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Design and Management of Historic Roads

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Introduction on Purpose and Summary of Content

The *Guidelines for Design and Management of Historic Roads* have been developed to address a specific type of historic property - historic roads. They are intended to demonstrate how the inherent flexibility in the current policies, manuals, criteria, rules, standards, and data sets that underlie the transportation planning and project development process can be used to preserve historic roads and roads in historic districts and settings. The guidance outlines some of the approaches encouraging use of flexibility and how to apply it to develop balanced solutions tailored to all types of projects, from new construction to addressing site specific safety problems. Achieving balanced designs where history matters does not require different or ―special" criteria or policies; the ways to do so efficiently are already in place. It is the practice itself that benefits from recognizing and using available means to craft outcomes that respect and preserve historic significance without compromising safety and operations. This guidance is specific to historic roads and roads in historic settings because they are frequently part of transportation projects, but it is in no way exclusive to them. The approaches described herein are systemic and can be applied to any project involving historic properties or other cultural or environmental considerations.

The guidelines are neither a typology nor a checklist of prescribed solutions. Rather, they are founded on an iterative process by which transportation agencies work collaboratively with multiple perspectives to address safety, mobility, and historic preservation of distinguishing characteristics equally. Best practices for preserving historic roads demonstrate that successful designs that solve the transportation problem and favor preservation are generally founded on four strategies associated with the current project delivery process (include historic preservation from the outset of project planning; understand and use inherent flexibility; use what makes a road historic a meaningful measure; and use what underlies the 13 controlling design criteria to develop balanced solutions). Each of the four strategies is developed in succeeding chapters. This approach provides the opportunity to address what needs to be preserved and why it is important from the outset of planning and project development when that information can have the greatest effect on the outcome.

The guidelines were prepared through the collaboration of experienced roadway engineers and managers working with historians well versed in researching and assessing transportation resources. Both are experienced with developing nationally applicable guidance or policy related to road design. The guidance was crafted not for a specific audience but rather to provide the types of information that will assist the full range of professionals currently involved in transportation planning and project development (1) to understand what underlies the policies and practices of other perspectives, (2) to become familiar with existing flexibility, and then (3) to use it to develop balanced solutions for historic roads. It is anticipated that the guidelines will be used in a variety of ways, depending on the experience level and specific goal or goals of the user. For instance, a historic preservationist just starting with a state historic preservation office or consultancy may find the information on what underlies the 13 controlling design criteria most useful while the experienced highway design engineer will appreciate understanding how some historic roads are defined. Other historians and preservationists well versed in the process may find the suggestions on how to solve specific transportation problems, like narrow width or limited sight distances, more useful. How distinguishing characteristics for specific historic roads are determined may prove useful to all perspectives as can how to use that data to support balanced designs. Each perspective may also benefit from a "refresher" on their own perspective as well as how policies and practices have evolved to support using professional judgment and inherent flexibility to support preservation and conservation of historic roads and historic district settings.

1.0 Preserving Historic Roads: Starting Out in the Right Direction

1.1 Introduction

Many types of roads, from the unpaved, 18^{th} century Albany Post Road in Putnam County, New York, to America‘s first superhighway in New Jersey, are valued historic properties significant in American history as are roads that contribute to the historic significance of their setting, like city streets in architectural historic districts or an unimproved road in a rural historic district like Green Springs in Louisa County, Virginia.

Historic roads have been part of the transportation project development process since 1966 and passage of the National Historic Preservation Act (NHPA) that gave standing to those concerned about the effects of federally funded projects on identified historic properties and the USDOT Act that charged the Secretary of Transportation with avoiding use of historic properties unless there were no other feasible and prudent alternatives. Provisions of both acts serve to integrate historic preservation into developing transportation projects and determining their outcomes. They also mandate that departments of transportation include the perspectives of others in collection of data and decision making, including other regulators like state historic preservation offices (SHPO) that are responsible for defining historic properties and commenting on the effects of proposed work to them.

During the intervening years there have been significant changes in how transportation projects involving historic properties are advanced. Practitioners and the public have successfully increased awareness about why history matters and the benefits of incorporating historic preservation into the designs. As a result, a wider range of properties, including all types of roads and design elements, are now recognized as being historic and thus worthy of preservation. Federal legislation consistently emphasizes addressing environmental and community values as part of transportation projects, and the approach that considers the compatibility of transportation improvements with their settings is now commonplace. Effective practices have been developed to achieve those goals as preservationists and engineers routinely collaborate on developing policies and treatments that respect history. Many transportation agencies recognize that good designs are not based exclusively on operations and safety but include how well they blend with their contexts, like the New York State DOT‘s improvements on the iconic Taconic State Parkway in Westchester, Putnam, Duchess, and Columbia counties that also serves a high volume of automobile traffic.

AASHTO seeks to encourage greater application of the many tools available to achieve favorable outcomes for projects involving historic roads. The purpose of this guidance is to illustrate how two disciplines with seemingly conflicting objectives – engineers to provide a safe and efficient transportation system and preservationists to preserve historic properties – can work together and within their own policies, manuals, criteria and procedures to develop designs that accommodate both perspectives. In order to be immediately useful, this guidance is applied to the current planning and project development process used by transportation agencies that are advancing work using federal funds or permits. Research and best practices demonstrate that balanced outcomes can be achieved by moving beyond common misconceptions and combining professional judgment with the existing flexibility to support performance-based designs appropriate for their settings and contexts.

This guidance has been prepared to add technical background to the knowledge base of those who contribute to developing transportation solutions. It strives to demonstrate that there is sufficient flexibility within the current transportation planning and project development process to achieve solutions that balance sound engineering practice with historic preservation. It does not establish a set of best design practices or processes, nor does it mandate the use of flexibility, the practice of which varies from state to state. The guidance is not intended to be a detailed design manual that would supersede the need for the application of sound principles by design professionals, nor is it intended to establish guidelines, criteria, or standards for the design of roadways or the definition of historic roads.

1.2 Background of Inherent Flexibility

Commencing with passage of the Intermodal Surface Transportation Efficiency Act of 1991, Congress has emphasized preservation of environmental and cultural resources as a desired outcome of transportation projects, and it has reiterated and reinforced that intent in succeeding acts and reauthorizations. Key to designs that go beyond simply addressing transportation needs has been the leadership of the Federal Highway Administration (FHWA), with their policies and guidance, and AASHTO‘s research, endorsement of guidance, and adoption of policies that facilitate those outcomes. Hands down the most effective means for achieving balanced designs is the inherent flexibility that has been developed and refined by the engineering community since 1966. It is integral to many if not most of AASHTO‘s performance and risk assessment design policies and is included in *A Policy on Geometric Design of Highways and Streets*. Commonly known as the "Green Book," it is used in many states and FHWA as their main roadway design criteria. Flexibility is also integrated into many federal and state programs. For instance, recognizing that rural highways in Wyoming are different than those in more densely populated Connecticut, FHWA allows states to develop their own design criteria to best meet their specific needs. Those types of flexibility coupled with professional judgment are supported by many AASHTO manuals and guidance, like their 2004 *Guide to Flexibility* and the 2008 *Guidelines for Historic Bridge Rehabilitation and Replacement*. With its ability to quantify the safety and the severity of crashes by providing information relative to the long-term safety performance of specific designs and site conditions, the 2010 *Highway Safety Manual* also serves as an effective tool to science-based flexibility.

The basis for flexibility in selecting design criteria has also been synthesized in National Cooperative Highway Research Program (NCHRP) and Transportation Research Board (TRB) reports and has been applied in actual practice to preserve and to keep in service historic roads like Connecticut‘s Merritt Parkway, Oregon‘s Columbia River Highway, New York‘s Taconic State Parkway, and New Jersey‘s Route One Extension to the Holland Tunnel. Additionally, many transportation agencies, like the Massachusetts Highway Department and the Missouri Department of Transportation, have moved in the direction of programs based on cost effectiveness and maintaining prevailing site conditions when existing roads are performing satisfactorily. The research repeatedly demonstrates that using flexibility does not imply any lessening of safety or less-than-acceptable design values.

1.3 Moving Beyond Common Misconceptions and Using Inherent Flexibility

For a variety of reasons, including the preference for highest value design criteria, the fear of tort liability, or the failure to recognize that preservation guidelines accommodate modern upgrading of historic properties, some engineers and preservationists are reluctant to use the inherent flexibility in their current policies, manuals and criteria. Some of these misconceptions are attributable to the programmatic differences between the goals and objectives of each perspective and the basis for their policies, criteria, standards, and guidance, while others are attributable to the lack of clear understanding or the breadth of experience. The goal of this guidance is to move beyond common misconceptions and to explain how using the flexibility options to develop designs will deliver a product with which engineers and preservationists alike are comfortable. Review of engineering policies and manuals reveals that for many if not most situations there is sufficient flexibility within the design criteria for accommodating professional judgment and environmental issues. Likewise, the criteria and standards that underlie historic and preservation decision making affords a great deal of flexibility in order to address current conditions and a wide variety of circumstances.

1.3.1 Recognize That Words Have Different Meanings and Respect Differences in Terminology

Integrity, rehabilitation, reconstruction, and *preservation* are some of the words common to both engineers and preservationists, but to each perspective they have very different meanings. Not acknowledging that the particular definitions define the very different goals of each perspective can result in misunderstanding and tension that can complicate the project development process and make it difficult to develop balanced solutions. These issues are further complicated because some of the common words with different definitions are linked directly to programmatic issues. For instance, rehabilitation is defined for engineers in the Green Book to mean ―the major work to restore the structural integrity of a bridge as well as the work necessary to correct safety defects." It also specifies the expected programmatic outcome of rehabilitation. For the preservationist, rehabilitation is defined in *The Secretary of the Interior's Standards for Rehabilitation* as "the process of returning a property to a state of utility" while preserving significant features. These two definitions are considerably different. In order to meet the engineering definition of rehabilitation, work to historic roads would most likely have an adverse effect by the preservation definition because significant features would be changed in order to correct substandard safety features and conform with current design criteria. Although each perspective is mandated to apply their definition of the word, it does not follow that there is not sufficient flexibility to accommodate both or that one definition exclusively and arbitrarily controls the project development process. By using professional judgment and the available flexibility available, it is possible to address and resolve the expectations of differing definitions by integrating both outcomes into defining and refining a project's purpose and need narrative, as measures during the screening and evaluation of prudent and feasible alternatives, criteria for selecting the preferred alternative, and part of long-term maintenance practices.

1.3.2 **Understanding the Flexibility Available in Existing Policies, Manuals, Criteria, and Standards**

The basis for the common misconception that perspectives are rigid is often a lack of understanding on the part of all stakeholders, not just engineers or preservationists, of the available opportunities to use flexibility. For instance, AASHTO's Green Book is often cited as the reason engineers are inflexible, but evidence supports that the Green Book is not the problem. To the contrary, AASHTO affords designers flexibility in selecting design criteria for new construction for classifications of roadways, from low volume local roads to major arterial expressways. There is also a process to support exceptions to design criteria in order to avoid adverse effects when circumstances and mitigation support not using Green Book criteria. Moreover, there is nothing procedurally that prevents states from working with the FHWA to adopt their own design criteria for all roads except those on the National Highway System, like the state of Vermont did in 1997. Additionally, an owner or agency is not prevented from treating designated historic roads or segments differently in terms of applicable design criteria, like the National Park Service (NPS) does. But while opportunities exist to tailor design criteria for new work and for existing roads, it is noted that these criteria are still founded on safety and operational considerations and an understanding of what underlies the values of well-established design criteria.

Likewise, it is a commonly held misconception that preservationists consider everything that is old is historic and that they use the environmental review process to block change and freeze roads and historic districts in time. Review of preservation standards and criteria, like the National Register Criteria for Evaluation that define historic properties, reveals that there is sufficient flexibility to distinguish among properties that are old and those that have historic significance. Additionally, change, albeit change that is thoughtful and sensitive to preserving what makes properties historic, has been the cornerstone of the preservation process since *The Secretary of the Interior's Standards for Rehabilitation* were initially developed in 1977. They serve to direct appropriate treatments for upgrading historic properties, and they are purposely broad to provide the flexibility to accommodate using professional judgment to match individualized solutions with site specifics to achieve an efficient contemporary use.

In addition to the flexibility in the policies, manuals, criteria, and standards that underlie the planning and project development process, there are a variety of means to encourage its use. This includes state mandates, administrative actions, corridor management plans, and the development of good inter-agency relationships where environmental issues like historic resources are identified early in the process, much like the National Environmental Policy Act (NEPA)-U.S. Army Corps of Engineers (USACE) 404 merger process. With approval from FHWA, states agencies can adopt and use different and sometimes lesser than Green Book design criteria like Vermont has done. There is also the opportunity to program incremental work using 3R (resurfacing, restoration, or rehabilitation) design criteria that may be more favorable to cite specific safety improvements on historic roads that are not on the National Highway System (NHS).

1.3.3 Recognize That Old Roads Can Perform Adequately

There is a common misconception that old roads, due to their age and the no-longer current standards to which they were built or improved, are not safe and cannot function adequately to accommodate modern usage. While this may be true, wholly or in part, for some old roads, it is certainly not an accurate or fair generalization. The adequacy and safety of roadways need to be determined on a case-by-case basis. With the aid of recently developed tools, like FHWA‘s *Interactive Highway Safety Design Module* (IHSDM) software program and AASHTO‘s *Highway Safety Manual* (HSM), the current and long-term safety performance of roads can be scientifically determined. Additionally all existing roads have a crash history that can and should be used to evaluate safety performance. And as the research that supports AASHTO‘s policy on very low volume local roads geometry, old and historic roads that do not meet the current geometric standards may still operate satisfactorily.

1.3.4 Use History to Advance, Not Block, Achieving Project Goals

The Section 106 process is intended to identify those resources with historic significance by meeting the National Register of Historic Places Criteria for Evaluation, as opposed to those that are 50 years old and greater and happen to be located in a transportation project area. History, not just advocacy, needs to matter because without a clear and well-developed justification of why a resource meets the criteria and which of its features are distinguished and thus convey that significance, it is difficult for engineers and other stakeholders to understand and then include preservation of that significance as part of the overall project. Effective practices for defining historic roads have demonstrated time and again that a good understanding of what makes a road, and by extension some of its components, significant facilitates developing appropriate ways to preserve them as part of accomplishing needed transportation improvements. Fulfilling an advocacy mission alone often results in design decisions founded more on having a means to affect the outcome of a project than by maintaining history, like mitigation measures rather than preservation of significance.

1.3.5 Understand and Respect Other Disciplines

Outcomes that balance sound engineering with preservation of historic significance are most easily achieved when each perspective starts with respect for the mission and the concerns of others along with a well founded understanding of their policies and criteria. In other words, each discipline is more effective when it understands what underlies the practices of the other and then uses that knowledge to develop ways to balance the two. Understanding the goals and means of others can provide insights that facilitate discussions leading to mutually acceptable solutions. For preservationists in particular, the clearer and more specific the information provided about historic significance, the more likely it will influence a favorable outcome (see Chapters 2, 3 and 4). Likewise, the better a transportation problem is documented and supported, the more efficiently common misconceptions can be overcome and work toward balanced solutions can commence.

1.4 Considerations Critical to Achieving Balanced Outcomes for Historic Roads

Designs that achieve the appropriate balance between historic preservation and sound engineering are typically founded on strategies, or steps, that are already part of current planning and project delivery process. And within that process, there are milestones where, if historic preservation issues have not been considered, it becomes difficult to achieve a balanced outcome. This guidance focuses on four critical considerations that offer the greatest opportunities for outcomes that reflect the consideration of historic preservation in planning and designing improvements to historic roads and in maintaining them. They are (1) incorporating historic preservation from the outset of planning and project development; (2) using professional judgment and inherent flexibility throughout the process; (3) making history matter in decision making; and (4) using an understanding of what underlies the 13 controlling design criteria to identify how to balance sound engineering with preservation. Each consideration is summarized below and fully addressed in separate chapters.

Integrate Historic Preservation from Outset of Planning and Project Development

The single most effective way to achieve balanced solutions resulting in preservation of historic roads, or any historic property, is to include historic preservation considerations from the outset. This includes doing the research and analysis to identify if historic properties are present in proposed project areas during the planning stage, and not looking for them after a preferred alternative has been determined or the purpose and need statement has been defined. It is critical for balanced outcomes to (1) develop a clear and concise purpose and need statement that broadly defines the transportation problem or problems to be addressed rather than state a predetermined solution; (2) support the purpose and need statement with a goals and objectives narrative that memorializes other desirable outcome(s) such as preservation of significant features; and (3) involve stakeholders as participants in developing and evaluating ways to solve transportation problems. Well-defined goals and objectives related to preservation of historic significance also need to serve as criteria in screening and evaluation alternatives, and as a constant and consistent measure for defining when alternatives meet all goals, including the project purpose.

Many agencies talk about the value of consulting early, but in many instances it does not occur, especially for small projects. Early integration of historic preservation into project planning should be the expected practice for all projects involving historic roads.

Use Existing Flexibility to Develop Balanced Solutions

For a variety of reasons some designers are reluctant to use the flexibility available in the current policies and manuals. To overcome inherent reluctance, engineers and owners need to become comfortable with using their engineering judgment and flexibility to tailor highway designs to particular settings and circumstances. Preservationists need to become familiar with the historic contexts of road design and construction in order to better understand what makes some roads historic and how to preserve distinguishing characteristics while accommodating needed change to maintain the road‘s currency. There are many ways to ensure that flexibility is better understood and used, and they include education, leadership, administrative action, rule making, legislation, and case study reports. There is a large body of research and empirical data to support that flexibility does not lessen safety or operations. In the view of AASHTO, established processes and design guidance can accommodate balanced solutions that are not in conflict with safety or tort liability in highway design.

Make History Matter in Decision Making

Roads meet the federal definition of historic for a wide range of reasons, and preserving the distinguishing characteristics that make roads historic are key to maintaining their historic significance. Those characteristics vary from one historic road to another.

Successful projects generally start with all stakeholders understanding and accepting why a specific road is set apart from other as having historic significance. When historic significance is explained in terms of the relative importance of the component features to the overall importance of the resource, that information serves as an invaluable measure for developing solutions that result in preserving the features that make the road historic. Generally not all features of a road are equally important to conveying or preserving its historic significance. Combining an understanding of significance with what needs to be improved sets in motion the collaborative process for developing balanced solutions. While there is no nationally consistent definition of a historic road or which features are distinguished, there are generally accepted practices based on NPS guidance.

Use Understanding of What Underlies 13 Controlling Design Criteria to How to Balance Sound Engineering with Preservation

Understanding how streets and highways are designed plays a significant role in successfully developing a plan for preserving them. Productive collaboration is linked to understanding what underlies the policies and the practices of other perspectives involved in the design process and then using that data set to create solutions that meet engineering and preservation objectives. Since projects on historic roads are driven by transportation, not preservation, problems, solutions that also address preservation will often come from nuanced understanding of the intent of specific design criteria that control highway design – the reasoning behind the values. The same goes for preservation issues, where understanding what makes a particular road historic and how to accommodate needed upgrades without compromising its historic value will drive developing appropriate treatments. For preservation in particular, integration of its concerns and desired outcomes into the planning and project development process needs to be more than reacting to alternatives developed by others. But for both perspectives, knowledge provides the ability to affect outcomes, and knowing how to solve transportation problems in a way that meets multiple objectives effects favorable outcomes.

1.5 Putting it All Together: A Hierarchy for Developing Balanced Solutions

Balanced solutions to safety and operational problems on historic roads are often not immediately obvious given that projects involve roads that have been in existence for decades or are located in settings with constraints. But the process to develop balanced solutions does not have to be difficult if it starts with current and well founded data sets, and all perspectives work together respectfully. Another critical factor in achieving the balanced outcomes is the ability of practitioners and regulators to be flexible and to make appropriate trade offs when required to do so. This does not mean compromising professional judgment or applying lesser standards. It does mean demonstrating a keen understanding of what underlies criteria and conclusions and an ability to consider different ways of solving problems in order to accommodate issues important to others. It also means recognizing that achieving consensus on the way or ways forward involves working with a variety of stakeholders and considering a variety of approaches, some of which may be non-traditional or innovative.

Since the purpose of federal legislation and environmental regulations regarding historic properties is to advance transportation projects without adverse effects, it may be useful to apply a hierarchical approach using this guidance to identify balanced solutions. Such an approach offers several benefits. The protocol can be used to ensure that needed data and an inclusive process are in place to facilitate balanced consideration of both engineering and preservation issues. Having all of the data and issues on the table, so to speak, at the outset of the planning and project development process or at the corridor management level can fulfill an agency's responsibility for screening and assessing all reasonable alternatives that meet the project purpose and need. It also sets up the framework for working collaboratively through alternatives that potentially can preserve historic significance and meet transportation need(s). While the level at which the preferred design is largely controlled by the nature of the transportation problem(s) to be solved, using the hierarchal approach supports the iterative process and generally results in balanced outcomes.

1.6 Hierarchy of Alternatives Matrix

The following hierarchy can be applied to efficiently achieving consensus on large and small projects alike using all of the concepts outlined in the guidance. The most successful use of the protocol is dependent on integrating preservation considerations from the outset of planning and project development, having a broadly defined purpose and need statement, using professional judgment and intended opportunities for applying flexibility and understanding which features are most important to preserving historic significance.

The first steps are founded on the assumption that the historic road features would stay intact while the last two apply when it has been concluded that an adverse effect is unavoidable.

1. When possible, develop traditional alternatives using the appropriate standard design criteria and without adversely affecting historic significance.
2. If the above is not possible (prudent), consider non-traditional alternatives using the appropriate standard design criteria, non-construction mitigation, or a combination of treatments.
3. If the above is not possible and there is no feasible and prudent alternative that avoids an adverse effect to historically significant features, consider developing a traditional alternative with design exceptions, but noting mitigation of the exception may be necessary.
4. If the above is not possible and there is no other feasible alternative, consider developing a non-traditional alternative with design exceptions, but noting mitigation of the exception may be necessary. This consideration may be most applicable to intersections.

The following assume the historic road features would be modified.

5. If the above is not possible, consider developing a traditional alternative using standard design criteria that modify and adversely affect historic features. Consideration of modifications to historically significant features should be prioritized to determine if the purpose and need can be met by changing those historic features with lesser importance rather than those with the most importance to preserving historic significance.
6. If the above is not possible, consider developing a non-traditional alternative using standard design criteria that modify and adversely affect historic features. Consideration of modifications to historically significant features should be prioritized to determine if the purpose and need can be met by changing those with lesser importance first.

2.0 Planning for Balanced Solutions Balanced Solutions: Incorporate Historic Preservation from Project Outset

2.1 Introduction

Advancing transportation projects has moved beyond simply solving for transportation needs. Federal and state environmental protection regulations must be considered, not just those related to historic preservation but also those related to clean air, water quality, migratory birds, wetlands, endangered species, wildlife refuges and noise. As a result, reaching a balanced solution often means weighing the relative costs, benefits and competing values embodied in transportation needs and among the various environmental policies. Fortuitously, historic roads have standing in the planning and project development process under the provisions in the US DOT Act of 1966. This law mandates that federally funded or permitted projects avoid adverse effects to historic properties or demonstrate through a Section 4(f) evaluation that there is no prudent and feasible alternative other than adversely impacting (using) a historic property. Carrying out this mandate is the responsibility of the lead federal agency, most often the Federal Highway Administration (FHWA). Research demonstrates that the law and procedures requiring consideration of historic properties is most efficiently and effectively implemented when their preservation is fairly considered from the outset of planning and project development. This approach starts a project well by establishing an environment where multiple perspectives can work together to develop balanced solutions that meets the specific transportation purpose and the broader goals like preservation and environmental protection.

2.2 Integrating Historic Preservation from the Outset of Planning and Project Development

For any transportation project to end well, it has to start well. The single most effective way to fulfill regulatory requirements and to achieve balanced solutions that benefit historic roads is to identify and incorporate preservation of significant historic features from the very outset of project planning and then to carry it through the design development process as a stated desired goal and as a meaningful measure in evaluating alternatives. This means that from the outset, various disciplines are brought together to work cooperatively to agree on project definitions and to ensure that preservation issues are addressed as a matter of advancing projects. The state of Vermont Agency of Transportation is so sure of this approach that it has been codified in their design standards. There is nothing procedurally that keeps other states from following suit.

In reality, the guidance for projects involving historic roads is no different than the approach to developing any other context-sensitive solution, which is as much a collaborative, iterative process as it is an outcome. The distinction is that for historic roads and roads in historic districts, the important physical manifestations of the past, or what makes the road historically significant, is the historic context used to define the goals and desired outcome, not other goals like beautification, heritage tourism, retaining scenic qualities or economic development.

2.3 Both Perspectives Have Important Roles to Play

Both FHWA and the American Association of State Highway Transportation Officials (AASHTO) have endorsed and enabled planning and project development processes to achieve the balanced outcomes. But endorsement of a process alone does not achieve preservation of historic roads. Balanced solutions are achieved when each constituency has respect for and an appreciation of the goals of other perspectives and demonstrates that understanding by bringing complete, accurate and relevant information to the planning and project development process. This includes well-founded data about why a road is historic and engineering data related to the road‘s condition and specific documentation supporting understanding of specific deficiencies.

Since DOT‘s generally serve with FHWA in their state as the joint lead agencies, they are responsible for interagency coordination and providing sufficient data on both engineering and historic properties to support the decision making process. This includes cultural resources evaluations, engineering data and information relevant to other NEPA issues that are part of the considerations. The efficiency of the process is largely dependent on the quality and completeness of that information. For example, SHPO‘s rarely have the staff to conduct their own research and field investigations, so they rely on the lead agencies to provide them with contextual and site-specific data and analysis of sufficient breadth and quality to facilitate their meaningful participation in the decision making process and to fulfill their obligations under Section 106 of the National Historic Preservation Act of 1966.

A review of the practice demonstrates that preserving historic roads occurs most often when all stakeholders have a clear and well supported understanding of why roads or their context is historic and which of their many elements or components are most important to maintaining that significance. The relative importance of specific road features varies among historic road types and their associative contexts. Understanding which components are vital to maintaining historic significance and which are not frequently informs ways of upgrading or improving without adverse effects. This is the kind of information that lead agencies need to provide to all stakeholders. Similarly, meeting a transportation need is generally most achievable when the information identifying the need for remedial work is documented and well presented. Well-supported reasons explaining the transportation deficiency or deficiencies (safety, mobility, reliability, not a predetermined solution) facilitate fair and balanced analysis of alternatives to achieve the appropriate balance between sound engineering and preservation.

2.4 Define Purpose and Need

The greatest opportunities for achieving balanced outcomes occur at the very outset of planning and project development when the purpose and need are being developed. It is at this stage that so many of the decisions that will influence the final design are made. When considerations like preservation are not included as part of the desired project goals, or purpose and need state predetermined solutions rather than the problem to be solved, the process of achieving balanced solutions can become protracted with a decision amenable to all parties difficult to obtain.

The key to starting out right is having project purpose and need statements crafted to clearly state the transportation issues (mobility, safety, reliability) to be addressed (e.g., the purpose is to improve safety along a highway segment that has a high crash rate). They should not be crafted in ways that focus on solutions or too narrowly constrain the range of alternatives (e.g., the purpose is to widen the road). Clearly identifying the transportation issues that are the purpose or purposes for the project facilitates consideration of a range of reasonable alternatives (Figure 2.1). It also initiates the needed dialogue among stakeholders for the most appropriate ways to meet the need, which might be accomplished using treatments other than widening, especially if they involve historic roads.

Figure 2.1. Importance of Proving Need. A proposed project to improve a county road was initiated without a justified and well supported purpose and need statement. Plans to reconstruct the road were scrapped when the purpose and need for the work could not be justified, but not after effort had been invested in advancing the project and assessing its effect on a segment of the road that had served as part of a road race circuit from 1950 to 1952. Initial cultural resources investigations missed the connection to the road course. Two years into the project, and after work had begun, local opposition forced reopening the Section 106 consultation. The road race circuits were determined National Register eligible and subsequently listed. Eligibility triggered an alternatives analysis, and it was at that point that the purpose and need could not be supported and justified. The reconstruction work was cancelled, and the county went forward doing incremental improvements not using federal funds.

Since transportation projects can achieve other important goals in addition to meeting purpose and need, transportation agencies have the discretion to add other objectives, like preservation of historic roads, as desired outcomes without making them part of the primary purpose. These goals and objectives follow the purpose and need statement and support it by defining additional outcomes and the full range of important factors that should be considered during the decision making process. Goals and objectives serve to refine the range of alternatives that should be considered and as a measure in defining when purpose and need have been met.

The purpose and need statement defines the fundamental reason that a site specific transportation project is proposed. For it to have credibility with the multiple perspectives involved in the project development process, the statement needs to be well supported and understandable using the qualitative and, most importantly, current quantitative data available to transportation planners and designers. For instance, a purpose and need statement to increase the load-carrying capacity of a bridge (operations) located on a historic road should not include widening the road (safety) when the performance of the road is not supported as unsatisfactory. Since historic roads are those with an established performance history, deficiencies should already be well documented. The absence of a crash history may support that there is no current safety problem.

The level of documentation to support the concept definition of purpose and need will vary from project to project, but at a minimum, it should include crash history specific to the project location, cumulative inspection data and predicted safety performance and capacity data generated by the IHSDM and the HSM. It cannot be overstated that the purpose and need for solving transportation problems on historic roads should be well supported and well justified in order to secure stakeholder concurrence that there is a problem that needs to be solved.

Likewise, for historic issues to be an effective tool in shaping final designs, they too need to be well founded and specific to proactively advance a way forward. This includes definition of specifically what makes the road historic so that those distinguishing features can be addressed as preservation goals and objectives and then used again as meaningful measures in evaluating alternatives. When what makes a road historic, like its scale and relationship to features beyond the right of way in historic districts, is not well articulated or understood by all, it becomes difficult to use history as an effective evaluation criteria or the basis for an appropriate design.

As with any project, the initial process of developing consensus also requires stakeholders to acknowledge there is a need for the transportation project. Without it, a project is unlikely to advance smoothly and achieving agreement on a preferred solution can be difficult. Conversely agreement on a problem or problems to be solved and inclusion of preservation of historic significance as a factor in the decision making process establishes the commitment or buy-in by stakeholders to work cooperatively toward a balanced solution as well as a definition of when it has been achieved. Otherwise, preservation of historic significance, along with any other perceived but undefined goal and objective becomes an ever-evolving concept that often delays development of successful balanced designs as stakeholders "discuss" its meaning and intent.

Some considerations to ensure that purpose and need narratives facilitate fair and balanced consideration of historic roads in project development include the following:

- Ensure that the same consideration for a well defined purpose and need statement with supporting goals and objectives is afforded small projects, not just large or complicated ones. Historic preservation cannot figure into developing a balanced design unless it is used as a factor in screening and evaluating alternatives.
- Ensure that data and analysis support the need for a specific project. There may be instances where data and research show that construction solutions are not needed. For instance, absence of crash history may demonstrate that there is no current safety problem. A highway engineering adage is that if you don‘t have a current safety problem or if you don‘t have a current operations problem, then you don‘t have a project (Figure 2.2).
- Ensure that the purpose and need are defined broadly enough to facilitate studying a broad range of alternatives, including meeting other desired outcomes like historic

Figure 2.2. **When Need For Project Is Not Well Supported.** A project to improve an acknowledged poor level of service illustrates the value of a well-supported purpose and need to moving forward and how non-construction treatments can support balanced solutions. Located in an urban setting of complicated intersections of an arterial street and park drives, major medical facilities, and museums, the designers sought to ―uncomplicate” the street pattern by straightening some streets and adding others to increase flow capacity through intersections. The park is National Register listed with its meandering drives, now collector streets, and associated bridges are important to conveying its significance. Part of the proposed improvements was to use poor stopping sight distance as justification for straightening a winding street and aligning it with a new segment across the park proper to create a standard urban intersection. This also included removing two historic park bridges. There was no crash history to support a stopping sight distance problem, and the bridges are both wider than the streets. At a field view, historians explained the significance of the roads and bridge and suggested that selected removal of overgrowth on the inside of the curve would improve sight distance, thus eliminating the need for a construction solution. Since the need and purpose for this component of the plan could not be supported, other alternatives that better integrate historic significance into design solutions are being developed.

preservation. The goals and objectives also need to be defined broadly enough to facilitate solving transportation problems while respecting historic significance.

- Ensure that transportation problems have been analyzed from the substantive safety perspective as well as the nominal perspective. For 2-lane rural roads, comparisons are possible using the HSM.
- If there are gaps in data supporting purpose and need, the research and analysis to address insufficient or out-of-date information should be completed. This can include technical reports and sophisticated analysis, as well as analysis of historic context to support identifying distinguished characteristics that merit preservation in order to maintain historic significance.
- Ensure that historic significance is well summarized and in sufficient specificity for all stakeholders to be able to use it to support project goals and objectives.

2.5 Integrating Historic Significance into Planning and Alternatives Analysis Stages

Planning and alternatives analysis is where critical decisions are made about selection of design criteria and which alternatives will be developed to determine the preferred alternatives or designs. In order to have a meaningful influence on design decisions, specific preservation goals and objectives need to be integrated at this stage. One of the most effective is to integrate historic preservation considerations is to use the goals and objectives narrative to memorialize desired outcomes and how history be used in decision making. That is most effectively accomplished by establishing how historic significance will be used as an evaluation criteria, or measures, for determining the range of alternatives that should be considered and how analysis of alternatives will assess preservation as it relates to meeting the project‘s purpose and need. The evaluation criteria can also serve as a key factor in defining "prudence" under Section 4(f) of the US DOT Act. Memorialized preservation goals and evaluation criteria can also be important tools when tradeoffs are necessary to meet the transportation purpose and need. When preservation goals and evaluation criteria are not integrated into the planning and alternative analysis stages, it can be difficult to determine which alternatives are reasonable, prudent or practicable or if all reasonable alternatives have even been developed.

Since decisions on what alternatives to develop and how they will be analyzed are often the most important and the most disputed among stakeholders because of their influence on selection of preferred alternatives, it makes practical sense to be proactive and include them in purpose and need narratives. Screening criteria need to be broad enough to accommodate historic factors, not just transportation. And even though preservation is a secondary goal and objective to the transportation purpose, it is nevertheless a factor that is critical in decision making, particularly in developing and evaluating a full range of alternatives that consider preservation. For instance, alternatives that meet the purpose and need can still be rejected as unreasonable on the grounds such as having adverse effects on important features of historic roads or roads in historic districts (Figure 2.1).

Defining how the evaluation criteria will be applied can be accomplished in several ways. It can be a formal protocol or methodology stating how preservation and other environmental issues or values will be applied and if weighting or prioritizing factors will be included. In many instances, particularly for smaller or less complicated projects, it is appropriate to use *The Secretary of the Interior's Standards for Rehabilitation* as the evaluation criteria.

To be most useful, all stakeholders need to be mindful of what is the appropriate range of alternatives to be studied. Under NEPA, "all reasonable alternatives" can potentially mean a very large number. This is determined through "screening" to identify the reasonable ranges and those within the range for detailed study. Reasonable alternatives are those that are feasible from a technical and economic standpoint, rather than simply desirable from the standpoint of the applicant. Not meeting the purpose and need is defined as an unreasonable alternative. If several alternatives meet the purpose and need, then the one with the least environmental impact that meets the project goals and objectives can be determined as reasonable and the others unreasonable.

The criteria become all the more important in the project development process because there is no inclusive 4(f) definition of what is prudent and what is not; it varies from project to project based on the purpose and the need, the existing conditions, and the desired project outcome. What is a prudent decision in one circumstance may not be for a similar project for a variety of reasons, ranging from cost to social or other environmental considerations.

To facilitate advancing projects through the NEPA process using a holistic approach, FHWA has defined a feasible and prudent alternative as one that "avoids using Section 4(f) property [like a historic road] and does not cause other severe problems of a magnitude that outweighs the importance of protecting the Section 4(f) property" (23 CFR Part 774.17). The regulations also make it appropriate to consider the relative value of the resource when assessing the importance of protecting the Section 4(f) property. Through codification (CFR 774.17), FHWA provides instances of when an alternative is not feasible and prudent.

- It compromises the project to such a degree that it is unreasonable to proceed with the project in light of its stated purpose and need;
- It results in unacceptable safety or operational problems;
- After reasonable mitigation, it still causes:
    - Severe social, economic, or environmental impacts;
    - Severe disruption to established communities;
    - Severe disproportionate impacts to minority or low income populations;
    - Severe impacts to environmental resources protected under Federal statutes;
- It results in additional construction, maintenance, or operational costs of an extraordinary magnitude;

- It causes unique problems or other factors;
- It involves multiple factors in paragraphs above of this definition, that while individually minor, cumulatively cause unique problems or impacts of extraordinary magnitude.

2.6 Using Established Preservation Guidance to Determine Effect and Define Prudence

One of the consistently most effective measures of the effect of proposed work on historic properties, as well as its prudence, is *The Secretary of the Interior's Standards for Rehabilitation*. Initially developed by the National Park Service in 1977 to apply to buildings, the codified standards proved to be so sound and broadly applicable that in most states, they serve as the criteria against which proposed undertakings for all types of historic properties are evaluated. As a general rule, if rehabilitation is done in accordance with the *Standards*, then it will be determined under Section 106 to not have an adverse effect. In 1995, the rehabilitation standards were augmented to include other treatments commonly associated with historic properties - preservation (maintenance), restoration and reconstruction - and a restyled *The Secretary of the Interior's Standards for the Treatment of Historic Properties* was issued. The treatment most commonly associated with improving transportation facilities is rehabilitation, but the other treatments can also be appropriate. Preservation is often the treatment for maintaining historic roads and significant features associated with historic districts.

Generally projects involving historic roads and roads in historic settings are rehabilitation because of their dynamic nature subjects them to any number of demands from accommodating increased usage to the effects of environmental degradation. The operative word in appropriately interpreting *The Secretary of the Interior's Standards for Rehabilitation* is "rehabilitation." It is defined as "the process of returning a property to a state of utility, through repair or alteration, which makes possible an efficient contemporary use while preserving those portions and features of the property which are significant to its historic, architectural, and cultural values." Since the standards acknowledge that change is part of keeping historic properties viable, they intentionally provide for flexibility in decision making so that solutions can be matched to specific conditions. They are not intended to be used to prevent appropriate change or freeze settings or facilities in their current state.

The rehabilitation standards consists of ten common-sense directives that balance retaining significant features and original fabric while appropriately accommodating the repair or alteration needed in order to affect keeping the property in use. They emphasize repair over replacement and limited rather than wholesale changes to accommodate improvements in order to preserve those qualities for which a property is National Register listed or eligible. Because of their intention to balance change with preserving historic significance, the standards can and should be used as the evaluation criteria for evaluating the alternatives and the measure to determine which meet project need and broader goals without an adverse effect or have the least overall harm. Their integration into the project development process has the added advantage of fulfilling environmental laws and regulations. Since application of the standards addresses the same considerations needed to inform Section 106 determinations of effects, their use as a meaningful measure of developing the final design facilitates efficiently completing the Section 106 effects report, as well as the Section 4(f) evaluation. The types of information these documents require will have already been completed.

It is important to not lose sight of the fact that there will be instances where the best preservation solution will still result in a procedural finding of an adverse effect. This is because the codified criteria of effect and adverse effect are the most narrowly defined criteria applied to preservation of historic resources. For example, moving a bridge is defined as an adverse effect, yet historically metal truss bridges have routinely been relocated since the last quarter of the nineteenth century. Today, relocating a historic truss bridge so that it can be rehabilitated for an adaptive use is a well-established preservation treatment, yet it is defined in 36 CFR 800.5 as an adverse effect. Still, practitioners should strive for the best outcome, even when the solution is determined, based on the codified criteria, to have an adverse effect.

2.7 Value of Early Assessment of Environmental Risks

Conducting a field view to screen for environmental risks early in the planning and project development process has proven to be an effective planning strategy for historic properties, including historic roads. In addition to providing an understanding of the historic context and site characteristics, the field view affords an opportunity for candid and informal discussions among agency planners, project managers, environmental coordinators, cultural resources personnel and SHPO staff before presumptions and preferred outcomes are formulated or agendas have been set. Environmental "red flags" or risks can be identified and discussed, and discussions can be relayed back to owners and managers in a proactive and non-threatening manner. Optimally this informal field view occurs early in the planning process as the purpose and need is being considered and refined.

A common byproduct of joint field views is an understanding of the "lay of the land" that often triggers thinking about alternative ways to solve transportation problems. Being in the field and experiencing deficiencies firsthand increases awareness of the purpose and need that in turn will be reflected in appropriately defining or refining the purpose and need statement.

2.8 Scope Projects Correctly

How projects are scoped can make a significant difference in outcomes for historic roads or roads in historic districts. Since historic roads are existing older roads, much of the work is for reasons other than addressing geometry and therefore may be more appropriately considered a resurfacing, restoration or rehabilitation (3R) project rather than new construction. State transportation agencies generally have developed 3R design criteria that are specific to the needs of their jurisdiction for all types of highways, except those on the National Highway System (NHS).

Planning for Balanced Solutions Sources

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3.0 Many Routes Go In the Right Direction: Using Inherent Flexibility

3.1 Background on Using Inherent Flexibility

For any transportation project to end well, it has to start well. For projects involving historic roads, one of the most important factors in starting out correctly is for engineers and historic preservationists to understand the decision making flexibility available in their policies and procedures and then to apply it to develop site-specific, balanced solutions. Using available, or inherent, flexibility facilitates fulfilling the transportation need while achieving broader goals and objectives, like preserving distinguished features that convey historic significance. This concept is not new and is a well-established practice. Consideration of issues other than the cost and efficiency of improvements has been part of our national approach to project development since passage of the US DOT Act of 1966 and the National Historic Preservation Act in 1966. Since then, associations such as American Association of State Highway Transportation Officials (AASHTO), transportation agencies, state legislatures, and Congress have provided an ever-increasing range of tools and opportunities for transportation projects to reflect a variety of considerations and values in their outcomes beyond the most cost effective transportation solutions. For example, starting with passage of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), Congress has emphasized preservation of environmental and cultural values affected by transportation facilities. This includes the meaningful participation of a wide variety of stakeholders, such as those concerned with the built and natural environment, in defining project need and the finished appearance of transportation projects.

Using flexibility in determining design values and outcomes is consistent with current federal and AASHTO guidance on how transportation projects should be advanced. Repeatedly, NCHRP and TRB research and reports have supported the soundness of the concept, and it has been validated by the successful approaches used to preserve seminal roads like Connecticut‘s Merritt Parkway or Oregon‘s Columbia River Highway or Vermont‘s policy that all highway improvements will be appropriately scaled for their setting. Ongoing research and case studies continue to demonstrate that using inherent flexibility and professional judgment does not imply any lessening of safety or less-than-acceptable design values. The approach is also consistent with the current emphasis on substantive safety and performance-based solutions.

The means to use flexibility and professional judgment in decision making is present in any number of state and federal programs, from states being able to develop their own design criteria to best meet their site-specific needs to the policy on very low volume local roads that has been incorporated into the AASHTO‘s *A Policy on Geometric Design of Highways and Streets*, commonly known as the Green Book. It is also supported by guides and manuals, like AASHTO‘s *A Guide to Achieving Flexibility in Highway Design* (2004) and it‘s *Guidelines for Historic Bridge Rehabilitation and Replacement* (2008*)*. The 2010 AASHTO *Highway Safety Manual* provides a tool to quantify safety and the severity of crashes by providing information relative to the long-term safety performance of specific designs and site conditions. States and municipalities both have endorsed using flexibility and adopted a variety of tools for achieving balanced solutions, from legislative mandates to state design criteria.

While ways to be flexible are inherent in current policies, criteria and manuals, the means is not; that is provided by leadership. In the introduction to its *A Guide for Achieving Flexibility in Highway Design*, AASHTO states that it "supports the concepts and principles of flexibility in highway design and believes that all professionals responsible for highway and transportation projects should understand how to accomplish flexible design solutions within current design processes and approaches." If flexibility is to be a useful tool in developing balanced solutions, leadership at the federal, state, and local levels needs to promote an environment that encourages its use. Leadership also needs to expect using flexibility is how all projects involving historic properties, including historic bridges and roads, will be advanced.

Ways to encourage and convey permission to use flexibility throughout the planning and project development and environmental review processes are as varied as are its sources; there is no one-size fits all approach or prescribed answer for specific needs. For projects involving historic roads or roads in historic districts, from functionally deficient bridge width to the need for additional lane capacity to improve operations, there are generally multiple ways to address the transportation need and preserve historic significance.

3.2 Ways to Use Inherent Flexibility

3.2.1 **Legislative Mandates**

To ensure that cultural values and distinguishing characteristics are retained, some state legislatures and municipal governments have passed laws stating specifically how certain roads or classes of roads will be treated. Such legislation can carry the weight of settled law, and they direct transportation agencies on how projects should be advanced, thus transferring tort liability considerations in part from transportation agencies to the legislative branch itself. The advantages of legislative actions are many, but in general, they result in defined processes and climates where multiple disciplines are mandated to proactively work together toward the long-term historic preservation of roads. Legislative mandates can be as broad as Vermont's statewide design criteria or as specific as Tampa, Florida's ordinance mandating preservation of its remaining brick-paved streets. Nationally one of the most famous legislative mandates is Hawaii's protection of named historic and scenic rural roads, including Maui's Road to Hana, from being improved using "conventional highway design." This is accomplished by adopting flexibility as the policy for those roads and providing liability immunity (Figure 3.1).

Figure 3.1. Road to Hana. In 2005, the Hawaii state legislature passed legislation to protect the Hana Highway and other named historic and scenic rural roads. The state act is founded on using the design flexibility enabled by AASHTO and FHWA. It also provides for immunity from liability. The winding, 68-mile long Hana Highway is a popular tourist destination complete with many natural and historic attractions along the way, not to mention the technological feat of building the road in 1908.

In Oregon, the state legislature enacted a law enabling the preservation and enhancement of the Columbia River Highway Historic District. This legislation gives the State Transportation Agency permission to do what is necessary, including acquiring property, to preserve the scenic 1910s roadway and its setting for limited vehicular and recreational use, and it calls on the agency to work with a structured advisory committee and other agencies. Over the past two decades, a series of projects involving federal, state, and local participants have been instrumental in restoring and reconnecting the highway, which is also noted for technological innovations such as its grade and curve standards, reinforced concrete bridges, and Warrenite asphaltic concrete pavement. Funds from the 1986 Columbia River Gorge National Scenic Area Act (Public Law 99-663) and federal highway sources have been important to the conservation and rehabilitation effort. The level of significance for the Columbia River Highway is considered so high that extraordinary measures to preserve it were deemed justified, and the collaborative and cooperative effort has been successful. The highway, a National Historic Landmark, ranks as one of the nation‘s premiere scenic highways and is often held up a model for preservation of a state-agency administered historic road (Figure 3.2).

In order to provide ―clear technical direction" to designers, the Vermont State Legislature passed design standards in 1996 that include sensitivity to the social and environmental context of the state for all projects on all classifications of roads. This includes historic preservation of roads, road features, and historic settings through which roads pass. Design criteria are arranged by roadway classification and provide *Special Design Guidelines* to help designers avoid, minimize, or mitigate negative effects and better fit the improvement to its setting. In some instances the design values in the design standards are lesser, and in others they are greater than previous state and AASHTO guidance.

Figure 3.2. Historic Columbia River Highway Preservation. The success of Oregon DOT's efforts to preserve the Columbia River Highway illustrates what can be accomplished when multiple disciplines cooperate on achieving a legislated mandate – preservation of an iconic American engineering achievement. Here the historic design of the wood 1920 Standard Guard Fence seen in the historic view of the highway is recreated using a steel-backed wooden railing system. However, the new railing has larger-dimension lumber than the original railing and is backed by galvanized steel plates and uses heavy nuts and bolts rather than spikes. To ensure its safety performance, it was tested and certified for crashworthiness at 50 mph by the Texas Transportation Institute in 1993. Since then the standards have changed, but ways to modify the fence to meet NCHRP 350 criteria are being investigated by ODOT. Modern photo courtesy, Robert Hadlow, Oregon DOT; Cross & Dimmitt postcard view courtesy columbiariverhighway.com.

3.2.2 Administrative Actions

Administrative action by agency leadership can be used to define how specific features or types of projects will be treated. They can be as precise as New Hampshire DOT's 1990 Roadside Stone Wall Reconstruction Policy that makes reconstruction of stone walls an allowable project activity (Figure 3.3). Or, they can also be the dominant approach to highway design throughout the state, like the Missouri Department of Transportation's 2005 "practical design" policy that emphasizes using flexibility and creativity for cost-effective, balanced solutions. More and more states, like Ohio, are moving to a "fix-it-first" administrative approach to maintaining transportation facilities. The practice is proving to be particularly effective as a way to conserve roads and roadside features that are performing satisfactorily by using performance-based rather than standards-based design criteria. This approach is not only good for historic roads; it is also

Figure 3.3. The dry laid rubble stone wall located near Chichester, NH was reconstructed in 1993 in accordance with the state DOT's administrative policy on rebuilding stone walls parallel to roadways. Photograph courtesy of Marc Laurin, NHDOT.

cost effective for projects that do not require major horizontal or vertical realignment as supported by the large body of research outlined below.

Missouri Department of Transportation "Right-Sizing"

In 2005, the Missouri Department of Transportation (MDOT) implemented its design policy to make practical design, also known as "right-sizing," the dominant approach to highway design throughout the state. The focus of establishing project design criteria begins with the project purpose and need and the context of the road's surroundings (urban or rural) rather than striving toward maximum nominal values and standards based on road classification. The policy encourages designers and decision makers "to think outside the box" and develop the best value for the least cost while improving safety.

MDOT's manual establishes desirable values and design guidance with constant emphasis on not over-building while improving safety. Even though their policy does not specifically address the environmental planning framework or types of settings beyond general categories of urban or rural (e.g., wetlands, residential, commercial, historic districts, etc.), it does encourage collaboration among multiple perspectives and using inherent flexibility. The surrounding environment, which could include a historic road corridor, helps to define project-specific design criteria.

Massachusetts Department of Transportation Footprint Roads Program

The Massachusetts Department of Transportation's Footprint Roads Program is applicable to roads demonstrated to be safe and where the needed work can be accomplished within the existing right-of-way or footprint, including historic roads and those in historic districts. It is intended for projects that generally are not addressing geometric deficiencies or are not located in "high-hazard" areas. The "permission" to retain existing geometry is based on the assumption that if the road is performing well, then it is not necessary to upgrade it to meet current values. Work that can be done under the footprint program includes drainage, signing, guide rail, treatment of the roadside, and placement of sidewalks and bike lanes.

Connecticut Department of Transportation Merritt Parkway Policy

In 1994, the Connecticut Department of Transportation's administrator declared it policy that the National Register-listed, late-1930s parkway would receive corridor-specific treatments. The agency also committed to not increase the capacity of the limited-access parkway, which is located in a densely populated part of the state. The agency worked with a multi-discipline stakeholder committee (working committee) to develop a landscape master plan and guidelines for general maintenance and transportation improvements intended to guide future work within the landscaped parkway reservation. The committee concentrated on addressing the overriding safety issue of the severity of roadside crashes through a series of treatments including increasing the shoulder width from 2 feet to 4 feet, placing an aesthetic traffic railing (steel backed timber that meets NCHRP 350 criteria), and removing identified high risk trees. Key to the success of making the highway safer while preserving its seminal significance has been involving multiple perspectives in the development of mutually acceptable treatments and addressing documented safety problems with site-specific solutions rather than corridor-long, standardized solutions.

3.2.3 Using Resurfacing, Restoration, Rehabilitation Design Criteria (3R)

Changes in federal aid policy in 1976 allow states to use federal funding to extend the life and improve the safety of existing roads while retaining their characteristics and without the cost of full roadway reconstruction. Known as 3R (resurfacing, restoration, or rehabilitation), it is widely used for repaving existing roads. However 3R work can also include incremental safety improvements, like widening pavement where it is limited to less than a lane width, rehabilitating short segments of pavement with partial-depth repairs, and targeting safety improvements to existing highways that are otherwise performing adequately. 3R cannot be used to add lanes. Since historic roads are most often existing roads, much of the work to them is incremental in nature and, therefore, could appropriately be considered 3R rather than new construction.

Any state transportation agency, with approval from FHWA, may develop 3R design criteria tailored to the specific needs of their jurisdiction for all types of highways, except those on the National Highway System (NHS). Most states have 3R design criteria and policies that may provide opportunities to improve the safety performance of historic roads while preserving their essential features.

3.2.4 Guidelines for Geometric Design of Very Low-Volume Local Roads

The guidelines recognize the unique needs of very low volume local roads and matches decisions about road geometry and bridge width to current performance and the cost-effectiveness of proposed work. Now part of Green Book policy, the approach uses risk assessment and cost benefit of safety improvements as the basis for rehabilitation and new construction decisions rather than full design criteria on local roads with average daily traffic (ADT) of less than 400. If the road is performing satisfactorily, then upgrading it is not needed; existing values may remain. The policy is particularly relevant to historic roads or roads in historic districts because many are often very low volume local facilities, and they have a performance history.

The AASHTO policy and guidance are founded on NCHRP's 1994 *Report 362* that demonstrated less-stringent standards for existing roads could save money without compromising safety. The study represents a watershed in thinking about safety and design criteria, and it has probably done more to promote flexibility in highway design and thinking about what really underlies Green Book design criteria than any other research to date. Its adoption by AASHTO speaks to the commitment on the part of highway designers and facility owners to consider sound and supported approaches to design decisions and to accommodate different values for different circumstances, like very low-volume historic roads and roads in some rural settings.

3.2.5 Use Substantive Safety as Basis for Design Criteria and Decision Making

When working with historic roads or roads in historic settings, it is particularly important to recognize the difference between nominal and substantive safety because of the effect that the two can have on defining design values. "Nominal" means that when design values for specific roadway elements are consistently met, then a road is considered safe for the long term. If a value is not met, a road is typically considered unsafe. But what does that mean? Is the road as safe as it can be? Is it as safe as it should be? Or is it as safe as the budget permits? Since nominal values are typically a blend of operational and safety considerations reduced to a single required value, or range of values to be considered safe by engineers, the safety within a given nominal value cannot be quantified to predict how many accidents and their severity may occur in the future.

Substantive safety is the long-term or expected safety performance of a roadway based on comparison of models and statistics for locations with similar characteristics. It provides the actual numbers of predicted accidents, their type and their severity. By using substantive safety, the degree to which a specific design may be safer than others can readily be measured and compared. In the past it was not always possible to determine substantive safety. With AASHTO's 2010 release of the Highway Safety Manual (HSM) and its supporting Interactive Highway Safety Design Module (IHSDM), techniques and methodologies are now available to predict long term safety performance by quantifying crash frequencies and their severities as well as side-by-side comparisons of existing and changed geometry.

In actual experience, the road's level of performance will vary based on one of any number of factors related to the context and type of highway and its geometry. Current understanding of the relationships among many factors supports that the true safety risk is better represented by substantive safety and that analyzing it should be part of the decision making process rather than relying on nominal design criteria values alone. The benefits of quantifying safety are many. The Highway Safety Manual and its supporting software can be used to quantify whether or not proposed changes to historic roads will produce the expected improvement to long-term safety performance. It moves decision making beyond assumptions about the safety associated with nominal values and enables owners, managers and designers to calculate the cost of safety when deciding to retain or modify historically significant roadway features, like trees and walls along the right of way or intersection design.

3.2.6 Use Interactive Highway Safety Design Module and Highway Safety Manual to Support Changes to Geometry

AASHTO and FHWA have developed tools that can quantify the safety and operational effects of geometric design and support using flexibility in decision making. The *Highway Safety Manual (*HSM) offers advisory guidance that brings science and statistical analysis to quantifying safety. It enables designers and all stakeholders to determine quantifiably what effect on safety proposed changes will make. The manual is linked to FHWA's *Interactive Highway Safety Design Module* (IHSDM), a suite of software that is used as an analytical tool to predict long term safety performance for all roadway types except freeways. It checks existing and proposed designs against relevant design policy values and provides expected safety (substantive safety) and operational performance. Because the IHSDM facilitates checking the long-term safety performance of both current and proposed geometric design, modifications to existing roads can be evaluated for their substantive safety rather than relying on assumptions about the safety of nominal values. The IHSDM software is free and can be downloaded from http://www.fhwa.dot.gov/ihsdm/.

3.2.7 Context-Sensitive Solutions

Over the past decade, the context sensitive design/context sensitive solutions (CSD/CSS) approach considering projects as more than efficient transportation solutions has come to be recognized as an effective methodology for advancing a wide variety of projects, including those involving historic roads. Since 1991, AASHTO has consistently endorsed CSD/CSS. It underlies federal highway-related legislation and gives permission to project managers and designers to put effort into developing solutions that fit with their setting or historic context, even if they cost more than the most efficient solution. It is increasingly becoming the way transportation agencies do business and is the approach recommended for all projects involving historic roads, whether they are small or large.

CSD/CSS is not so much a specific design outcome as it is a defined, reiterative process by which transportation agencies work collaboratively with multiple perspectives to equally address safety, mobility, and for historic roads or roads in historic settings, historic preservation of significant characteristics. The approach provides the opportunity to address what needs to be preserved and why it is important as part of the planning and early project development process when that information can have the greatest effect on the outcome. Using the SCD/CSS approach can also result in advancing projects more efficiently.

Some practitioners consider CSD/CSS as highway "beautification" in a different guise. From the historic roads standpoint, it is worth cautioning that typical commonly used CSD/CSS treatments, such as the use of traffic calming devices, roadside landscaping, or the use of form liner finishes that mimic historical materials like stone are not historic preservation. Such treatments are more appropriately considered as beautification rather than preservation or conservation of distinguishing historic features. The more appropriate approach for historic roads and roads in historic districts is to reflect historic context in design solutions, and those that meet the Secretary of the Interior standards, is to use compatible contemporary treatments that blend in with the historic character and scale of the historic setting rather than ones that compete with it (Figure 3.4).

3.2.8 Tort Liability and Flexibility

Fear of tort liability can contribute to reluctance by some to use inherent flexibility. The purpose of this general discussion is to demonstrate that while tort liability should be considered, it should not be an impediment to decision making that balances sound engineering with historic preservation of what makes roads historic. It is a well-established principle that tort liability is not an acceptable rationale for selecting the highest design values and rejecting the flexibility inherent in the range of design criteria found within AASHTO's Green Book and state design guidelines. Nor does fear of tort liability override public policy objectives embodied in national and state legislation on environmental and cultural resources protection, including the National Historic Preservation Act of 1966 and federal transportation legislation, such as the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) of 2005. This act emphasizes consideration of the environmental, scenic, aesthetic, historic, and community impacts of highway projects. There is an ample range of federal and state legislation to make preservation of historic roads or historic settings a legally legitimate and defensible goal.

Court decisions at the federal and state levels have upheld design decisions that balance many factors, including aesthetics, environmental impact, historic preservation, and available financial resources. For instance, in *Bowman v. United States*, Federal courts determined that a design decision not to place guide rails along a certain section of the Blue Ridge Parkway had been weighed carefully and appropriately, balancing many factors, such as safety and the effect on the historic parkway. In *Helton v. Knox County, Tennessee*, the Tennessee Supreme Court upheld the county's decision not to install standard guard rails based on cost and concern for the preservation of a historic bridge.

Figure 3.4. When history is the context, then history, and not conjecture or beautification, should be used to inform the design of new features, particularly in historic districts. In an attempt to blend into historic settings, applied decoration is often used to make the road-related features look like something that it is not as illustrated by the replacements of straightforward encased stringer bridges (A) located in a late-19th and early 20th-century market and proto-industrial town that is a National Register-listed historic district. A variety of stock trim items and stone veneer have been applied as decoration to standard box beam bridges, and this in an area where stone is historically not plentiful and was rarely used for bridge superstructures (B, D). The historic iron railings, originally and logically located at the cub line, have also been used as part of the decorative scheme. Because the decoration creates a false sense of history, the new bridges do not compliment their historic setting or reflect the historic significance of the district. Decorated treatments like these should be avoided. Well-proportioned modern bridges, much in the spirit of the ―modern” bridges they replaced, is the approach recommended in the Secretary of the Interior‘s guidance. Additionally, consideration should be given to quietly complimenting historic settings, not competing with them. That generally encourages restrained treatments that let the historic character dominate, like the new highway through and over old Yuma (C). Photographs M. McCahon.

Practice has demonstrated that the best defense against tort liability is procedures for thoroughly documenting design decision processes that balance safety with other goals, like the preservation of significant features of historic roads. Most transportation agencies already have in place such documentation procedures to demonstrate that the nominal and substantive safety aspects of the design were evaluated with a thorough assessment of the selected design values. Project documentation should also thoroughly describe the physical and environmental factors that make the chosen design necessary, including decisions to preserve distinguishing characteristics that make roads historic. Typical information that should be collected and evaluated includes, but is not limited to, a description of existing highway conditions and those features that make the road historically significant through an objective application of the National Register criteria and a thorough description of the work that would affect those features. It should also include crash data for at least the previous three years, cost analysis, discussion of any adverse impacts that would result from meeting current or higher value design criteria, and safety enhancements that would be made to mitigate the effects of non-standard features.

3.2.9 **Use National Park Service Guidance to Integrate Preservation**

Starting in the mid-1970s with *The Secretary of the Interior's Standards for Rehabilitation,* the National Park Service (NPS) has promulgated preservation guidance for rehabilitating historic properties that emphasizes repair over replacement and limited rather than wholesale changes to accommodate keeping them viable and in use. Their standards and guidelines have come to be the definition and measure of appropriate approaches to working on historic properties, and they provide a useful framework for developing design solutions that include historic preservation of essential features. The standards were initially developed for buildings, but their broad applicability to all types of historic properties has stood the test of time. They have come to be the evaluation criteria for determining if work will have an adverse effect or not. The rehabilitation standards have been revised several times, and in 1992 they were augmented by *The Secretary of the Interior's Treatment for Historic Properties*[1] that added standards for preservation, restoration, and reconstruction to rehabilitation. What has not changed is their reality-based, common sense direction on how to address those distinguished attributes and physical features for which a property was demonstrated to be historic. They also provide guidance on new construction and adding new features.

Flexibility was purposely built into *The Secretary of the Interior's Standards for Rehabilitation* with the intention of promoting appropriate preservation solutions rather than freezing properties

[1] *The Secretary of the Interior's Standards for Historic Preservation Projects* were initially prepared in 1979 by W. Brown Morton III et al. They were subsequently updated and expanded to include *Guidelines for Rehabilitating Historic Buildings* in 1983. They were revised again in 1990 and 1992. Detailed information about the standards for rehabilitation is contained in1991 (reprinted 1997) *The Secretary of the Interior's Standards for Rehabilitation and Illustrated Guidelines for Historic Buildings* by W. Brown Morton III et al and the 1995 *The Secretary of the Interior's Standards for the Treatment of Historic Properties with Guidelines for Preserving, Rehabilitating Restoring & Reconstructing Historic Buildings* by Kay D. Weeks et al. Both are National Park Service publications.

in time or precluding change. Indeed, the *Standards* confirm that historic properties must be updated to remain current and viable, and they prescribe ways to make improvements and preserve historic significance. The most common treatment for maintaining historic roads is rehabilitation, and it is defined as "the process of returning a property to a state of utility, through repair or alteration, which makes possible an efficient contemporary use while preserving those portions and features of the property which are significant to its historic, architectural, and cultural values."[2]

In many ways, the Secretary of the Interior‘s treatment and standards are the historic preservation equivalent of the Green Book in that they outline a hierarchy of treatments and a range of values. The guidance starts with conserving historic fabric whenever practical, then making any needed replacement in kind or making needed new work or features compatible in scale and finish. Note that recreating false history does not meet any of the *Secretary of the Interior's Treatment of Historic Properties* or the *Standards for Rehabilitation*. The guidance encourages adding to, rather than taking away from, meaning that placing a modern but compatible design traffic barrier in front of a historic railing in order to preserve the historic railing can be an acceptable solution and one that does not have an adverse effect (Figure 5.18).

3.3 Memorandum of Agreement and Programmatic Agreement

The Memorandum of Agreement (MOA) and the Programmatic Agreement (PA) are widely accepted and useful tools that transportation agencies use to formalize acceptable systemic approaches and treatments pursuant to Section 106 of the National Historic Preservation Act. They are used to implement regulations codified in 36 CFR Part 800. The difference between a MOA and a PA is that a MOA is typically historic property specific and a PA covers a range of activities associated with a class of resource or a specific historic property like a particular historic road. MOAs and PAs are binding, signed agreements negotiated among the FHWA, the Advisory Council on Historic Preservation, state transportation agencies, the SHPOs, and other participating parties such as municipalities and community stakeholders.

There are many forms of PAs related to historic roads. Most states' transportation agencies work within PAs that cover minor project categories such as roadway resurfacing or minor drainage improvements. The agreements are intended to make efficient use of resources and streamline processes that under most circumstances are unlikely to have any impact on historic resources. Typically they also spell out which kinds of projects require greater levels of effort and consultation to identify cultural resources and the potential effects on them.

For instance, the New York State Department of Transportation (NYSDOT) has a PA that covers a range of activities associated with the maintenance and improvement of the Taconic State Parkway, a National Register-listed, 100-mile long scenic highway developed in phases between

[2] U.S. Department of the Interior National Park Service. The Secretary of the Interior‘s Standards for Rehabilitation, 1995.

1927 and 1963. This PA came about as a result of a series of on-going NYSDOT tasks to address safety and operational deficiencies and concerns. It covers specific activities and divides the parkway into segments where different approaches will be used based on operational characteristics such as heavier traffic volumes on the southern end and the greater opportunities to retain distinguished roadway features at the less congested, rural northern end. Some of the activities covered by the PA include placing barriers designed in deference to and complementing the parkway‘s historic character, adding lanes to increase capacity, lengthening of acceleration and deceleration lanes, and modifying the median to improved safety and lessen the likelihood of cars crossing into opposing lanes. The PA has proven to be useful to practitioners because of its level of specificity regarding the treatment of physical features of the parkway that were identified as important to maintaining historic significance (Figure 5.19).

An MOA is developed when a project is determined to have an adverse effect on a historic property, including to a historic district. MOAs contain a series of stipulations that have been negotiated among the parties, and they must be carried out by the implementing agency. For example, the MOA for the reconstruction of Paris Pike through the historic district near Lexington, Kentucky, stipulated the process by which the reconstruction design development would take place and the creation of a task force with representatives of various engineering, planning, and historic preservation perspectives; objectives and a schedule; the qualifications and process by which design consultants would be selected; and treatments for specific features related to the road‘s historic significance including stone walls, gates, and buildings. Since the significant features of the historic district were largely beyond the road and how the road related to the landscape rather than the road itself, the MOA correctly focused on issued that maintained the relationship of the road to its setting (Figure 3.5).

A concept that is gaining currency for transportation projects is to use the extra effort that incorporating preservation goals and objectives often entails, as the mitigation for any adverse effect. Since the stated intention of the environmental laws is to minimize harm, the additional analysis done to achieve that goal as part of the overall project may prove to be the most effective means to mitigate an adverse effect. When significance has been adversely affected, it is generally preferable for the mitigation to improve new design rather than attempt to create a false sense of history. The all-too-common practice of decorations mimicking period treatments is not recommended as mitigation. It meets none of the evaluation criteria or the principles of good design (Figure 3.5).

3.4 America's Byways (Scenic Byways) Designation

When the project goal is maintaining and enhancing the road for other reasons, like heritage tourism, beautification, recreation, or economic development, consideration should be given to designating it a scenic byway. FHWA's National Scenic Byways Program[3] links promoting leisurely travel opportunities with grass roots efforts to protect and enhance roads with cultural, historic, archaeological, recreational, natural, and scenic values. It is often a better fit for achieving non-historic preservation desired outcomes, especially when the road itself is not historic. An additional advantage to scenic byway designation is that FHWA provides funding though state DOT's for byway planning and specific implementation projects.

Scenic Byways designation may offer a viable alternative to National Register eligibility for the large class of historically themed resources connected by a road, like US 101, the Oregon coast highway linking Conde B. McCullough's renowned 1920s and 1930s bridges, a Pony Express route, or important sites associated with the Civil Rights movement. The program is used to bring together from the outset all the stakeholders, including transportation agencies, to plan and develop the designation application, which includes defining the features to be protected and enhanced as well as the means to achieve the goal of promoting the value of the byway through education and to the traveling public. The group defines the "intrinsic qualities" of the byway corridor and develops a 14-point Corridor Management Plan (CMP) specifying how those qualities and the linkage or access to them will be maintained and upgraded as needed. A significant part of that plan addresses road-related characteristics and highway deficiencies, including a review of the road's safety and accident record to identify any ―correctable faults in highway design, maintenance, or operation," and a discussion of design standards that are applicable to correcting deficiencies and their effect on the intrinsic qualities. Since DOT's, planners, and elected officials are part of the group developing, and are thus committing to the CMP, the process enables planning and project development related to the byway corridor to be proactive, objective, cost effective, and flexible. The program permits states to develop, in consultation with the FHWA, their own design criteria for scenic byways.

With its emphasis on resources adjacent to roadways and definition of intrinsic qualities that are worthy of historic preservation for edification and enjoyment, the National Scenic Byways Program in many ways is modeled on the National Register of Historic Places. This includes its registration procedures, emphasis on historic preservation of resources within their broader historic context(s), use of roads as themes that link contiguous resources with shared contexts, demonstration of how roads meet prescribed criteria, nomination applications with required information and analysis, defined and justified boundaries, and vetting and review by experts, much like a professional review board. In fact, the similarities are so direct that the Byways Designation process even utilizes the National Register aspects of integrity as an evaluation criterion (see Chapter 4).

[3] The National Scenic Byways Program was established in 1991 as part of ISTEA and reauthorized in 1998. It is administered through state DOTs. Nationally the designated byways are promoted as a collection as *America's Byways*.

Figure 3.5. When the Road Is Located In a Historic District. The Kentucky Transportation Cabinet‘s Paris-Lexington Road Reconstruction Project has been widely recognized as an excellent example of balanced design solutions applied to a historic district in the Bluegrass Region of the state, but that outcome is not how the project stated. The project need was to address the poor safety performance of the main road through the historic district, which is significant for cultural landscape beyond the right of way. Initially planning to improve the road began in the 1960s, it did not take historic significant into account. There was considerable community opposition and concerns about the effects of widening the 12.5-mile-long highway from two to four lanes, and a court injunction held the project up until 1993.

The way forward was defined by a Memorandum of Agreement and a public involvement process that created an advisory task force to ensure that the design respected historic, scenic, and rural qualities of the Paris Pike Historic District. Property owners were invited to attend workshops and take part in a visual preference survey. Resource mapping was conducted to identify the location of features that merited preservation, including stone fences, farm entryways, trees, and buildings. Developing the improved highway was an iterative process gradually identifying design preferences and treatments incorporating grass (unimproved) shoulders, minimal cut and fill, aesthetic guiderails, pulloffs, and interpretive centers. In the end, it was not the fabric of the original roadway cross-section that was preserved but rather the roadway‘s relationship to its historic setting, which was the basis of the road‘s significance. Preservationists and engineers collaborated on every aspect of the design, including walking and mapping the route identifying changes in the alignment of the old two lane road and the location of the two additional travel lanes. Where necessary historic features were reconstructed or moved, the original relationship to the roadway was maintained. The project was completed with no design exceptions.

The Scenic Byways program goes further and addresses the inability of the National Historic Preservation Act of 1966 to save historic properties by coupling designation with stakeholders committing to preserve and interpret the resources. This includes proactive activities to ensure a broad consensus of understanding about what is being preserved, why it is important, and a methodology for specifically how preservation and enhancement will be accomplished. Applications also require definition of the intrinsic qualities evaluated as "representative, unique, irreplaceable, and distinctly characteristic to the byway" in order to provide decision makers an understanding up front of what is of value and why. The program also requires a public involvement-developed corridor management plan that defines how the intrinsic qualities will be preserved and enhanced at the time of application. This ensures that the entire process is locally supported and initiated, including from the state DOT that administers the program.

3.5 Design Exceptions

There are a variety of site-specific conditions and constraints where it will not be possible to meet the 13 controlling design criteria values and dimensions. For instance, designers may encounter situations when the appropriate design solution supports using values or dimensions outside the allowable range. When, at the end of the analysis screening and evaluation stage, it is not possible to use the inherent flexibility to achieve a balanced design and still meet the 13 controlling criteria minimum values, a design exception may be considered. A design exception is a documented decision to utilize a highway element or segment of highway to design criteria that do not meet minimum values or ranges established for that highway or project. This includes 3R projects as well as new construction and full reconstruction. Additionally, some states have adopted other roadway elements that also require design exceptions. Seeking a design exception is a conclusion that is arrived at through the project development process rather than an assumption or desired goal made at the beginning of it.

There are many reasons why design exceptions may be considered and found to be necessary, including impacts on the natural environment, preservation of historic properties, and construction costs or right-of-way costs. And while the reasons for design exceptions are valid, designers and owners know that any exception to design criteria may adversely affect safety and traffic operations. Consequently potential impacts to safety and operations need to be fully analyzed and understood prior to committing to a design exception. Mitigation measures to minimize impacts resulting from variances may also be required. Design exceptions will not be granted if they result in measurably degrading the relative safety and operation of the roadway (Figure 5.4). To apply for an exception, design engineers must thoroughly describe the physical or environmental factors that make the exception necessary.

Although the use of exceptions in and of themselves does not automatically establish a lower level of safety, imply negligence, or demonstrate failure to follow established procedures, agencies must be mindful of a potential lawsuit if an accident occurs. For this reason, design exceptions must be formally written, usually following a specified format, and provide detailed information on why the design criteria cannot be met. Proportional cost increases (i.e. it is cheaper to construct 11 feet versus 12 feet wide lanes) are generally not accepted as a reason to grant a design exception. After a design exception is granted, records to support the application need to be filed and kept as a defense against any ensuing litigation. The documentation includes explanation of why the particular design standard could not be met, the rationale for opting to pursue an exception, and detailed information on why the exception should not create an operational or safety hazard. The expected long-term safety performance can be demonstrated using the HSM or IHSDM program. For historic roads, the discussion would include a complete description of the deviation; the past three years of accident history; how the deviation is expected to affect future safety; what the adverse impact would be on the historic property to meet the design standard; proposed mitigation and support for the design exception based on sound engineering practices and benefit/cost analysis.

3.6 Corridor-Specific Management Plans

A corridor-specific management plan can be an effective means to define appropriate treatments or cyclical maintenance for the long-term conservation and preservation of historic roads and roads in historic districts or settings. A plan can be as detailed or as general as deemed appropriate by the stakeholders. While management plans are a common tool for historic sites, they are less common in the transportation field.

Most National Park Service parkway units, such as the Blue Ridge Parkway, also have management plans. These comprehensive plans not only specify roadway improvements that are in keeping with the long-term stewardship of the historic road, usually they also develop approaches for dealing with the maintenance of off-the-road features such as landscaping and planned view sheds, along with a host of other issues from seasonal traffic volumes to interpretation and visitor amenities. This style of plan has much in common with the type of corridor management planning undertaken by the Scenic Byways program because it also deals with resources beyond the road.

A few states have historic road management plans that are specific to particular roads such as Connecticut‘s Merritt Parkway, New Jersey‘s Route One Extension, and Oregon‘s Columbia River Highway. The advantage of management plans for linear historic districts is that they are developed collaboratively with treatments that represent a balance among engineering, maintenance, and preservation considerations. They are particularly effective for expediting decision making because discussion about what and how to preserve significance has already occurred. Additionally the plans make clear points of agreement, duties, and responsibilities of all stakeholders involved in developing it. It must be noted that any management plan is a snapshot in time and that conditions and circumstances may, and generally do, change. Good management plans include provisions for periodic reviews and are revised or updated as needed to maintain their currency. They also include demonstration on the part of all parties to continue to work cooperatively toward the originally stated goals and objectives. Plans are only as effective as the sincerity of owners and managers in implementing it.

Another concept that can contribute to a holistic approach to historic road preservation is to consider changes within the context of a transportation corridor as a whole rather than just the limited changes often associated with incremental improvements. Decisions about incremental work should be framed within the context of the whole road rather than just specific locations or segments. This includes regional planning considerations. It seldom makes sense to widen bridges to Green Book values when there are no plans to widen or improve the many miles of narrow approach roads with unimproved shoulders.

Lessons may also be learned from the increasing number and variety of state historic bridge management plans. Some plans are in the form of manuals that provide general guidance on processes related to evaluating historic bridges and standard treatments for rehabilitation or maintenance by bridge type and/or material. In some states the management plans are intended to be a proactive approach to identify and plan for long-term preservation for certain classes of bridge, from the most historically and technologically significant to those in the best overall condition. Others, like Vermont‘s, are comprehensive and includes programmatic agreements, priority of treatments and types, and bridge-specific plans prepared by engineers and historians to identify preservation potential based on state highway design guidelines and current condition.

3.7 Maintenance Manuals or Protocols

There is also benefit in developing either road specific or generic guidance on routine and enhanced maintenance, particularly when the material is intended for the managers and departments charged with keeping the facilities functional. The people who do the work bring an important practical perspective that is needed in developing effective protocols. Maintenance is a an often overlooked but critical component of preservation, from both the transportation and historic perspectives, but more and more states are making the connection between performing routine and cyclical maintenance tasks with good asset management. This climate presents an opportunity for education on how to best conserve and preserve historic roads and make the shared objective a matter of practice. Generally accepted conservation and preservation practices are often cost effective and in fact may represent the most cost effective treatment, from both the initial and life-cycle cost perspectives.

Using Inherent Flexibility Sources

AASHTO. *A Guide for Achieving Flexibility in Highway Design*. Washington, DC, 2004.

AASHTO. "Guidelines for Geometric Design of Very Low-Volume Local Roads (ADT<400)." Washington, DC (2001) 96 pp.

Harshbarger, J. Patrick, et al. *Historic Bridge Rehabilitation/Replacement Decision- Making* Guidelines. Prepared for AASHTO, March, 2007.

U.S. Department of Transportation Federal Highway Administration. *Flexibility in Highway Design*. 1997.

Vermont Agency for Transportation. (http://www.aot.state.vt.us/progdev/standards/01intro.htm)

4.0 Considerations in Defining Historic Roads

4.1 Why Understanding Historic Significance Is Important

A goal of this guidance is to demonstrate that the national objectives of providing a safe and efficient roadway system and preserving historic roads are not mutually exclusive and that both can be accomplished as part of keeping the nation‘s streets and highways current, from Connecticut‘s Merritt Parkway, a high volume regional corridor, to Tampa, Florida‘s brick-paved local streets. What distinguishes successful solutions that balance sound engineering with historic preservation is that they start with a well founded understanding of what specifically makes a particular road historically significant. Recognizing and understanding which physical features convey that historic significance and which do not provides the information needed to develop a balanced solution and use history as a meaningful factor in developing the final design rather than it being addressed as an afterthought or as mitigation for an adverse effect. A clear understanding of what makes a road historic generally leads to stakeholders' agreement on which physical features of the road or its setting are essential to retain to maintain historic significance and most need to be respected. It provides the data to appropriately integrate history into the project development process from the outset of planning, when the opportunities for history to have a positive effect on design outcomes is greatest, and throughout the project development and construction phases as an invaluable factor in decision making. When history is not well understood or not integrated from the outset of the planning process, balanced solutions where history matters are often more difficult to achieve.

4.2 Defining Historic Roads: Whose Definition of What?

As straightforward as it appears, the concept of starting with a well founded understanding of what makes some roads historic, it can be difficult to achieve. Historic roads mean different things to different people. The result is that a variety of road types are considered ―historic" for a correspondingly variety of reasons. For example, a FHWA-designated scenic byway is valued for its pleasurable travel experience and for promoting heritage tourism. Other roads that are considered historic might include a route commemorating a historical event, such as the Washington-Rochambeau Trail from Rhode Island to Virginia or the Selma-to-Montgomery civil rights march in Alabama. They could include highways that retain innovative pre-World War II geometric design or are roads within manipulated landscapes such as a park road or parkway. Still others could be modern roads closely following historic trails like the Camino Real or a King‘s Highway, or a route once designated as a pre-1927 tourist trail such as the Lincoln Highway across America‘s heartland or the Dixie Highway from Michigan to Florida.

Historians, advocates, enthusiasts, preservationists, planners, engineers, and a host of others interested in old roads and routes have maintained a decades-long dialogue about which roads are historic and for what reasons, but there is no national consensus on either a consistently applied definition of historic roads or an understanding of how specific road-related features relate to conveying significance.

One of the reasons contributing to no national consensus on defining historic roads is that many subscribe to the "new social history" that swept through historical scholarship starting in the 1960s. This viewpoint has makes it legitimate to study and value the patterns and material culture of everyday life, and by extension the preservation of everyday common things, from vernacular houses to roads. When the National Register Criteria for Evaluation were adopted over 45 years ago, there was yet a fairly strong consensus among historians about which historical themes and features of the built environment were the significant ones. Today, with a broadening of perspectives, there is far less consensus and a tendency in the preservation community and the public to place significance on almost any old and standing feature, including those associated with roads that are 50 years old and greater (Figure 4.1).

Figure 4.1. Does the Road Convey Its Period of Significance? National Register listed or eligible resources are supposed to look like they did when they achieved their significance. Arizona's old US 80, then and now, illustrates the potential pitfalls of a long period of significance during which roadway design evolved significantly. Arizona considered all pre-1956 state highways eligible with no site-specific definition of what makes them significant. If the period of significance is from 1915 to 1955, which features of the road guide decisions for its improvement and maintenance? What is worthy of preservation? All features? Classifying all examples of a particular resource type as historic generally does not support the site specific decision making encouraged by this guidance where history matters.

4.3 The Federal Definition of Historic

These guidelines are a framework for advancing federally funded or permitted transportation projects involving historic roads. The appropriate definition of historic in this context is the federal one set forth in the National Historic Preservation Act (NHPA) of 1966. The act created the National Register of Historic Places, a listing of those buildings, structures, sites, objects, and districts that are considered worthy of preservation. Cultural resources such as historic roads are determined eligible for listing by developing historic contexts and then applying the National Register Criteria for

Evaluation. Properties like roads and bridges or archaeological sites are considered historic or determined eligible for listing in the Register when they meet the criteria for evaluation. The criteria are applied using a protocol developed by the National Park Service (NPS) to identify those properties that have significance rather than those that simply are old and share a common history. Fortuitously, that well-established NPS evaluation process is founded on the same types of information that are useful in informing design and management decisions. That is, placing a road in its historic context in order to determine if it has significance and then using the research and analysis to define the most important physical attributes that convey why it is important. In other words, the current process to identify and support when a road meets or does not meet the federal definition of historic calls for the same analysis of what makes a road historic as that needed to achieve balanced designs where history is acknowledged in the planning and project development process.

4.4 What Kinds of Roads Meet the Federal Definition of Historic

National Register Criteria for Evaluation are purposely broad in order to include all types of properties that have significance. The criteria are met by establishing significance and then meeting at least one of four specific criteria (A-D) and having enough integrity to convey that significance. The most common criteria applied to roads are Criteria A and C. Criteria A applies to those that have associations with events that have made a significant contribution to broad patterns of American history. For instance, roads determined historic because they meet Criterion A may once have carried significant tourist trails or memorial highway designations, like the Dixie Highway or the Lincoln Highway. They could be segments of early transcontinental routes like the Oregon Trail. Or they could be local roads that stimulated significant development, such as the 1924-25 Venetian Causeway across Biscayne Bay in Miami. Criterion C applies to those that are significant examples of technological development, are now rare examples of once-important roadway designs or contribute to historic districts. Under Criterion C, they may be engineered roads that incorporate important advances in highway engineering such as innovative paving treatments or proved influential in the evolution of interstate highway design. They could be scenic, landscaped parkways.

Some roads are significant both for associations with events and for their engineering (Criteria A and C). One example is Oregon‘s Columbia River Highway. Samuel C. Lancaster‘s design philosophy of integrating the road into the landscape led to the National Park Service adopting its "Lying Lightly on the Land” philosophy for national park roads beginning in the 1920s (Criterion A). Lancaster and other engineers designed the Columbia River Highway to high engineering standards that included maximum grades, minimum turning radii, reinforced-concrete bridges, drainage systems, and asphaltic concrete pavement (Criterion C). Finally, roads, along with other historic properties, can also be contributing features of historic districts, from downtown main streets to narrow, improved roads in rural areas.

National Register criteria for evaluation do not intend that old roads that do not meet current geometric standards and retain a historical feel are eligible and thus historic. To meet the criteria, significance must be established within appropriate historic contexts, and the roads must retain the ability to convey its significance through the aspects of integrity (Figure 4.2). How or why roads meet the federal definition of ―historic" needs to be supported by a complete and well founded synthesis of their significance compiled in accordance with National Register guidance specified in *National Register Bulletin: How to Apply the National Register Criteria for Evaluation*, also known as *"Bulletin 15*." Roads must have significant histories that are distinguishable from the common history shared by other roads. This is established through the development of historic contexts. The analysis should be founded on a thorough understanding and appropriate synthesis of primary and secondary sources and be site specific, establishing a clear link between the present appearance and the reasons for historic significance. Establishing that link is achieved by fairly and rigorously considering the aspects of the integrity that are a part of the criteria for evaluation.

Figure 4.2. When the Current Road Doesn't Match the Historic Significance. The Revere Beach Parkway began in the late 1890s as an Olmsted-designed, 30'-wide, two-lane carriage way from Boston proper to the beach. The 2007 National Register nomination focuses on its pre-automobile and early automobile improvements when in reality it is a dualized, post-1955 arterial highway. The period of significance for the road was taken to the 50-year cut off of 1957, but many highway features post-date even that later date. The historic significance justified in the nomination and how the road as it appears today is not consistent, and the information is of little use when advancing projects because it provides no guidance as to what specifically should be preserved to convey significance. The road appears to be old-in-name only.

The National Register is a federal program implemented at the state level, so it is important to understand the predisposition of the state in which work is being conducted as perceptions of which roads may meet the criteria often vary from state to state. Definitions are often based on understandings that have been reached among state transportation agencies, state preservation offices, and historic roads advocates. Arizona, for example, had an interagency agreement that considers all pre-1955 state highways as historic for the potential information that they can yield. Very few states have this type of encompassing definition, and transportation agencies generally consider National Register eligibility based on road-specific assessments. Many states have undertaken research and evaluations to prepare historic contexts for development of their highway networks or have considered historic roads as part of inventories or surveys to identify historic bridges.

4.5 Is it the Road Itself or Resources Beyond the Road that Makes it Historic?

It is vital that those who prepare the documentation supporting why roads are historic are also able to interpret and identify specific road-related attributes that contribute to significance. Roads that meet the National Register of Historic Places criteria generally fall into one of two broad categories. One is that the road itself – its cross section and physical features located within a right-of-way – is historic. The other is when the road is located in a historic district/context and links properties beyond the right-of-way that are the basis of its historic significance. The road may or may not contribute to historic significance of the historic district. It is the relationship of the road to the historically significant features beyond the right of way that is notable, not the road in its own right. Such an example is the Ashley River Road Historic District in Charleston, South Carolina (Figure 4.3). The road connects a series of antebellum plantations, but it is a mid-20th century highway that is not historic and is not a contributing resource to the district with its pre-1861 period of significance.

Figure 4.3. Ashley River Road Historic District (South Carolina). Ashley River Road outside of Charleston lends its name to the National Register-listed historic district of antebellum mansions that line the river, but it is not why the district is significant. The road links the houses that give the district its historic and architectural significance. The road itself is just a transportation corridor that connects the significant resources. It is not even listed in the nomination as a contributing resource to the district. In fact, during its antebellum period of significance, the river was the dominant transportation corridor. Research shows that Ashley River Road was widened, paved, curves and alignments improved, and all bridges replaced by the state from 1934 to 1960. It is, in comparison to the historic district, a modern facility. What is significant is not the geometric design of the current roadway but rather the relationship of the right of way, including orientation, to the historic properties adjoining it. The fabric of the road itself is not historic; it is what is beyond the right of way that is historic. Photograph J.P. Harshbarger.

The reason for distinguishing roads as historic in their own right from those in historic districts/contexts is that they call for very different sets of preservation questions and design guidance. Under the National Register criteria, when roads are the significant resource, they are to be treated as historic structures where the physical attributes of the road strongly convey its significance. An example could be an early application of a significant paving material or a technologically significant engineering achievement. In each of these cases, the physical attributes, engineered or evolved design and materials that are the basis for significance should inform design and preservation decisions. A project's purpose and need narrative can then address maintaining the historically significant features of the road as a desired outcome. The same understanding of significance can also serve as a measure in developing and evaluating alternatives that achieve the desired outcome.

When roads are ancillary features of larger historic districts/contexts, the preservation issues generally change to ones of scale, texture, and relationship of the road to the beyond-the-road resources. Emphasis shifts to those qualities that make the setting significant rather than the road fabric itself. Roads in historic districts are generally not individually distinguished, but how they relate to the setting as a whole and how to maintain those attributes should be addressed in design solutions. With few exceptions, the emphasis for roads located in historic districts will be on the setting and preserving the relationship of the road to that setting, rather than the road itself as an artifact worthy of preservation.

From a practical perspective, roads in National Register-eligible historic districts have been successfully dealt with for many years under the federal regulatory process. Proposed changes to the roads are assessed for their direct and secondary effects on the adjacent historic properties with appropriate measures taken to avoid, minimize or mitigate adverse effects. There are numerous examples where this has successfully been done in locally significant historic districts, from those with local significance like the Kings Highway Historic District in Princeton Township, New Jersey (Figure 5.9) to the nationally significant Route 1 Extension approach to the Holland Tunnel in New Jersey that is considered America's first superhighway (Figure 4.4).

Figure 4.4. In response to the need to accommodate traffic approaching the 1923 Holland Tunnel through an already congested part of Jersey City, the New Jersey State Highway Department applied the economic theories of railroad location to a vehicular highway and built America's, and potentially the world's, first superhighway known historically as the Route One Extension. It is the quintessential engineered highway as it segregated through from local traffic and made provisions for changing grades along the limited-access, dualized highway that also passes through the Bergen Ridge as it approaches the at-grade tunnel portal. Most of its geometric features contribute to its historic significance. Because the highway was literally wedged into the existing fabric of Jersey City, the portion of the road from the tunnel to the south end of the Pulaski Skyway could not be widened. A completely new road on a new alignment (Jersey City Extension to the New Jersey Turnpike) was constructed in the 1950s to increase capacity. Its construction largely ensured that the historic road would retain its integrity. Photographer: Thomas Flagg.

It May Have Historic Significance, But Does It Possess the Integrity Needed to Convey Its Significance?

Simply put, for properties to meet the federal definition of historic, they need to have the ability to convey their historic significance; it must possess integrity. The National Register Criteria for Evaluation recognize seven aspects or qualities that define when a property has integrity: location, design, setting, materials, workmanship, feeling, and association. The NPS protocol specifies in *Bulletin 15* that "to retain historic integrity, a property will always possess several, and usually most, of the aspects." If roads do not retain the aspects of integrity, then they do not meet the federal definition of historic (Figures 4.5, 4.6, 4.7). Assessment of integrity should be specific and address the physical attributes of roads as they exist today, including plan, profile, and roadside treatments. The analysis is particularly useful to the planning and project development process because it focuses on the relationship between historic significance and the essential features to convey that significance.

To arrive at a reasonable assessment of integrity, alterations must be evaluated to determine if they changed the design, appearance, or workmanship of roads or compromised the technological and/or historic significance. Most roads represent an amalgam of design features that have evolved over time, often making assessment of integrity challenging. Evaluation requires applying an understanding of roads as structures, including a working vocabulary of their structural elements and how they relate, or do not relate, to their historic significance. If for instance a road is identified as a significant superhighway, emphasis should be placed on whether it retains the original balanced-design geometry of the travel lanes and limited-access features such as original overpasses and interchange geometry. If it is an evolved road, the geometric features determined to be the distinguishing characteristics from the period of

Figure 4.5. When Integrity Is Lost, It Is Lost. The Maine Turnpike from Kittery north to Portland was the first toll road in America built after World War II. Its success at alleviating Maine's summer tourist traffic tie ups and, more importantly, its financial success in using toll revenues to pay back construction costs at a rate that defied skeptics and the predictions of federal engineers, made it a major factor in persuading a dozen other states to build toll roads from the late 1940s to 1950s. While the historic significance of the Maine Turnpike was recognized, an assessment of its integrity found that the original design had largely been lost due to subsequent widening, modern shoulder and median improvements, reworking interchanges, and replacement of the original toll plazas. The turnpike was found not eligible for the National Register due to its lack of integrity.

significance need to remain. This can include cross section, edge of pavement treatment, intersection design, and horizontal and vertical profiles.

Figure 4.6. When Significance Is Associated With Past Events and Now Looks Entirely Different. The 100-mile-long, concrete-paved, two-lane trunk highway that traverses the length of Delaware was begun in 1908 by philanthropist T. Coleman DuPont, who built the road at his own expense. For the first time it provided the state with an all-weather paved highway connecting the rural southern part with the urban north (bottom view). The road has historic significance. Over the decades, it was repeatedly widened and evolved into a multi-lane highway (top view) owned and operated by the State of Delaware since 1917. Currently few physical features of the original highway remain, but the road is largely on the original location. It has important historic associations but little physical fabric that is more than 50 years old. Today the road continues to evolve and change to meet modern transportation needs and is widely recognized by the public as a road with historical qualities. Delaware DOT developed a context for the DuPont Highway in two counties with eligibility criteria established for associated features such as gas stations, restaurants, and motels, but the right of way itself has not been determined eligible. Historic view courtesy DelDOT; Contemporary view J.P. Harshbarger.

Integrity of design and materials are generally the most important aspects for roads to retain because, by definition, they are composed of geometry, road and roadside treatments, and the technologies and materials used to build or maintain them. Since so much of the historic significance of roads is associated with their geometry, alterations to their geometric design and

Figure 4.7. **Historic Roads Need to Have Integrity As Well As Significance.** I-85 Business at Lexington, North Carolina, built in the early 1950s, was one of that state's earliest limited-access freeways and was subsequently taken into the interstate highway system. An assessment of its integrity was critical to understanding the road as a historic structure and the refinements in roadway geometry that made it a "superhighway" in its time. The interchanges were considered so novel in this rural state that the department issued instructions to drivers about how to use exit and entrance ramps. This photo illustrates the median and shoulder treatments that were features of the original design. The roadway has significance within the statewide context of post-World War II urban bypasses. It remains largely as originally designed and meets the aspects of integrity. Photograph J.P. Harshbarger

the roadside can mean that they do not have integrity, which is an all or none determination. To meet National Register criteria, both individually and as contributing resources to historic districts, roads should look like they did and function as they were intended when they achieved their significance (Figure 4.5). Upgrades like guide rails, pavement striping, lighting, or traffic signals added to keep roads current and are reversible without adverse effect to the historic fabric would be excluded for the integrity assessment.

Of less importance are the aspects of workmanship and location. For most of the past century, the technologies used to build and maintain roads were largely national in application. Workmanship was generally standardized. Location was closely related to the roads' history because their purpose is to connect points, but roads generally remain on the same or very close to their original alignment/location. However location is relative considering that some roads are improved and/or reconstructed on the same location with significant changes to the center line, grade, and horizontal alignment, and roadside appliances in effect replacing all of the original design, materials, and workmanship.

Some evaluations may discuss the importance of roads retaining their historic "feel," but National Register guidance is clear that roads must retain more than the aspects of feeling and association in order to be determined to retain integrity. Feeling and association alone are not sufficient to possess integrity and thus meet the federal definition for historic roads. If the setting is considered an important aspect, then roads should most likely be considered as a feature in and contributing to historic districts.

4.6 Distinguishing Historic Significance from Historical Character

When defining and supporting what distinguishing physical characteristics make roads historic, it is important to not confuse historical character with historic significance; they are different. Historical character, or "historic character" as is commonly used, is a vague term that is frequently interpreted to mean inclusion of nearly every attribution or quality that chronicles the past. Historic significance is the supported reasons that makes a property important based on the historical record and analysis of its value within appropriate historic context(s). In Maryland State Highway Administration‘s scenic byways guidance, for example, historical character is taken to mean an "element of the road and roadside context that contribute to the byway‘s scenic and/or historic character.” This is not the same as what makes roads eligible for the National Register of Historic Places. The byways definition implies existing roadway features be "frozen in time.” The broad and subjective nature of the guidance could be taken to mean that any old geometric feature is preservation worthy, even when it has little to do with why historic roads are considered significant (Figure 4.8).

As with any historic property, not all physical attributes are equally important in conveying or preserving its significance. Roads, like any other type of resources, have requisite features, like edge treatments, horizontal profiles, cross sections, and travel way surfaces, that must be present for them to be roads. Just because features are old does not mean they are significant. Recognizing the distinction between historical character and the specifics of why roads are historically significant is crucial to establishing a framework for developing effective preservation and maintenance treatments. Blurring the difference between the two concepts is often a source of confusion for engineers, planners, historians, and others because efforts to preserve historical character instead of the distinguishing features that convey historic significance lessens the opportunities for developing balanced solutions – ones where historic significance matters.

4.7 Determining Which Road Features Are the Significant and Essential Ones

Just as the design of roads are site specific, so too is what makes them historic. Knowing which ones are essential is critical. Since history and its present

Figure 4.8. **Which Matters, Historical Character or Historic Significance?** This 1968, four-level, interstate highway interchange in the greater New York City region was determined to have national significance and thus eligibility for the National Register of Historic Places because of its geometric design. Curiously, the determined eligible portion of the complicated interchange was limited to the bridges over the at-grade interstate highway; all approach roadway segments (ramps) were excluded. Since the significance of the roadway resource is its geometric design, the design of the railings/barriers has no bearing on its eligibility status. Since the barriers are not what make the geometric design historic, changing them should have no adverse effect. While the historical character will be different when a modern safety shape barrier is used instead of the open railings that were standard in 1968, what makes this property historic – the geometric design – has not changed. Photograph M. McCahon.

Figure 4.9. Understanding of Technological Significance Is Founded Knowing the Evolution of Highway Design. Evaluating the historic significance of Georgia's highway system included understanding the evolution of its four-lane with median (i.e., dualized) highways. The 1938 Atlanta-Marietta Highway (top) represented the state's transition from the 2-lane state highways of the 1920s and 1930s to those applying the principles of balanced design. The Atlanta- Marietta Highway was the state's pioneering, and thus historically significant, effort on the part of the state highway department to design a high-volume, high-speed highway. The historic context supported that most post-World War II dualized highways were not technologically significant because they were based on well established application of national design guidance developed by the federal Bureau of Public Roads in cooperation with AASHO. Source: Georgia Department of Transportation.

physical condition are generally specific to each transportation resource, identification of the distinguished features that are essential to maintaining historic significance needs to be done on a case-by-case basis rather than applying categorical assumptions. All features of roads should not be treated as equally significant simply because they are old and present. Additionally, the level of significance of both individual elements and the relationship of the road to its setting is different for different roads (Figure 4.9).

While distinguishing characteristics do vary from road to road, how they are determined does not. They are the essential physical features that convey the supported and justified historic significance established by analysis of the historic record. For instance, at Paris Pike near Lexington, Kentucky, it was relationship of the evolved road to its historic district setting that mattered most, not the actual fabric of the road itself (Figure 3.5). For the Taconic State Parkway in New York, maintaining the rustic appearance of the original parkway design was most important when new roadside features needed to be placed (Figure 5.19). In both instances, design decisions for improving the historic roads were founded on a clear understanding of why each road is historic. As is often the case with roads located in historic districts or settings, that understanding of significance generally extends beyond the physical road itself to include its relationship to the resource as a whole.

Roadway components can generally be grouped into plan, profile, structure, or associated features. The roadway plan consists of location and historical alignment. The profile is a synonym for those features that denote the vertical dimensions of roads, such as the pavement cross section, edge of pavement treatments, and paving material (Figure 4.9). Structures are bridges and tunnels designed to carry roads over, through, or under natural and manmade obstacles, and associated features include designed landscapes (e.g., parks or parkway reservations), toll booths, roadside barriers, and scenic pull offs to name a few.

Tying all the components of a particular road‘s design back to why it is historic is how the distinguishing characteristics, and thus features essential to conveying significance, are determined. Many features, such as defined travel ways, unimproved shoulder treatments and intersections, are common to all roads. So explaining why particular features rise above the ordinary is important to providing complete and useful definition. Consequently it is helpful to consider the level of significance of roadway components within the context of different road types. There are three broad categories. They are general categories and are not necessarily mutually exclusive, but most historic roads will have attributes strongly associated with one of them.

- Planned/Engineered Roads;
- Pre-automobile or Early Automobile-era Road Segments;
- Evolved Roads

The Planned/Engineered Road

Planned or engineered roads are usually 20th-century highways, parkways, expressways, or superhighways that were built within discrete periods of time to plans that provided for relatively uniform geometry and appearance throughout its length and reflecting then-current design criteria. Engineered roads are often technologically significant representing significant advances in highway design (Criterion C) (Figure 4.10). They may also be historic for association with important events or trends in American history (Criterion A), like the Venetian Causeway in Miami that is recognized for its significance in planning and development. The rights-of-way may extend to include manipulated landscapes, providing corridors with significant naturalistic or scenic appearances, as in parkways or scenic parkways (Figure 2.2). Planned roads are usually the first roads that come to mind as historic roads because they provide a consistent appearance and are usually the least difficult of roads to define using National Register criteria because contexts, periods of significance, connectivity, and integrity are well documented by plans and other primary source materials. The distinguished characteristics are also generally clear, from the geometric elements that distinguish it to the treatment of the settings of parkways or the overall aesthetic used for roads.

Figure 4.10. Historic Planned/Engineered Road US 27/Fort Benning Road (Georgia) Significance: First balanced-design road in Georgia applying federal-developed concepts, influenced all later designs and set standard that would be used over and over again on all later dualized (four-lane with median) highways (Criterion C). Significance established through statewide historic context for dualized highways. Integrity: Since balanced design is source of historical significance, location, design and association are the important aspects of integrity to consider. Significant features of road: design philosophy: design controls - speed, sight distance, grade, control of access all balanced in relationship to one another. Reflected in vertical and horizontal alignment, cross-sections, curve radii, use of a median, and construction of grade separation bridges located at points where military post roads could have access to the high-speed highway. Less significant features are the original pavement, shoulder treatments, side slopes, and railings.

Pre-automobile or Early Automobile-era Roads and Road Segments

Pre-automobile or early automobile-era roads or road segments are usually bypassed, abandoned, or lightly traveled and have minimum levels of subsequent improvement. They may retain original paving material and geometric features, such as brick-paved streets or unimproved shoulders. While they may retain a high degree of integrity of design and materials, they may be discontinuous and greatly shortened from their original length (Figure 5.11). The segments may range from a few hundred feet to several miles or more. Supporting their significance as a property type (Criterion C) is likely to require survey and comparison against other roads sharing similar contexts and physical features with preference given to those that have sufficient supportable significance and/or integrity. Other segments may be documented to have significance in association with noteworthy cross-state or cross-country early automobile tourist trails, such as designated routes of the Lincoln or Dixie highways that retain their pre-1927 appearance (Criterion A). Other roads may be a contributing feature that links historic properties like a main street through a downtown noted for its architectural and commercial significance (Criteria A and C). The essential features for pre-automobile roads need to convey the significance of that era and physically represent it.

Evolved Roads

Roads whose appearance has changed, or evolved, over time account for the vast majority of highway miles in the United States today. By one estimate, there are approximately two million linear miles of road on locations that have been in use for more than 100 years. Evolved roads were usually laid out early in a region‘s or a community‘s history and then adapted and upgraded over time to meet changing transportation needs and patterns as well as understandings about roadway design and maintenance. Evolved roads can date to non-motorized eras of travel and may exist on, or be approximate to, rights-of-way that have been in use for long periods of time. It is important to remember that they have likely been repeatedly straightened, re-graded, widened, re-paved, reconstructed, and/or improved with intersections and safety features, particularly if they are a major highway (Figure 4.6). The degree of alteration, and thus integrity, is often dependent on any number of variables. This includes, but is not limited to, climate, traffic volumes, the natural life cycles of the materials used, patterns of surrounding development, and the tendencies, preferences, and patterns of maintenance and improvement of various owners and managers.

Evolved roads are an amalgam of engineered features that have accumulated over time. They are often not characteristic of a single period, design, or method of construction, and thus generally do not have technological significance under Criterion C (Figure 4.11). The reason(s) for their historic significance is likely to be their association with a pattern of events or historical trends that made significant contributions to the broad patterns of American history on the local or state level under Criterion A. To identify the distinguishing characteristics of an evolved road, which typically does not have specific construction dates and many have physical attributes from several eras, the years of the period of significance must be clearly defined and supported. For these reasons, it can be challenging to determine distinguishing characteristics from the simply old and extant features. Historic significance meeting Criterion A may be perceived to be strong, but the ability of the road to convey that significance to the years when it achieved its historic significance may be minimal, especially if the period of significance dates to the pre-automobile era and the road is still in service.

For both pre-automobile era and evolved roads, the assessment of integrity should include determining how much of the road lies on original right-of-way and center-line and how much does not, along with how much of the design and materials from the period of significance remain. Many pre-automobile and evolved roads that have strong historic associations may not have integrity. If roads have integrity of location, but not of design and materials, then thoughtful consideration should be given to assessing whether location, setting, association, and feeling alone are sufficient for them to be convey their significance and which of their remaining distinguished characteristics are worthy of preservation in order to convey that significance. ―Freezing" evolved roads by advocating for no changes runs counter to their historic contexts, especially if they have continued to evolve over the past 50 years in a reciprocal and ever-changing relationship to the environment they serve. Consideration should be given to whether it is appropriate to attempt to preserve roads to any one period over another or to emphasize the preservation of any one design feature over another rather than fostering a process that encourages the road‘s continuing evolution.

4.8 Strong Historical Connection Between In-Use Roads and Change

Another important consideration in understanding the historic context of roads that remain in service is the strong historical connection between roads and change. Nearly all historic properties change over time – they must in order to remain viable for contemporary use. Most in-service roads, even historic ones, have changed, and their history reflects a continuum of change. From paving materials to superelevation of curves, modifications in cross section to improve drainage or treatment of the roadside, change is part of the historic context of roads, just as introducing plumbing or air conditioning to an old house is part of its historic context (Figure 4.11).

Figure 4.11. The history of many historic roads is one of change. The iterations of US 80 across southern Arizona reflect the historical and technological evolution that is typical of important routes. In Arizona, all in use and abandoned segments of the pre-1956 state highways system have been determined to meet National Register criteria, meaning that they meet the federal definition of historic.

How that change has been accommodated is the important consideration when using the historic context of a road in developing designs for improvements. Historically when improvements were made to roads, from shoulder treatment to paving and number and width of lanes, they were generally forward-looking representing then-current design, technology, and aesthetics. When modern features must be introduced in historic settings or to upgrade historic roads, compatible contemporary design is generally preferable to conjectural or inexpensive interpretations of the past. Keeping highway designs current also perpetuates the true history of highway development in this country.

4.9 Use Historic Information Through the Entire Project

These guidelines strongly encourage practitioners to use the well-established practice of applying the National Register criteria in accordance with National Park Service guidance to define historic roads. The research and analysis not only identifies roads that meet the federal definition of historic, it also provides the information about historic significance needed for the planning and project development process. In other words, both tasks use that same information to inform sound policy for advancing projects that can result in preservation of historic significance. Since the desire is for preservation of significance to be a proactive project objective, preserving significance defined in National Register eligibility evaluations will assist with assessing effects. If significance can be preserved, then alterations to other components of the roadway may not have an adverse effect and history will become an integrated component of a balanced solution rather than a treatment added to mitigate adverse effects.

Enumerating and explaining the specific features that make a specific road historic is most useful when it is done in a manner to support the entire planning and project development process, not just the identification of historic properties phase. It takes effort to do the research and understand the relationship of the physical features to conveying and maintaining historic significance. However without it, the history and historic context of roads are not likely to be preserved. This information is most beneficial to the planning and project development process if it is compiled and integrated into the project development process as early as practical. When all stakeholders understand what makes roads historic and which features are essential to maintaining that significance, the information can then serve as a critical and meaningful evaluation measure throughout the planning and design processes. Otherwise, and too often the case, consideration of history ends up being added at the end as mitigation rather than being a meaningful factor in developing a balanced solution.

Despite over 50 years of practice using the National Register criteria to define historic for federally funded and permitted projects, to many the term "historic" still means something other than meeting National Register criteria. Mixing those perceptions with the federal definition can complicate using historic significance to shape an outcome where history matters. This is particularly true when historic significance is equated with achieving outcomes like promoting heritage tourism, beautification, scenic conservation, farmland conservation, or limiting growth and development. Since the intent of the National Historic Preservation Act and its role in the overall NEPA process is preservation of historic properties, it is important to stay focused on history, not other objectives (Figure 3.4).

4.10 Considerations for Making Historic Information Most Useful to the Planning and Project Development Process

- Recognize that while the National Register Criteria for Evaluation support considerable latitude in defining a wide variety of road types as historic, justification of significance needs to be founded on sound scholarship and understanding of historic contexts along with a reasonable assessment of integrity to convey that significance. If features have been lost, they are indeed gone, and they should not be used to support historic significance or maintaining the aspects of integrity. This is especially important for roads having associative significance under Criterion A (Figures 4.2, 4.5, 4.6).
- Recognize that transportation resources are not the same as discrete historic properties because they are systems, not places. Since the historic purpose of public roads has largely been for the movement of goods and people, they are generally part of larger networks of roads that are dependent on connectivity for their significance and integrity. This means that roads are best looked at in total, not just segments that come into agency work plans. Additionally, most roads are dynamic resources subject to upgrading, incremental improvements and maintenance to keep them in service. Defining historic significance of roads has credibility with all stakeholders when the analysis reflects an understanding of the historical evolution of road design context and maintenance over time. This includes acknowledging that most components of roads are based on standardization of values and details that were common to the era when the road was constructed or improved. The "as-is" appearance of a road does not in and of itself lessen its historic significance, but it does mean that historic contexts to establish significance and integrity will be critical to the analysis and application of the National Register criteria.
- For historic districts, it is important to define specifically how roads contribute or do not contribute to its historic significance. Is it the road itself or relationships to resources beyond the right of way that is significant? How do roads relate to and contribute to the historic significance of the district? In some instances, the road may serve as the linkage for the properties that give the district its historic significance, and they do not contribute to that significance. In other instances, they are determined to be contributing to a historic district or context not because of their historic or technological significance but because they are located within the district, were built during its period of significance, and retain their appearance from the district‘s period of significance.
- Since historic districts are based on the concept of the whole being greater than the sum of its parts, properties that make up the district can generally accommodate a higher

degree of alteration than properties that are individually historic. Consequently, the aspects of integrity are generally less stringently applied to the resources that make up historic districts.

- Evaluations should be founded on specific information relevant to existing characteristics of the road or setting under consideration. Determining entire classes, systems, or types of roads stretching over hundreds of miles as meeting the National Register criteria and thus considered historic generally does not provide the specific information needed to build consensus on historic significance or develop appropriate treatments. Such categorical definitions of historic significance, like all pre-1955 state highways or all parkways in a particular state or all iterations of tourist trails because they once carried a trail designation, are considered by some practitioners to defeat the purpose of the site specific analysis needed to support informed and balanced decision making. When such information is absent, it can extend the environmental review process, especially Section 4(f) evaluations, to properties that do not merit that level of consideration. (Figure 4.11).
- Avoid defining all roadway features as distinguishing characteristics essential to conveying significance in order to avert change. This approach is generally unfounded and counterproductive unless the road is located within an entirely protected and controlled environment and preservation or restoration of the original design is the objective. Roads do change over time, as do many other types of historic properties, and not all physical features are equally important to conveying significance.

4.11 Examples of How Specific Roads Meet National Register Criteria

Criterion A: Made a significant contribution to the broad patterns of American History, which are usually trends or events supported by a historic context. The trend or event must be clearly important, not just old and maintaining its old appearance.

- Route 66 Segments (Illinois, Missouri, Kansas, Oklahoma, Texas, New Mexico, Arizona, California) – significant for its association with popular culture
- Oregon Trail Segments (Missouri, Kansas, Nebraska, Wyoming, Idaho, Oregon) – significant to 19th century westward migration.
- Dixie Highway in Mitchell County (Georgia) -- significant as examples of pre-1927 geometric design of first generation of paved state highways.
- Venetian Causeway (Florida) -- significant in community planning and development in Miami as it linked filled islands for residential development in Biscayne Bay.
- Jefferson Downtown Historic District (Georgia) -- significant because the main street contributes to the physical attributes of the mid-19th century through 1940 commercial and residential center of the town. District also meets criterion C.

- Columbia River Highway (Oregon) – significant as the first scenic highway in the United States. It is the prototype for the National Park Service‘s "lying lightly on the land" philosophy for their park roads starting in the 1920s.

Criterion B: That are associated with the lives of significant persons, and are generally those that best represent the person‘s historic contributions. The significance must be direct, not a posthumous memorial designation, such as the highway named after a deceased political figure. The works of most highway engineers are better recognized under Criterion C.

- Long Island Expressways (New York) – significant for association with Robert Moses who transformed the outer boroughs and Long Island by planning and constructing a network of parkways and expressways and major river crossings.

Criterion C: Embody distinctive characteristics of a type, period, or method of construction, represent the work of a master or possess high artistic merit, or are, like many roads, significant and distinguishable entities (a historic district); in other words, properties significant for their physical design or construction.

- Route One Extension (New Jersey) – significant for technologically innovative limited-access highway that set the national standard.
- Merritt Parkway (Connecticut) – significant as an engineered parkway with high artistic merit.
- Early Dualized Expressways (North Carolina) -- significant for their road design technology as the earliest limited-access highways in the state.
- Olcott Avenue Historic District (New Jersey) -- significant as a historic district in areas of community planning and development, education, and architecture under criteria A and C. Road linking resources serves as name, but historic significance is founded on properties beyond the right of way. Because they retain their appearance from the district‘s period of significance, local streets are contributing resources.

Criterion D is for archaeological sites likely to yield information important in historic or prehistory. It generally is not applied to active roads because the road itself is not the important source of information about its construction and appearance. Automobile-era roads are generally not treated as archaeological resources. They are largely a 20th-century artifact, and there are many documentary sources of information about the original construction, maintenance, or improvement of automobile-era roads, including plans, design standards, photographs, maintenance records, agency reports, and the administrative record. It is not likely that a motor road is itself the primary source of information important to its history, but the criterion can be applicable to ancient roads.

Considerations in Defining Historic Roads Sources

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5.0 Highway Design; Past, Present and Balanced

5.1 Background

Understanding why streets and roads look like they do and how they function plays a critical role in developing successful strategies for preserving them since it is likely that the basic design principles that shaped the initial construction of a historic road will in some fashion inform their improvement. The geometric design policies that underlay current criteria are founded on the distillation of over 100 years of road-building practice and analysis, but the basic design criteria that still control highway design were compiled into the American Association of State Highway Officials (AASHO) guidelines (precursor to the Green Book) during the late 1930s and early 1940s. Since then, the principles that underlie design criteria and the values therein have been constantly questioned, studied, reconsidered, and refined by the profession in order to provide the most cost-effective safe and efficient highway designs.

The 1960s were a watershed in highway design because non-engineering perspectives were given greater standing in shaping the outcome of projects. Over the ensuing decades the project development process has also evolved to include the flexibility needed to accommodate a variety of goals and objectives, from protecting habitat to tailoring projects to fit with communities and the natural environment. Much of the flexibility to achieve results that balance sound engineering with preservation is provided by the highway design community itself through its policies and manuals, as well as through legislation, administrative action, and professional judgment. Key to developing that judgment is understanding the purpose and reasoning behind geometric design criteria and values. Knowing the intent of a criteria and how it factors into the integrated design of a roadway provides the skill set needed to develop alternative ways to achieve outcomes that meet transportation goals while accommodating issues important to others, like preserving historic properties or scenic vistas. Successful balanced designs are often nuanced designs, and knowledge is the basis of a nuanced approach. Knowing what underlies the design criteria also facilitates working toward a balanced solution from the outset of the planning and project design process rather than in reaction to a predetermined design later in the process. And since most roads in service today are engineered to work as an integrated system of features, the same skill set supports looking holistically at each of the controlling criteria to determine where there is flexibility to address deficiencies in a manner that includes considerations beyond the transportation need.

5.2 Evolution of Geometric Roadway Design Policy and Criteria

Highways are complex designs affected by many factors and generally subject to unrestricted usage. They typically extend for many miles and have a construction history that has evolved over decades or even centuries. Their inherent complexity is compounded by the many different types of roads (local, collector, arterial, freeway, etc.), each with their particular usage and design needs. Whether engineered or evolved, roads are a geometric design, which is defined as the combination of the fundamental three-dimensional features of the road that are visible and affect their operational quality and safety. Whether a road is old or new, a completely designed facility or one that evolved, its design is largely governed by the principles of ***balanced design***. Balanced design means that all roadway elements — curve radius, lane width, shoulder width, sight distance, superelevation, grade, etc. — are determined by and based on consistent speed (the design speed) so that drivers can easily anticipate road conditions and do not encounter surprises.

The integrated principle of balanced design matured during the years between the world wars when this country was transforming wagon roads to highways capable of meeting the needs of motorized vehicles. The understanding of how important stopping sight distance and superelevating (banking) horizontal curves were to safety came to the fore in the 1910s, as did the importance of lane width and pavement type to operations. In 1914, the federal Bureau of Public Roads (BPR) and the states established the American Association of State Highway Officials (AASHO) that in 1973 became the American Association of State Highway Transportation Officials, or AASHTO, to address all modes of transportation as a means to more effectively disseminate knowledge about research results and practical, effective road-building practices. The cooperative federal-state partnership represented by AASHO worked through a committee structure where the federal government assumed the lead for research and the states approved nationally applicable geometric design criteria. Problems, like horizontal curves or length of sight lines, were researched. Data was synthesized to inform draft policy that was refined and approved by the states. By 1942, a national policy was in place for primary highway design based on seven policies linking design values to safety and driver comfort.

The breakthrough for a nationally applicable highway design policy came in the mid-1930s when research proved the correlation of safety to speed and superelevation in curves. In 1937, the BPR completed a manual of design standards for curves. The standards were founded on research that linked speed, curve radii, and superelevation with driver comfort. It included a practical set of design tables for spiral curves (curves that transition from superelevation to normal cross section) that are still used today. The manual calculated in 10 mph increments all curve features with the maximum permissible design speed not exceeding a useful tire side friction coefficient of 0.30 in order to counteract centrifugal force. The data resulted in a new design concept of using curve radii, superelevation, and side friction to define design speed and then using the design speed for coordination of all alignment and geometric design values. The principles of balanced design quickly gained currency and were used as the basis for the seven design policies. Though refined over the decades, the principles of balanced design continue to underlie geometric design policy to this day.

After World War II, balanced design, as well as better understanding of the relationship between traffic-carrying ability and roadway characteristics (Highway Capacity Manual published by the Highway Research Board in 1950), were used to develop design policy for different types of highways, including those in urban areas, freeways and interstates. In 1984, the previously compiled and published policy by AASHTO for urban roadways (Blue Book) and for rural roadways (Red Book) were combined into one publication – *A Policy on Geometric Design of Highways and Streets* (Green Book). It has been revised periodically to remain current with research findings.

Two recent Green Book policy revisions with positive effects for historic roads include the 2001 policy on low volume local roads (ADT ≤2000) and on very low volume local roads (ADT ≤ 400). Since local roads primarily serve local or repeat drivers familiar with the facility, the revisions allow for less restrictive design criteria than used on higher volume roads. To that end, widening of lanes and shoulders, changes in horizontal and vertical alignment, and roadside improvements are discouraged except when such improvements are likely to provide a substantial safety benefit (cost benefit). This provides flexibility to retain the existing roadway widths, including bridges, and roadside design when the existing features are performing satisfactorily (no proven safety problems).

In addition to the standards and policy provided by the Green Book, there is other guidance in the form of manuals that are based on best practices and good engineering. With the exception of Federal Highway Administration's (FHWA) *Manual on Uniform Traffic Control Devices* (MUTCD), which sets the mandated standards for highway signs and markings and traffic signals and the 13 controlling criteria, the guidance in the Green Book and the supporting manuals is advisory. And like the Green Book, all of the manuals are updated periodically to reflect new technology and research. AASHTO's *Roadside Design Guide* addresses the safety of the roadside beyond the pavement. Elements for which guidance is provided include slopes of the right-of-way, ditches, and barriers/railings. AASHTO's *Highway Safety Manual (HSM)* is a guide used to quantify the number and severity of crashes that may be reduced by making certain improvements to a highway. Transportation Research Board's (TRB) *Highway Capacity Manual* provides a methodology for determining the number of highway lanes required to accommodate a given volume of traffic.

History of Geometric Design Criteria Sources

Seely, Bruce E. *Building the American Highway System Engineers as Policy Makers*. Philadelphia: Temple University Press, 1987.
U. S. Department of Transportation Federal Highway Administration. *America's Highways 1770-1976*. Washington, DC: Government Printing Office, 1976.

5.3 Green Book Applicability to Existing Streets and Highways

The Green Book criteria do not apply to all projects on existing streets and highways. The Green Book is intended by AASHTO and FHWA as the policy for new construction (built on a new alignment) and full-depth reconstruction (rebuilt along the existing alignment with the complete replacement of the roadway). In response to a Congressional mandate, FHWA uses the Green

Book as its design standards, and compliance with its policies is required for all highways on the National Highway System (NHS). Additionally, states, in cooperation with FHWA, can develop and adopt their own design criteria for all roads except those on the NHS. Some states do not want multiple standards for the same functional classification of roadways, so they either adopt the AASHTO Green Book as their design standard or have design standards based on it. Other states set their design criteria to exceed or be less than Green Book values.

The Green Book is not intended by AASHTO as the policy for the engineering definition of resurfacing, restoration, or rehabilitation (3R) projects on existing roads. For projects where major realignment is not needed, existing design values may be retained. 3R projects typically involve rehabilitating short segments of pavement with partial-depth repairs and targeted safety improvements, and states, in cooperation with FHWA, can and generally do develop their own 3R design criteria to meet the needs of their jurisdiction for all types of highways, except those on NHS. 3R standards may have values lower than Green Book values. Additionally, many states may have standards for bridges to remain in place (rehabilitated rather than replaced), and these too have lesser values.

The purpose of 3R standards is to maintain the investment in an existing roadway that is operating satisfactory and its overall condition does not require complete replacement. The cost of 3R repairs for operational or safety reasons are generally small compared to the cost of reconstructing the entire roadway. Since 3R projects involve retention of existing three-dimensional alignment, they represent a category of work commonly associated with existing streets and highways. Types of work that can be advanced using 3R design criteria include widening pavement where it is limited to less than a lane width, improving or widening shoulders, improvements to horizontal alignment, and other work that improves safety, like adding rumble strips on the shoulders or down the center line. 3R projects are not intended to add capacity by the addition of lanes, including lanes adjacent to an existing alignment or turning lanes, changing the fundamental character of the highway, or reconfiguring intersections and interchanges.

Figure 5.1. Depressed Roadway in Danville, PA Historic District. The depressed roadway takes the new river crossing approach road under, rather than through, the Danville, PA Historic District. Although the new road is a modern element introduced into the historic district, it represents an innovative, balanced solution that is scaled and detailed to be compatible while meeting the transportation need and purpose of the project. Source:contextsensitivesolutions.org

5.4 Balancing Design Criteria with Preservation of Historic Significance

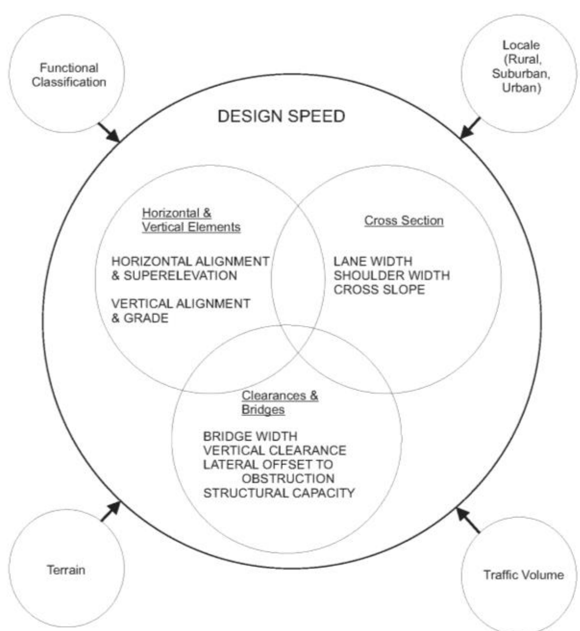
Making historic roads safer and operationally more efficient or in compliance with current design criteria does not mean that historic significance has to be or will be lost. Transportation agencies all across the country maintain and rehabilitate historic roads while preserving what makes them historic in the first place. For example, New Jersey‘s seminal Route One Extension is both National Register listed because of its national significance as America‘s first superhighway and an arterial highway in the most congested part of the state. It is just one of the countless examples of how roads can be made safe and efficient while preserving what it is that makes them historically significant. Likewise, new roads can be constructed through historic districts without ruining historic character as demonstrated by the new dualized Paris Pike in Fayette County, Kentucky or the 320 foot-long depressed approach roadway to the 1991 Susquehanna River Bridge that passes under rather than through the heart of the Danville, Pennsylvania Historic District (Figure 5.1). Modern features can also be introduced, like the Natchez Trace Bridge outside of Nashville (Figure 5.2).

Figure 5.2. Natchez Trace Parkway The award-winning bridge carrying the National Park Service‘s Natchez Trace parkway over Birdsong Hollow near Franklin, TN illustrates the compatibility of contemporary design with historic districts and designed landscapes. The elegant, straightforward design where form follows function is timeless and enhances rather than competes with its setting. Compatible contemporary design is generally the correct choice for balanced designs in historic districts. The Trace was started in 1938 but not completed until the mid 1990s. Source: Byways.org.

In this guidance, each of the Green Book's 13 controlling design criteria is described as to its purpose and how it is integrated into the overall balanced design of a road. Alternative or non-traditional ways to meet the purpose applying inherent flexibility are described. Often, balanced solutions are dependent on addressing more than one criteria or using more than one treatment, like improving a bypass route that can accommodate oversized vehicles rather than making dramatic changes to scale and character of the existing route along a main street that is located in a historic district. And while potential treatments to achieve balanced solutions are not exclusive to historic roads, what is different is the thoughtfulness that needs to be used by engineers and preservationists, among others, to evaluate their appropriateness based on the particular historic significance of the road and the transportation problem(s) to be solved.

In many ways, this approach is not unlike that used for any other transportation project involving constraints, like steep topography or a densely developed urban site. Similarly, treatments are neither universally applicable nor all-inclusive. They need to be developed and considered on a case-by-case basis. Conditions vary from site to site, as does what makes a particular road historic. An approach that works in one location, like the selected removal of trees to improve roadside safety or stopping sight distance, may not be appropriate for another, like along a landscaped parkway where the plantings are integral to its historic significance. Additionally, circumstances stimulate an innovative solution. What is a constant is that designs need to be tailored to fit their location, the reasons the road or setting is historic and the understanding of the transportation problem to be solved.

5.5 The Thirteen Design Criteria that Control Roadway Design



Source: TranSystems

Figure 5.3 Design Criteria and Controls

The Green Book and the related design criteria that states have adopted cover a wide range of design considerations. In order to focus on the elements deemed most important to safety and operations, FHWA has identified 13 controlling design criteria as having substantial importance to the safety and operational performance of any highway (Figure 5.3). When conditions prevent meeting any of the controlling criteria, a design exception justifying why a specific criterion cannot be met must be secured. Many features associated with the design of highways, like roadside features, intersections, signage, etc. are not controlling design criteria. Selection of design elements beyond the 13 controlling criteria, like treatment of the offer opportunities for flexibility based on engineering judgment, with the exception of traffic control devices, that are governed by the MUTCD.

The 13 controlling criteria are based on five inputs known as design controls: (1) design speed, (2) traffic volume, (3) functional classification of the roadway, (4) terrain, and (5) locale.

Thresholds are used to define the design controls that in turn inform the values for the 13 controlling design criteria.

Design speed serves as both a controlling criteria and as a design control to establish the range of values for the other controlling criteria, and it is the only one of the 13 criteria that is not a specific physical attribute of the roadway. The other 12 controlling design criteria can be placed in one of three broad categories: (1) elements of design that are related to the plan and horizontal and vertical profiles of the road; (2) cross sectional elements; and (3) clearances and bridges. Horizontal and vertical elements of design include stopping sight distance, horizontal alignment (curves), superelevation, vertical alignment, and grade. Cross sectional elements include lane width, shoulder width, and pavement cross slope. Clearances and bridges include bridge width and bridge structural capacity, vertical clearance, and lateral offset to obstruction.

5.5.1 **Design Speed**

Design speed has more effect on the design of a roadway than any other criteria. It serves as the controlling criterion that establishes the range of design values for the geometric features that affect or are affected by driver speed, like lane width, horizontal curve radius, superelevation, and stopping sight distance. Since speed is used as both a design criteria and a performance measure, there is desire to achieve a harmonious relationship among design speed, operating speed, and the posted speed limit, but historically design speed is often higher than the posted speed. Factors that influence determining an appropriate design speed include those over which the designer has no control, like terrain, location and climate, as well as those associated with the nature and characteristics of the roadway, like its functional classification as either urban or rural arterial, collector, or local street, and the volume and composition of traffic.

Every state has a method for selecting design speed. One of the two most common is to add five mph to the speed limits for road types set by state statute (e.g., rural roads posted for 55 mph or urban streets posted for 25 mph). Typically, speed limits represent the 85^{th} percentile speed of all drivers (i.e., 85% of all drivers obey the speed limit), and the design speed represents the 95^{th} percentile speed (i.e., 95% of all drivers will not exceed the speed limit by more than five mph). In states that do not have statutory speed limits, the speed limit is typically determined after the highway is constructed and in use by measuring the 85^{th} percentile speed of vehicles actually using the highway. In these states, the design speed is determined by the anticipated speed limit.

The traditional thinking behind selecting design speed has been to select as high a value as practical because higher speed designs are generally safer, but recent trends indicate a modification in this thinking. Many states are using operating speed or the anticipated posted speed as the design value. As a rule, the lowest design speed that can theoretically be selected is the anticipated speed limit of the roadway. AASHTO‘s new definition for design speed supports this practice:

> *Design speed is a selected speed used to determine the various geometric features of the roadway. The assumed design speed should be a logical one with respect to the topography, anticipated operating speed, the adjacent land use, and the functional classification of the highway.*

Green Book policy provides a wide range of speed values matched to highway type and terrain to facilitate using engineering judgment in selecting design speed, not necessarily the highest value. It recommends that the selected design speed for new and full reconstruction should accommodate most drivers and be consistent with driver expectations. Importantly for historic roads, the policy also states that where significant constraints are encountered, other appropriate values may be used. The wide range of appropriate speed values combined with the general guidance on using significant constraints represents flexibility for designers in states without statutory speed limits. It is the intent of AASHTO that designers exercise judgment in the selection of an appropriate design speed for the particular circumstances and conditions. This provides some measure of flexibility when addressing historic roads where lower design speeds will result in less dramatic changes to the geometry.

Research shows that most drivers (85^{th} percentile) will not significantly alter what they consider to be a safe operating speed regardless of the posted speed. Designs based on artificially low operating speeds, instead of the anticipated operating speeds, can result in inappropriate geometric features that violate driver expectations and thus degrade the safety of the facility. The Green Book, which is founded on the principle of balanced design, recommends that designers not propose a different design speed for a segment of highway or seek a design exception for design speed. The recommended approach is to consider each geometric feature and address design exceptions, including mitigation, on a feature-by-feature basis.

Higher speeds generally mean greater change to historic roads – wider lane widths and shoulders, straighter and lower profile alignments, and greater stopping sight distances. Greater opportunities for preservation are often associated with lower design speeds and are more common in urban and suburban areas and in park settings. Urban areas can present opportunities for using the inherent flexibility in the Green Book to create a safe roadway environment in which the driver is encouraged by geometric values and treatment of the roadside to operate at low speeds. There is less inherent flexibility with design speed for arterial highways and freeways that are intended for higher speed and through traffic.

Considerations for Determining Design Speed That Favor Balanced Solutions

- Green Book policy permits considering other-than-recommended ranges of design speed when significant constraints, like historic properties, are encountered. This includes applying AASHTO‘s 2004 definition of design speed. That definition supports considering the historic roads as a constraining factor. A lower design speed, or a consistent one, may provide more opportunities to retain historical geometric features.

- Consider basing design speed on the research-proven principle that safety is improved most by speed consistency (not higher speeds). This may support using a lower design speed and its associated lower design criteria values that in turn may provide more opportunities to retain historical geometric features.
- Consider using the *Highway Safety Manual* to assess the effect of different potential design speeds on the expected safety performance. The analysis will enable direct comparison of higher and lower values and also demonstrate the long-term safety performance benefit. The analysis will make the purpose and need for the transportation project stronger and may provide more opportunities to retain historical geometric features.
- Consider using cross-sectional elements, like more enclosed urban cross section, to manage speed. This gives drivers the cue to slow down and it contributes to discomfort when going too fast. This approach may provide more opportunities to retain historical geometric features.

Design Speed Sources

Design Speed, Operating Speed and Posted Speed Practices. NCHRP Report No. 504, 2003.

5.5.2 **Horizontal and Vertical Elements**

5.5.2.1 *Horizontal Alignment (Curves) and Superelevation*

Horizontal alignment and superelevation are combined because the two criteria are interrelated in terms of their effect on geometric design.

The horizontal alignment of a highway is composed of tangents (straight segments), simple circular curves, and spiral curves used at the ends of a curve section to transition from superelevation to normal pavement crown (cross section). Of the design controls that affect the physical appearance of the highway, none is more important than horizontal alignment. Curvilinear horizontal alignment is based on a design speed that uses the combination of superelevation and the curve radius to provide an acceptable level of driver comfort. Horizontal alignment also affects another design control – stopping sight distance.

Superelevation, the banking of the pavement on the approach to and through a curve, along with tire side friction helps the driver steer through the curve. Insufficient superelevation can cause a vehicle to skid, resulting in run-off-the-road events.

Superelevation is the rotation of pavement on the approach to and through a horizontal curve. It is intended to assist the driver by counteracting the lateral acceleration produced by tracking the curve. Design speed for horizontal curves is based on the combination of superelevation and curve radius. In order to preserve a tighter curve (smaller radius), consider if it is possible to increase the superelevation.

Green Book criteria specify a minimum curve radius for a given design speed, and that value is calculated from the maximum rate of superelevation. The AASHTO horizontal curve design model is based on providing a level of comfort to drivers, and that data is derived from empirical research on what drivers are willing to accept in cornering. The most common problems associated with insufficient horizontal alignment on any road are curve radius and resulting run-off-the-road accidents.

Appropriate Treatments for Horizontal Alignment and Superelevation

- When possible, advance incremental work as a 3R project to increase opportunity for favorable preservation outcomes. Much of the work to existing roads, including selected safety improvements, are site-specific and may not require full-depth reconstruction to achieve the desired increase in safety performance. This approach will maintain more of the historical roadway geometry.
- Ensure that the inherent flexibility in the Green Book and engineering judgment have been used to select an appropriate design speed since it will control horizontal curve values. Design speed controls geometry values, like lane and shoulder width, curve radii and stopping-sight distance, and these often are important features of historic roads, especially in historic districts where it is largely about scale and the proportions of historical development.
- Since design speed for horizontal curves is based on the combination of superelevation and curve radius, consider if it is possible to increase the superelevation in order to achieve the safety improvement and preserve a tighter curve (smaller radius) without full reconstruction. This approach would be applicable when curve radii and cross sectional geometry are reasons why the road or historic district is significant.
- Use the IHSDM or HSM to characterize risk associated with curves and superelevation on existing roads and to quantify the effect of changes to geometry in terms of expected long-term safety performance. The analysis can serve to verify that the predicted effect on safety performance will be achieved and support the project purpose and need statement, or it can validate that the road is currently performing satisfactorily or has specific locations with safety problems.
- Use an approach of incremental improvements for curves with a crash history rather than full depth reconstruction if the road is otherwise performing satisfactorily. This can result in less change to the historic cross section and alignment when those features are important to historic significance.
- Place warning and advisory signs or pavement markings in advance of sharp curves as an alternative to construction or as mitigation if a design exception is warranted. This includes dynamic signs reporting real-time conditions. In addition to generally being a non-construction treatment or mitigation, the signs are reversible. Their placement will still need to be considered for effect on historic significance, but in many instances, sign

placement in support of preservation does not adversely affect historic significance on unrestricted usage streets and roads (Figure 5.4).

Figure 5.4. Ten Sleep-Buffalo Highway The Ten Sleep-Buffalo Highway (US 16) illustrates how to blend safer and more efficient roads into environmentally sensitive settings. The scenic rural highway leads into Big Horn National Forest in north-central Wyoming in a spectacular setting with challenging topography. It has a variety of users from tourists to logging and heavy trucks, school buses, and bicyclists. Because of a higher-than-state-average crash rate, a 9-mile long segment was rebuilt in 2004 using a variety of treatments to address site constraints, including environmental considerations. For many reasons, the balanced solution was to rebuild on the existing alignment using mitigation for design exceptions rather than strict adherence to Green Book design criteria. Meeting all design criteria was neither feasible nor prudent. Treatments used to improve safety and operations include advance signing, truck brake-check and turnout areas, climbing lanes, and guardrail that blend with the rugged natural setting.

- To keep vehicles in lanes, place delineation in curves, e.g., chevron signs, rather than a construction solution. This treatment is particularly appropriate when there are constraints to realigning the facility. (Figure 5.5)
- Install skid-resistant or grooved pavement if paving is not what makes the road historic. This can improve safety without changing the geometry.
- Address the roadside to mitigate substandard horizontal alignments. The importance of a forgiving roadside generally increases as the horizontal alignment becomes more severe due to the increased likelihood of errant vehicles and run-off-the road crashes.

- To improve drivers' ability to stay within the lane or ability to recover if they leave the lane, use enhanced pavement striping, delineation, rumble strips, and safety edges. This can include wide pavement marking in curves and roadside delineators.
- Install lighting to improve all-weather visibility at curves with a crash history or selected segments of high-speed rural roadways with narrow lane or shoulder widths.

Figure 5.5. Signs can be used to warn in advance of sharp curves when there are constraints that preclude realignment, like on this early-19th century road with its stone arch bridge in a historic district near Princeton, NJ. Flashing chevrons and advisory signs were selected as the non-construction solution for several deficiencies, including alignments and superelevation. Note how striping has been used to mark and maintain travel lane width over the bridge while the shoulders are not. To accommodate pedestrians, the county placed a separate bridge (left of road bridge). All of these treatments preserve historic features while making the crossing as adequate as possible given the site limitations and strong desire by the community to retain the historic character of the district. Photo M. McCahon.

Horizontal Alignment and Superelevation Sources

Mitigation Strategies for Design Exceptions, FHWA, 2007.

Flexibility in Highway Design, FHWA, 1997.

A Policy on Geometric Design of Highways and Streets, AASHTO, 2004.

Low-Cost Treatments for Horizontal Curve Safety, FHWA, 2006.

A Guide for Reducing Collisions on Horizontal Curves. NCHRP Report 500, Volume 7, TRB 2004.

5.5.2.2 *Grade and Vertical Alignment*

Vertical alignment includes vertical tangents (straight segments) and vertical curvature, both crest (top of vertical curve) and sag (bottom of vertical curve) of a highway. The design of the vertical alignment is linked to meeting requirements for safe stopping sight distance, comfortable operation, and a pleasing appearance. A vertical curve is used to provide a smooth transition between two vertical tangents of different slope rates. Crest vertical curves are designed to meet minimum stopping sight distance requirements. The design of sag vertical curves is based primarily on the ability of a vehicle's headlight to illuminate the roadway throughout a distance equal to the stopping sight distance for a specific design speed.

Grade is the rate of change of the vertical alignment, and the criteria require grades to be within maximum and minimum values. Grade is related to terrain and functional classification of the highway. Adequate grade is needed to establish proper drainage for both safety and operational reasons. Grade affects vehicle speed and control, particularly for large and heavy trucks, where the safety concern is that drivers will lose control when descending steep grades. Grade-affected speed differential can also cause problems as cars climb faster than trucks, and a horizontal curve at the base of a steep grade can contribute to run-off-the-road crashes.

Issues relating to operational effects of grade on heavy vehicles are a significant factor in developing balanced solutions. The Green Book policy on grades largely reflects design practices related to cost and operational efficiency, particularly regarding heavy vehicles, as opposed to safety. While designers are encouraged to stay within Green Book policy, flexibility may be acceptable to meet local conditions. Steeper grades may be acceptable, for example, if they are short and the operational effects can be proven to not be adverse, if there is a small percentage of heavy traffic, or if the total traffic volume is low. They may also be acceptable if the vertical curve is long enough to enable sufficient stopping sight distance. Less than minimum grade may be acceptable where the cross-slope can be designed to compensate for drainage and where alignment is primarily straight (tangent). Terrain can preclude ability to meet minimum values, in which case a design exception will be required.

Appropriate Treatments for Vertical Alignment and Grade

- When improvements to drainage are necessary, make those improvements in keeping with original/period treatment if that is a feature that makes road or setting historic and it is effective. This can be an especially important consideration for early engineered highways and park roads and parkways. Otherwise, develop a system that is compatible in appearance and effective in operation. In areas with curbed cross sections, the profile of the gutter can be adjusted by slightly varying the cross slope of the lanes thereby creating the grade along the curb between the inlets. (Figure 5.6)

Figure 5.6. On the Historic Columbia River Highway, the removal of generations of asphaltic overlay brought back to the original Warrenite pavement (lighter color), an early 20th century proprietary bitulithic paving material. This has also allowed for the restoration of the concrete gutter system. Photo courtesy Robert Hadlow, Oregon DOT.

- Provide advance warning of steep grades, a proven effective treatment, instead of a construction solution (Figure 5.4).
- Provide incremental climbing lanes or downgrade lanes when added in a manner that maintains historic character.

- To increase night-time driver comfort in a sag vertical curve, install lighting to improve stopping sight distance and driver comfort. This is a non-construction approach that will maintain existing geometry.
- Treat the roadside, including providing sufficient recovery area and compatible barrier treatment, as a component of a balanced solution when these treatments do not adversely affect what makes the road historic.

Vertical Alignment and Grade Sources

Mitigation Strategies for Design Exceptions, FHWA, 2007.
A Policy on Geometric Design of Highways and Streets, AASHTO, 2004.
Highway Drainage Guidelines, AASHTO, 2000.
A Guide for Reducing Collisions Involving Heavy Trucks, NCHRP Report 500, Volume 13, TRB, 2004.
Recommended Procedures for the Safety Performance Evaluation of Highway Features, NCHRP Report 350, TRB, 1993.

5.5.2.3 *Stopping Sight Distance*

Stopping sight distance refers to that distance a driver needs to see an object of a given height in the road ahead with enough distance to avoid a crash by braking to a full stop. The range of stopping sight distance values varies in relationship to the design speed. The Green Book provides design guidance for other sight distances in addition to stopping sight distance. They are (1) intersection sight distance; (2) passing sight distance; and (3) decision sight distance, which is intended for avoidance maneuvers.

Stopping sight distance is intended by Green Book policy to apply to the entire length of a highway, but the relative risk of limited sight distance can vary significantly over its length. Sight restrictions associated with vertical geometry require a geometric solution, but evaluations of locations with limited sight distance need to be well understood before defining a need and developing potential solutions. This includes evaluating the roadway or other conditions in the area of limited sight distance and how significant the deficiency is to safety and operations. Some conditions pose a greater safety risk than others, including high-volume intersections and steep grades.

When considering flexibility in stopping sight distance, Green Book values are not directly derived from measures of safety performance, even though safety is why sight distance is important in balanced design. NCHRP research confirmed that the values for stopping sight distance and vertical curvature provide a substantial margin of safety against the actual risk of a crash attributable to insufficient stopping sight distance. The values were revised in 2001 using a higher object height and a lower driver eye level to reflect characteristics of the current vehicle fleet. The values for lower speed roads are slightly shorter while those for higher speed highways are slightly higher, but the difference between pre- and post-2000 standards is minimal.

Appropriate Treatments for Stopping and Intersection Sight Distance

- Use the Green Book guidance recommending looking beyond its operational model to assess the risk of limited stopping sight distance or criteria below current values as an alternative to a construction solution that changes historical geometry. The crash history should be used to inform the assessment, and it may support that the road is performing satisfactorily and does not warrant changing.
- In urban areas, use turn restrictions or traffic signals to eliminate higher risk maneuvers instead of reconstructing intersections. Refer to Appendix A.
- When not affecting what makes the road or its setting historic, remove or relocate physical obstructions that interfere with sight distance, especially at curves, interchanges, and intersections. Manmade obstructions, like overhead bridges, stone walls, and other edge-of-right-of-way treatments often contribute to historic significance, and the appropriateness of this treatment needs to be evaluated on a case-by-case basis. But when it is determined that relocating the feature or removing vegetation facilitates a mutually agreeable solution, it should be done in accordance with original orientation and using original construction techniques or generally accepted preservation practices. This balance accommodates needed safety and operational improvements while maintaining historic character.
- Selectively cut back vegetation and limit slope reductions to increase sight distance before developing a construction alternative. In many instances, vegetation is not what makes a road or setting historic. When plantings are a significant feature, consider appropriate pruning, which is also a sound maintenance practice. In many instances, sight lines can be improved and original geometry preserved. Additionally, diseased material may be considered for removal and/or in-kind replacement to improve safety (Figure 2.2).

To better understand location-based risk of limited stopping sight distance, use the IHSDM to create stopping sight distance profiles for 2-lane rural roads. Findings can be used to justify and support changes to geometric features that are important to preserving historic significance. The modeling program permits safety to be quantified and the results used to demonstrate the increase in safety performance.

As an alternative to a construction solution, increase driver awareness of intersections with advance warning signs or enhanced signs (e.g., larger signs, install flashing lights). This offers a non-construction option for improving safety performance.

In order to tailor improvements to their context, consider match improvements in historic districts to scale and the basis for significance of the district. This includes customizing details like intersection design to conform to existing treatments rather than standard details when those treatments are adequate. Attention to details like these go a long way in preserving historic significance in historic districts.

- In urban settings use a narrower cross section to slow drivers instead of changing existing geometry to manage speed and improve stopping sight distance.
- For severe sight restrictions, some improvements can be effective even if minimum stopping sight distance is not provided. Gaining some increase may be beneficial, even if criteria are not met.

Stopping Sight Distance Sources

Mitigation Strategies for Design Exceptions, FHWA, 2007.
A Policy on Geometric Design of Highways and Streets, AASHTO, 2004.
Determination of Stopping Sight Distances, NCHRP Report 400, TRB, 1997.
Recommended Procedures for the Safety Performance Evaluation of Highway Features, NCHRP Report 350, TRB, 1993.

5.5.3 Cross Section Elements

The roadway cross section includes the lanes and shoulders, any medians, border areas that include tree lawns and sidewalks, side slopes, and drainage. Lane width, shoulder width, and shoulder surface type play a significant role in roadway operations and safety. Design criteria values for these elements are greatly influenced by factors such as traffic volume and composition, including pedestrians, bicyclists, and the nature of the adjacent land use (urban, suburban, and rural). These factors become increasingly important as the alignment becomes more curvilinear. Shoulder treatments, in particular, are generally a prominent feature of historic roads, and the original treatment can be important to preserving what makes a road historic (Figure 5.7).

5.5.3.1 *Lane Width*

Lane width is the width of the lanes in the travel way. It does not include shoulders, curbs, or parking lanes. Lane width is defined by values influenced by terrain, design speed, the volume and character of traffic, and the functional classification of the roadway. Widths generally range 9 feet for local roads to 12 feet for higher speed roads, like freeways, arterial highways in suburban areas, and rural arterial and collector roads. Exceptions do exist; for example, Georgia uses a 14 foot width for center turn lanes. The lane width value should also include consideration of the horizontal alignment, particularly along curves, and widths for left, right, and center two-way left turning lanes are often less than the lane widths for the through roadway. Reduced travel lane widths affect capacity (free flow of traffic), especially on high-speed roads. There are generally greater opportunities using flexibility in urban environments, where the range of values offers more latitude to maintain existing widths due to lower speeds and less traffic volume.

Figure 5.7. Unimproved shoulders are generally a significant feature of rural roads and unimproved roads. One-lane rural roads in Ohio generally have passing shoulders (right) while in more congested New Jersey, gravel shoulders beyond the pavement are common (left). Maintaining the character of the historic treatment can be an important component of a balanced solution involving shoulder treatments. Photographs by M. McCahon

Design policy provides some flexibility on how lane widths can be tailored to fit the particular environment in which the roadway functions. For low-volume rural local roads, the basis for lane width is safety and risk assessment. In urban areas there is less direct evidence of a safety benefit associated with incrementally wider lanes than other cross sectional elements, and lane widths may vary from 10 feet to 12 feet for arterials. For full-depth reconstruction of rural two-lane highways, the Green Book notes that less than 12.feet lane widths may be retained "where alignment and safety record are satisfactory.” In other words, there is no mandate to widen an existing rural highway if its safety performance is acceptable.

5.5.3.2 *Shoulder Width*

A shoulder is the paved or unpaved portion of the roadway contiguous to the travel way. It is considered part of the clear zone. The graded shoulder width is measured from the edge of the traveled way to the edge of shoulder slope. The paved or treated shoulder width is measured from the travel way to the edge of the paved portion of the shoulder. Shoulders perform a number of functions important to safety and traffic operations, including emergency storage for disabled vehicles, space for maintenance activities, area to maneuver to avoid crashes, accommodation of bicycles, and recovery area for drivers who have left the travel lane (Figure 5.8).

They are not usually considered a pedestrian facility. Shoulders can also improve stopping sight distance at horizontal curves and provide an offset to objects like traffic barriers and bridge substructure units. On streets and roads with curbs, shoulders store and carry water, keeping it off the travel lane. On narrow rural roads, shoulders serve as structural lateral support for the travel way pavement and additional width for meeting or passing drivers.

Figure 5.8. There is a wide range of flexibility for shoulders depending on local conditions. One of several treatments could be applied to increase the safety and operations of this segment of state highway for its multi-modal uses, including incremental widening of the travel lanes and shoulders, which in this locale also serve as a buggyway. Note that even the buggies off track on the inside of the curve. Enhanced pavement markings could improve the ability of motorized vehicles to stay in the appropriate travel ways, especially on the inside of the curve as buggies labor up the hill. Photographs M. McCahon.

Research has proven that the greatest safety benefit of shoulders is that they enable motorists to avoid crashes. Shoulders also have a measurable effect on traffic operations and highway capacity, particularly high-speed arterial streets and highways. Their effect is less on rural two-lane roads where the substantive safety effects of incremental shoulder widths are less.

Green Book policy defines a range of values from 2 feet to 12 feet depending on the functional classification of the road with both paved and usable area counting toward that value.

Appropriate Treatments for Lane Width and Shoulder Widths

Lane and shoulder width treatments have been combined because normally they are evaluated in combination, particularly when there is limited cross-sectional width. The two criteria are also interrelated in terms of their effects on safety and operations, as is often the case with historic roads. From the preservation perspective, the two features are generally considered together and they can work in tandem to accommodate needed improvements and preserve historic significance. For instance, when travel lanes are widened, reestablishing the historic shoulder treatment can minimize the visual impact of the lane widening.

- When the nature of the work is incremental safety improvements, advance it as a 3R project in order to increase opportunity for favorable outcome for preservation. Much of the work to existing roads is site-specific and may not require full-depth reconstruction to achieve the desired increase in safety performance. This approach will maintain more of the historical roadway geometry.
- Any widening of lanes and/or shoulders should always be done with sensitivity so as not to overpower the historic character and be as minimal as possible. Scale is often a critical consideration, especially in historic districts, with the amount of justified change predicated on the existing and historic scale. A good rule of thumb is that the larger the feature, the less intrusive making it bigger will be. For instance, it might be possible to widen a 150 feet-long pony truss bridge 6 feet to increase lane width without exaggerating the original proportions of the bridge, but doing the same thing to one 75 feet long will not work. The increase is just too great for the original proportions.
- If the historic road is sufficiently deficient that it requires reconstruction, consider bypassing the historic road or street with a new, full-capacity road on a new alignment. This approach has been successfully for urban bypasses and for arterial through routes. Upgrading routes by building on a new alignment and leaving the old road in place has been the keystone of transportation route improvements starting with the railroads in the middle of the nineteenth century.
- Location in a historic district or being a historic property in its own right are just two of the constraints encountered when upgrading or maintaining an existing road. When cross-sectional width is limited or constrained, make the best use of the width available instead of widening. To optimize safety and operations within existing cross section, analyze and then distribute cross sectional width based on optimal combination of traveled way and shoulder widths, site characteristics, performance history, highway type, traffic volumes and nature, geometry, crash history, and crash type. The intent is to reduce the incidence of the specific problem(s), like run-off-the-road crashes or truck off-tracking. When cross-section is limited, consider constructing a separate path and bridge, if needed, for pedestrians and bicyclists (Figure 5.5). It is noted that care needs to be used to blend the new pedestrian facility with the historic context into which it is being introduced (Figure 5.9).
- When compatible with the reason(s) the road is historic, improve the vehicle‘s ability to stay within the traveled way using pavement markings or delineation like reflective roadside delineators or wide pavement marking. Raised pavement markers are particularly useful to mark narrow lane and shoulder widths.

Figure 5.9. The crossing is located in overlapping historic districts, each with its own significance. The bridge was originally built in 1907 as part of a lake developed for rowing regattas, and as such it was an incident in a manipulated landscape as well as a transportation facility. The highway itself was listed in the National Register as an evolved highway dating to the colonial era. It was taken into the state highway system in 1919 and subsequently upgraded using AASHTO design criteria. The National Register nomination was prompted by local desire to limit truck traffic or increase in roadway width. Consequently, the unimproved pavement edge treatment is very important to local stakeholders, who also wanted the new bridge and clear zone to accommodate pedestrians. In order to not adversely affect either historic district, the new bridge was finished with stone-veneered fasciae. It continues to serve as a frontispiece in the lake-centric historic district. The pedestrian bridge was integrated into the roadway bridge, and the desired sidewalk was finished as stabilized earth so as to maintain the historical unimproved pavement edge treatment. The standard safety-shape barriers were finished with tinted concrete. The bridge is in a suburban setting dominated by post-World War II houses in Princeton New Jersey. Photographs M. McCahon.

- Where lanes are narrow, incrementally widen at sharp horizontal curves and/or rumble strips to improve safety performance concerns instead of full reconstruction of segments of highway. This approach is most useful when the reason for the project (purpose and need statement) is precisely defined and well supported by crash history. Both the need for work and the effect of the improvements can be confirmed using the HSM or IHSDM. Safety and operational improvements at targeted locations result in preservation of historical features and character.
- When modifications to width are justified, match the existing edge conditions prior to construction, like relocating walls and fences, reestablishing drainage features including ditches, or reestablish vegetation in order to maintain historic character (Figure 5.10).

Figure 5.10. Sometimes historic features are safety hazards and the only prudent and feasible way to maintain them is to relocate them. Before the mortar was dry on the carefully restored parapets that flank a busy, 18'-wide county road through the National Register-listed district, they were hit and damaged (A and C). When rebuilt and hit again, it was clear to estate managers, engineers, county maintenance forces, and historians that the parapets are simply too close to the road and that preservation would be better served if the culvert pipe was extended and the parapets reconstructed away from the travel lanes. Relocation would preserve the relationship of the feature with the historic landscape scheme. Those set back from the road do retain their original detailing, which reinforces the soundness of the relocation treatment (B). By 2010, the Duke Foundation had just given up trying to preserve the parapet and had finished it in "as found" condition (D). In this instance, the better choice would be to relocate the feature rather than leave it as an obvious safety hazard. Photographs M. McCahon.

- Unimproved shoulders and treatments that convey that character are often a significant feature of historic roads. They serve as the visual transition from the pavement to the setting and features beyond the pavement. They contribute to the character of the road and setting. In order to maintain that aspect of the road's appearance, use a stabilized earth shoulder treatment that provides a recovery area and honors the character of the road. How the edge of pavement is addressed can be a significant issue to preservationists and the public.

- To provide ability to recover if a driver leaves the traveled way, move the drop off farther from the travel lane when the side slope is not a feature that makes the road historic, or construct a safety edge that provides a beveled edge pavement instead of a near-vertical edge. The safety edge is particularly useful for limited cross sectional width and local roads and will have minimal impact on the character of the road.
- When fixed objects with historic significance interfere with the desired shoulder width, treatments other than removal may reduce the severity of crashes. This could include redesigning a feature like light standards to make it break away or shielding with appropriately styled and finished barriers or naturalistic treatments, like slopes and berms. The barrier, however, may become a large obstruction.

Lane Width and Shoulder Width Sources

Guidelines for Geometric Design of Very Low-Volume Local Roads (≤ 400 ADT), AASHTO, 2001.
Mitigation Strategies for Design Exceptions, FHWA, 2007.
A Policy on Geometric Design of Highways and Streets, AASHTO, 2004.
Roadway Widths for Low-Traffic Volume Roads, NCHRP Report 362, TRB, 1994.
Highway Capacity Manual, TRB, 2000.

5.5.3.3 *Cross Slope*

Pavement cross slope is the transverse profile of the pavement, and it is important for both safety and operations. The purpose of the cross slope is to drain water from the roadway and to minimize ponding on the traveled way and shoulders, which in turn minimizes icing and promotes economy of maintenance. It is an important criterion for historic roads because addressing drainage is frequently the reason resurfacing projects are initiated. Cross slopes that are too steep can cause vehicles to drift or skid and become unstable when crossing the crown to change lanes.

There is a range of minimum and maximum values for cross slope determined by factors like local climate conditions and the number of lanes. In general the maximum value of the cross slope break between pavement lanes is .032 ft/ft and, and where superelevated sections exist the break between the high side of the superelevated lane and the adjacent shoulder is .07 ft/ft.

Appropriate Treatments for Cross Slope

- Since the primary concern for locations with insufficient cross slope is inadequate drainage, place "Slippery When Wet” signs to warn motorists of sections with insufficient cross slope.
- Groove pavement to improve ability to maintain control on slick pavement when the cross section is too flat or too steep and it is what makes the road historic. This would not be appropriate for streets with specialty paving, like brick streets.

Figure 5.11. A concrete apron set into the integral curb on the concrete roadway is a historic treatment that appears to continue to function well given the condition of the bypassed section of US 66 in Missouri. Modern curbs and drop inlets would change the historic significance of the geometric design of the 1943 dualized highway. Photographs M. McCahon.

- Consider using soil bio-engineering to stabilize slopes.
- Landscape storm water management facilities (retention ponds) in a manner that is compatible with the historic significance of the setting.
- Use historic treatment as basis for design if (1) drainage treatment is source of historic significance and (2) analysis demonstrates that it was adequate (Figure 5.11).
- Placement of standard curb and gutter treatments can be out of character with historic treatments. Reestablish the historic treatment, including width of tree lawns, width and pavement type of sidewalks, driveway cuts and other features that contribute to the historic character of historic settings if there are no safety or operational reasons supporting not using the historic treatment. The same consideration should be afforded the transitions from new to the existing cross section (Figure 5.12).

Figure 5.12. Historic treatments of tree lawns or parkways, sidewalk pavement and curbing are often significant features in urban historic districts, and consideration should be given to maintaining the historic details. In the Jefferson (GA) Historic District, the concrete hexagonal pavers are noted in the nomination as a significant feature in the historic district (A). Likewise, the width of the tree lawn and the fact that stone edging is used for one side of the sidewalk is a contributing feature (B). Even when curb and gutter section is placed, attention to reusing historic treatments elsewhere whenever possible will preserve historic character in districts. Photographs M. McCahon

- Use of conjectural or contemporary pavement treatments, like stamped or formed pattern concrete, should be avoided. They are contemporary treatments that are not historic or appropriate as a means for preserving historic significance. Creating a false sense of history is not an accepted preservation practice, and it does not conform to *The Secretary of the Interior's Standards for Rehabilitation* (Figure 5.13).

Figure 5.13. The stamped paisley pattern treatment and brick crosswalks added to a misaligned intersection with a vertical crest in the center of a small historic district is not only inappropriate from the historic perspective, it adds visual confusion to an already complicated intersection. Treatments that never existed in history should not be used in historic districts. It is more appropriate to use traditional pavement striping and signs. Photograph M. McCahon.

Cross Slope Sources

Mitigation Strategies for Design Exceptions, FHWA, 2007.

A Policy on Geometric Design of Highways and Streets, AASHTO, 2004.

Highway Drainage Guidelines, AASHTO, 2000.

5.5.4 **Clearances and Bridges**

5.5.4.1 ***Vertical Clearance***

Vertical clearance is the height of an obstruction, like a bridge, over the roadway. Vertical clearances are to be maintained over the entire roadway width (travel way and shoulder). The criterion most directly affects overhead bridges and portal bracing on through truss and arch bridges. Insufficient vertical clearance affects safety and operations.

The Green Book criteria provide vertical clearance values for the various highway functional classifications and whether the highway is rural or urban. The value is one-foot greater than the maximum legal vehicle height, and is at a minimum not less than 14 feet except for interstate highways where the minimum value is 16 feet. Typically, highway agencies will add additional vertical clearance in their initial design to permit future resurfacing projects. Where the vertical clearance is designed to a minimum, the depth of the proposed resurfacing material must be removed from the existing pavement before resurfacing can be done. Policy includes provisions for flexibility in urban areas where one route in a given direction must meet the requirements rather than every route.

Appropriate Treatments for Vertical Clearance

- Sign an alternative route when the overhead obstruction is significant to maintaining historic significance.
- Provide advance and on-obstruction signing. This could include a barrier with an audible warning (chimes) in advance of a bridge or tunnel. Advance warning signs can also be used to protect tree canopies or overhead bridges (Figure 5.14).
- On a road with more than two lanes, provide signing that moves tall vehicles to inner lanes (Figure 5.15).
- Raise obstructions like bridge superstructures. In many instances, raising can be done with no adverse effect unless the vertical profile of the facility carried is changed in a historic setting. It is a treatment that has been used historically.
- Lower the road under an obstruction if the vertical profile of the facility carried cannot be changed without an adverse effect. This has historically been a common treatment for streets and highways passing under railroads.
- When the bridge is not historic in its own right, replace a superstructure of an overhead bridge with one that is less deep in order to increase vertical clearance without changing the geometry of the road passing under the bridge.

Vertical Clearance Sources

Mitigation Strategies for Design Exceptions, FHWA, 2007.

A Policy on Geometric Design of Highways and Streets, AASHTO, 2004.

Figure 5.14.There advantages for posting vertical clearance signs in advance of the obstruction. They can prevent overhead bridges that contribute to historic districts from being physically damaged by oversized vehicles. It does little good to place warning signs after the overhead obstruction has been hit. Photograph M. McCahon

Figure 5.15. There are a handful of approaches to improving vertical clearance, including advance and on-structure signing and pavement marking. Unrestricted height crossings of this rail line are nearby. The overhead bridge and the roadway are both contributing resources to a historic district. Oversized vehicles must move to the inside lane in order to avoid striking the bridge. Photograph M. McCahon.

5.5.4.2 *Lateral Offset (To Obstruction)*

Lateral offset to obstruction is the distance from edge of pavement or designated point to a vertical roadside element, like a utility pole, bridge substructure, or tree. Adequate distance from these elements is provided in order to not affect a driver‘s speed or lane position and accommodate mirrors on trucks and buses and the opening and closing of vehicle doors. Lateral offset to obstruction is a common safety deficiency with historic roads and streets, particularly in urban areas and historic districts. In urban areas with curbed streets, the lateral offset is typically 1.5 feet from the face of curb. Lateral offsets on uncurbed rural designs vary depending on the functional classification of the roadway and volume of traffic.

Lateral offset is an operational consideration. It is not the clear zone, which is a clear recovery area free from rigid obstructions and steep slopes that has a safety function. Clear zone guidance, which is not one of the controlling criteria, is addressed in AASHTO‘s *Roadside Design Guide* (see 5.7.1). Chapter 10 of the *Guide* provides guidance on roadside safety in urban and restricted environments and emphasizes the need to look at each location and its particular site characteristics individually, including site constraints associated with historic roads and roads in historic districts.

Appropriate Treatments for Lateral Offset to Obstruction

- Assuming that an object cannot be removed or relocated, add reflective material around or appropriately attached to historically significant obstructions to make them highly visible to drivers. This applies to non-historic obstructions as well. Reflective marking should be installed to be completely reversible thus not marring historic feature.
- Depending on the historic significance of the obstruction, it may be appropriate to relocate rather than demolish obstructions in order to achieve balanced solutions. In many historic districts, the feature is an incident in a manipulated or evolved landscape with its historic significance and value as a contributor to the historic character of the district. If the feature can be reconstructed in its historic orientation, like the New Hampshire program to rebuild stone walls parallel to the roadway, historic character can be retained while safety and operational needs are met (Figure 5.10).
- Consider if the cross section can be reconfigured away from the obstructions with historic significance. This is particularly important in historic districts.
- Knowing the crash history can be useful in decisions on how to treat features with historic significance. For 3R projects in particular, unless there is a crash history related to the lateral offset or the roadside, any increase in existing width may be limited to that which may be reasonably attained.

Lateral Offset Sources

Mitigation Strategies for Design Exceptions, FHWA, 2007.

A Policy on Geometric Design of Highways and Streets, AASHTO, 2004.
Clear Zone and Horizontal Clearance, Frequently Asked Questions, FHWA, 2005.
Highway Capacity Manual, TRB, 2000.

5.5.4.3 *Bridges-Width and Structural Capacity*

Design criteria and treatments for bridges are addressed in detail in AASHTO's 2008 *Guidelines for Historic Bridge Rehabilitation or Replacement* and are not addressed in this guide.

Bridge Width and Structural Capacity Sources

Guidelines for Historic Bridge Rehabilitation or Replacement, AASHTO 2008.
Guidelines for Geometric Design of Very Low-Volume Roads, AASHTO, 2001.
A Policy on Geometric Design of Highways and Streets, AASHTO, 2004.

5.6 Intersections

Intersections are important components of highways, and their design affects efficiency, safety, speed, cost of operation and capacity of the facility. The objective of intersection design is to facilitate the convenience, ease and comfort of traversing it while enhancing efficient movement of vehicles and people. Although they account for a very small part of the highway system, nearly half of all vehicle crashes occur at intersections, with the left-hand turn representing the greatest risk. Intersections associated with historic roads and roads in historic districts can present a variety of challenges when it is necessary to bring them into conformance with current safety standards and meet operational needs. Providing adequate sight distance while preserving historic significance can also be challenging.

Intersection design is complex, and it involves consideration of many factors, including existing site constraints like the presence of historic properties or the road itself being the historic property. AASHTO recognizes the inherent complexity of intersections in several ways. Firstly, it provides flexibility to consider and address the many factors by making its policy guidance rather than prescribed minimum dimensions. Secondly, it provides a great deal of guidance on the subject by devoting over one-third of the total content of the Green Book to all types of intersections. Thirdly, it uses FHWA's Manual on Uniform Traffic Control Devices (MUTCD) to govern the design and placement of control devices, including traffic signals, stop and other regulatory signs, and warning signs. In keeping with the policy of driver comfort and consistency to avoid surprises, many of the dimensions, treatments, etc. in MUTCD are mandated.

For a more detailed explanation of the progression of treatments for making intersections safer and more efficient, refer to Appendix A: Factors Associated with Intersection Design and Operations. The information outlines the function of and thresholds for assigning right of way and issues to consider as design alternatives for geometric changes.

The design of intersections on existing roads will be significantly influenced by site-specific features or constraints as well as its potential users, from pedestrians to oversized vehicles (Figure 5.16). The basis for most of the intersection geometric features is accommodating turning paths of the design vehicle to prevent off-tracking. The larger the design vehicle, which generally minimizes encroachment of most vehicles into adjacent lanes and shoulders, the greater the size of the intersection. Consequently, selection of the design vehicle is among the most important intersection-related considerations when working with historic roads. The inherent flexibility in the Green Book allows for consideration of a design vehicle that arrives reasonably frequently at the intersection, rather than the largest vehicle that would ever use it. Once the design vehicle has been selected, the Green Book provides guidance, not policy, on radii and lane widths that are consistent with the design vehicle.

Figure 5.16. The design of intersections is significantly influenced by site-specific features or constraints as well as the potential users, from pedestrians to school and city buses. Shown here is a typical 90-degree street urban intersection within a historic district. Turning lanes and setbacks for traffic stopping lines have been installed, but the tracking of large vehicles still presents challenges. The basis for most of the geometric features is accommodating turning paths of the design vehicle to prevent off-tracking. Selection of the design vehicle is among the most important intersection-related considerations when working with historic roads. Photograph M. McCahon.

Stopping Sight Distance

Intersection sight distance criteria is consistent in principle with stopping sight distance, and is intended to provide sufficient clear sight distance for the driver in the intersection to avoid a potential conflict when moving through the intersection. Its purpose is to provide enough sight distance for motorists entering the intersection to either turn left or right from a crossroad and accelerate to a speed without oncoming traffic being forced to lower their speed substantially, or to cross the crossroad without oncoming traffic being forced to brake substantially to avoid a crash. It also considers the time a driver needs for perception and reaction, to make a decision, and to carry out the maneuvers associated with moving through the intersection.

Appropriate Treatments for Intersections

- When desired turning lane arrangements cannot be developed, use different movement-control designs, including turn prohibitions, special signal phasing, or other measures. See Appendix A.
- Remove on-street parking and allocate roadway to most effectively accommodate movements.
- When it is a viable option, reroute large vehicles to roadways going the same directions that can accommodate them.
- Where intersection sight distance is limited according to the Green Book criteria, consider non-construction options depending on the nature of the restriction, from removing obstructions to positioning the vehicle so that sight lines are clearer (Figure 5.17.)

Figure 5.17. In order to improve the preservation potential of a feature that contributes to a National Register-listed historic landscape and the safety performance and operations of high-traffic volume local roads through that landscape, the cross section was moved away from the obstruction (right). Note how natural stone curbing was to define the edge of pavement, pavement markings are used to position vehicles to provide adequate sight distance and room to execute turning maneuvers. The plain signal poles are painted to blend with the rustic setting. Even though the reconfiguring is a change to the old road pattern (left), which dated to an era when the estate was not surrounded by modern residential and commercial development, treatments like this should have no adverse effect on the historic property because the character and features that contribute to that character are preserved. This represents a balanced solution. Photographs M. McCahon.

- Before additional lanes are considered at signal-controlled intersections, signal timings and phases should be reviewed to determine if the green time provided to the various phases is being used efficiently, or whether a redistribution of green time to the various phases may permit additional traffic to travel through the intersection without additional lanes. See Appendix A.

- Consider non-traditional intersection design to increase level of service without adding lanes. See Appendix A.

5.7 Safety Principles

Refer to Section 3.2.5 and 3.2.6 for discussion of nominal and substantive safety, AASHTO's *Highway Safety Manual* and the *Interactive Highway Safety Design Module*.

5.7.1 **Roadside Design (Clear Zone)**

Roadside design as a component of highway geometric design is a relatively new concept. Post-1965 understandings of the importance of a forgiving roadside, one where a vehicle leaving the travel way is afforded the ability to recover or decelerate safely before striking a fixed object, resulted in development of an obstacle free, graded area known as the clear zone. Its affect on safety has been significant and irrefutable. Achieving an appropriate balance of maintaining historic significance and providing a forgiving roadside can be one of the greatest challenges when upgrading or improving historic roads and roads in historic districts. Design of the clear zone is addressed in AASHTO's Roadside Design Guide, that, as its name implies, is advisory and not policy.

The intent of AASHTO is to be flexible with respect to roadside design treatments. The Green Book refers to the Roadside Design Guide as general guidance and also states that more than one solution may be evident or appropriate for a given set of conditions that include design speed, rural or urban location, and practicality. While clear zone widths are provided in the guide, they should not be viewed as absolute or precise. Rather, they represent national consensus and practice based in part on empirical research and testing of the consequences of road encounters and cost effectiveness. It is expected that roadside design criteria and the design of the roadside will be tailored to address site- or project-specific safety needs.

The desired clear zone width is a function of the design speed, traffic volume, roadside slopes, and the horizontal alignment. Its design should be consistent with the expected speed of errant vehicles. Selection generally represents a compromise or balance based on engineering judgment between what can be practically built, the presence of constraints like historic properties, and the degree of protection afforded the motorist. Factors that can limit the clear zone width include the location, frequency and nature of roadside objects, valued historic resources, or the need to accommodate pedestrians. Because of the variables, treatments will differ significantly between urban settings, where speeds are lower and curbs can assist in redirecting errant vehicles, and rural settings where speeds are greater and the roadside is needed for recovery of errant vehicles.

Decisions regarding roadside design for existing facilities involve engineering judgment to determine whether a feature can remain or function even though it does not conform to current guidance. Crash histories of existing facilities are a very important factor in selection of a clear zone value and deficiencies that warrant addressing. To ensure that any risk assessment analysis is fair and complete, it should include using the body of performance history to identify specific features or locations that are not performing well and to assess the reason(s) for crashes.

The Roadside Design Guide recommends a hierarchy of safety treatments for existing roadside objects: removal, relocation, modification, shielding, and delineation. Removal, relocation, and modification can have an adverse effect on features that contribute to the historic significance of a road, like walls, fences, trees, and monuments. In some instances, however, relocation of an object, particularly walls and fences parallel to the roadway, can be an effective treatment for historic roads when it is the feature as an incident in the landscape next to the road that is generally the basis for its historic significance. How any treatment will affect preservation of what makes the road historic needs to be thoughtfully and fully considered, as should ways to minimize or mitigate the impacts, like replanting trees beyond the clear zone or reconstructing walls and fences. Moving such features with historic significance can facilitate their preservation as well as improve safety and operations. In certain instances, shielding may be appropriate when obstacles and nonconforming features cannot be removed from the clear zone (Figure 5.18). The approach is discussed below.

Barriers/Railings

When crash history demonstrates that barriers are warranted and appropriate to shield fixed objects, roadside obstacles, or non-conforming cross sectional or drainage features as well as on bridges, it is important that they be designed to be compatible with sensitive settings. While placement of new barriers in historic settings can be a challenge, increased awareness of the value of maintaining historic character has resulted in an ever-increasing range of aesthetic barriers and railings that have been crash tested or judged crashworthy. The variety of treatments, from stone veneered safety-shape barriers to weathering or painted beam guide rail systems that blend well with many settings (Figure 5.19). The

Figure 5.18. Barriers are an appropriate treatment to shield a historically significant object or fixture. Here barriers are placed between the roadway and the Art Deco-style pedestrian overlook at the Croton Reservoir Bridge on the Taconic State Parkway in New York.

variety of appropriate railings as well as the ability to custom design one like Oregon's steel-backed wood railings provides the opportunity to use a railing design that meets current safety criteria and is compatible with the setting (Figure 3.2).

To provide the desired level of safety, barriers and their terminals need to be crashworthy for speeds at which they will likely be struck, regardless of the overall design speed, since operating speeds may vary along the highway. Crashworthiness is based on a barrier's capacity to effectively redirect an errant vehicle and to safely stop it in a controlled manner. These characteristics are determined by adequate tests and meet established guidelines based on test levels (TL) and speeds specified in NCHRP Report 350, Recommended Procedures for the Safety Performance Evaluation of Highway Features. The highest value TL-5 railings are used on federal-aid projects and meet full-scale, crash-tested criteria. The flexibility to use railings and barriers that are appropriate for historic roads and roads in historic districts is restricted in some states that have adopted a policy of requiring a test level that may exceed what can be considered appropriate for the speed, volume, and character of traffic using a facility For instance, Florida requires all barriers and bridge railings to meet at least TL-4.

Figure 5.19. New York's Taconic State Parkway is an arterial freeway and a scenic byway that is eligible for listing in the National Register. Improvements are governed by Programmatic Agreement and a Scenic Byway Corridor Management Plan. The plan discusses appropriate treatments and guidelines for reconstruction, including lane widths, shoulders, lengthening of deceleration/acceleration ramps, drainage features, overpasses, and side slopes. A significant safety concern of the original design of the parkway was a demonstrated history of accidents caused by traffic crossing over the median into the opposing lanes. The solution is stone-faced barriers that reflect the original design. Photograph M. McCahon.

A good source for compatible railings and barriers that have been crash tested is a web site maintained by FHWA (http://www.fhwa.dot.gov/bridge/bridgerail/). Designs, including aesthetic ones, are grouped by type and include the TL rating. Many contemporary railings, like the open, tubular Wyoming Railing or the concrete Kansas corral railing, are often appropriate for use on historic roads and in historic districts because of the simple and unobtrusive design. Tubular metal railings should be painted to better blend with their settings (Figure 5.18).

Appropriate Treatments for the Roadside

Run-off-the-road crashes are generally a response to a geometric design deficiency, not a deficiency in the roadside. Whenever possible, appropriately define the project's purpose and need and consider improving the geometric deficiency first when the roadside obstruction is very important to historic significance. It is recognized that opportunities for addressing geometric deficiencies may be limited by site constraints, particularly in historic settings.

- In order to minimize changes to historic treatments, avoid establishing an arbitrary clear-zone width and use site-specific solutions to address deficiencies that are supported by performance and crash histories. The more historic fabric and features that can be preserved, the better the outcome for the historic road.
- When trees are a significant component of significance, limit removal to where it will substantially reduce the risk of crashes. Where trees are numerous, removal of isolated trees may not significantly reduce the overall crash risk, whereas removal or shielding of isolated trees noticeably closer to the roadway may in some instances be appropriate. Roadside barriers should be placed to shield trees only when the severity of striking the tree(s) is greater than striking the barrier.
- Knowing the crash history can be useful in decisions on how to treat roadside features with historic significance. For 3R projects in particular, unless there is a crash history related to the lateral offset or the roadside, any increase in existing width may be limited to that which may be reasonably attained.
- Use the age and health of trees as a consideration in decision making. The fate of some trees may be predetermined based on their condition.
- Place new landscape material so that in the future it will not become a fixed object requiring mitigation treatment.
- Steep side slopes can pose risks. Preservationists and designers should collaborate to develop solutions for flatter slopes that do not have an adverse effect on the overall significance of the resource. This can include acquiring additional right of way.
- Regrade to flatten embankment slopes in a manner that reestablishes the historic treatment when that treatment is significant. This is especially important for roadways in significant landscapes. It is important to maintain the integrated nature of manmade features in a designed landscape.
- Replace fixed object poles and supports with breakaway poles and supports that are detailed to be compatible with the historic significance. When the original design is not documented and known, consider using scale and color of compatible contemporary design rather than conjectural interpretations of period treatments per NPS guidance in *The Secretary of the Interior's Standards for Rehabilitation*.

- When a decision comes down to demolition, relocate historic features away from the roadway. When such features are appropriately reconstructed in their historical configuration, the effect may not be adverse.
- Consider an aesthetic treatment for barriers and railings. There are many crash-tested railings that meet TL-3 and TL-4 Report 350 requirements. When the desire is to use a custom barrier or railing, consider pursuing approval from FHWA. To minimize duplicate crash testing, FHWA may allow use of designs that are similar to crash tested designs based on an analytical comparison using their specified methodology.

Roadside and Barrier/Railing Sources

AASHTO. A Guide to Flexibility in Highway Design. 2004.
AASHTO. Roadside Design Guide (Updated). 2009.
www.fhwa.dot.gov/bridge/bridgerail/
FHWA. "Roadway Aesthetic Treatments 2001 Photo Album Workbook." Note: This CD produced by the WFLHD Technology Development Team is inclusive and shows a wide variety of treatments, some of which do not represent sound preservation practices. It was also followed by a second CD dated 2002.
FHWA. *Summary Report on Aesthetic Bridge Rails and Guardrails*. Report No. FHWA-A-SA-91-051. June, 1992.

5.8 Operations (Roadway Capacity) – TRB Highway Capacity Manual

The Transportation Research Board's *Highway Capacity Manual* (HCM) is a guide on the relationship between traffic-carrying ability and roadway characteristics. It provides the user with the ability to determine the number of lanes required for the roadway to operate at a specified level-of-service (LOS). The HCM uses the LOS concept based on control delay per vehicle (seconds per vehicle) to define the congestion on a roadway. Levels of service are graded "A," representing the least delay per vehicle, through "F" representing the most delay. As an example, the level-of-service for a freeway section is noted below.

Table 5.1 Level of Services Criteria – Basic Freeway Segment

Basic Freeway Segment LOS	Control Delay per Vehicle (seconds/vehicles)
A	≤ 11
B	> 11 and ≤ 18
C	> 18 and ≤ 26
D	> 26 and ≤ 35
E	> 35 and ≤ 45
F	> 45

LOS A indicates that free-flow speeds prevail, maneuverability is optimal, and the effects of incidents are easily absorbed. LOS F is characterized by breakdowns in vehicular flow, slow speeds, heavy congestion, and the inability to recover from incidents. The desired LOS for many projects is C, which is defined as stable flow conditions by the 2000 manual. At LOS C, most drivers are comfortable, roads remain safely below but efficiently close to capacity, and posted speed is maintained. Typically, LOS C is the recommendation for design in rural areas and LOS D for urban and suburban areas. However, in many highly built-up urban areas, LOS E may be considered due to high costs or the lack of available additional right-of-way. When the LOS becomes intolerable and site conditions permit, a roadway is likely to be studied for improvement to raise its LOS. A similar LOS rating is used for intersections (see Appendix A).

Appropriate Treatments for Highway Capacity

- If capacity of the road or level of service have been identified as the purpose and need for the project and is resulting in alternatives that adversely affect the road, develop an alternate route or reroute classifications of vehicles in order to preserve the historic road or a historic district.

APPENDIX A:

FACTORS ASSOCIATED WITH INTERSECTION DESIGN AND OPERATIONS

1 Introduction

Understanding how movements at intersections are controlled facilitates developing and considering alternatives to minimize the enlargement of intersections while increasing their safety and efficiency. Such alternatives may facilitate efforts to preserve or protect historic features of roadways that otherwise would be removed or destroyed if additional lanes were added to existing intersections.

2 Defining Intersections

Roadways consist of a combination of roadway segments and intersections. Roadways are typically defined as "the portion of a highway, including the shoulders, for vehicular use." For example, a divided highway has two or more roadways. A roadway segment consists of a continuous portion of roadway with similar geometric, operational, and vehicular characteristics. By contrast an intersection is defined as "the general area where two or more roadways join or cross, including the roadway and roadside facilities for traffic movements within the area."

Intersections are complex due to the additional traffic conflicts that occur at them, the need for the assignment of right-of-way for one roadway or movement over another, and the special lane usage that may be required to separate traffic into the desired movements. This makes their design and improvement a challenge, especially in settings with constraints like historic districts or on historic roads. Operation of an intersection is primarily dependent on two variables: (1) an adequate number of lanes to accommodate the traffic volumes for each movement within the intersection; and (2) the amount of time each movement is permitted to move. In order to minimize the need for the addition of lanes to existing intersections, the following considerations for increasing their safety and efficiency should be considered in the sequential order that the treatments are presented.

3 Assignment of Right-of-Way

At all intersections the assignment of right-of-way must be provided for one movement at a time over the other conflicting movements. Typically, the assignment of right-of-way is provided by yield signs, stop signs or traffic signals. Information pertaining to the use of these traffic control devices is contained in the Manual of Uniform Traffic Control Devices (MUTCD) that is published by the Federal Highway Administration (FHWA), or in state DOT versions that must comply with MUTCD's requirements. In most instances, the addition of signage should not be considered an adverse effect on a historic road or a road in a historic setting.

3.1 Assignment by Signing

Where traffic volumes are extremely low on both the major (road with higher traffic volume) and the minor (road with lower traffic volume) crossing roads, yield signs may be erected on the minor roadway to assign right-of-way to the major roadway and to inform users on the minor roadway that they must yield. As the traffic volumes increase on the major roadway and gaps in the traffic flow between vehicles are reduced, the next step in the assignment of right-of-way is to erect stop signs on the minor roadway for safety purposes. Requiring vehicles to stop generally provides more time for them to analyze the traffic flow on the major roadway and be more assured in finding safe gaps in the major roadway's traffic stream for either entering the roadway or crossing it.

Where traffic volumes increase on both the major and minor crossroads and it is relatively equal and does not meet the traffic warrants for a signal, stop signs may be erected on both approaches of both roadways (four-way stop). Four-way stops are used primarily to increase safety, and they help to create additional usable gaps in the traffic stream of both the major and minor crossroad and also provide for the assignment of right-of-way for both roadways.

3.2 Assignment by Traffic Signals

Warrants (or criteria) are established in the *Manual on Uniform Traffic Control Devices* (MUTCD) and must be met before traffic signals can be erected. The purpose of warrants is to provide a guarantee to the public that the need for a signal, which represents an investment to install and operate, is valid based on traffic operations, not for political reasons, as a method to ticket or levy fines, or enhance the movements of one entity over the greater movements of the public. There are a number of different warrants and each base their criteria on an individual item. The items include traffic volumes, pedestrian volumes, number of crashes, signal progression (ability to move from one signal to another without stopping), school crossings, interruption of continuous traffic, peak hour delay, peak hour warrant, combinations of warrants, etc. The addition of traffic signals is not generally considered an adverse effect on a historic road because it is reversible. There are numerous methods for mounting traffic lights and designs and finishes for light standards. Compatibility with historic settings should be a consideration.

Where traffic volumes at intersections increase, eventually they may meet the warrant for installing a traffic signal. But meeting the warrant does mandate that it be installed; it simply means it is permissible to install a traffic signal. Meeting the threshold represents the tradeoff point where the delay to motorists from using stop signs equals the delay encounter if the traffic signal were operating. However, as traffic volumes increases on either road, not installing the traffic signal increases delay.

When traffic signals are installed, three new elements are added in the assignment of right-of-way; signal phase, signal cycle, and signal-cycle length.

A signal phase is the permitted movements that receive a specified amount of green time plus yellow time and all red time allocated to the movements. The amount of green time displayed to each phase is generally proportional to the highest traffic volume per lane for a movement which is moving during that phase.

The signal cycle length is the summation of the green time, yellow time and all red time for each signal phase available within the signal cycle. As an example, a four-phase signal could display green time to; (1) the through and right turning traffic on the minor crossroad; (2) a separate amount of green time in another phase to left-turning traffic on the minor crossroad; (3) a separate amount of green time in another phase to the through and right-turning traffic on the major crossroad; and (4) a separate amount of green time in another phase to the left-turning traffic on the major crossroad. The cycle length for the four-phase signal would equal the summation of the four green times provided plus their related clearance times (yellow light) and all red clearance times before the next phases were started. A traffic signal cycle consists of all the signal phases that occur before they are repeated.

In general, the timings for each signal phase should be just long enough to accommodate the traffic volume for those movements within each signal phase. This will minimize delay and the length of the signal cycle, thereby permitting the return of those phases quickly to accommodate traffic that was stopped at the signal since the last signal phase for those movements.

When the traffic volumes reach the available capacity of the existing lanes, additional volumes may be moved through the intersection if the cycle length is lengthened. This reduces the number of cycles per hour that in turn reduces the number of times the clearance and all red intervals must be shown when traffic should stop moving, thereby permitting more green time to actually move traffic. As a rule of thumb, the capacity of a lane can be increased to carry more vehicles per hour if a method can be found to reduce the number of signal phases while providing adequate green time to all movements.

4 Lane Additions

Installation of a two-phase traffic signal to replace stop signs may be adequate for the major and minor cross roads, especially where both roads are two-lane roadways. As traffic increases, especially on the major cross road, gaps in the opposing traffic will be reduced for left-turning traffic. At some point if traffic continues to increase, it will be necessary to add left-turning lanes on the major crossroad or develop a non-traditional way to maintain an acceptable level of service for the intersection. Lane additions at the intersections of historic roads should be evaluated on a case-by-case basis to determine the effect they may have on the specific features of the road that contribute to its significance. In some instances, lane additions may be accomplished without having any adverse effects on significant features.

The determination of when a traffic lane should be added is usually based on a capacity analysis, an accident analysis, or both. Capacity analyses are used to determine the level of service (LOS) (a graded system of expressing relative amounts of delay incurred by motorists using the facility) and the volume-to- capacity ratio (V/C). The chart below summarizes the graded LOS, from A to F, and provides the range of delay in seconds for each level.

Level of Service Criteria – Signalized Intersections

Signalized Intersection LOS	Control Delay per Vehicle (seconds/vehicles)
A	≤ 10
B	> 10 and ≤ 20
C	> 20 and ≤ 35
D	> 35 and ≤ 55
E	> 55 and ≤ 80
F	> 80

For interrupted flow conditions, such as at signalized intersections, LOS is defined in terms of total delay, which is a measure of driver discomfort, frustration, fuel consumption, increased travel time due to geometrics, traffic, and incidents.

Total delay is the difference between the travel time actually experienced and the travel time that would result in the absence of any delay from traffic control, other vehicles and incidents. LOS A indicates that delay is minimal, progression is extremely favorable, and most vehicles arrive during the green light phase. For signalized intersections, LOS F generally indicates poor progression, long cycle lengths, individual cycle failures and high delays.

In addition to the LOS at intersections, the V/C ratio must also be considered. A V/C ratio of 1.00 represents full capacity of the lanes for a specified movement. Typically, engineers and planners would like to design with V/C ratios somewhere around 0.85. This would mean that after the design year is reached for an intersection, approximately 15% of the capacity for that movement would still exist before it was overcapacity.

The capacity of a signalized intersection involves a balance between the number of lanes available for any movement and the amount of "green time" from the signal which can be provided to that movement. Typically, the more green time that can be provided results in the least number of lanes required to move the traffic volume for that movement. However, there are only 3600 seconds in an hour, and green time must be divided and assigned to each movement. Using the methodology within the HCM, the number of lanes for any movement for any given LOS can be determined. The methodology also considers the time needed for pedestrians crossing and considers the additional time needed to move trucks, buses and recreational vehicles.

The purpose of the left-turn lanes is primarily to move left-turning vehicles out of the through or general purpose lanes so as not to block through and right-turning traffic from moving through the intersection. Adding left-turn lanes does not necessarily require a separate signal phase for the left turners on the major roadway. But as traffic continues to increase, at some point a separate signal phase for left turners may well become necessary and with it the need to modify the old geometry and provide the needed or required additional lanes.

Many state DOTs have developed warrants to determine when it is beneficial based on delay to provide either a left- or right-turning lane. The turn-lane warrants may be based on either/or a combination of traffic volumes for the turning and opposing traffic and the number of crashes due to rear-end conflicts with through traffic. As traffic volumes increase there may be a need for additional through lanes as well. However, before any additional lanes are considered, signal timings and phases should be reviewed to determine if the green time provided to the various phases is being used efficiently, or whether a redistribution of green time to the various phases may permit additional traffic to travel through the intersection without additional lanes.

4.1 Types of Lane Additions

When the capacity of an intersection is reached or motorist delays have become substantial, there may be a choice in the type of additional lanes to construct, i.e. through-, left-turning or right-turning lanes. The types of lanes constructed can have a major effect on the historic footprint of the intersection and its roadway segments. Typically, when through lanes are added, they must be added for relatively long distances. This will result in widening not just the intersection but also the roadway far beyond the limits of the intersection. In general, right- or left-turning lanes only widen the roadway on the approaches to the intersection, and for only the length required to permit sufficient stacking or storage within the lane before receiving the green light during their phase. Since the capacity of a movement (i..e. left turn movement) at an intersection is based on the number of lanes available for moving traffic and the amount of green time provided to that movement, it is often possible, for example, to move more through traffic by constructing either an additional right- or left-turning lane. This may have a pronounced effect on minimizing the footprint of the overall width of the corridor.

When site conditions permit, it is sometimes possible to add additional turning lanes in order to avoid adding additional through lanes. Since the same turning volumes will be accommodated for the turning movement, the amount of green time for the turning movement can be reduced and then transferred to the through movement. A similar example would be related to water hoses. In general, just as much water could be squirted out a four inch hose in ten minutes as could be squirted out a two inch hose in twenty minutes. While the lanes for the through movements remain the same, the amount of green time to that movement increases.

4.2 Alternatives to Lane Additions

Instead of adding lanes, it may be possible to increase intersection capacity by using new intersection designs known collectively as **non-traditional intersections**. Non-traditional intersections include continuous flow intersections, paraflow intersections, quadrant intersections, roundabouts, and superstreets to mention a few. In general, these intersections provide alternatives to efficiently move left turning vehicles, and thereby decrease the number of signal phases.

Non-traditional intersections can increase capacity over their traditional counterparts by 50% – 90%, thereby possibly eliminating the need to add additional lanes at intersections and negate an increase in the width of the footprint. One example of a non-traditional intersection is the "Michigan U-Turns". An intersection using Michigan U-Turns would restrict all actual left turns at an intersection. However, in order to provide an equivalent movement to the left turn, drivers would continue through the intersection for approximately 600 feet to point where they can make a U-turn. Once they make the U-turn (which could be signalized), they travel back to the intersection and make a right turn, which is equivalent of making a left turn initially. By not allowing left turns at the intersection, the signal phasing can be reduced to 2 phases. As a result, delays and travel times are reduced over what they would have been if left turns were allowed. Typically, the U-turns can be made on the existing pavement. Where additional pavement is needed, small bulbouts, known as loons, can be built without much interference to the existing roadside. Since several of the non-traditional intersections accommodate improvements within existing or minimally modified street patterns, non-traditional intersections can offer flexibility for historic roads and settings.

5 Geometrics

The primary geometric elements for intersections are roadway lane width and shoulder width. However, there are other elements that may be considered, such as urban tree lawn width, sidewalk width, median width and islands. Islands may be added to channel vehicles or to provide pedestrian refuges. Many of these elements have a range of values depending on the roadway's functional classification. When the goal is to minimize the width in order to preserve or maintain historic features, it may be possible to select values from the bottom of the range. Other geometric considerations at intersections include the angle of the intersection – the angle between the two crossing roadways. Preferably, intersection should cross each other at 90˚, but angles of 70˚ are permitted. An angle of 60˚ may be used when the intersection is signalized and the intersection is skewed such that a driver stopped on the side road has the acute angle (at center of intersection) on his left side (vision not blocked by his own vehicle).

A final element to consider is the corner radius return that provides the pavement connection for vehicles turning right from one roadway to another. The radius used to connect the two roadways must consider the context of the application. Variables such as whether the intersection is urban or suburban, signalized or unsignalized and the potential conflict with pedestrians must be considered for the safety and convenience of both motorists and pedestrians. In general, the smallest radius possible for the circumstances should be used, rather than one which would accommodate the largest possible design vehicle, which accounts for less than 2% of total users. Large radii can encourage the speed of turning motorists, which can affect the safety of pedestrians crossing in the crosswalks and lengthen the distance of their crossing; thereby, providing additional exposure to pedestrians.