klein. “Historic Bridges: A Heritage at Risk; A Report on a Workshop on the Preservation and Management of Historic Bridges.” Rio Rancho, NM: SRI Foundation, 2004.