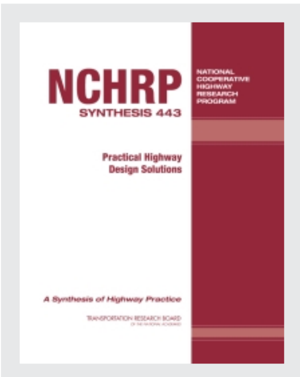


# Practical Highway Design Solutions

## DETAILS

96 pages | 8.5 x 11 | PAPERBACK
ISBN 978-0-309-22383-6 | DOI 10.17226/22636

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NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

# NCHRP SYNTHESIS 443

# Practical Highway Design Solutions

## *A Synthesis of Highway Practice*

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Vienna, Virginia

SUBSCRIBER CATEGORIES
Administration and Management • Highways • Design

Research Sponsored by the American Association of State Highway and Transportation Officials
in Cooperation with the Federal Highway Administration

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WASHINGTON, D.C.
2013
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The needs for highway research are many, and the National Cooperative Highway Research Program can make significant contributions to the solution of highway transportation problems of mutual concern to many responsible groups. The program, however, is intended to complement rather than to substitute for or duplicate other highway research programs.



## NCHRP SYNTHESIS 443

Project 20-05, Topic 43-05
ISSN 0547-5570
ISBN 978-0-309-22383-6
Library of Congress Control No. 2013955685



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The members of the technical panel selected to monitor this project and to review this report were chosen for their special competencies and with regard for appropriate balance. The report was reviewed by the technical panel and accepted for publication according to procedures established and overseen by the Transportation Research Board and approved by the Governing Board of the National Research Council.

The opinions and conclusions expressed or implied in this report are those of the researchers who performed the research and are not necessarily those of the Transportation Research Board, the National Research Council, or the program sponsors.



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*are available from:*

Transportation Research Board
Business Office
500 Fifth Street, NW
Washington, DC 20001

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## ACKNOWLEDGMENTS

Hugh W. McGee, Sr., Ph.D., P.E., was responsible for the collection and assessment of the information reported in this synthesis. Dr. McGee is a senior highway safety engineer with the firm of Vanasse Hangen Brustlin, Inc.

The synthesis would not have been possible without the cooperation of the representatives of the state departments of transportation who responded to the questionnaire survey and particularly those who participated in follow up interviews; they included:

- Joseph Jones, Missouri Department of Transportation
- George Lukes, Utah Department of Transportation
- Jeff Jasper, Kentucky Transportation Cabinet
- David Polly and Kent Belleque, Oregon Department of Transportation
- Jonathan Marburger and Jim Brewer, Kansas Department of Transportation
- Loren Thomas, Idaho Department of Transportation

Valuable assistance and guidance was provided by the Topic Panel. The project was managed by Jo Allen Gause of the NCHRP Synthesis staff.

## FOREWORD

Highway administrators, engineers, and researchers often face problems for which information already exists, either in documented form or as undocumented experience and practice. This information may be fragmented, scattered, and unevaluated. As a consequence, full knowledge of what has been learned about a problem may not be brought to bear on its solution. Costly research findings may go unused, valuable experience may be overlooked, and due consideration may not be given to recommended practices for solving or alleviating the problem.

There is information on nearly every subject of concern to highway administrators and engineers. Much of it derives from research or from the work of practitioners faced with problems in their day-to-day work. To provide a systematic means for assembling and evaluating such useful information and to make it available to the entire highway community, the American Association of State Highway and Transportation Officials—through the mechanism of the National Cooperative Highway Research Program—authorized the Transportation Research Board to undertake a continuing study. This study, NCHRP Project 20-5, "Synthesis of Information Related to Highway Problems," searches out and synthesizes useful knowledge from all available sources and prepares concise, documented reports on specific topics. Reports from this endeavor constitute an NCHRP report series, *Synthesis of Highway Practice*.

This synthesis series reports on current knowledge and practice, in a compact format, without the detailed directions usually found in handbooks or design manuals. Each report in the series provides a compendium of the best knowledge available on those measures found to be the most successful in resolving specific problems

## PREFACE

*By Jo Allen Gause*
*Program Officer*
*Transportation*
*Research Board*

Some state departments of transportation (DOTs) have adopted design solutions—often labeled "practical design"—for specific roadway projects at reduced costs, thereby allowing the agencies to better address critical needs of the entire roadway system. This synthesis presents information on the application of practical design approaches in roadway project development.

Information used in this study was acquired through a review of the literature, a survey of state DOTs, and follow-up interviews with six state DOTs that have adopted formal practical design policies.

Hugh W. McGee, Sr., Vanasse Hangen Brustlin, Inc., collected and synthesized the information and wrote the report. The members of the topic panel are acknowledged on the preceding page. This synthesis is an immediately useful document that records the practices that were acceptable with the limitations of the knowledge available at the time of its preparation. As progress in research and practice continues, new knowledge will be added to that now at hand.

# CONTENTS

Note: Many of the photographs, figures, and tables in this report have been converted from color to grayscale for printing. The electronic version of the report (posted on the Web at www.trb.org) retains the color versions.

# PRACTICAL HIGHWAY DESIGN SOLUTIONS


## SUMMARY

There are many demands on state departments of transportation (DOTs), from simple maintenance of ever-expanding assets to addressing the increasing mobility and safety needs of all highway users. State DOTs are continuously striving to meet this challenge with limited financial resources. In doing so, some state transportation agencies have adopted design solutions for specific roadway projects at reduced costs, thereby allowing the agencies to address critical needs of the entire roadway system. For example, the Missouri DOT (MoDOT) has initiated a process—labeled Practical Design—that critically reviews projects to establish reduced-cost scope and roadway geometrics based on needs and not standards. They have stated that they want “fewer spots of perfection and more good projects that make a great system.” The Kentucky Transportation Cabinet (KYTC) has approached this program from a somewhat different perspective through their Practical Solutions initiative, where the philosophy of building reduced-cost projects is emphasized using the existing condition as the baseline design and thus achieving a positive outcome with project improvements beyond the existing conditions.

As documented in this report, a few other states have adopted similar programs, labeled variously as Practical Design, Practical Solutions, or Practical Improvements. Whatever label is given by the state, the adoption of this cost-saving initiative is increasing and gaining the attention of many other DOTs. The objective of this synthesis is to identify current knowledge and practice in the application of Practical Design (the default term used in the report) approaches in roadway project development.

Information gathered for this synthesis included the following:

- What states have a Practical Design or similar policy.
- How states define and implement Practical Design.
- Barriers and lessons learned from states that have implemented Practical Design.
- Relationship of Practical Design to Context Sensitive Design, Context Sensitive Solutions (CSS), Value Engineering (VE), and other similar initiatives.
- How Practical Design differs from the traditional design process.
- Modifications to roadway geometric design criteria.
- Project-specific roadway design tradeoffs considered.
- Cost savings resulting from Practical Design projects.
- Performance measures for Practical Design, including safety and operational performance, and system condition.
- Liability risk of implementing Practical Design approaches.

Information for this synthesis came from published literature, a survey of state DOTs, and interviews with state DOTs identified as having a Practical Design or similar policy. To date the literature is limited for this emerging project development and design philosophy; therefore, relatively little was gained from that review. An online survey was sent to all state DOTs to (1) determine which states have a Practical Design (or other term) policy; (2) become aware of their policy and procedure; (3) identify states that are considering adopting a policy; and (4) determine information states would like to have that would assist them in developing

or modifying a Practical Design program. The survey achieved an 82% response rate, with 41 of 50 states responding. Follow-up interviews were conducted with those states determined to have a formal Practical Design policy.

From the questionnaire, 29 of the 41 responding DOTs indicated that they have a Practical Design (or similar term) policy. These agencies can be grouped into two categories: those that have an explicit, documented Practical Design policy or program and those that have "something similar." For the former group, the following DOTs are included:

| | |
|---|---|
| Practical Design | Missouri, Oregon, Utah |
| Practical Solution | Kentucky, Idaho |
| Practical Improvements | Kansas |

MoDOT adopted a formal Practical Design policy in 2005, making it the first state do so. The DOTs of Oregon and Utah also identify their policy as Practical Design. The KYTC and Idaho DOT use the term Practical Solutions. Kansas has adopted Practical Improvements as a title for their similar program.

Twenty-three DOTs responded that they have a Practical Design (or similar term) policy. However, they did not have an explicit policy and in their response to other "similar programs," they referred to context sensitive design or solutions, resurfacing, restoration, and rehabilitation (3R) design criteria, design flexibility, design exceptions, road safety audits, minimum design approach, and other terms. The practices of these states were not examined in this synthesis.

The six state DOTs that have an explicit, documented policy are profiled in this report. For each state, how they developed and implemented their policy, how their policy is applied to project development and design, what benefits were derived, and other information sought by states who are considering adopting a policy is discussed. Where examples exemplifying their approach were provided, they are included in the synthesis. A summary of each state's policy is as provided here:

Missouri—MoDOT can lay claim to being the first state to adopt a Practical Design policy, initiating it in 2005. As stated in its implementation guide *Practical Design, Meeting Our Customer's Needs,* the goal of Practical Design is to build "good" projects, not "great" projects, to achieve a great system. The key principle is to define the project scope by focusing on achieving the project purpose and need while considering the surroundings of each project. In its implementation guide, MoDOT provides primary design guidance for 29 areas including type of facility, geometric design elements, pavements, structures, roadside safety, and miscellaneous. The guidelines provided in that document allow for flexibility in the selection of the specific design value.

Idaho—The Idaho Transportation Department (ITD) adopted its Practical Solutions/Design (both terms are used) policy in 2007. The program was initiated based on the favorable reports from Missouri. ITD's philosophy is to build cost-effective projects to achieve a sound, safe, and efficient transportation system. In its guidance document, ITD provides "primary guidance" for several design elements, of which the two primary elements are design speed—which is to be the posted speed or as appropriate to context and intent—and level of service (LOS)—which can be selected at a lower level; for example, LOS D instead of LOS C. The document also provides primary guidance for several other design elements including those related to geometrics, roadside, pavement, structures, bicycle and pedestrian facilities, right-of-way, and even materials and traffic control.

Kentucky—KYTC adopted Practical Solutions as its policy in 2008. As with Missouri, the impetus was to find a way to "do more with less." And as with other states, its underlying principle is to identify the project purpose and need, which drives the project scope. In issuing its Practical Solutions policy, KYTC's state highway engineer included values for several design elements—pavement and shoulder widths, curve radius, pavement and shoulder cross slopes, grade, stopping sight distance, and passing sight distance—for three classes of roads: two-lane arterials, rural collectors, and rural local roads. The policy also suggests that for two critical factors affecting design—the design speed and the design year traffic volume—lower, in the case of design speed, or nearer, in the case of design year, values can be considered.

Kansas—The Kansas DOT (KDOT) adopted a formalized Practical Improvements approach to its projects in 2009. KDOT defines Practical Improvement as "the overarching philosophy which guides our decisions that affect project cost and scope in order to stretch our transportation improvement dollars further while still maintaining a safe and efficient highway system." KDOT issued *Practical Improvements*, a document that provides guidance on how the Practical Improvement process is to be followed in the development of a project, specifically on developing alternative scopes. In Kansas, projects are initially programmed by the planning department and reach the design office with a general scope and budget, which usually cannot be exceeded. To stay within this budget, proper scoping of the project is considered an integral part of the Practical Improvement process. When applying the Practical Improvement approach, alternative scopes may involve selecting design criteria outside of the prevailing criteria range.

Oregon—The Oregon DOT (ODOT) issued its Practical Design policy in 2010 after being mandated by the state legislature in its Jobs & Transportation Act of 2009. ODOT was to follow design practices that incorporate the maximum flexibility in the application of standards to reduce cost while preserving and enhancing safety and mobility. ODOT, in its *Practical Design Guidebook*, presents a process for applying Practical Design; it does not provide specific design values. Design flexibility is the hallmark of its process and is guided by three overarching goals:

1. To direct available dollars toward activities and projects that optimize the highway system as a whole.
2. Develop solutions to address the purpose and need identified for each project.
3. Design projects that make the system better, address changing needs, and/or maintain current functionality by meeting, but not necessarily exceeding, the defined project purpose, and need and project goals.

Utah—With the issuance of its *Practical Design Guide* in 2011, Utah is the most recent state to adopt a Practical Design policy. The Utah DOT (UDOT) has not developed different design criteria; rather, it offers general guidelines for implementing Practical Design. For UDOT, the most critical element in Practical Design improvement projects is the project's objective statement. Practical Design is a "design up" approach, not a "strip down" process; meaning, rather than starting with the desired level of improvement and removing items until they meet the budget, project teams are advised to look at the existing conditions and design improvements that meet the project's objective statement. A key aspect of its program is design flexibility and the use of design exceptions, which can be implemented when either of the following applies:

- The design standard exceeds the objective statement or
- A lower cost solution not meeting design standards is identified that does not compromise safety.

Other key findings of the study include the following:

- The Practical Design approach does not appear to apply explicitly to 3R projects. Each of the six states profiled has a separate 3R policy for guidance for those projects. However, it is noted that 3R projects are not typically improved to full standards, which makes 3R and Practical Design-based projects similar.

- For the six states that were profiled, most recognize a relationship and similarity in the principles of CSS and Practical Design. For instance, Kansas stated that both CSS and Practical Design apply flexibility in the application of design features. Oregon views its Practical Design policy as the next logical step to CSS. Utah views its Practical Solutions policy as combining elements of CSS and VE. Practical Design seeks an economical solution for individual projects, focusing on the projects' purpose and need. CSS seeks a solution that addresses the needs of multiple users and functions of the facility, which sometimes can lead to added costs.
- Practical Design is not the same as VE, although here too there are similar goals. VE, which is usually reserved for large-scale projects, is a method to determine the most cost-effective way to achieve proposed improvements. Practical Design is a method to determine the most cost-effective way to achieve the projects' purpose and need. The tools and procedures used for VE can be used for Practical Design.
- Design exceptions are frequently used as part of the Practical Design process in most states that have adopted this policy. When a value for a design element is chosen that is less than what would be required by its design manual, design exceptions are required by the states.

Practical Design has emerged as a project development and design program that seeks to develop individual projects with improved safety and operation but at a reduced cost, using the savings for more projects within a fiscal budget. For all states that have adopted this policy, the driving force was to maximize the use of available transportation funds, which were becoming limited and less able to meet all of the many system needs.

There are numerous ways to describe Practical Design and similar policies. One would be a project development and design philosophy whereby projects are scoped to be "right-sized" to meet the project purpose and need, avoiding the desire to arbitrarily bring the facility up to a maximum level for all design elements.

Practical Design does not apply to just geometric design elements. It can be all-encompassing, ranging from deciding during planning and scoping phases on the type of facility to meet the purpose and need; to the selection of design volumes, design speed, and specific design elements; and even to the selection of pavement material and thickness.

CHAPTER ONE

# INTRODUCTION

## BACKGROUND

There are many demands on state departments of transportation (DOTs), from simple maintenance of ever-expanding assets to addressing increasing mobility and safety needs of all highway users. State DOTs are continuously striving to meet this challenge of increasing demands with limited financial resources. In doing so, a few state transportation agencies have adopted initiatives that result in design solutions for specific roadway projects that they believe allows them to better address the critical needs of the entire roadway system. Most notably, the Missouri DOT (MoDOT) has initiated a process that critically reviews projects to establish appropriate project scope and resultant roadway geometrics based on needs, not standards. MoDOT's goal is to have fewer areas of perfection and more good projects that make an overall great system. In its opinion, this approach will allow for the completion of more roadway projects in a shorter period of time. To implement its approach, called "Practical Design," MoDOT reviewed its existing design standards and revised them in a way that provides a practical design approach.

The Kentucky Transportation Cabinet (KYTC) has implemented a similar initiative through its "Practical Solutions" initiative. The approach uses existing conditions as the baseline and tries to achieve results from project improvements that are better than the existing conditions. This approach underscores the importance of understanding the specific needs and goals of a project. The approach develops a customized solution that will address the specific needs while using the flexibilities inherent in the design process.

## SYNTHESIS OBJECTIVE

As will be documented in this report, a few other states have adopted similar policies, variously labeled as Practical Design, Practical Solutions, or Practical Improvements. Whatever label is given by the state, the adoption of this cost-saving initiative is increasing and coming to the attention of other DOTs. Therefore, the objective of this synthesis was to identify current knowledge and practice in the application of Practical Design approaches to roadway project development. (For simplicity, the term Practical Design will be used throughout this report unless another term is more appropriate to the discussion.) This synthesis provides transportation professionals with the information required to understand this change in project development and design philosophy and the new practices implemented by a few transportation agencies.

Information gathered for this synthesis included the following:

- How states define and implement Practical Design and other policies or programs that may have different names, but share the same philosophy, concepts, and principles.
- Barriers and lessons learned from states that have implemented Practical Design approaches.
- How Practical Design differs from the traditional design process.
- Modifications to roadway geometric design criteria.
- Relationship of Practical Design to Context Sensitive Solutions (CSS), Value Engineering (VE), and other similar initiatives.
- Consideration of project-specific roadway design trade-offs.
- Application of design exceptions for Practical Design.
- Cost savings resulting from Practical Design projects.
- Performance measures for Practical Design, including safety and operational performance.
- Liability risk of implementing Practical Design approaches.

## APPROACH

Typically, NCHRP synthesis projects rely on information obtained from state DOTs on their current practices related to the subject at hand, supplemented by published literature. In this instance, it was known at the outset that only a few states had a Practical Design or similar policy, a situation that would have made a comprehensive questionnaire inappropriate. Consequently, the work plan included the following tasks:

1. Distribute a brief online questionnaire to all states with two objectives in mind:
   a. Identify those states that have adopted a Practical Design policy, and

   b. Identify states that are considering developing a Practical Design policy and determine what information they would like to see about a Practical Design approach.
2. Review and synthesize the Practical Design policy of those states identified in 1a.
3. Conduct follow-up interviews with selected states to gather more information related to the bulleted items listed previously.
4. Obtain information for several projects of varying types to illustrate how Practical Design was applied and what benefits were derived. These would serve as case examples.
5. Draw lessons learned and conclusions for the benefit of those states that are considering adopting a Practical Design policy.
6. Identify any knowledge gaps where additional research may be needed.

## SYNTHESIS CONTENTS

The contents of the remaining chapters are as follows:

- Chapter two reports on the results of the initial survey.
- Chapter three provides background information on the project development process, design standards, and other initiatives relevant to Practical Design.
- Chapter four profiles those states that reported they have a formal Practical Design (or similar term) policy. Included in the profiles are examples how Practical Design was applied, and, within the discussion, answers to questions raised by those states considering a policy are provided.
- Chapter five discusses the collective findings from the state profiles and identifies needed research to address knowledge gaps.

After the References section, several appendices provide supporting information.

CHAPTER TWO

# RESULTS OF INITIAL SURVEY OF STATE DEPARTMENTS OF TRANSPORTATION

## SURVEY OF PRACTICES

A questionnaire was sent to all state DOTs using the membership of AASHTO's Subcommittee on Design, primarily to identify those states that have a Practical Design policy. The questionnaire posed the following questions:

1. Does your state have a formal or informal policy related to Practical Design, Practical Solutions, or some other similar project development or design philosophy?
2. If yes, explain or provide a link to any documents on your website or send to the consultant.
3. If no, is your state considering developing a policy?
4. If the answer to question 3 is yes, what information would be useful to your state in either developing or expanding upon a Practical Design policy?
5. If the answer to question 1 is yes, would your state be willing to be interviewed by the consultant?

The survey document is provided as Appendix A. The survey achieved an 82% response rate, with 41 of 50 states responding. The results are summarized here.

## STATUS OF STATES REGARDING A PRACTICAL DESIGN POLICY

Twenty-nine of the 41 states responded "yes" to this question. The results of question 1 are shown in Appendix B, Table B1 by state. These states can be grouped into two categories: those that have an explicit documented policy labeled as Practical Design, Practical Solutions, or some similar term, and those that referred to a practice they believed to be similar in principle. For the former group, the following six states are included:

| | |
|---|---|
| • Practical Design | Missouri, Oregon, Utah |
| • Practical Solution | Kentucky, Idaho |
| • Practical Improvements | Kansas |

Missouri was the first state to adopt a formal Practical Design policy, and this label is also used by Oregon and Utah; Kentucky uses Practical Solutions, and Idaho initially used the label Practical Design but now uses Practical Solution. Each of these states provided a guide, manual, or similar document describing their policy; each of which will be discussed in chapter four.

Twenty-three states responded "yes" that they have a policy similar in principle to Practical Design and then referred to "similar" practices or policies. Using the comments provided by these 23 states (see Appendix B, Table B1 for the full responses), the following categorization can be made for the "something similar" group:

| | |
|---|---|
| • Refer to resurfacing, restoration, and rehabilitation (3R) design criteria | Arkansas, South Carolina, Wyoming |
| • Refer to CSS | Colorado, Georgia, Hawaii, Minnesota |
| • Refer to design flexibility | Delaware, Indiana, Vermont |
| • Refer to design exceptions | Michigan |
| • Refer to CSS, Complete Streets, design exception and 3R | Massachusetts |
| • Refer to Road Safety Audits | Maryland |
| • Refer to Smart Transportation | New Jersey |
| • Informal Practical Design policy | Louisiana, Montana, Rhode Island |
| • Design guidelines for each project | North Dakota |
| • Minimum design solution approach | New Hampshire, Nebraska |
| • Tier design | North Carolina |
| • Project Development Policy | Virginia |
| • Practical Design policy under development | Maine |

The following are a few of the statements made by the respondents that exemplify how their state follows the principles of Practical Design:

- Arkansas does not have a policy that is designated as practical design. However, for many years we have used the 3R process to achieve practical design on many miles of highway. In 1989, geometric design criteria were established for nonfreeway 3R projects. These design criteria are less than normal design standards; however, it provides a safe and improved facility at a reduced cost.
- Colorado DOT (CDOT) has a formal and informal CSS process, which leads to practical designs by incorporating multi-disciplinary (within CDOT and outside) teams to develop solutions.

- Delaware's *Road Design Manual* allows for flexibility within the design standards and for design exceptions when the standards cannot be met. Delaware DOT (DelDOT) does not however have a policy strictly based on Practical Design or Practical Solutions.
- [In Maryland] Road Safety Audits are conducted to identify low-cost improvements to enhance the safety of a given facility. Roadway segments with lower safety performance are reviewed by a team of technical experts representing multiple disciplines.
- Beginning in 2006, within its VE unit, New Jersey began what was called Smart Solution reviews on all complex, high-dollar projects. The difference between a traditional VE review and this new Smart Solutions approach was that we removed the main goal in the VE process, achieving an equal or better product. Instead, a team of multi-disciplined personnel (similar to a VE team) would focus on solving the original problem that started the project. The goal of the Smart Solutions team was to hone in on the conditions causing the problems. Any substandard condition that was not causing crashes or listed on one of the management systems lists was not improved. We are no longer trying to make everything perfect; we were trying to improve the existing conditions. (Pennsylvania, who did not respond to the questionnaire, also has a Smart Transportation policy, as was learned from the literature review.)
- Louisiana's program is informal. Our process is similar to Kentucky's practical solutions. We typically apply these concepts to spot replacement type projects (bridge replacements, spot safety improvements, etc.).
- New Hampshire has not developed any specific approach to the fiscal constraint issues, but we have taken a very simplistic solution to design issues, that being do as little as possible while still solving the problem that needs to be addressed (like widening in-kind instead of full-depth reconstruction). We are constructing the least costly alternative in almost all situations. Although this is not a written directive, we make sure we always include a "minimal design solution" as an alternative for consideration.

Although these 23 states responded that they do follow a Practical Design approach, because they do not have a formal, documented policy, they were not investigated further.

## STATES CONSIDERING A PRACTICAL DESIGN POLICY

Only a few states indicated that they are considering developing a Practical Design policy; these included Alabama, Florida, New York, Washington, and Wisconsin. States that responded that they were not planning to develop a Practical Design policy included Colorado, Hawaii, Louisiana, Montana, South Carolina, South Dakota, and Tennessee.

## INFORMATION USEFUL IN DEVELOPING A PRACTICAL DESIGN POLICY

The purpose of question 3 was to ascertain what information states that do not yet have a Practical Design policy would like to have about the Practical Design approach. It was intended that the responses would help frame what questions should be posed to those states with a formal policy that might help those states considering adopting or perhaps modifying their policy. The answers from all the states are listed in Table B2 in Appendix B. The types of information sought by the respondents are listed here:

- Examples of costs and time savings realized using Practical Design.
- Lessons learned and current practices.
- Goals, objectives, and success measures.
- Implementation procedures including documentation.
- Obstacles encountered and how they were addressed.
- Industry standard for definition of performance-based design, as well as tools and criteria for practicing it.
- Need to demonstrate value (compared with consequences) of implementing a formalized policy to obtain management and public acceptance.
- How the consultant community is integrated into the Practical Design process and procedures.
- Data on inherent trade-offs of such a policy as this will often result in parameters that fall below AASHTO guidelines.
- Specific criteria used to determine when Practical Design is appropriate.
- How to encourage project teams to embrace Practical Design rather than view it as another forced policy from the central office.
- Safety records for implemented Practical Design projects.
- How to address AASHTO minimum design criteria.
- Need for more design exceptions.
- Reactions by professional engineers to utilizing Practical Design.
- How to incorporate the *Highway Safety Manual* methodologies into the project development process.

These information needs were used as the basis for the interviews conducted with the six states identified earlier as having a formal Practical Design policy. The results of those interviews are included in the profiles of each of six states with a Practical Design policy presented in chapter four.

CHAPTER THREE

# BACKGROUND INFORMATION ON PROJECT DEVELOPMENT AND DESIGN METHODS

As noted in the previous chapter, several states referred to other terms as support for responding "yes" to implementing a practical-design-like procedure, if not a formal policy; these terms included design exceptions, CSS, 3R projects, VE, and flexible design. Although likely familiar to most readers, these terms are concisely described in this chapter because they will be referred to in the discussions of the six state profiles in the next chapter. Also, they are discussed in the context of the project development process and current design standards, guidelines and approaches. A more in-depth discussion of these and other design principles can be found in *NCHRP Synthesis 422: Trade-Off Considerations in Highway Geometric Design* (*1*).

## PROJECT DEVELOPMENT PROCESS

The AASHTO document, *A Guide for Achieving Flexibility in Highway Design* (*2*), describes the four stages of the project development process, as illustrated in Figure 1 and summarized here:

- **Concept Definition**—In this initial stage, the purpose and need for a project or improvement is identified. FHWA describes the purpose and need statement as the foundation of the decision-making process, influencing the rest of the project development process, including the range of alternatives studied and, ultimately, the alternative selected (*3*). As shown in Figure 1, projects can be identified from needs studies (e.g., pavement condition congestion and safety history), outside requests, or long-range transportation plans. In the AASHTO guide, it is noted that a key to context-sensitive planning and design is developing a clear understanding of the *need* for the project during this stage. This principle applies equally to Practical Design, because one of its tenets is developing the project to resolve the identified need.
- **Planning and Alternatives Development**—In this stage, alternatives are proposed and studied, environmental and community impacts are assessed, and decisions are reached about the key physical, environmental, and operational aspects of the proposed project. Once the purpose and need for a project have been determined, high-level design criteria are selected. The basis for the project design criteria will generally be the transportation agency's design guidelines. Key high-level design decisions would include such factors as:
  - Design year
  - LOS
  - Type of facility—freeway, expressway, divided versus undivided, etc.

The culmination of this stage is the selection of the preferred plan or solution. The AASHTO guide emphasizes that the greatest opportunities and challenges for a flexible transportation solution occur during this stage—the same statement could apply to Practical Design.

- **Preliminary Design**—In this stage the geometric elements of the highway or street are developed in sufficient detail to establish their impacts and full right-of-way and construction requirements. Key design elements include establishing the design speed.
- **Final Design**—In this stage the complete plans, specifications, and construction bid documents are prepared; all design elements have been established and usually only minor revisions occur perhaps to save costs, improve constructability, or reflect refinements based on actual right-of-way acquisition negotiations.

## DESIGN POLICY, STANDARDS, AND GUIDELINES

Each state has its own road design manual that provides standards, guidance, and procedures to follow throughout the project development process. State DOTs generally follow the design guidelines provided by AASHTO, modified to meet their particular situation, condition, and policy. With regard to geometric design elements, AASHTO's *A Policy on Geometric Design of Highways and Streets* (*4*), now in its 6th edition and often referred to as the *Green Book*, is the primary guide. For roadside elements—that area beyond the travel way and shoulder—it is AASHTO's *Roadside Design Guide* (*RDG*) (*5*) that applies.

For geometric design elements the *Green Book* provides suggested limiting values—either minimums or maximums depending on the specific design element, which in some cases can vary depending on the type of road, design speed, terrain, volume, and other factors. These values are to be considered guidelines and not strict requirements. Each state

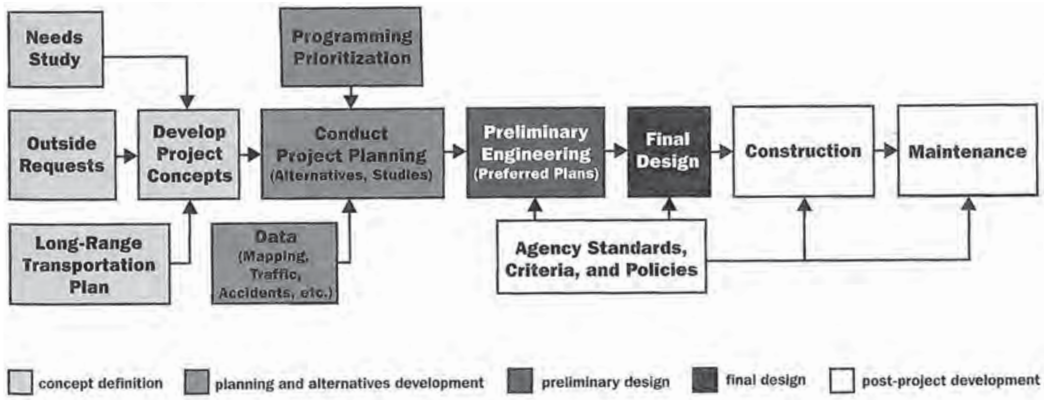



FIGURE 1 Project development process. *Source:* AASHTO (*2*).

is to exercise engineering judgment in selecting appropriate design values. The following statements in the foreword of the *Green Book* could apply to Practical Design:

- This policy is therefore not intended to be a detailed design manual that could supersede the need for application of sound principles by the knowledgeable design professional. Sufficient flexibility is permitted to encourage independent designs tailored to particular situations.
- Cost-effective design is also emphasized. The goal of cost-effective design is not merely to give priority to the most beneficial individual projects but to provide the most benefits to the highway system of which each project is part.

In the *RDG*, the following similar points about the application of that guide are relevant to Practical Design:

- If including the highest level of roadside design criteria is routinely required in each highway design project—regardless of cost or safety effectiveness—it is likely that system-wide safety may stay static or even may be degraded.
- Knowledgeable design, practically applied at the project level, offers the greatest potential for a continually improved transportation system.

## DESIGN EXCEPTIONS

A design exception is a documented decision to design a highway element or a segment of highway to design criteria that do not meet minimum values or ranges established for that highway or project (*6*). For various reasons, it is not always *practical* [emphasis added] or desirable that a project meet each and every design criteria and standard; some of these include:

- Impacts to the natural environment,
- Social or right-of-way impacts,
- Preservation of historic or cultural resources,
- Sensitivity to context,
- Sensitivity to community values, and
- Construction or right-of-way costs (*6*).

Each state has its own policy, guidelines, and practices for when and how design exceptions will be used during project development and design. The state practices for design exceptions are documented in *NCHRP Synthesis 316: Design Exception Practices* (*7*). As explained in that synthesis, FHWA provides both regulatory (compulsory) and nonregulatory direction on design exceptions. FHWA has established minimum design criteria for projects on the National Highway System (NHS), which includes the entire Interstate system. These criteria are included in the AASHTO *Green Book* and in the AASHTO *Policy on Design Standards—Interstate System* (*8*). FHWA indicates that "[a]lthough all exceptions from accepted standards and policies should be justified and documented in some manner, the FHWA has established 13 controlling criteria requiring formal approval" (*9*). The following 13 elements identified by FHWA in the *Federal-Aid Policy Guide* require formal design exceptions:

1. Design speed,
2. Lane width,
3. Shoulder width,
4. Bridge width,
5. Structural capacity,
6. Horizontal alignment,
7. Vertical alignment,
8. Grade,
9. Stopping sight distance,
10. Cross slope,
11. Superelevation,
12. Vertical clearance, and
13. Horizontal clearance (other than clear zone).

## CONTEXT SENSITIVE SOLUTIONS

FHWA defines CSS as "a collaborative, interdisciplinary approach that involves all stakeholders in providing a transportation facility that fits its setting. It is an approach that leads to preserving and enhancing scenic, aesthetic, historic, community, and environmental resources, while improving or maintaining safety, mobility, and infrastructure conditions" (*10*). There are several key elements of CSS. First is the "context," which is a broad description of a project's physical, economic, and social setting. The context may include the community, ecological, aesthetic, and transportation conditions, as well as the political and policy environment. Another key element is the use of an interdisciplinary team—stakeholders with different backgrounds (community members, elected officials, interest groups, and affected local, state, and federal agencies) who work collaboratively to solve a common problem. It puts project needs and both agency and community values on a level playing field and considers all tradeoffs in decision making. This process differs from traditional processes in that it considers a range of goals that extends beyond the transportation problem, including goals related to community livability and sustainability, and seeks to identify and evaluate diverse objectives earlier in the process and with greater participation by those affected. A key tenant of CSS is recognizing the need to consider that transportation corridors may be jointly used by motorists, pedestrians, cyclists, and public transit vehicles.

Many states have a policy on CSS and incorporate its principles into their project development process. *NCHRP Synthesis 373: Multi-Disciplinary Teams in Context-Sensitive Solutions* (*11*) reported on state DOT CSS practices and *NCHRP Report 480: A Guide to Best Practices for Achieving Context Sensitive Solutions* (*12*) focuses on how state DOTs can incorporate CSS into transportation project development. More information about CSS can be found at: http://contextsensitivesolutions.org/content/reading/context_sensitive_solutions_pri/.

## RESURFACING, RESTORATION, AND REHABILITATION PROJECTS

The program of resurfacing, restoration, and rehabilitation—commonly referred to as RRR or 3R—emerged out of the 1976 Federal-Aid Highway Act. The legislation permitted the use of federal aid to rehabilitate highways to extend their useful life without necessarily improving existing geometrics. These projects were not required to comply with the then current design standards, and would typically not change existing design dimensions. The 3Rs were defined as follows:

- **Resurfacing**—Work to place additional layers of surfacing on highway pavement, shoulders, and bridge decks, and necessary incidental work to extend the structural integrity of these features for a substantial time period.
- **Restoration**—Work to return the pavement, shoulders, and bridges over a significant length of highway to an acceptable condition to ensure safety of operations for a substantial time period. This work may include the following: grinding and repair of joints of portland cement concrete pavement; sealing of shoulders and pavement joints in conjunction with other work; placement of a skid-resistant surface treatment; correction of minor drainage conditions; and work to prepare a bridge deck for an overlay.
- **Rehabilitation**—Work to remove and replace a major structural element of the highway to an acceptable condition to extend the service life of a significant segment for a substantial period of years commensurate with the cost to construct. This may include the following: replacement of bridge deck, pavement, or shoulders without significant widening; recycling of pavement and shoulder materials; replacement of the individual bridge elements to correct a structural deficiency; and minor subgrade work incidental to other work.

The federal regulatory requirements have changed over time. Current federal requirements are documented in FHWA's Technical Advisory T5040.28 *Developing Geometric Design Criteria and Processes for Non-Freeway RRR Project*s (*13*). The technical advisory provides procedures, a process for developing 3R programs and projects, and design criteria for individual geometric elements. The technical advisory notes that the states' 3R design criteria should address all 13 controlling geometric elements mentioned under Design Exceptions. In addition, guidance is provided on other design features such as pavement improvements including skid resistant surfaces and pavement edge drop-off remediation, intersection improvements, and traffic controls and regulations.

Nearly all states have a policy and design guidance for 3R projects; this was documented in 2011 in *NCHRP Synthesis 417: Geometric Design Practices for Resurfacing, Restoration, and Rehabilitation* (*14*).

## VALUE ENGINEERING

FHWA defines VE as a systematic process of project review and analysis during the concept and design phases by a multi-disciplinary team of individuals involved in the project conducted to provide recommendations for:

1. Providing the needed functions safely, reliably, efficiently, and at the lowest overall cost;
2. Improving the value and quality of the project; and
3. Reducing the time to complete the project (*15*)

Although for many years VE has been recognized as a valuable tool for developing a cost-efficient project, it was the Federal-Aid Act of 1970 that made it a requirement for federal-aid projects. In late 1995, Congress passed the NHS Designation Act that included a provision requiring the secretary to establish a program that would require states to undertake a VE analysis for all federal-aid highway-funded projects with an estimated total cost of $25 million or more. Recent years have seen adjustments to the legislation and regulations established for VE. The current policy (*16*), published on March 15, 2012, continues the $25 million threshold, but also requires VE for:

- A bridge project with an estimated total cost of $20 million or more, and
- Any other project designated by the secretary of transportation.

State DOT VE practices, as of 2005, were documented in *NCHRP Synthesis 352: Value Engineering Applications in Transportation* (*17*). Among the many findings reported were:

- VE is more effective and influential on the performance, quality, and cost of a project when performed relatively early in the development of the project schedule.
- VE can effectively be integrated with or into other technical management improvement approaches, such as asset management, RSA, contest sensitive design, and accelerated construction technology teams.

## FLEXIBLE DESIGN

Flexible design refers to a design philosophy that permeates the entire project development process. There are no specific design criteria or guidelines associated with flexible design. In 1997, FHWA published *Flexibility in Highway Design* (*18*) to illustrate the flexibility available to designers within adopted state standards to tailor their designs to the particular situations encountered in each highway project. It was prepared to demonstrate how agencies could accomplish the objectives of CSS within accepted design processes and criteria. Subsequently, in 2004, AASHTO published *A Guide for Achieving Flexibility in Highway Design* (*2*). This guide promotes the incorporation of sensitive community and environmental issues into the design of highway facilities. It comprehensively addresses the overall project development process and offers specific examples of incorporating flexibility into the selection of specific design elements.

CHAPTER FOUR

# PROFILES OF STATES WITH PRACTICAL DESIGN POLICIES

This chapter provides a description and discussion of each of the six (Missouri, Idaho, Kentucky, Kansas, Oregon, and Utah) state's Practical Design policy and procedures. Included within the discussion are the responses to the questions posed during a phone interview with a representative of the state DOT. The following information is provided for each state profile:

- Background information on how the program developed.
- Overview of the Practical Design process and guidelines.
- Other considerations with respect to information that other state DOTs were seeking.
- Examples of projects where Practical Design was followed, if they were provided by the state.

The states are profiled in chronological order as to when they adopted their policy and are based on statements made by the state DOT representative interviewed and the documents that the states have prepared.

## MISSOURI DEPARTMENT OF TRANSPORTATION

### Background

MoDOT is recognized as the first state to implement a formal Practical Design policy. It started in 2005, when senior management realized that Missouri citizens would resist any new taxes to fund the many needs of the highway program and, therefore, the department would have to stretch its available dollars to deliver a highway system that met the needs of the taxpayers. The concept of Practical Design evolved out of this financial realization with the mantra, "building good projects everywhere—rather than perfect projects somewhere—will yield a great transportation system in the end" (*19*). MoDOT believed that perfect projects resulted when the design achieved the maximum level standards contained in MoDOT's *Project Development Manual*, which has since been replaced by their *Engineering Policy Guide* (*20*). In some cases, MoDOT management believed that using these standards resulted in a project that was overdesigned when evaluated against its purpose and need. Design exceptions were pursued only if the standard design was fiscally not feasible or had environmental or cultural constraints.

MoDOT senior management believed that good projects could be achieved through common sense engineering that focused on achieving the project purpose and need while considering its context. This Practical Design philosophy resulted in projects with design elements that addressed identified deficiencies, fulfilling only the purpose and need of the corridor, no more and no less. This approach resulted in cost savings that could be used for additional projects, keeping within its 5-year program budgets.

After proposing the Practical Design idea to the Missouri Highways and Transportation Commission, senior management met with personnel at each of the 10 MoDOT districts to explain this new program. The districts were challenged to deliver their entire 5-year program for 10% less money than budgeted at the time. The savings would be turned back to each district for additional projects. The challenge had three ground rules: (1) each project must be safer than its in situ condition; (2) better communication was necessary between the central and district offices as well as stakeholders, including FHWA, the state legislature, and the public; and (3) quality would be maintained, meaning that the solution had to function properly and not leave a legacy of maintenance problems. These three rules have become the core philosophy underlying MoDOT's use of Practical Design.

Initially, the concern about liability exposure was voiced because designers would not be following the traditional design values cited in their road design manual. This issue was addressed during meetings with the guidance that engineers would be following common sense engineering judgment and that design exception documentation would be part of the program as it has been in the past. The design exceptions are based on the standard 13 controlling criteria developed by FHWA. One change made was that design exceptions could be approved at the district level rather than at the central office. MoDOT's legal department embraced the Practical Design approach because it was easier to defend engineering judgment than the unquestioned application of values in a table from the design manual.

MoDOT applies Practical Design principles to all types of roads and projects, but acknowledges that there is less opportunity for higher order facilities because of the higher design speeds. Practical Design applies to all projects irrespective of federal funding. Practical Design can be applied at all phases of project development; however, MoDOT officials believe it is most effective at the scoping level, where major decisions are made as to what design elements are followed.

**Practical Design Process and Guidelines**

MoDOT's Practical Design process was first documented in *Practical Design Implementation* (*21*). It was developed during the early implementation of Practical Design as a temporary design guideline to provide designers with some published guidelines. This document is now integrated into its *Engineering Policy Guide* (see http://epg.modot.org/index.php?title=Category:143_Practical_Design).

During the early development of Practical Design, from the many comments received from district personnel, 75 design policy areas were identified. Subsequently reduced to 25, these design areas were considered "cost drivers" because they accounted for 80% of the project costs. These areas are discussed in the above-mentioned *Practical Design Implementation* (*21*). The following is a list of those elements and they comprise the table of contents of the *Implementation* document. For each of the 25 areas, primary guidance is provided, followed by a discussion elaborating on that guidance. Figure 2 is an example of one the areas. Appendix C provides the primary guidance for each of the 25 areas. As seen from that document, MoDOT is the only

# Shoulder Width

**Primary Guidance**

- Never eliminate shoulders altogether. Motorists expect them.
- Shoulders on major roadways (both rural and urban) are to be 4 to 10 ft. wide based on the volume of traffic, the percentage of trucks and context of the surrounding road.
- Shoulders on rural minor roadways are to be 2 to 4 ft. wide.
- Shoulders will not be provided on urban roadways with no access control if ample turning opportunities exist for a vehicle to leave the roadway.
- An earthen shoulder will be provided behind a mountable curb.
- Rumble strips are to be provided on major and minor roadways with paved shoulders at least 2 ft. wide (see Rumble Strip guidance for further information).

**Discussion**

A shoulder is the portion of the roadway contiguous to the traveled way that accommodates stopped vehicles, emergency use, and provides lateral support of the subbase, base and pavement. Shoulders may be paved (with concrete or asphalt) or unpaved (with aggregate or soil).

Desirably, a vehicle stopped on the shoulder should clear the edge of the traveled way by at least 1 ft., and preferably by 2 ft. This preference has led to the preferred use of a 10 ft. shoulder on major roadways. A shoulder at least 2 ft. wide is encouraged on minor roadways.

On urban roadways, the shoulder is located inside a curb. Surfaced areas behind curbs located on urban roadways may be perceived as a sidewalk and thus subject to ADA requirements. Therefore, a surfaced area is not to be provided behind a mountable curb.

When roadside barriers, walls, or other vertical elements are present, the shoulder that is provided should be wide enough to ensure the vertical element is offset 2 ft. from the edge of the useable shoulder. This is also true when guardrail is placed along the roadway.

Regardless of the width, a shoulder functions best when it is continuous. The full benefits of a shoulder are not realized unless it provides a driver with refuge at any point along the traveled way. A continuous shoulder provides a sense of security so all drivers making emergency stops will leave the traveled way. Although continuous shoulders are preferred, narrow shoulders and intermittent shoulders are still superior to no shoulders at all.

**Rural major Routes**
For rural Major routes, rehabilitation projects should provide a minimum 4 ft. shoulder. Always consider the context of the surrounding route. New construction projects should provide 10 ft. shoulders.

**Rural Minor Routes**
The shoulder on rural minor roadways serves as structural support for the pavement and as additional width for the traveled way. This permits drivers meeting or passing other vehicles to drive on the edge of the roadway without leaving the surfaced area. Roads with a narrow traveled way, narrow shoulders and significant traffic tend to provide a poor level of service, have a higher crash rate, and need frequent and costly maintenance.

For rural Minor routes, rehabilitation projects should provide a minimum 2 ft. shoulder. Always consider the context of the surrounding route. New construction projects should provide 4 ft. shoulders.

FIGURE 2 Example of MoDOT design guidance for shoulder width. *Source: Practical Design Implementation* (*21*).

state that provides specific design guidance under its Practical Design policy.

1. Type of Facility
    1) Facility Selection
    2) At-Grade Intersections
    3) Interchanges
2. Typical Section Elements
    4) Lane Width
    5) Shoulder Width
    6) Median Width
    7) Inslope Grade
    8) Roadside Ditches
3. Horizontal and Vertical Alignment
    9) Horizontal Alignment
    10) Vertical Alignment
4. Pavements
    11) Paved Shoulders
    12) Bridge Approach Slabs
    13) Pavement
5. Structures/Hydraulics
    14) Bridge Width
    15) Bridge and Culvert Hydraulic Design
    16) Seismic Design
6. Roadside Safety
    17) Rumble Strips
    18) Guardrail
7. Incidental/Miscellaneous
    19) Disposition of Routes
    20) Bicycle Facilities
    21) Pedestrian Facilities
    22) Embankment Protection
    23) Borrow and Excess Earthwork
    24) Minimum Right of Way Width
    25) Design Exception
8. Type of Facility
    26) Facility
    27) At-Grade Intersections
    28) Interchanges
9. Typical Section Elements
    29) Lane Width
    30) Shoulder Width
    31) Median Width
    32) Inslope Grade
    33) Roadside Ditches
10. Horizontal and Vertical Alignment
    34) Horizontal Alignment
    35) Vertical Alignment
11. Pavements
    36) Paved Shoulders
    37) Bridge Approach Slabs
    38) Pavement
12. Structures/Hydraulics
    39) Bridge Width
    40) Bridge and Culvert Hydraulic Design
    41) Seismic Design
13. Roadside Safety
    42) Rumble Strips
    43) Guardrail
14. Incidental/Miscellaneous
    44) Disposition of Routes
    45) Bicycle Facilities
    46) Pedestrian Facilities
    47) Embankment Protection
    48) Borrow and Excess Earthwork
    49) Minimum Right of Way Width
    50) Design Exception

### Other Considerations

*Relation to Context Sensitive Solutions and Value Engineering*

MoDOT believes that Practical Design has similarities to CSS because, as stated in their *Engineering Policy Guide*, ". . . the selection of the design elements [is] made in context of the surroundings; the solution is to fit into the road context." The example of a bridge improvement is cited—it is not necessary to design a bridge that is being rehabilitated to full standards; that is, 12 ft lanes, 8 ft shoulders, if the adjoining road will not be upgraded to meet the same standards in the foreseeable future.

MoDOT believes that Practical Design could be considered as VE applied continuously from scoping through final design, although formal VE studies are still conducted. In the past some VE recommendations were rejected because they challenged standards. That barrier has since been removed at MoDOT, making VE a beneficial management tool to accomplish Practical Design. MoDOT is conducting more concept stage VE studies, developing many alternatives to identify the best solution.

*Application of Practical Design for 3R Projects*

3R project standards remain and are followed by MoDOT. 1R and 2R projects are considered preventive maintenance, wherein only severe safety deficiencies are addressed with appropriate countermeasures. A 3R project (where rehabilitation occurs) is more like a regular project where Practical Design would apply.

*Evaluation of the Potential Safety Impacts*

MoDOT is implementing the procedures of the *Highway Safety Manual* (*HSM*) (*22*). The applicable procedures within the *HSM* are to be followed in every design exception analysis. Crash modification factors (CMFs) are applied where available. An example is how the *HSM*, and specifically the application of CMFs, was offered for an Interstate project where there was a rock cut within the design clear zone. Rather than create a wider clear zone at high cost, it was determined that the application of edge rumble strips would be a more cost-effective alternative based on its crash reduction potential.

*Measuring Success of the Program*

The overall goal for Practical Design relates back to why it was implemented—delivering good projects to meet a specific location's needs while saving funds that can be applied to other projects, thereby improving the entire system. It is also stated in MoDOT's *Guide* that the Practical Design method will allow MoDOT to deliver safer roadways, of great value, in a faster manner. With regard to this safety goal, although the safety record of individual projects is not explicitly monitored and evaluated, MoDOT tracks its statewide safety performance. As reported by Jones (*19*), since the inception of Practical Design in 2005, Missouri experienced a downward trend in fatalities over the next three years. Table 1 provides data from NHTSA's Fatality Analysis Reporting System for the years 2005 through 2011, showing that Missouri, as with the nation at large, experienced a steady decrease in fatalities in those years. Missouri's average decrease over that time was higher than the national average. Although these data alone do not prove that the application of Practical Design in Missouri has made its roads safer than the nation, it does indicate that it has not resulted in less safe roads, with respect to the occurrence of fatalities.

MoDOT officials also note that the Practical Design program focuses on the system-wide application of safety devices, citing the use of cable barrier for medians that has been shown to reduce fatalities in the state. This is a cultural shift from MoDOT's earlier practice of focusing safety improvements in high-accident locations.

### Case Example

A Practical Design case example provided by MoDOT is shown in Appendix D. The project involved a four lane expansion of an 11 mile section of State Route 50. Some of the design measures adopted under Practical Design included:

- Pavement slab narrowed from 28 ft to 26 ft.
- Mainline pavement thickness reduced from 13 in. of asphalt or 10 in. of concrete to 8 in. of asphalt or 8 in. of concrete.
- Narrowed ditches, which reduced excavation cost.
- Narrower outside shoulders.
- Thinner shoulder pavements.
- Alternate bids for pavement type.
- Rolling grades to match surrounding terrain.
- Minimization of expensive excavation in rock.
- Acceptance of alternative drainage pipes.
- Increased efficiency of culverts.

For this project, MoDOT cites a savings of $5.4 million under the original construction budget of $35.3 million.

## IDAHO TRANSPORTATION DEPARTMENT

### Background

The ITD adopted a Practical Design policy based on the favorable reports of MoDOT. It was issued with a memorandum from its director, on January 1, 2007, and updated on February 20, 2009. On January 1, 2011, it was updated yet again and re-labeled as Practical Solutions. This latest memorandum is provided in Appendix E. The two initial paragraphs of the memorandum are:

> Practical Solutions is intended to challenge traditional standards and to develop safe and efficient solutions to solve today's project needs. ITD's philosophy is to build cost-effective projects to achieve a good, safe, efficient transportation system. Innovation, creativity, and flexibility are necessary for us to accomplish our growing transportation challenges.
>
> To accomplish Practical Solutions, we must properly define the project scope by focusing on achieving the project purpose and need, while considering the surroundings of each project. We must be sensitive to where the project is located, and implement

TABLE 1
COMPARISON OF FATALITIES FOR ALL STATES COMPARED WITH MISSOURI, 2005 TO 2010

| Year | Number of Fatalities | | Percent Change in Fatalities from Prior Year | |
|---|---|---|---|---|
| | All states | Missouri | All states | Missouri |
| 2005 | 43,510 | 1,257 | NA | NA |
| 2006 | 42,708 | 1,096 | –1.84 | –12.81 |
| 2007 | 41,259 | 992 | –3.30 | –9.49 |
| 2008 | 37,243 | 960 | –9.30 | –3.23 |
| 2009 | 33,808 | 878 | –9.66 | –8.54 |
| 2010 | 32,885 | 819 | –2.73 | –6.72 |
| 2011 | 32,310 | 785 | –1.75 | –4.15 |
| Average Annual Change, 2005 through 2011 | | | –4.78 | –7.49 |

NA = not available.

> standards that are appropriate to the context of the surroundings. Our goal is to get the best value for the least cost. Life cycle cost must be considered. It is not our goal to shift burdens to maintenance.

ITD changed the label to Practical Solutions when guidelines were formalized. Because ITD is implementing "practical" approaches into construction and other areas, they believed it would be more inclusive to remove the "Design" moniker to improve acceptance by others.

At ITD, all design is done at the district level; hence, it was necessary to include the districts to get the Practical Design policy accepted. Because Idaho is a mountainous state ITD noted that "it is difficult to build to AASHTO design standards, thereby requiring frequent preparation of design exceptions," a situation that made Practical Solutions more acceptable to the district staff. Although the policy was new, it was considered by staff as simply an extension of long-standing standard practice.

Consultants became aware of the program through regular communication channels. The local FHWA office was a partner in the process and is receptive to the use of design exception reports when necessary. There was no public involvement for vetting the policy.

### Practical Design Process and Guidelines

The guidelines for the application of Practical Design in Idaho are presented in *Practical Solutions for Highway Design* (*23*) (see http://itd.idaho.gov/manuals/Online_Manuals/Current_Manuals/PSHD/PSHD.pdf), a 17-page document that discusses the design criteria to be used at the transportation planning level and guidelines for several roadway design elements. Its Introduction presents some primary general guidance:

- The type of facility chosen must fulfill the purpose and need of the corridor and involves more than traffic volume alone.
- The design speed will be the posted speed or as appropriate for the context and intent of the project.
- Some congestion is not bad. It is adequate for all routes in rural locations to accommodate the 20-year peak hour traffic at a Level of Service of D and off-peak traffic at a Level of Service of C. For urban and suburban roads, these levels can be E and D, respectively.
- When the desired level of service requires a four-lane facility, it will be designed as an expressway unless a freeway is mandated.

Under Transportation Planning, guidelines are presented for the following four design criteria:

1. Design speed—to be the posted speed for existing facilities, or as appropriate for the context and intent of the project.
2. Interchanges/at-grade intersections—as a result of high cost, use only when warranted and consider roundabouts as an alternative to signalization.
3. Two-way left-turn lanes—only to be considered in places where commercial driveways make up a substantial portion of total driveways, overall driveway density is managed, and where the percentage of vehicles turning left at peak hours is at least 20%.
4. Passing lanes—consider as an interim solution to adding additional lanes.

Under Roadway Design Elements, "primary guidance" is offered for the following design elements:

1. Lane width;
2. Shoulder width;
3. Horizontal and vertical alignment;
4. Roadside design elements to include rumble strips and guardrail;
5. Pavement structure—paved shoulders and pavement;
6. Structures, with respect to bridge width;
7. Bicycle and pedestrian facilities;
8. Property (right-of-way);
9. Processed materials to include aggregate, asphalt, and cement;
10. Traffic control during construction; and
11. VE.

A brief summary-level discussion is provided in the document for each of these elements.

The process for the implementation of Practical Design in Idaho is to consider the guidelines outlined previously in the planning and design of projects. The Introduction states that ". . . this guide does not supersede nor replace ITD's Design Manual, section manuals, or administrative policy or change the need for documentation of design criteria or properly documented design exceptions. It is to be used as a companion document during the planning and design process" (*23*).

### Other Considerations

#### *Relation to Context Sensitive Solutions and Value Engineering*

Idaho adopted the CSS approach in 2005 and has a well-documented guide for its application to the development of its projects. The CSS policy pre-dates its Practical Solutions policy; therefore, there is no mention of Practical Solutions in that *Guide*. Likewise, there is no mention of CSS in the ITD's Practical Solutions guide. Nonetheless, the ITD individual interviewed for this project described their Practical Solutions approach as a combination of CSS and VE. The process and procedures followed to achieve a CSS are similar to those applied for Practical Design—the common goal is to correctly define the project purpose and need and develop the project accordingly.

As noted in ITD's Practical Solutions guide, Practical Solutions is not intended to be used in place of VE. Although

VE is normally reserved for larger-scale projects with a high potential for savings, its underlying principle of identifying less expensive, but acceptable, design elements is applicable to Practical Solutions, which also has the objective of satisfying the project purpose and need cost-effectively.

*Consideration of Safety Impacts*

A stated goal of ITD's Practical Solutions policy is that ". . . safety will not be compromised and every project will make the facility safer after its completion" (*23*). Presumably that goal is accomplished through the improvements that are made for any given project. During project development, crash records are reviewed and safety audits performed. There is no specific safety analysis, such as that defined by the *HSM* (*22*), followed to assess the safety impacts of alternative designs.

*Benefits Derived from Practical Design*

IDT has a commitment to efficiency in delivering its transportation program. Periodically it reports on how well it is achieving this overarching goal. In its most recent Efficiency Report for the period 2004 to 2012 (see http://itd.idaho.gov/info/efficiencyreport/Efficiency_Report.pdf) information is provided on cost savings attained through several Practical Design projects. Table 2, adopted from that report, shows the savings reported by one of its six districts.

ITD reported a savings of $50,814,500 for the fiscal years 2004 to 2012 for all six districts combined. As stated in this report, these savings are used for additional projects.

## KENTUCKY TRANSPORTATION CABINET

### Background

KYTC embarked on its version of Practical Design in 2008 with the issuance of State Highway Engineer Policy memorandum #2008-07, which provides guidance for the use of Practical Solutions to project delivery (see Appendix F). Drawing on the Missouri Practical Design approach, KYTC chose the "solutions" term because it wanted to emphasize that the program was to encompass the entire project development process, from planning through operations and maintenance. In Kentucky, the basic concept of Practical Solutions is the need to consider and examine a range of approaches and determine which solution meets the purpose and need with the least cost.

The adoption of this project development policy emerged from a situation in which Kentucky's program had more projects than the state had funding to deliver. No longer having a fiscally constrained program made it difficult to move projects forward because someone in authority had to make a determination on which projects could proceed and which projects had to wait. To implement more projects and improve Kentucky's infrastructure, the agency realized that

TABLE 2
REPORT OF SAVINGS USING PRACTICAL SOLUTIONS BY ONE DISTRICT IN IDAHO

**Efficiency Measures**
**2008 forward — Division of Highways**

Practical Design Definitions:
- BST: Bituminous Surface Treatment
- CRABS: Cement Recycled Asphalt Base
- SALSA: Stress Absorbing Layer of Straight Asphalt

**Practical Design (continued)**

| District 3, FY08 Projects | Initial Project Cost | Revised Project Cost | Design Method Used To Obtain Savings | Total Savings |
|---|---|---|---|---|
| • U.S. 20/26, Corridor preservation, Caldwell to Eagle | $1,400,000 | $1,270,000 | Optimize right-of-way purchases | $130,000 |
| • SH-55, Main Street, Donnelly | $1,820,000 | $1,755,000 | Reduce width | $65,000 |
| • SH-51, SH-67 Junction, Mountain Home | $690,000 | $545,000 | Reduce lane width on Elmcrest Street | $145,000 |
| • SH-69, Kuna to Meridian, corridor plan | $225,000 | $205,000 | Limit study area | $20,000 |
| • SH-52, Payette to Horseshoe Bend, corridor plan | $250,000 | $230,000 | Limit study area | $20,000 |
| • U.S. 26, Parma to Caldwell, corridor plan | $200,000 | $180,000 | Limit study area | $20,000 |
| • SH-19, Wilder to Caldwell, corridor plan | $200,000 | $180,000 | Limit study area | $20,000 |
| • SH-55, Deinhard Lane to Zachary Road, McCall | $1,955,000 | $1,682,000 | Reduce ballast | $273,000 |
| • I-84, Leveling course, Cleft to Sebree | $4,030,000 | $3,774,000 | Seal coat from fog line to fog line only | $256,000 |
| • District traffic study | $100,000 | $90,000 | Limit study area | $10,000 |
| • District traffic safety study | $100,000 | $90,000 | Utilize new technology | $10,000 |
| TOTAL FY08 SAVINGS: | | | | $969,000 |

it had to use available funds more efficiently; hence, Practical Solutions emerged as the means to achieve that goal.

The development of Practical Solutions was a top down process, starting with the KYTC highway engineer, who with other staff examined Missouri's program. There was no formal public involvement process leading to its adoption. Meetings were held with district personnel to help shape the program. The program was embraced by the governor and its adoption was announced at a press conference. It was included in the Road Plan submitted to the state legislature, where opposition was initially voiced by some members who "did not want cheap projects;" however, it was eventually adopted. The program was implemented from the central office down to the districts through several meetings with key staff, where it was discussed how projects were over-designed with unneeded elements. Outside consultants were brought up to date on KYTC's policy through the Partnering Conference, an annual event that is attended by KYTC staff and consultants.

### Practical Solutions Process and Guidelines

A description of KYTC's program is best reported in *Practical Solution Concepts for Planning and Designing Roadways in Kentucky* (*24*). The authors stated that the basic notion of Practical Solutions, as practiced in Kentucky, is the need to consider and examine a range of approaches and determine which solution meets the project needs with the least cost. To arrive at a cost-effective solution it is essential to have a balance among operational efficiency, safety, project constraints, and costs. In this paper, the following five principles are emphasized for the implementation of practical solutions:

1. **Target the goals/objectives of the purpose and need statement.**

   Every project is guided by a purpose and need statement that substantiates the transportation need in specific terms and establishes the purpose of the project. This statement must serve as the foundation of the project against which all improvements and solutions will be evaluated. In order to deliver a truly 'practical' design, the purpose and need statement should serve as the target, not the lowest threshold of acceptance performance.

   An example is offered: The purpose and need statement will often state that the purpose of the project is to "improve mobility" owing to a need brought about by "failing operations at the intersection." This need should be further refined to determine a more precise purpose, such as improve intersection delay to less than 50 seconds per vehicle during the typical peak hour. "Providing a more precise purpose and need will lead to developing a solution that addresses the specific problem, not one that enlarges the project."

2. **Meet anticipated capacity needs.**

   The concept of Level of Service measures roadway user acceptance of roadway performance on a grade scale of A to F and is often used to compare alternatives. However, it is not sufficient by itself to compare projects that have designs where capacity is determined differently. A case in point is the comparison of widening a road to four lanes vis-à-vis providing passing lanes on a two-lane road. The capacity of the former alternative is based on vehicle density, while the latter alternative is measured on percent time spent following another vehicle. Since their capacities are measured differently this should be considered in weighing alternatives and ultimately achieving a cost-effective solution.

3. **Evaluate safety compared with existing conditions.**

   It is apparent that safety in any proposed solution should be evaluated to determine the impact of the design on the safety levels. However, an issue that is often overlooked is that safety evaluations are comparing alternatives among each other and not as incremental gains from the existing conditions. Therefore, designs are often selected because the solution is safer than any of the other alternatives. This could easily lead to over-designed and over-built projects simply because of the erroneous assumption that safety improves incrementally with each design regardless of costs. This approach fails to consider that each alternative is an improvement over the existing conditions and thus misses the opportunity to evaluate the safety gains based on the rate of return approach. Considering such incremental safety gains allows for creating savings on a project by increasing safety over the existing conditions (but not totally) and thus using the additional funds for other projects that may need to be improved.

4. **Develop and evaluate design options and alternatives.**

   In order to tailor a design to the project constraints, all design options and alternatives should be available to the designer. Having a full range of options and alternatives will allow the design team to determine which yields the best value of the project.

5. **Maximize design to the point of diminishing return.**

   Projects are financial investments that accrue a variety of benefits. However, there is always a point where the return remains virtually unchanged with increasing investment—the point of diminishing returns. Selecting a design based on far out traffic forecasts (e.g., 20 years) may result in a overdesign that may not yield the benefits if the forecasts are not realized. Therefore, the design life may need to be revisited in order to provide the most practical solution (*24*).

The most critical component of Practical Solutions in planning and design is the definition and clarification of the initial project purpose and need. Focusing on what is to be built to meet the need allows for greater savings than a design focused on how the project is to be built. At KYTC the emphasis is building "right-sized" projects. This requires that the project objective for safety or capacity be the target and the design element value be chosen to achieve the stated objective.

Although KYTC has not prepared a document that provides specific guidance on how to implement Practical Solutions, the policy memorandum does include values for

TABLE 3
COMPARISON OF DESIGN VALUES FOR RURAL COLLECTORS WITH 400–1,500 ADT AND LEVEL TERRAIN

| Design Element | Design Value Per | |
|---|---|---|
| | *Highway Design Manual*[1] | Practical Solutions[2] |
| Design Speed (mph) | 50 | See note[3] |
| Pavement Width (ft) | 22 | 18–20 |
| Graded Shoulder Width (ft) | 5 | 3–5 |
| Minimum Clear Roadway Width of New and Reconstructed Bridge (ft) | Approach roadway width | Approach roadway width |
| Minimum Radius (ft): | | |
| @emax 4% | 930 | 930 |
| @emax 8% | 760 | 760 |
| Normal Pavement Cross Slope (%) | 2 | 2 |
| Normal Shoulder Cross Slope (%): | | |
| Earth | 8 to 10 | 8 to 10 |
| Paved | 4 to 6 | 4 to 6 |
| Maximum Grade (%) | 6 | 6 |
| Minimum Stopping Sight Distance (ft) | 425 | 425 |
| Minimum Passing Sight Distance (ft) | 1,835 | 1,835 |

[1]KYTC *Highway Design Manual,* HD-701, Geometric Design Guidelines, Exhibit 700-02.
[2]Table “Practical Solutions Geometric: Rural Collectors” in Appendix F.
[3]Justification for the design speed shall be based upon comprehensive analysis of existing roadway geometrics, adjacent roadway features, and purpose and need for project. Documentation shall be included in the design executive summary.
ADT = average daily traffic.

several design elements—pavement and shoulder widths, curve radius, pavement and shoulder cross slopes, grade, stopping sight distance, and passing sight distance—for three classes of roads: two-lane arterials, rural collectors, and rural local roads. These tables are found in Appendix F. Table 3 compares the design values for one class of road, rural collector, from its standard *Highway Design Manual* and its Practical Solutions guidelines. For the condition selected; that is, 400–1,500 average daily traffic and level terrain, the differences between the two design guidelines are in the selection of design speed, pavement width, and graded shoulder width, where lower values are acceptable under Practical Solutions.

**Other Considerations**

*Relation to Context Sensitive Solutions and Value Engineering*

KYTC views Practical Solutions as compatible with CSS and it could be considered a subset of CSS. This topic is the focus of the paper by Stamatiadis and Hartman, “Context Sensitive Solutions vs. Practical Solutions: What Are the Differences?” (*25*). In their paper, which specially addresses KYTC’s Practical Solutions program, the authors note that Practical Solutions provides two improved CSS principles—relating to the project purpose and need and using agency resources effectively—and one new principle—relating to the system-wide context—to the extensive CSS attribute list. The authors further state that “if the Practical Solutions methodology is used completely in lieu of CSS, it would provide an excuse to ignore several very important (and beneficial) CSS principles for project development and delivery.” In recognition of this point, KYTC employs a CSS process with a Practical Solutions mindset on all of its projects, thus combining the best attributes of both processes.

VE is applied by KYTC and there are similarities with the Practical Solutions process. In VE the project design is evaluated by a separate group that looks for alternatives that would provide equivalent value. In Practical Solutions, “value” is considered in deciding on a specific design feature. A classic example would be deciding on the value of a four-lane road vis-à-vis the existing two-lane road with passing lanes provided.

*Practical Solutions and 3R Improvements*

KYTC has guidelines for 3R projects. It believes that in a way they have been applying Practical Solution principles to 3R projects for many years. With some 3R projects they have been updating their guardrails; in doing so, they developed a less expensive guardrail end treatment that was equally effective and were able to apply the savings to complete more resurfacing projects statewide—a practical solution.

*Practical Solution and Safety Assessments*

Safety assessments are made of alternatives as part of the Practical Solutions process. Subject matter experts from both the district and headquarters office evaluate the tradeoffs for critical design elements to determine the best value. This process includes examining crash records to determine what types of crashes occur. If a design value is selected that is less than would be required, then a design exception report to justify this decision is prepared. Also, less costly treatments that would mitigate any anticipated safety problem would be proposed.

**Case Example**

Appendix G provides summaries of four projects that were developed following KYTC's Practical Solutions initiative. The four examples involved:

- Reducing the original cross-section design for two bridges in close proximity by reducing the inside shoulders from 6 to 4 ft, the travel lanes from 12 to 11 ft, the outside shoulders from 12 ft to 4 ft, and the sidewalk and bike path from 12 ft to 8 ft, thereby realizing a savings of $140 million.
- Reducing the original cross-section design of an existing two-lane bridge from 12 ft lanes and 8 ft shoulders to 10 ft lanes and 2 ft shoulders, which matched the approach lanes, thereby realizing a savings of $197,500.
- Improving a rural section of 3.23 mile two-lane road to 11 ft lanes and 2 ft shoulders rather than a "super 2-lane" cross section with 12 ft lanes and 8 ft shoulders in the urban section, thereby realizing a savings of $2.1 million.
- Removing large trees that were restricting the visibility of an intersection on a two-lane road at a cost of only $13,500, rather than realigning the curve, which would have cost $780,000.

**KANSAS DEPARTMENT OF TRANSPORTATION**

**Background**

KDOT adopted a formalized "Practical Improvements" approach to its projects in 2009. The executive staff of KDOT was influenced by the Practical Design program at MoDOT and it determined that a similar program should be instituted in Kansas. As with other states, the driving force for adopting its program was to maximize the use of available transportation funds, which were becoming limited and inadequate to meet all system needs. KDOT adopted the label Practical Improvements because they believed that the term Practical Design might imply that previous designs were not practical, when actually KDOT believes its staff and consultant designers have developed practical designs for its projects for many years. Rather, the Practical Improvements program allowed KDOT to formally document savings and other benefits realized by their commonsense engineering efforts. KDOT defines Practical Improvement as "the overarching philosophy which guides our decisions that affect project cost and scope in order to stretch our transportation improvement dollars further while still maintaining a safe and efficient highway system" (*26*).

After internal agency discussions about how it should develop this approach, KDOT issued *Practical Improvements* (*26*) (available at http://kart.ksdot.org), a document that provides guidance to those involved in the project development process—both KDOT staff and consultants. The first 8 pages of this 22-page document describe the Practical Improvement process and provide generalized guidance on how it is to be followed in developing a project, specifically on developing alternative scopes. Subsequent pages provide examples of how Practical Improvements concepts were applied to several projects.

The development of the Practical Improvements program was primarily an internal central office KDOT activity. Numerous meetings were held during the programs development and instruction was then provided to those involved in project development. There were no formal public meetings. KDOT did not experience any obstacles in getting Practical Improvements accepted.

KDOT projects are developed and designed at the central office; therefore, there were no issues raised at the district level. The Practical Improvement approach has aided KDOT in getting public acceptance of the project scope. Recognizing that KDOT is limited by the designated funding for a project, the public better understands that the project scope and design elements must be matched to that funding.

KDOT applies its Practical Improvements approach to all transportation projects regardless of the level of federal funding. This is because prevailing criteria are still followed and design exceptions are processed when appropriate. On large-scale projects, Practical Improvements may first focus on phasing critical portions of the project, while considering future expansion. On small-scale, lower-volume roads, Practical Improvements may mean using the full range of design criteria rather than automatically selecting the highest levels of improvement.

### Practical Improvement Process and Guidelines

KDOT initially programs projects in its planning division. Projects reach the design office with a general scope and budget, which usually cannot be exceeded. To stay within this budget, careful scoping of the project is considered an integral part of the Practical Improvement process. Excerpts from the *Practical Improvement* document elaborate on this point:

> Applying the Practical Improvement philosophy to the initial scope includes consideration of:
>
> 1) The primary purpose of the proposed project (i.e., bridge replacement, pavement rehabilitation);
> 2) existing conditions and needs for modernization;
> 3) how the initial scope compares with existing roadway features and with anticipated enhancements to the surrounding roadways under evaluation; and
> 4) available funding.
>
> If there are components that the initial scope does not address or over-addresses relating to these four factors, alternate scopes may be developed (*26*).

In the document, two examples of assessing alternate scopes are offered:

- A project may have an initial scope calling for major reconstruction. However, on further evaluation of the project it may be determined that the geometrics are considered acceptable and that only the pavement needs replacement, thus changing the scope to pavement replacement.
- A project to address a two-lane highway's capacity and LOS deficiency might call for creating a four-lane facility. However, a Practical Improvement approach may arrive at an alternate scope; simply adding passing lanes. Both improve capacity and LOS, but to different degrees; however, the latter scope could be considered more cost-effective. Consequently, if there were an anticipated project in the area to expand an adjacent road to four lanes, only the former approach would address item 3.

When developing alternative scopes, KDOT specifies that current design criteria found in AASHTO's *A Policy on Geometric Design of Highways and Streets* (*4*) and the *Roadside Design Guide* (*5*), its own *Road Design Manual* (available at http://kart.ksdot.org), and other pertinent sources of design criteria should form the basis for design. When applying the Practical Improvement approach, alternative scopes may involve selecting design criteria outside of the prevailing criteria range. An example cited in *Practical Improvements* concerns retaining a shoulder of a less-than-standard width over an existing bridge to avoid the major expense of structure replacement. When an element is associated with one of FHWA's 13 controlling criteria, choosing a design element value outside of the prevailing criteria will require writing a design exception.

Other guidance on the application of Practical Improvements found in the document is limited to the following elements:

- **Roadway shoulders and roadside elements**—when considering the clear zone width, side slope grades, and shoulder width and type, KDOT will consider relevant factors that include existing conditions, posted speed, traffic volumes, route continuity, projected traffic needs, right-of-way issues, and utility impacts.
- **Drainage structures**—KDOT's guidance suggests designing structures to "the highest degree of protection that is cost-effective under existing circumstances." Applying the Practical Improvement philosophy to the design of drainage structures is to balance the importance of the roadway, available finances, the possibility of road closure, and the reasonable flood year risk to adjoining property.
- **Facility type**—the guidance provided is that when a facility type (freeway, expressway, or two-lane highway) is investigated consideration should be given to balancing access (the spacing of interchanges or intersections, the choice of interchanges vs. overpasses, etc.) with the overall project cost and safety.
- **Traffic handling and accommodation**—how traffic would be handled and accommodated during construction is to be considered for each alternative scope. For example, different pavement types (asphalt versus concrete) or actions (pavement replacement versus rehabilitation) can affect traffic flow, which in turn will affect the amount of time and money it will take to construct the project. Hence, this factor should be considered during project scoping.
- **Environmental process**—the time and expense in preparing and processing environmental documents should be considered in determining the project scope and specific design decisions.

In the Practical Improvements process, alternative scopes are developed and investigated as to how well each balances cost, operations, environmental concerns, stakeholder input, and safety. How well each scope takes into consideration the four factors mentioned earlier is to be compared. The result of this analysis with a recommended scope is then presented to a program review committee.

### Other Considerations

*Relation to Context Sensitive Solutions and Value Engineering*

KDOT has a policy on CSS whereby it will consider the desires of stakeholders and the users of the project roadway. CSS-type projects are typically in urbanized areas where there is a higher concentration of nonmotorized users (pedestrians, bicyclists, etc.), where right-of-way is limited, and where there may be historical, environmental, and social concerns that need to be considered. In such situations, the goal may not be to reduce the cost of the project but to address those needs cost-effectively. However, flexibility in the application of design features is common to both CSS and Practical Improvement philosophies.

In Kansas, VE is usually limited to large projects that meet federally defined criteria. The purpose of VE is not simply to find ways to cut costs, but to determine if the same value can be achieved at a lower cost. VE is typically applied during preliminary design to determine if certain design components—not just geometric design—can be modified to lower the cost while still achieving the same LOS. As with CSS, the Practical Improvements approach and VE share the application of flexible design criteria.

### *Evaluating the Safety Impact of Alternate Scopes*

As noted earlier, KDOT develops and evaluates alternate scopes to include specific variations for design elements for assigned projects. The potential safety impacts are considered along with cost differences and other factors. In doing so, they will investigate the safety (crash) history of the existing road and conduct a field review. There is no formal process at this time; however, they have begun to use the guidance and information found in the *HSM* (*22*). KDOT also uses the Roadside Safety Analysis Program (RSAP) (*27*) for roadside improvements. Both analyses are used to compare dissimilar alternatives that meet prevailing criteria (i.e., not to justify using lower than accepted criteria). They will evaluate each of FHWA's 13 critical design elements and prepare a design exception report where necessary to justify a reduction of any design criteria.

### *Practical Improvement Program Evaluation*

KDOT's goal that infuses all of its projects is to deliver a product that satisfies the project needs in a safe and efficient manner at the appropriate cost. This overarching goal applies to all projects regardless of whether or how Practical Improvement philosophy is followed; there is no monetary-based goal per se. Projects come from the planning division with a general scope and a defined budget. The goal of the design team is to develop that project within or below that budget, while maintaining or even improving safety.

KDOT maintains a log of projects, by each design squad, where the application of practical improvements is followed. Table 4 shows an excerpt of this log, listing the project with a brief description of the scope change that resulted in a cost savings. In FY 2012, KDOT projected a construction cost savings of nearly $41 million for 18 projects, ranging from as little as $4,000 to as much as $10,000,000.

### Case Examples

A key component of KDOT's Practical Improvements policy is to develop and compare alternate scopes. In their Practical Improvements document four project examples are provided and they are presented in Appendix I and summarized here:

1. A section of Route K-23, a low-volume two-lane highway, had not undergone major reconstruction since its initial construction in the 1940s. The alternative scopes considered varied from reconstruction of the alignment to meet AASHTO criteria to replacement of the pavement, which was badly deteriorated. The "pavement replacement scope" was chosen because it was determined that the existing geometrics and roadside slopes were favorable to remain in place and the simple action of pavement replacement along with lowering the profile would allow for a shoulder width of 2 ft where before there was little or no shoulder. Overall, the pavement replacement scope would provide additional service life and a safety improvement in less time and for approximately $7 million dollars less compared with the reconstruction scope.
2. On a section of Route K-7, a high-volume road, an interchange was to replace an at-grade intersection. Issues related to its construction and resulting traffic management were examined when comparing three options. The most expensive option was chosen because of the foreseeable impact of the delay in completing the project resulting from an anticipated 11-month settlement period was considered to outweigh the additional construction costs associated with this option.
3. The third example dealt with alternate designs of the width and type of shoulder, clear zone widths, and foreslopes for the road section of a bridge replacement. The optional sections evaluated are shown in Table 5. The least expensive option cited in this table, D, was selected because of its lower cost and that it matched into the existing roadway smoothly and stayed within the current criteria ranges.
4. In the fourth example, handling traffic during construction was an important concern. The project involved a 4.5-mile section of US-36 with two lanes, 10 ft shoulders, and deteriorating pavement. Scopes considered were pavement replacement and pavement rehabilitation and the selection of shoulder width and foreslopes. The options considered are shown in Table 6.

   The scope selected was pavement rehabilitation utilizing a typical section with 10 ft composite shoulders and 6:1 foreslopes. This option saved $2,860,000 in construction costs and would allow for traffic to be carried through construction. The shoulder selection matched the existing shoulders on adjacent segments and complied with existing criteria.

TABLE 4
SAVINGS OF PRACTICAL IMPROVEMENT PROJECTS IN KANSAS

| **Practical Improvements Sorted by Road Squad** | **Design Method Used To Obtain Savings** | **FY** | **Total Project Savings** |
|---|---|---|---|
| 25-55 KA-2282-01; LOGAN COUNTY (Grading and Surfacing) | This 11.2 mile pavement replacement project was initiated to address the deteriorated pavement condition on this segment of K-25. Instead of reconstructing this rural 2L highway to AASHTO standards (at $1,000,000 per mile), the pavement was replaced using a practical design that used 11' driving lanes, 2' paved shoulders with rumble strips, and 4:1 side slopes. The project was recently let for $5,613,000. | 2011 | **$5,600,000** |
| 4-5 KA-0040-01; BARTON COUNTY (Bridge replacement) | Closing the road during construction to save $190,000 and paying the county $75,000 for local road improvements. | 2013 | **$115,000** |
| 70-32 KA-0724-01; GOVE COUNTY (Pavement Replacement) | Adjusting median grading to save inlets. **($30,000)** | | |
| | Using clear zone tables to calculate length of need and extend structures. **($73,000)** | 2016 | |
| | Match existing interchange geometry to avoid complete reconstruction of ramps. **($500,000)** | | |
| | Reducing scope from full reconstruction with 6:1 slopes to pavement replacement with 4:1 slopes. **($6,500,000)** | 2012 | **$7,103,000** |
| 70-32 KA-0725-01; GOVE COUNTY (Pavement Replacement) | Reducing project scope from full reconsturction with 6:1 slopes to pavement replacement with 4:1 slopes. | 2012 | **$3,200,000** |
| 70-55 KA-0723-01; LOGAN COUNTY (Pavement Reconstruction) | Adjusting median grading to save inlets. **($5,000)** | 2016 | |
| | Using clear zone tables to calculate length of need and extend structures. **($10,000)** | 2016 | |
| | Reducing Scope from full construction with 6:1 slopes to pavement replacement with 4:1 slopes. **($1,400,000)** | 2012 | **$1,415,000** |
| 192-44 KA-0024-01; JEFFERSON COUNTY (Bridge replacement) | By allowing a design exception, the sag vertical curve was lowered resulting in the need for less contractor-furnished earthwork, less right-of-way acquisition, and a shorter project length. **($300,000)** | 2013 | |
| | Use of state-route detour for through traffic. Despite of the relatively long detour this decision is consistent with our detour selection practice given the low-volume of traffic on this route. In addition, there is a local road available for local traffic. If shoofly detour were to be used it would cost $410,000. **($410,000)** | 2013 | **$710,000** |
| 24-14 KA-0708-01; CLAY COUNTY (Bridge Replacement) | Sidewalk across proposed bridge reduced from both sides to one side. | 2012 | **$796,000** |
| | | **TOTAL SAVINGS:** | **$18,939,000** |

TABLE 5
KDOT'S PRACTICAL IMPROVEMENTS ALTERNATE PROJECT SCOPE—EXAMPLE 3

| Option | Shoulder Width | Foreslope Rate | Clear Zone Width, ft | Construction Cost |
|---|---|---|---|---|
| A | 10 | 6 | 30' | $8,670,000 |
| B | 10 | 4 | 34' | $8,340,000 |
| C | 8 | 6 | 30' | $8,350,000 |
| D | 8 | 4 | 34' | $7,930,000 |

TABLE 6
KDOT'S PRACTICAL IMPROVEMENTS, ALTERNATE PROJECT SCOPES—EXAMPLE 4

| Option | Savings (FY 2012 dollars) |
|---|---|
| Pavement Rehabilitation vs. Pavement Replacement | $1,800,000 |
| 10 ft Composite Shoulder vs. 10 ft Fully Paved Shoulder | $1,060,000 |
| 4:1 Foreslopes vs. 6:1 Foreslopes | $234,000 |

## OREGON DEPARTMENT OF TRANSPORTATION

### Background

ODOT initiated its Practical Design policy in 2009. As in other states, it was instituted as a strategy to stretch scarce dollar resources. ODOT defines Practical Design as a strategy to deliver focused benefits for the state's transportation system while working with the realities of a fiscally constrained funding environment. As stated in the *Practical Design Guidebook* (*28*)—ODOT's guidance document—". . . it [Practical Design] pulls all of the concepts and values we currently apply to our work into a defined, repeatable strategy with defined feedbacks . . ." At the core of ODOT's Practical Design strategy is the project's purpose and need statement that is defined and agreed upon at the initial development of the project. This project purpose and need guides all project decision making moving forward and confirms that the project team has clear expectations for what the project is intended to address.

ODOT has legislative support for its Practical Design policy. In 2009, the Oregon State legislature passed HB 2001—the Jobs and Transportation Act, which directed the agency to implement transportation design practices that follow the concept of Practical Design.

ODOT developed its Practical Design strategy with a 12-person committee. It implemented the policy through several training sessions within its five regions. Training modules were developed and have been used to train ODOT staff and consultants. The training modules can be viewed at http://www.oregon.gov/ODOT/CS/Training/docs/ACECPresentations2011/R1_AndrewJohnsonGlencoe.pdf?ga=t. ODOT applies Practical Design for all roadways and project types, be it simple maintenance, preservation, or modernization, and there is no distinction if the project is federally funded.

### Practical Design Process and Guidelines

ODOT's *Practical Design Guidebook* can be viewed at its website devoted to Practical Design at http://www.oregon.gov/ODOT/HWY/TECHSERV/practical_design.shtml. It explains the Practical Design principles thoroughly and includes the guide noted earlier. Some key points are summarized here.

ODOT has five key design values associated with Practical Design, which form the acronym SCOPE:

- **Safety**—the goal is to make the system as safe as practical with every project either making the facility safer or maintaining the safety level.
- **Corridor Context**—design criteria are applied consistently throughout the corridor respecting the character of the community.
- **Optimize the System—**an asset management approach to managing pavement, bridge, and roadway safety features allows for available funding to be allocated on a priority basis to ensure that the entire highway system is optimized for safety, mobility, and financial investment.
- **Public Support**—opportunities are provided for the community to shape the chosen solution; an essential element is to have clarity with the public about the project purpose, need, and alignment of the proposed project with the overall state's plan.
- **Efficient Cost**—by restricting the scope of the project to meet the project-specific purpose and need allows for redistribution of funds where they will produce the most benefit to the system.

These values shape three overarching goals that guide the application of Practical Design at ODOT:

- Goal #1—Directs available dollars toward activities and projects that optimize the highway system as a whole.
- Goal #2—Develops solutions to address the purpose and need identified for each project.
- Goal #3—Designs projects that make the system better, addresses changing needs, and/or maintains current functionality by meeting, but not necessarily exceeding, the defined project purpose, need, and project goals.

A key element in selecting projects is for decision makers to not only examine the merit of individual projects, but to consider cost-efficiency and the project's ability to contribute to what ODOT is trying to achieve for the overall system. ODOT has developed the following several questions to help stimulate discussion among project leaders, designers, and other decision makers as they integrate the ODOT mission, Practical Design values, and goals with the program/project purpose and need.

SCOPE Integration Questions:

- ✓ Does this project address the purpose and need? Does it meet the project goals?
- ✓ Is the improvement or benefit worth the cost? Is this improvement or benefit too expensive or a throwaway?
- ✓ Is the solution better than current conditions? Is doing something better than doing nothing (consider the opportunity cost to the system)?
- ✓ What are the design priorities?
- ✓ Does it meet the corridor/system context? Does it meet the project context?
- ✓ Are we meeting the expectations of the stakeholders?
- ✓ Is this project consistent with ODOT mission, goals, and policies?
- ✓ Have we analyzed alternatives and conducted value engineering?
- ✓ What are the constraints—physical, fiscal, environmental, schedule?
- ✓ Is there a feedback loop for continuous improvement?
- ✓ What has changed from the original concept and scope? Are original assumptions still valid?

ODOT has developed two tools to assist in the implementation of Practical Design: the Practical Design Decision Model and the Project Charter. Figure 3 shows their Project Delivery Life-Cycle model. As stated in ODOT's *Practical Design Guidebook*, The Project Charter is a written narrative agreement that spells out the charge given to the project team and the responsibilities of all involved, providing a means to clarify all aspects and nuance of direction, expectations, philosophies, and decision making on the project need, priorities, parameters, flexibilities, roles, accountability, etc. The Project Charter provides the foundation to guide the project:

- Gives the green light for the project team to proceed as they see fit to get the work done.
- Formally authorizes the project and defines and documents the project purpose and need.
- Reinforces what to do and when.
- Provides focus when identifying project purpose, need, and objectives. They should be specific enough to provide accountability for decisions made.
- Provides minimum requirements—those critical elements that are always present on a project.
- Ties together project purpose and need, objectives, and overall project performance measures and/or indicators of success.

Appendix J provides an example of a project charter.

### Other Considerations

*Relation to Context Sensitive Solutions and Value Engineering*

ODOT views Practical Design as a logical next step for CSS; it can be considered CSS with limited funding. Practical Design requires evaluating the project solution in the broader context of the corridor and even the state system. The ODOT Practical Design process includes public involvement and other ingredients of the CSS process.

ODOT typically applies VE to larger-scale, complex projects involving major structures, interchanges, and new alignments. Although some of the same principles and goals apply to both Practical Design and VE, there is no formal relationship acknowledged within ODOT.

*Measuring the Success of Practical Design*

ODOT has established three indicators of success for its Practical Design policy:

1. **Institutionalization of Practical Design approach, values, and goals.** Success indicators include:
   a. Planning, project delivery, and maintenance staff trained in practical design.
   b. External communication and training for consultant and local agency partners.
   c. Projects have project charters.
   d. Projects have five new SCOPE integration and documentation tasks included in milestones.
   e. Interactive website enables understanding and acceptance of Practical Design and provides a platform for evolvement and continuous improvement.
2. **System Optimization** within available funding. The following Key Performance Measures (KPM) are being collected and reported on an annual basis:

| | |
|---|---|
| • KPM #1 Traffic Fatalities | Per 100 million vehicle-miles traveled |
| • KPM # 11 Travel Delay | Hours of travel delay per capita per year in urban areas |
| • KPM #15 Pavement Condition | Percent of pavement lane-miles rated "fair or better" |
| • KPM # 16 Bridge Condition | Percent of state highway bridges that are not deficient |

3. **Delivering the:**
   a. **Right Projects:**
      i. Successfully addresses and documents integration of SCOPE values;
      ii. Provides targeted system and/or corridor improvements; and
      iii. Purpose and need is clear and has stakeholder consensus and accountability.
   b. **Right Time**—has stakeholder support (including funding and a focus on timely delivery).
   c. **Right Costs:**
      i. Least cost solution to address specific purpose and need.
      ii. Incremental improvements for incremental investments when warranted by system benefit.

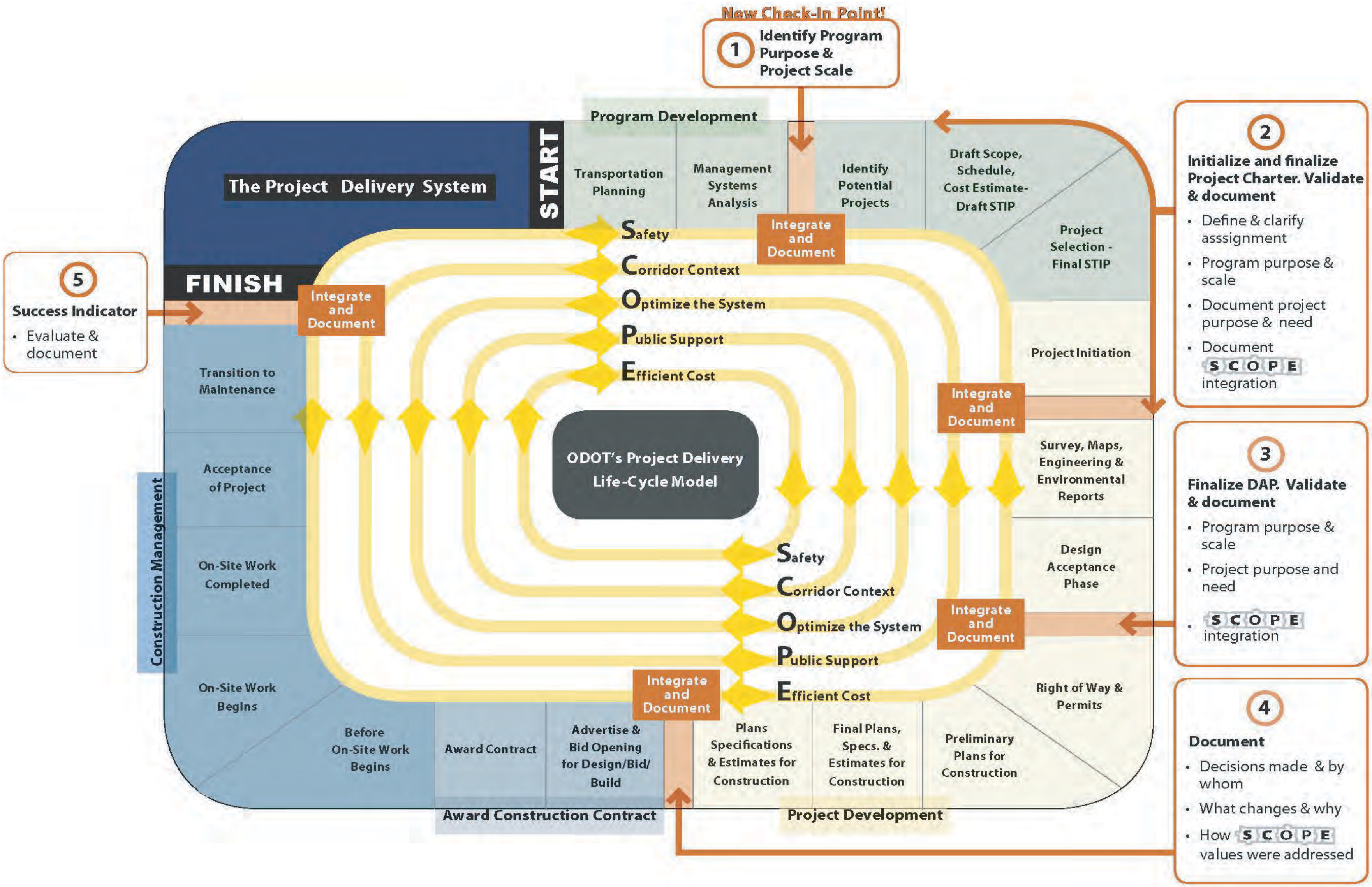



FIGURE 3 Project delivery life-cycle model for Oregon. *Source:* ODOT *Practical Design Guidebook* (*28*).

d. **Right Way:**
   i. Minimizes mobility, environmental, and stakeholder impacts;
   ii. Minimizes rework; and
   iii. Risk conscious, value focused, context sensitive, and outcome oriented.

## UTAH DEPARTMENT OF TRANSPORTATION

### Background

The Utah Department of Transportation (UDOT) formally adopted Practical Design on February 2, 2011, with the issuance of a memorandum from its Engineer of Preconstruction (see Appendix K). The policy had been about two years in the making and was initiated by senior leadership after hearing about Missouri's and other states' similar programs. The memorandum states that UDOT was implementing Practical Design immediately to support ". . . UDOT's continuing emphasis on innovation, cost savings, and providing the public with the transportation system that meets their needs. The goal of Practical Design is to only build 'right sized' projects that meet focused needs, which allows UDOT to spread limited resources more effectively throughout the transportation system."

During the two-year buildup senior personnel from the central office met with colleagues from the regional offices to explain the Practical Design policy. (In Utah, the central office establishes programs, projects and funding levels, and provides the various resources; however, the regional offices are responsible for delivering specific projects.) Although the regional offices were consulted, the implementation of Practical Design was directed by the central office. There was initial concern with the policy from the regional offices, but they have come to embrace this project development process. Initially, local offices of FHWA were also reluctant, but have come to accept Practical Design as part of the on-going design exception practice. Consultants are used for design and have been advised of the Practical Design policy through the UDOT's Listserves and other outlets, such as the American Council of Engineering Companies. There was no public involvement program leading up to the implementation of the Practical Design policy.

UDOT believes that Practical Design is a continuing evolution of its project development and design process. It has always looked for innovative solutions to address a project need—Practical Design simply formalizes the process.

### Practical Design Process and Guidelines

UDOT's Practical Design program is documented in its *Practical Design Guide* (*29*). The 16-page document can be viewed at http://www.udot.utah.gov/main/uconowner.gf?n=3142031557718121. It provides guidance on how Practical Design is to be implemented; it does not replace UDOT's *Design Manual*. Some key elements are summarized here.

UDOT believes that investments in any project reach a point of diminishing returns—investing more in one specific project does not necessarily result in equal returns. Any investment above the point of diminishing returns is an inefficient use of resources that can be applied to other projects with higher returns to the total system.

UDOT has established the following three overarching goals for Practical Design:

- **Goal #1: Optimize the transportation system as a whole.** Prior to Practical Design, projects were developed and prioritized for various design periods; that is, 10, 20, and 30 years, and there was no clear understanding of how the improvement served the objectives of the corridor and system. Under Practical Design, project teams are given a clear understanding of how each project fits into the roadway system and corridor priorities as the driving force behind each project.
- **Goal #2: Meet the goals of the objective statement identified for each project.** Prior to Practical Design, the focus was on maximizing improvements within the project limits to address needs using design exceptions and waivers only to meet the budget. With Practical Design, the focus is to meet, not exceed, the objective statement, using exceptions and waivers to sufficiently meet the project objective.
- **Goal #3: Design the most efficient method (cost and function) to achieve the objective statement.** Prior to Practical Design, the entire budget was used to maximize improvements and VE was used to determine the most cost-effective way to achieve the proposed improvement. With Practical Design, the focus is on maximizing cost savings while meeting the project objective statement. The resultant savings can then be applied to other projects.

UDOT recognizes that the most critical element in Practical Design projects is the project's objective statement. The project is to be scoped to meet the objective statement. By so doing, Practical Design eliminates "over designing." The objective statement notes the goals of the project and not a specific solution. For example, the objective statement should not say, "The objective is to add a lane." The *Practical Design Guide* (*29*) provides direction on how to develop the objective statement through the following five steps:

1. Identify the current conditions.
2. Determine the existing deficiencies.
3. Identify the deficiencies to be improved.

4. Determine the project objective
5. Clearly and specifically describe the objective statement of the project.

The project sponsor (i.e., System Planning and Programming, Region Maintenance, Traffic, and Safety) is responsible for defining the initial objective statement, which can be updated as needed.

UDOT applies Practical Design principles in all stages of project development, from initial planning to the scoping stage, design, and finally construction. At the planning stage, significant savings can be attained by evaluating major design features to determine if a less than ideal solution is warranted. For example, a project that might normally include a grade-separated interchange could be achieved through the use of new innovative intersection designs. Another example would be where the construction of passing lanes would be a Practical Design solution over the construction of a four-lane divided roadway.

The following, excerpted in part from UDOT's *Practical Design Guidelines*, best describes how Practical Design is applied for UDOT's projects.

> Practical Design requires flexibility. Design standards typically do not allow the necessary flexibility for Practical Design. Rather than focusing on meeting all minimum standards, Practical Design establishes the existing condition as a baseline and the design is evaluated as the project is improved beyond the existing conditions. A design standard may be waived when the objective statement is satisfied and all impacts from not meeting design standards are mitigated.
>
> Current Approach
> - Design standards dictate the desired level of improvement.
> - Exceptions, deviations, and waivers are used when resources do not allow for the design standard to be built.
>
> Practical Design Approach
> - Design standards are the "ideal" improvement.
> - The project objective statement clearly describes the expected outcome of the project.
> - Exceptions, deviations, and waivers are used when either of the following applies:
>   - The design standard exceeds the objective statement.
>   - A lower cost solution not meeting design standards is identified which does not compromise safety.
> - The design starts with existing conditions and builds up to meet the objective statement. The design is not a stripped down version of the design standards.

In applying Practical Design, UDOT pursues design exceptions, deviations, and waivers as necessary to achieve the project objective statement. Some of the more common of these include:

- Reduced shoulder paving width from full to half.
- Bridge rehabilitation deemed acceptable versus bridge replacement.
- Bridge deck replacement deemed acceptable versus bridge replacement.
- Pavement rehabilitation deemed acceptable versus replacement.
- Bridge width needs only to match existing roadway width.
- Narrow lane width from 12 ft to 11 ft.
- Pavement thickness reduced based on design life of 15 years as opposed to 20 years.
- Appropriate design life reduced to 15 years from 30 years.
- Average annual daily traffic projects for 10 years deemed sufficient.

Appendix L provides an example of a completed design exception for a Practical Design project.

### Other Considerations

*Relation to Context Sensitive Solutions and Value Engineering*

UDOT views Practical Design as combining CSS with VE, which means that the facility should be designed within the context of its purpose and need and its environment, in a cost-effective way. UDOT has had a policy on CSS since 2000. As stated on their website for CSS, it is a philosophy that guides UDOT wherein safe transportation solutions are planned, designed, constructed, and maintained in harmony with the community and the environment. CSS balances safety, mobility, and transportation needs while preserving scenic, aesthetic, historic, cultural, environmental, and community values.

UDOT recognizes the connectivity of VE to Practical Design. Indeed, VE is considered a tool for Practical Design, meaning the analysis and assessment made when applying VE to a project are similar for Practical Design. The distinction is that VE is a method to determine the most cost-effective way *to achieve proposed improvements* and typically focuses on maximizing project improvements. On the other hand, Practical Design is a method to determine the most cost-effective way *to achieve the project objective statement* and focuses on maximizing roadway system improvements and UDOT's strategic goals.

*Success Indicators*

As stated in UDOT's *Practical Design Guideline* (*29*), UDOT has established success indicators, which are identified as Goals and Performance Measures as enumerated here:

> A. Institutionalized Practical Design Philosophy, Values, and Goals
>
> All parties involved in the development of transportation improvements must integrate Practical Design practices into all

decision making for Practical Design to be successful. The success indicators include:

- All proposed projects have a clear objective statement that describes how the project will help the system meet the Final Four.
- Each proposed project is clearly the best system-wide solution.
- Project teams identify, monitor, and document Practical Design.
- Project teams focus on improving the system as a whole, not just within their project limits.
- Project teams report savings due to Practical Design.

B. Performance Measures

To measure the performance of Practical Design implementation, the following indicators will be measured:

- Total cost savings for the overall program.
- Percent savings for the overall program.
- Percent savings per project.
- Percent of projects using Practical Design.
- Percent savings by project type (new construction, maintenance, etc.).
- Percent savings by project size.

The goals are broadly stated and have no numerical value applied to them. For example, there is no goal for how much savings are to be realized, either in absolute dollars or as a percent dollar reduction attained from the standard design. Also, there are no safety-related goals and no corresponding performance measures to determine if the Practical Design has maintained or changed, for better or worse, the safety performance as measured by the frequency and severity of crashes.

CHAPTER FIVE

# FINDINGS, CONCLUSIONS, AND SUGGESTED RESEARCH

## FINDINGS

### States That Have a Practical Design Policy

Of the 41 states that responded to a survey questionnaire, six were identified as having an explicit Practical Design policy. Missouri, Oregon, and Utah use the term Practical Design, Kentucky and Idaho the term Practical Solutions, and Kansas the term Practical Improvements. Each of these states has a formal policy and has published guidelines, to varying degrees of specificity as to how Practical Design (using this label for all three types) is to be applied in developing projects. Another 23 states reported that they have a policy or program similar to Practical Design, citing such terms as design flexibility, context sensitive solutions (CSS), smart transportation, design exceptions, value engineering (VE), and their resurfacing, restoration, and rehabilitation program.

### How States Define and Implement Practical Design

None of the six states that have a Practical Design-type policy have an explicit definition for the term they use; rather, they define their policy in terms of goals, tenets, principles, and process. The definitions provided here were composed from either statements made by each state or from the goals of the state's Practical Design, Solutions, or Improvements policy documents:

- **Missouri**—Practical Design is an approach to transportation where the value of an individual project is maximized within the context of its surroundings, such that it contributes to the entire system instead of its individual perfection.
- **Idaho**—Practical Solutions is a project development process whereby the project is defined to meet the purpose and need through a cost-effective design, considering life-cycle costs, and in consideration of the context of the surroundings.
- **Kentucky**—Practical Solutions is a project development process from planning through operations and maintenance that examines a range of approaches and determines which solution meets the purpose and need with the least cost.
- **Kansas**—Practical Improvements is an overarching philosophy that guides project development decisions that affect project cost and scope in order to stretch transportation improvement dollars further while still maintaining a safe and efficient highway system.
- **Oregon**—Practical Design is a systematic approach to deliver the broadest benefits to the transportation system, within existing resources, by establishing appropriate project scopes that meet the purpose and need and are within the system context.
- **Utah**—Practical Design is a project development approach that focuses on maximizing improvements to the roadway system as a whole, rather than maximizing improvements to a few locations, by building a series of good, not great, projects.

Rather than try to define either of these practical labels, it is appropriate to describe each through its tenets or principles. Although some minor variations exist among the profiled states, the basic tenets or principles of practical design/solutions/improvements can be summarized as follows:

- The goal of Practical Design is to build many "good" projects, rather than fewer "great" projects, to maximize system-wide safety and capacity improvements
- The design of a project is based on addressing its stated objective—purpose and need—and not necessarily providing more than that. The goal is to satisfy the project's objective in the most cost-effective manner.
- Practical Design does not eliminate the state engineering standards; rather, it promotes flexibility needed to produce the most efficient design to meet the system and project objective statements.
- Practical Design is a "design up" approach. It starts with the current conditions (if it is an existing facility) and builds up the improvements to meet the project objectives.
- Practical Design requires designers to follow engineering judgment in making decisions about design elements rather than unquestioned application of design standards.

### Barriers and Lessons Learned from States That Have Implemented Practical Design

None of the states voiced any significant barriers that were not overcome through training, education, and communication among the stakeholders. State legislatures embraced the program as a practical way to achieve improvement projects across the state within limited budgets. Some of the states interviewed acknowledged initial concerns by staff when Practical Design was first introduced to them, primarily because of not always using the higher level of design values for projects. These concerns were assuaged with training and instruction on the applying of engineering judgment to meet the projects purpose and need. Acceptance of the policy grew as it was shown that savings from individual projects with good design features could be used for more projects on the system.

### How Practical Design Differs from the Traditional Design Process

The "traditional" design process applies to Practical Design in that the same project development steps are followed and the state's road design manual is used as a basis for design. What differs, or is more emphasized, is the proper scoping of each project at the planning level to satisfy the purpose and need, and then alternative designs are evaluated to achieve that scope at the least cost while improving safety and operations.

The focus of Practical Design is on cost reduction for individual projects so that the savings can be used on additional projects. Therefore, its application may result in "downsizing" a project or, as some states, state "right-sizing." From the six state profile discussions this can mean:

- Scoping a project based on a shorter design year; for example, 10 year versus 20 year, consistent with a project's unique needs.
- Scoping a project based on a lower level of service (LOS); for example, LOS D versus LOS C.
- Selecting a design speed equal to the current posted speed limit, which in turn affects the selection of some design element values.
- Selecting a specific design element, such as shoulder width, different than would be required under the state's design manual.
- Customizing the pavement thickness or using different pavement material as appropriate based on the underlying soil.

### Modifications to Roadway Geometric Design Criteria

For all six states, the geometric design criteria in their road design manuals still apply and serve as the basis for design with modifications, through design exceptions or variances, made as needed to meet the projects purpose and need. Only two states—Missouri and Kentucky—supply specific modifications to their geometric design criteria. Missouri's *Practical Design Implementation Manual* provides general guidance on selecting design elements as shown in Appendix C. In Appendix F, accompanying Kentucky's Practical Solutions memorandum, is a series of tables for the various functional roadway classifications with design values for several elements. These tables are meant to "provide guidance" and the flexibility needed to adapt critical design elements to be consistent with the purpose and need for the project.

### Relationship of Practical Design to Context Sensitive Solutions, Value Engineering, and Other Similar Initiatives

As described in chapter three, CSS seeks a solution that addresses the needs of multiple users and functions of the facility within the context of its setting considering land use, users, the environment, and other factors. Another key element of CSS is interaction and communication with all stakeholders—local governments, citizens, elected officials, etc.—to achieve an acceptable solution. The hallmark of Practical Design is developing a project that satisfies the purpose and need and fits within the project limit context, which is a similar goal for CSS. However, in applying Practical Design, cost, in terms of cost-effectiveness and rate-of-return, becomes a critical driver that could limit the project solution under CSS.

The relationship of Practical Design to CSS was the focus of a paper by Stamatiadis and Hartman, "Context Sensitive Solutions vs. Practical Solutions: What are the Differences?" The authors initially recognized the possible conflict between the two project development policies, but later noted that they can be in harmony. In discussing KYTC's Practical Solutions approach, it ". . . provides two improved CSS principles (relating to purpose and need and using agency resources effectively) and one new principle (regarding the system-wide context) to the extensive CSS attribute list." The authors opine that ". . . if the Practical Solutions methodology is used completely in lieu of CSS, it would provide an excuse to ignore several important (and beneficial) CSS principles for project development and delivery."

Several of the states that did not have a Practical Design policy responded that their application of CSS policy could be considered Practical Design. For the six states that were profiled, most recognize a relationship and similarity in principles. For instance, Kansas reported that both CSS and Practical Design apply flexibility in the application of design features. Oregon views its Practical Design policy as the next logical step to CSS, a point that is made by Stamatiadis and Hartman. Utah views its Practical Solutions policy as combining elements of CSS and VE.

Practical Design is not the same as VE, although here too there are similar goals. VE, which is usually reserved for large scale (more than $25 million) projects, is a method to determine the most cost-effective way to achieve proposed improvements. Practical Design is a method to determine the most cost-effective way to achieve the projects purpose and need. However, the tools and procedures used for VE can be used for Practical Design. For the states interviewed, they see these two initiatives as being separate programs, but as noted Utah views its Practical Solutions as a combination of these two initiatives.

### Project-Specific Roadway Design Tradeoffs Considered

The issue here was twofold—what types of design tradeoffs are considered and how are those tradeoffs evaluated. The case examples provided in chapter four and in the appendices indicate the types of tradeoffs considered, which, of course, vary by specific project. They include most of the primary design elements, including cross-section widths, roadside features, and longitudinal alignment. Most of the states interviewed indicated that they examine the expected safety outcomes under the different alternatives in evaluating tradeoffs. Several states indicated that they are starting to use the information and procedures contained in the *Highway Safety Manual.*

### Application of Design Exceptions for Practical Design

The preparation of design exceptions is an important element when applying Practical Design. Each of the states profiled in chapter four reported that design exceptions or design variances are prepared when a value for a design element is chosen that is less than what would be required by its design manual.

### Cost Savings Resulting from Practical Design Projects

Practical Design emerged out of the need to stretch available funding so that more improvement projects could be completed within the fiscal budget. The several case examples in this report provide evidence of the cost savings attained, which for many projects was substantial. According to the states these savings were used for additional projects. The cost savings presented were construction costs and not life-cycle costs, which could not be established until the projects reached their design life.

### Liability Risk of Implementing Practical Design Approaches

Specific data on the incidences of tort liability claimed against Practical Design was not collected nor sought from the states interviewed. However, none of the states interviewed indicated that this was a concern for senior level management. In fact, two states indicated that they believed they would have less risk, because they would be applying engineering judgment supported by adequate documentation of their rationale.

## CONCLUSIONS

All state transportation agencies have project needs that exceed their available funds and are seeking project development solutions that optimize these funds for their entire system. Practical Design/Solutions/Improvements is an emerging project development paradigm that has been adopted as a policy by only a few, specifically six, states as of this synthesis preparation. A few states are either in the process of adopting a policy or considering doing so. Still other states believe that they are following Practical Design principles through similar initiatives including CSS, Smart Transportation, flexible design, design exceptions, and VE.

The six states that have a formal policy are not using the same label; however, they have a common goal—developing individual projects cost-effectively to meet only the project's purpose and need and applying cost savings for additional projects, thereby optimizing their budgets statewide. This typically results in individual projects being downsized in various ways, including shorter design year, attaining a lower LOS, limiting the design speed and selecting lower design values for specific geometric design elements, structures, and pavements, commensurate with the project context. This project development paradigm has been shown to achieve the goal of implementing more improvement projects with available resources. Data to date, while not nearly robust enough to draw a conclusion, indicate that safety has not been compromised.

In Missouri, the first state to adopt it, Practical Design has been in operation for only seven years and for the other five states even less time. With more time, states will have more experience and data on how well the application of Practical Design is achieving its goal.

## SUGGESTED RESEARCH

There are two areas where research is suggested to support further development and application of Practical Design.

1. Practical Design is based on the premise that it is better for the entire system to develop several "good" projects than a lower number of "higher designed" projects within a fixed budget for system improvements. It is assumed that the entire transportation system is improved more so under this strategy than if the "standard" approach was followed. This assumption has yet to be proven by either of the states that are applying Practical Design policies. The cost savings are well-documented; however, there has not been a comprehensive evaluation by any of the states to determine if this assumption is valid.

   To do so would not be easy. What would be the performance measures? They would likely include safety, operations, and costs as a minimum. One would have to assume how the performance measures would have changed without a Practical Design policy. Nonetheless, some high-level, macroscopic evaluation of the Practical Design approach is recommended so that its efficacy can be established for future considerations.

2. The application of practical design frequently requires making choices among alternative design elements, especially some that are related to safety; that is, crash occurrence. For example, there may be a choice between having wide shoulders throughout the project limits versus reducing the severity of one or more horizontal curves. These types of tradeoff decisions are better made if it is known what the relationship is between either of these two design elements and safety. What will be the crash frequency and severity change for each alternative? Progress has been made in developing crash modification factors (CMFs) (see the CMF clearinghouse at http://www.cmfclearinghouse.org/ for more information) for many design elements and traffic control devices. These CMFs are continuously being developed and updated for new elements and variations. This research needs to be continued so that the states know that the safety/design element relationships and can better evaluate alternatives.

# REFERENCES


1. Dorothy, P.W. and S. Thieken, *NCHRP Synthesis 422: Trade-Off Considerations in Highway Geometric Design*, Transportation Research Board of the National Academies, Washington D.C., 2011.
2. American Association of State Highway and Transportation Officials (AASHTO), *A Guide for Achieving Flexibility in Highway Design*, AASHTO, Washington, D.C., May 2004.
3. *Executive Order 13274—Purpose and Need Workgroup Baseline Report*, Federal Highway Administration, Washington, D.C., 2005.
4. American Association of State Highway and Transportation Officials (AASHTO), *A Policy on Geometric Design of Highways and Streets,* AASHTO, Washington, D.C., 2011.
5. American Association of State Highway and Transportation Officials (AASHTO), *Roadside Design Guide*, AASHTO, Washington, D.C., 2005.
6. *Mitigation Strategies for Design Exceptions*, Federal Highway Administration, Washington, D.C., July 2007 [Online]. Available: http://safety.fhwa.dot.gov/geometric/pubs/mitigationstrategies/index.htm.
7. Mason, J. M. and K. M. Mahoney, *NCHRP Synthesis 316: Design Exception Practices*, Transportation Research Board of the National Academies, Washington, D.C., 2003.
8. American Association of State Highway and Transportation Officials (AASHTO), *A Policy on Design Standards—Interstate System,* 5th ed., AASHTO, Washington, D.C., Jan. 2005.
9. Application of Design Standards, Uniform Federal Accessibility Standards and Bridges, Federal Highway Administration, Washington, D.C. [Online]. Available: http://www.fhwa.dot.gov/design/0625sup.cfm.
10. "Context Sensitive Solutions," Federal Highway Administration, U.S. Department of Transportation, Washington, D.C. [Online]. Available: http://contextsensitivesolutions.org/?
11. Lane, L. B., *NCHRP Synthesis 373: Multi-Disciplinary Teams in Context-Sensitive Solutions*, Transportation Research Board of the National Academies, Washington D.C., 2007.
12. Neuman, T. R., et al., *NCHRP Report 480: A Guide to Best Practices for Achieving Context-Sensitive Solutions*, Transportation Research Board of the National Academies, Washington, D.C., 2002.
13. *Geometric Design Criteria and Processes for Non-Freeway RRR Projects*, Technical Advisory, T 5040.21, Federal Highway Administration, Washington, D.C., Oct. 17, 1988 [Online]. Available: http://www.fhwa.dot.gov/design/t504028.cfm.
14. McGee, H.W., *NCHRP Synthesis 417 Geometric Design Practices for Resurfacing, Restoration, and Rehabilitation*, Transportation Research Board of the National Academies, Washington, D.C., 2011.
15. "Value Engineering," Federal Highway Administration, U.S. Department of Transportation, Washington, D.C. [Online]. Available: http://www.fhwa.dot.gov/ve/.
16. "Value Engineering, Laws, Regulations, and Policy," Federal Highway Administration, U.S. Department of Transportation, Washington, D.C. [Online]. Available: http://www.fhwa.dot.gov/ve/vepolicy.cfm.
17. Wilson, D. C., *NCHRP Synthesis 352: Value Engineering Applications in Transportation*, Transportation Research Board of the National Academies, Washington, D.C., 2005.
18. *Flexibility in Highway Design*, Report FHWA-PD-97, Federal Highway Administration, Washington, D.C., 1997.
19. Jones, J., "Practical Design," *Public Roads*, Vol. 73, No. 4, Jan./Feb. 2010.
20. *MoDOT Engineering Policy Guide*, Missouri Department of Transportation, Jefferson City, n.d. [Online]. Available: http://epg.modot.org/index.php?title=Main_Page.
21. *Practical Design Implementation*, Missouri Department of Transportation, Jefferson City, n.d.
22. American Association of State Highway and Transportation Officials (AASHTO), *Highway Safety Manual*, Volumes 1, 2, and 3, AASHTO, Washington, D.C., 2010 [Online]. Available: www.highwaysafetymanual.org.
23. *Practical Solutions for Highway Design*, Idaho Department of Transportation, Boise, n.d.
24. Stamatiadis, N., A. Kirk, D. Hartman, and J. Pigman, *Practical Solution Concepts for Planning and Designing Roadways in Kentucky*, Kentucky Transportation Cabinet, Frankfurt, Oct. 2008.
25. Stamatiadis, N. and D. Hartman, "Context Sensitive Solutions vs. Practical Solutions: What Are the Differences?" presented at the 90th Annual Meeting of the Transportation Research Board, Jan. 23–27, 2011.
26. *Practical Improvements*, Kansas Department of Transportation, Topeka, 2009.
27. Max, K. and D. Sicking, *NCHRP Report 492: Roadside Safety Analysis Program* (*RSAP*)*—Engineer's Manual*, Transportation Research Board of the National Academies, Washington, D.C., 2003.
28. *Practical Design Guidebook*, Oregon Department of Transportation, Salem, Mar. 2010.
29. *Practical Design Guide, Planning and Designing Practical Transportation Solutions for Utah*, Utah Department of Transportation, Salt Lake City, Feb. 1, 2011.

# APPENDIX A

## State DOT Survey Questionnaire

NCHRP Synthesis 43-05: Practical Design/Practical
Solutions Practices

Dear State Design Engineer:

The Transportation Research Board (TRB) is preparing a synthesis on Practical Design/Practical Solutions Practices. This is being done for the National Cooperative Highway Research Program (NCHRP), under the sponsorship of the American Association of State Highway and Transportation Officials, in cooperation with the Federal Highway Administration.

To meet the challenge of increasing demands with limited financial resources, some state transportation agencies adopted initiatives that result in design solutions for specific roadway projects that allow them to address critical needs of the entire roadway system. This approach allows for completing more roadway projects in a shorter time period and at lower costs. This new design paradigm is called “practical design or practical solutions.”

The objective of the synthesis is to compile and synthesize current state DOT practices, recent literature findings, and research-in-progress addressing practical design or practical solutions as a new procedure for developing and designing roadway projects. As an initial step in conducting this synthesis, the consultant prepared this current state practices survey. The survey is designed to:

- Identify those states that have developed a program for practical design, practical solutions or some other project development and design strategy that embraces these objectives.
- Of those states that have practical design, practical solutions programs, identify those which would be willing to provide further information on their program and provide information on sample projects using this approach.
- Identify those states that are in the process of or are considering a similar program.

This questionnaire is being sent to members of the AASHTO Highway Subcommittee on Design. Your cooperation in completing the questionnaire will ensure the success of this effort. There are only a few questions to achieve this objective. If you are not the most appropriate person to complete this questionnaire, please forward it to the correct person.

Please compete and submit this survey by January 31, 2012. We estimate that it should take approximately 15–30 minutes to complete. Your early response is appreciated. If you have any questions or have any supporting materials please contact Hugh McGee, the consultant who is preparing the synthesis, at hmcgee@vhb.com or 703-847-3071.

SURVEY QUESTIONS

Before completing the survey, we offer 'definitions' of practical design and practical solutions as suggested by two states that have adopted these design procedures:

Practical Design: The Missouri DOT initiated a process that critically reviews projects to establish appropriate project scope and subsequent roadway geometrics based on needs, not standards. They stated that they want "fewer spots of perfection and more good projects that make a great system." This approach allows for completing more roadway projects in a shorter time period. To implement their approach, called "practical design," the Missouri DOT reviewed its existing design standards and revised them in a way that addresses the practical design approach in the new design manual.

Practical Solutions: The Kentucky Transportation Cabinet implemented a similar initiative through their "practical solutions" program. The approach uses existing conditions as the baseline and tries to achieve results in project improvements that are better than the existing conditions. This approach underscores the importance of understanding the specific needs and goals of the project. The approach develops a customized solution that will address the specific needs while utilizing the flexibilities inherent in the design process.

1) Given the definitions provided above, does your state have a formal or informal program related to practical design, practical solutions, or some other similar project development and design philosophy?

[ ] Yes

[ ] No

If you answered YES to #1, explain briefly below. Alternatively, provide a link to any documents on your website or e-mail this material to the consultant identified at the end of this survey.

2) If you answered NO to #1, are you considering developing a program?

If you answer YES here, proceed to #3. If you answer NO, you may make whatever comment you wish under #5 and then return the survey.

[ ] Yes
[ ] No

3) What information would be useful to your state in either developing or expanding upon a PD/PS program?

4) Would you be willing to be interviewed by the consultant and provide information and data on one or more projects where practical design or practical solutions was applied?

[ ] Yes

[ ] No

It is anticipated that the project consultant will interview a representative by phone and request that design data and other information be provided, such as:

- roadway design tradeoffs considered;
- modifications to geometric design criteria;
- cost savings;
- design exceptions; and
- lessons learned from following this practice.

5) Provide any other comments below:

Thank you for taking our survey. Your response is very important to us. If you have any questions or comments, please feel free to contact Hugh W. McGee at:

E-mail: hmcgee@vhb.com

# APPENDIX B

## State Responses to Survey Questionnaire

TABLE B1
RESPONSES TO QUESTION NO. 1

| Number | State | Has PD/PS Policy? | | If YES, explain briefly below. |
|---|---|---|---|---|
| | | Yes | No | |
| 1 | AL | | No | |
| 2 | AR | Yes | | Arkansas does not have a program that is designated as practical design. However, for many years we have used the 3R process to achieve practical design on many miles of highway. In 1989 geometric design criteria was established for nonfreeway resurfacing, restoration and rehabilitation projects. This design criteria is less than normal design standards; however, it provides a safe and improved facility at a reduced cost. This 3R design criteria is based on FHWA Technical Advisory T5040.28. |
| 3 | CO | Yes | | CDOT has a formal and informal CSS process. This process leads to practical designs by incorporating multi-disciplinary (within CDOT and outside) teams to develop solutions. |
| 4 | DE | Yes | | The DelDOT Road Design Manual allows for flexibility within the design standards and allows for design exceptions when the standards cannot be met. DelDOT does not however have a program strictly based on practical design or practical solutions. |
| 5 | FL | | No | |
| 6 | GA | Yes | | We have a Context Sensitive Design Manual that was developed in 2006. In addition, we have developed our own Design Policy Manual. We don’t, however, have a formal documented Practical Design/Practical Solutions manual. |
| 7 | HI | Yes | | We have a CSS program that has yet to be formalized. We are currently applying the CSS philosophy to several consultant-designed “pilot” projects in order to build up a “lessons learned” library. These lessons will be applied to future consultant-designed and in-house designed projects. |
| 8 | IA | | No | |
| 9 | ID | Yes | | http://itd.idaho.gov/manuals/Online_Manuals/Current_Manuals/PSHD/PSHD.pdf |
| 10 | IL | | No | |
| 11 | IN | Yes | | We are rewriting our design manual to achieve flexibility in design. |
| 12 | KS | Yes | | Emailed Practical Improvement Guide to Consultant. |
| 13 | KY | Yes | | KYTC started a Practical Solutions initiative four years ago. I will email information to you. |
| 14 | LA | Yes | | Our program is informal. Our process is similar to Kentucky’s practical solutions. We typically apply these concepts to spot replacement type projects (bridge replacements, spot safety improvements, etc.) |

TABLE B1
(*continued*)

| Number | State | Has PD/PS Policy? | | If YES, explain briefly below. |
|---|---|---|---|---|
| | | Yes | No | |
| 15 | MA | Yes | | Although not really the Missouri and Kentucky approach which are primarily based on the need to reduce cost, we have several "programs" that relate to context sensitive design and the need to build in the context of the surroundings. This includes our Project Development and Design Guide, our Footprint Bridge Policy, our Complete Streets initiative, our Green DOT policy which addresses sustainability, our Design Exception policy, our support of Value Engineering and Constructability reviews, and related Engineering Directives including 3R allowances. All recognize that building to full AASHTO Green Book standards is not always practical or feasible. |
| 16 | MD | Yes | | RSA or Road Safety Audits are conducted to identify low cost improvements to improve safety of a given facility. Roadway segments with lower safety performance are reviewed by a team of technical experts representing multiple disciplines. Implementation has been a challenge. |
| 17 | ME | Yes | | Maine is presently developing a Practical Design philosophy and guidance for geometric design. |
| 18 | MI | Yes | | MDOT has no formal policy, but allows designers to evaluate situations where MDOT or AASHTO standards cannot be met based on a safety/operational analysis and cost. This is done via the design exception process. |
| 19 | MN | Yes | | Design flexibility included as an element within Context Sensitive Solutions, a flagship initiative of the department and our overall design philosophy; link: http://dotapp7.dot.state.mn.us/edms/download?docId=700077; additionally, performance-based design unit created within the engineering services division, 2012 |
| 20 | MO | Yes | | Missouri invented "practical design." Our EPG can be found on our website. |
| 21 | MS | | No | |
| 22 | MT | Yes | | Montana's program is informal. Over the years we have utilized various forms of a level of development process to meet the essential transportation needs even though it may not achieve the most desirable design on any given project. These include a roadway width evaluation process that considers safety, level of service and operational characteristics. We also have a pavement evaluation program with the goal of providing the right treatment at the right time (e.g., preventive maintenance and rehabilitation to postpone the need for full reconstruction). |

(*continued on next page*)

TABLE B1
(*continued*)

| Number | State | Has PD/PS Policy? | | If YES, explain briefly below. |
|---|---|---|---|---|
| | | Yes | No | |
| 23 | NC | Yes | | Subregional Tier Design Guidelines for NCDOT Bridge Projects (Minor Collectors, Local and Secondary Roads) |
| 24 | ND | Yes | | The NDDOT has what we refer to as Design Guidelines which is a part of our Design Manual for differing project strategies. Each strategy has a set of guidelines that is followed for project development. |
| 25 | NE | Yes | | Practical Design: Our State created a "Board of Public Roads Classifications & Standards" who created Minimum Design Standards based on the Green Book ranges, when appropriate following the minimum value. http://www.dor.state.ne.us/gov-aff/pdfs-docs/manuals/proc-class-stan-min-des.pdf. Practical solutions: The Funding Distribution Team's Final Report details a new approach for allocating highway funds. The Team recommends giving top priority to preserving the state's existing highway and bridge assets. After all asset preservation needs have been met, the next priority is to allocate funds for capital improvements. Further info can be found at http://www.dor.state.ne.us/docs/funding-reports/FDT-Final.pdf |
| 26 | NH | Yes | | NHDOT has not developed any specific approach to the fiscal constraint issues, but we have taken a very simplistic solution to design issues, that being do as little as possible while still solving the problem that needs to be addressed (like widening in kind instead of full depth reconstruction). We are constructing the least costly alternative in almost all situations. While this is not a written directive we make sure we always include a "minimal design solution" as an alternative for consideration. |
| 27 | NJ | Yes | | Beginning in 2006, within our Value Engineering Unit, NJDOT began what was called Smart Solution reviews on all of our complex—high dollar projects. The difference between a traditional VE review and this new Smart Solutions approach was that we removed the main goal in the VE process—achieving an equal or better product. Instead, a team of multidisciplined personnel (just like a VE team) would focus on solving the original problem that started the project. Prior to our Smart Solutions initiative, a project, within NJDOT, would begin with a "problem statement" and once the project got underway, we would try to bring everything, within the limits, up to current standards—whether or not those substandard conditions were causing problems. At the same time, our different offices were establishing Management Systems where "Subject Matter Experts" representing different offices were prioritizing our infrastructure deficiencies. Prioritized "Management" lists were made for: Congestion hot spots, Crash & Safety, Bridges (and just Bridge Decks), Culverts, Pavement and Drainage. The goal of the Smart Solutions team was to hone in the conditions causing the problems. Any substandard condition that was not causing crashes or listed on one of the Management Systems lists was not improved. As was stated in the introduction, we were no longer trying to make everything perfect; we were trying to improve the existing conditions. |

TABLE B1
(*continued*)

| Number | State | Has PD/PS Policy? | | If YES, explain briefly below. |
|---|---|---|---|---|
| | | Yes | No | |
| 28 | NY | | No | |
| 29 | OK | | No | |
| 30 | OR | Yes | | Will email |
| 31 | RI | Yes | | We do not have a formal program, but our overall design philosophy embraces these concepts. See #5 |
| 32 | SC | Yes | | SCDOT utilizes 3R principles to eligible projects. This results in utilizing design criteria that are more appropriate to the project in lieu of forcing adherence to standards. |
| 33 | SD | | No | |
| 34 | TN | | No | |
| 35 | TX | | No | |
| 36 | UT | Yes | | The Utah DOT has implemented Practical Design as a policy and requires project teams to evaluate cost reductions due to practical design. |
| 37 | VA | Yes | | http://www.extranet.vdot.state.va.us/locdes/electronic%20pubs/iim/IIM226.pdf |
| 38 | VT | Yes | | We have taken several different approaches to this topic over the past 15 years, starting with the VT State Standards http://www.aot.state.vt.us/progdev/standards/statabta.htm. These were instituted in 1997 and provide a great deal of flexibility in design. In addition, starting roughly five years ago we undertook the "Road to Affordability." The primary goal of this effort was to review our practices, set reasonable expectations and "get back to basics" in attempting to preserve our existing infrastructure: http://www.aot.state.vt.us/policies/6013.1.htm |
| 39 | WA | | No | WSDOT has two initiatives being developed that are related to the Practical Design/Solutions philosophy. |
| 40 | WI | | No | |
| 41 | WY | Yes | | WYDOT programs projects based on need and classifies them by 1R, 2R, 3R, or 4R. This triggers a set of criteria to be used for design. See the links under Chapter 8 of the Road Design Manual for those criteria: http://www.dot.state.wy.us/wydot/engineering_technical_programs/manuals_publications/road_design_manual |
| | Total: | 29 | 12 | |

TABLE B2
RESPONSES TO QUESTION NO. 3

| State | What information would be useful to your state in either developing or expanding upon a PD/PS program? |
| --- | --- |
| AL | Types of practices used by states with existing programs and the saving in time and money realized |
| CO | More training on possible solutions. |
| FL | Goals, Objectives, Implementation Plan, Obstacles Encountered (and how they were overcome or couldn't be). |
| GA | What would be useful for our Georgia would be the state of the practice in other states. What type of documents and polices do other states have in place regarding PD/PS. |
| HI | Current information on lessons learned from similarly sized programs and the current state of measurements of success. |
| IN | Layout of some best practices and pitfalls |
| KS | 1. Kansas has integrated practical design concepts into the development of every project (we believe we were practical prior to the term being coined, but we're doing more to document solutions that optimize project scopes). What types of documentation are typical? When are estimates made (design concept report? field check?)? How is inflation handled in aggregated reporting (i.e., several projects with different letting years)?<br><br>2. In addition, we have identified specific projects/corridors as candidates for practical improvements. These projects typically have a set budget and the designer evaluates alternatives to maximize the effectiveness (primarily concerning safety and operations) of the improvements. Additional experience regarding evaluation of dissimilar alternatives would be helpful (i.e., pave shoulders for 8 miles or fix two horizontal curves in the same section of highway). We are currently applying the Highway Safety Manual as a tool in this decision making process, but don't believe it has developed to its full potential/reliableness to apply definitively.<br><br>3. Further, these projects do not typically fall into traditional categories for reconstruction/new construction/3R/1R. Practical Improvements can be incorporated into any of these, but a "practical improvements" project may not fit the mold of any previously established category.<br><br>4. A common practical design approach in recent years has been the use of aggregate surfaced temporary diversion roadways (shoofly detours) with lower design speeds. National guidance/research regarding low type shoofly design elements (AADT limits, minimum radius, superelevation, max. speed drop, width, etc.) would be beneficial. |
| KY | We are always looking for successful ways to save money and complete the projects. |
| LA | We would need to demonstrate the value (compared to the consequences) of implementing a formalized program like Missouri's to obtain buy-in from the management and the public. |
| MD | The approach described above has not been migrated to the entire project development process like Missouri. Data on the inherent trade-offs of such a program would be helpful as this will often result in parameters that fall below AASHTO guidelines. We want to make choices that are supported by sound data. |

TABLE B2
(*continued*)

| State | What information would be useful to your state in either developing or expanding upon a PD/PS program? |
|---|---|
| ME | Peer results and experiences, successful partnerships with the consultant community |
| MI | What specific criteria are used by other states to determine when a "practical design" is appropriate? |
| MN | Industry standard for definition(s) of performance based design as well as tools and criteria for practicing it; industry standard for acceptable levels of performance, particularly when "standard" measures such as LOS are not useful or their standard design values are not achievable nor practical. |
| MO | Missouri has pioneered the practical design philosophy and has shared the concept with many other states. While no specific information is desired at this time, Missouri is open to any suggestions that will improve the program. |
| MS | Examples of costs savings that other states have realized using PD/PS. |
| MT | We would like to see what other states are doing. This information might provide useful tools. |
| ND | I would be interested in any information from the findings of the survey. |
| NE | Unsure |
| NH | More examples of where practical solutions were used and how much savings were realized. |
| NJ | Lessons learned, both from our state and others that have done it. |
| NY | Example projects/case studies and more information of the criteria that Missouri DOT modified in their new manual. |
| SC | Please provide a link to Missouri DOT's information. We are currently updating our design standards and this information would be helpful to us. |
| TX | State of the practice |
| UT | We are developing a strategy to evaluate projects from planning, CD, design, advertising, construction and closeout. It would be helpful to see how other states are able to encourage project teams to embrace Practical Design rather than see it as another program that Central is forcing them to use. |
| VA | What are the safety records for these projects that utilized a PD/PS system? How does the cost of projects developed by a PD/PS type system compare to a state's normal plan development process? How do states that implement PD/PS programs address AASHTO minimum design criteria? Specifically, are there more design exceptions on projects utilizing PD/PS? What are the reactions by professional engineers to utilizing this type of program? |
| WA | How to incorporate Highway Safety Manual methodologies into the project development process. Lessons learned in implementing the new PD/PS process |
| WI | Directly discuss with Missouri and Kentucky some project examples to compare our current practices. |

# APPENDIX C

# Missouri DOT Practical Design Implementation Manual

**NOTE: The following are the Primary Guidance statements from the MoDOT Practical Design Implementation Manual.**

## TYPE OF FACILITY

### Facility Selection

- For both major and minor routes, the type of facility will be based upon the desired level of service (LOS) given the 20-year traffic projection of the corridor. More specifically:
  - Peak Hour LOS
    - Rural – D
    - Urban – E
  - Off-Peak LOS
    - Rural - C
    - Urban - D
- Irrespective of LOS, Planning Division will continue to identify the general types of facilities for statewide system continuity.
- The facility must represent the appropriate balance between access and mobility for its intended purpose.
- When the desired LOS requires a four-lane facility, it will be designed as an expressway unless freeway is mandated.
- Two-way left-turn lanes (TWLTL) are permissible where practical.
- Passing lanes may be used in areas where poor LOS is a result of inability to pass safely.

### At-Grade Intersections

- Signalized intersections can be considered for expressways that pass through communities.
- In rural areas, a designer is not to consider including a signalized intersection for expressways, although one may be installed at an existing intersection with Traffic's recommendation.
- The minimum distance between intersections along MoDOT roads is determined by whether the road is a major or minor road and whether the road is urban or rural. Refer to the Access Management Guidelines for desirable spacing between at-grade intersections.

### Interchanges

- An interchange is to be considered when it is warranted by the 20-year design traffic projection or safety concerns.
- The desired spacing between interchanges is two miles in current and projected urban areas and five miles in rural areas.

## TYPICAL SECTION ELEMENTS

### Lane Width

- Lanes on both rural and urban major roadways are to be 12 ft. wide.
- Lanes on rural and urban minor roadways are to be 10 to 12 ft. wide, based on the volume of traffic and the context of surrounding roadway.

- Auxiliary lanes ati nterchanges facilitate traffic movements. These lanes are to be as wide as the through-traffic lanes.
- Lane widths on very low volume local and collector roads and streets that carry less than 400 vehicles per day are to be based on the guidance contained in the AASHTO document Guidelines for the Geometric Design of Very Low Volume Local Roads

### Shoulder Width

- Never eliminate shoulders altogether. Motorists expect them.
- Shoulders on major roadways (both rural and urban) are to be 4 to 10 ft. wide based on the volume of traffic, the percentage of trucks and context of the surrounding road.
- Shoulders on rural minor roadways are to be 2 to 4 ft. wide.
- Shoulders will not be provided on urban roadways with no access control if ample turning opportunities exist for a vehicle to leave the roadway.
- An earthen shoulder will be provided behind a mountable curb.
- Rumble strips are to be provided on major and minor roadways with paved shoulders at least 2 ft. wide (see Rumble Strip guidance for further information).

### Median Width

A wide separation between traffic moving in opposing directions is safer and more comfortable for the motorist than head-to-head traffic in close proximity. While this works well in rural areas, it may be necessary in densely developed areas with expensive right of way to provide a narrower median with a positive barrier. Therefore, the following items are important:

- The preferred typical section for expressway and freeway facilities will include a depressed median 60 ft. wide, measured from edge of traveled way to edge of traveled way. A median of this width satisfies clear zone concepts.
- A narrower median with a positive barrier can be used on expressways and freeways if the decision is based upon an economic analysis. This situation is most likely to occur when the cost of right of way adjoining the improvement is expensive or when its vertical alignment causes high fills or deep cuts.

### Inslope Grade

- The preliminary geotechnical report contains grading recommendations including the slope ratio that is not to be exceeded.
- The AASHTO Roadside Design Guide may be consulted to select the proper combination of inslope ratio and clear zone concept.
- Use of guardrail is preferable to a 1V:6H/1V:3H (“barnroof”) design when addressing economic concerns (e.g. to balance earthwork quantities or to decrease the amount of R/W).

### Backslope Grade

- The preliminary geotechnical report contains grading recommendations including the slope ratio that is not to be exceeded.
- When good quality rock is present, and grading recommendations included benching, utilize a 1:1 backslope from the back of the ditch to establish the theoretical slope limit used to determine the R/W line.

### Roadside Ditches

- Roadside ditches are to be of sufficient depth to insure drainage from the design storm event and prevent seepage under the pavement through a permeable base.
- When pavement edge drains are necessary, the roadside ditch must be of sufficient depth to permit location of the drain above the water surface elevation during the pavement drainage design event.
- Flat bottom or V-ditches are to be selected for use based on hydraulic capacity and the inslope and backslope requirements necessitated by clear zone principles and/or soil conditions.
- The ditch will be designed to meet the criteria set forth in the Roadway Overtopping Criteria section.
- Necessary erosion control methods will be used in areas as determined by the district to reduce or withstand the flow velocity.

## HORIZONTAL AND VERTICAL ALIGNMENT

### Horizontal Alignment

- Horizontal alignments are to be coordinated with anticipated posted speeds.
- Chapter 3 of the AASHTO publication A Policy on Geometric Design of Highways and Streets (the Green Book) will be used as guidance to determine maximum horizontal alignments.
- A relatively sharp curve may be designed if the curve is properly signed.

### Vertical Alignment

- Vertical alignments are to be coordinated with anticipated posted speeds.
- The AASHTO publication A Policy on Geometric Design of Highways and Streets (the Green Book) can be used as guidance to determine maximum vertical grades.
- Every effort should be made during the design of a project to insure the quantities of fill and excavation are balanced (i.e., the excavation plus swell volume equals the fill plus shrinkage volume).

## PAVEMENTS

### Paved Shoulders

- On major roads the entire shoulder width should be paved.
- On minor roads the shoulder should be aggregate stabilized except where maintenance or safety concerns (e.g., edge drop off, high runoff road occurrence) justify a paved shoulder.
- Shoulders on urban roadways with access control (major or minor) are to be paved.
- In no case will a paved or aggregate surface be used directly behind a mountable curb along the outer edge of a roadway.
- A curb and gutter will only be used with an anticipated posted speed less than 50 mph.

### Bridge Approach Slabs

- Bridge approach slabs will be used on all major road bridges. The approach slabs will only be omitted by design exception not by a construction value engineering (VE) proposal.
- On minor roads bridge approach slabs will not be used except with a design exception.

## Pavement

- The Construction and Materials Division will determine the pavement thickness for all projects on major roads. During early scoping, pavement thicknesses for conceptual design and estimating purposes may be obtained from the ME (Mechanistic-Empirical) Design Table for Project Scoping.
- On minor roads, for spot improvements such as pavement replacement less than 0.5 miles in length adjacent to bridge replacements, widening for turning lanes for a turning movement that has less than 1000 vehicles per day or for short realignments, a pavement thickness determination by Construction and Materials is not required. The new pavement thickness is to be equivalent to the existing pavement thickness on 4 in. of aggregate base or 5 3/4 in. on 4 in. of aggregate base, whichever is greater. For these projects, the new pavement is to consist of asphalt (cold mix or hot mix) or concrete pavement, at the contractor's option. If the AADT is between 1000 and 2000, the cold mix may be eliminated. If the AADT is greater than 2000, cold mix is not allowed.
- On minor roads, for improvements greater than 0.5 miles in length or for widening for turning lanes for a turning movement with more than 1000 vehicles per day, the Construction and Materials Division will make a pavement thickness determination. During early scoping, pavement thickness for conceptual design and estimating purposes may be obtained from the ME (Mechanistic-Empirical) Design Table for Project Scoping.
- Superpave mixes are not appropriate for minor roads except for unusual circumstances with a design exception.
- Aggregate surfaces will not be used except on very low volume or dead end road applications, such as outer roads, temporary bypasses and roadways to be turned over to another agency. In these circumstances an aggregate surface may be appropriate if dust can be tolerated. For these situations a minimum 2 in. thickness of gravel, crushed stone, or chat may be used.

## STRUCTURAL/HYDRAULICS

### Bridge Width

- For Major roads, bridge width equaling full roadbed width is desirable.
- For Minor roads, strive for 2' shoulders (24 to 28 foot bridge width, depending on lane width).
- Minimum width for all bridges is 24'.
- Full shoulders are required for bridges over 1000' long.

### Bridge and Culvert Hydraulic Design

- Roadway Overtopping
    - Minor Routes
        - For bridges and boxes, the water level shall be no deeper than 1 foot below the lowest shoulder point during a 25- to 50-year event. For pipes, the water level shall be no deeper than 1 foot below the lowest shoulder point during a 10- to 25-year event.
    - Major Routes
        - For bridges and boxes, the water level shall be no deeper than 1 foot below the lowest shoulder point during a 50- to 100-year event. For interstates use the 100-year event. For pipes, the water level shall be no deeper than 1 foot below the lowest shoulder point during a 25- to 50-year event. For interstates use the 50-year event.

- Freeboard for Bridges on All Routes
  - For a drainage area less than 20 square miles, the bridge shall have 1 foot of freeboard during a 50-year event. For a drainage area greater than 20 square miles, the bridge shall have 2 feet of freeboard during a 50-year event.
- Backwater/Headwater for bridges, box culverts and pipes on all routes shall meet the National Flood Insurance Program requirements. The designer must consider the impacts to upstream improvements, crops and property values as well as the depth, frequency, extent and duration of the backwater impacts. The backwater must be reasonable for the full range of flows less than or equal to the design event. "Impact," is defined in terms of value and quantity of property that may be affected. Prior to selecting backwater criteria, the potential backwater impacts are evaluated:
  - For bridges and boxes in areas with low levels of potential impact, allow from 0 to 2 feet of backwater over natural in a 100-year event. In areas with moderate to high potential impact allow 0 to 1 foot of backwater over natural in a 100-year event.
  - For pipes with upstream impacts that may be moderate to high, analyze backwater and consider impacts from depth, extent and frequency of flooding for the range of flows.
- The Design High Water Elevation (DHW) will be based on the return period of the freeboard design.
- Design exceptions for frequency or criteria are encouraged when they are practical.
- When an existing structure that is to be replaced has provided adequate performance, a design exception to match the hydraulic performance of the existing structure is necessary and encouraged. Thorough documentation of the adequate historical performance is included with the Design Exception.

### Seismic Design

- Seismic design of bridges is guided by the AASHTO design specifications, which delineate seismic zones in Missouri.
- New bridges on major roads and Earthquake Emergency Routes are modeled (comprehensively analyzed) and designed to resist earthquakes according to Seismic Performance Categories (SPC) B, C and D.
- New bridges on minor routes in SPC B, C and D, include limited seismic details to improve their resistance to earthquakes; however, they are not modeled (comprehensively analyzed) and specifically designed to resist earthquakes.
- A decision is made on each bridge rehabilitation project as to the necessity and extentof seismic retrofitting.

## ROADSIDE SAFETY

### Rumble Strips

- All major roads will have edgeline rumble strips.
- All major 2-lane roads with new pavement will have centerline rumble strips.
- Edgeline rumble strips may be used on minor roadways as a specific safety countermeasure with a paved shoulder. Where several sections of edgeline rumble strips are installed in close proximity, continuity should be maintained.
- Centerline rumble strips may be used on minor roadways with a significant accident history. Where several sections of centerline rumble strips are installed in close proximity, continuity should be maintained.
- Rumble strips are omitted where the posted speed limit is less than 50 mph.

### Guardrail

- The clear zone concept is the preferred method of providing roadside safety.
- If providing the proper clear zone is impractical, then shielding (concrete barrier, guardrail, or guard cable) is preferred. If shielding is also impractical, the obstacle must be delineated as a final, but least preferred, alternative.
- Shielding should be specified when the possibility of poor public perception of the clear zone exists, especially in areas of high fill.

## INCIDENTAL/MISC.

### Disposition of Routes

- A written agreement for disposition should be in place before a project is placed on the STIP.
- During project development, if a written agreement is revoked, then the project will be removed from the STIP. A written agreement must be in place before a project is advertised for letting.
- It is acceptable to negotiate small improvements to the existing route in order to make the relinquishment more attractive.

### Bicycle Facilities

MoDOT values the needs of all customers including non-motorized travelers. The provision of bicycle facilities on improvement projects during planning, and design activities is necessary when any one or more of the following conditions exist:

- The local jurisdiction has a comprehensive bicycle policy in the area of the proposed improvement.
- There is public support through local planning organizations for the provision of bicycle facilities.
- The local jurisdiction agrees to fund the total cost of the facility (right of way and construction) plus the provision of future maintenance.
- Bicycle traffic generators are located near the proposed project (i.e., residential neighborhoods, employment centers, shopping centers, schools, parks, libraries, etc.).
- There is evidence of bicycle traffic along the proposed project or the local community supports the incorporation of facilities at this time.
- The route provides access across a natural or man-made barrier (i.e., bridges over rivers, roadways, or railroads or under access controlled facilities).

Dedicated bicycle facilities will not be provided on interstate roadways.

### Pedestrian Facilities

MoDOT values the needs of all of its customers including non-motorized travelers.

The provision of pedestrian facilities on improvement projects during planning, and design activities is necessary when any of the following conditions exist:

- The local jurisdiction has a comprehensive pedestrian policy in the area of the proposed improvement.
- There is public support through local planning organizations for the provision of pedestrian facilities.

- Pedestrian traffic generators are located near the proposed project (i.e., residential neighborhoods, employment centers, shopping centers, schools, parks, libraries, etc.)
- There is evidence of pedestrian traffic along the proposed project or the local community supports the incorporation of facilities at this time.
- The route provides access across a natural or man-made barrier (i.e., bridges over rivers, roadways, or railroads or under access controlled facilities).
- Existing sidewalks are disturbed by construction.

When sidewalks are constructed the following items are to be considered:

- In developed areas, sidewalks are to be separated from the traveled way by a barrier curb.
- Sidewalks are not to be designated on paved shoulders located behind a mountable curb.
- In rural areas where it is necessary to accommodate pedestrian movements, a paved shoulder may be used.
- Designated sidewalks or pedestrian paths must be accessible according to the Americans with Disabilities Act of 1990 (ADA).
- Sidewalks are to be a minimum of 5 ft. wide and 4 in. thick. However, if necessary, the width of the sidewalk can be reduced to 4 ft., the minimum width allowed by ADA guidelines.
- Additional guidance regarding sidewalk design can be found in the AASHTO publication Guide for the Planning, Design, and Operation of Pedestrian Facilities or the Americans with Disabilities Act Accessibility Guidelines (ADAAG) publication Part 2 Designing Sidewalks and Trails for Access.
- Technical assistance on a case-by-case basis is also available from the Missouri office of the United States Access Board or MoDOT's Bicycle and Pedestrian Program Coordinator.

## Embankment Protection

- Rock blanket is used under the ends of all grade separation structures, around bridge end slopes, around culverts and to protect stream banks.
- Concrete slope protection may be used for aesthetic reasons to prevent slope erosion under the ends of grade separation structures or other locations.

## Borrow and Excess Earthwork

- When borrow material is necessary on a project, the contractor will be required to locate a satisfactory site from which the necessary material can be obtained.
- On rare occasions (i.e., highly sensitive environmental or cultural areas) a commission furnished borrow site may be provided. When this is done, the site is indicated on the plans and the contractor must use the site to obtain the borrow material.
- When it is necessary to dispose of excess material, the above guidance is to be used.

## Minimum Right of Way Width

- Acquire only the minimum R/W width needed to build and maintain the facility.
- Attempt to minimize breaks in R/W line.

## Design Exception

- Design exceptions are encouraged wherever the potential for additional value lies outside of written engineering policy.
- Design exceptions, using the standard form, must be completed and approved for each variance, whether the change fails to attain or exceeds engineering policy.
- A slightly different production and approval process exists for each of the following project categories:
  1. Full FHWA Oversight Projects
  2. Exempt Roadway Projects
  3. Exempt Bridge Projects
  4. Consultant Designed or Cost Share Projects

# APPENDIX D

## Case Example of Practical Design for Missouri DOT

Staff summary

Prepared by
Organizational Results Division
Missouri Department of Transportation

**May 2007**
For more information, contact:
Jennifer Harper or Bill Stone

## Practical Design Case Study

An In-House study by Organizational Results in cooperation with the Central District

### MoDOT Summary Statement

***Practical Design has been a resounding success at MoDOT in delivering projects to meet specific location needs while saving millions of dollars. In just its first two years, Practical Design saved Missouri taxpayers $400 million. Even when faced with increased construction costs, Practical Design helped the Central District deliver a critical transportation project by reducing project costs by more than 15 percent.***

### Background

Missouri voters passed Amendment 3 in November of 2004. The Missouri Department of Transportation had the opportunity not only to improve Missouri's roadways, but also to prove to Missourians that they could be good stewards of their tax dollars. The Amendment 3 funds were used for three different elements.

- Element 1, called Smooth Roads Initiative, improved the condition and safety along 2,200 miles of existing roads.
- Element 2 involved accelerating projects that already had a funding source.
- Element 3 funds were used to construct projects that had no funding source such as the 4-lane expansion of Route 50 from St. Martins to California.

#### Original Route 50 Project

The original Route 50 project involved making a two-lane road into a four-lane road from Jefferson City to Sedalia. The original project had been through a preliminary design phase, but due to the $343 million price tag, no funding had been available. The Practical Design process began and the Route 50 project eliminated $30 million from the initial budget. When Amendment 3 passed, district leaders knew that the Route 50 project was of great importance, but the $313 million project was not likely to receive full funding. The decision was made to split the job into 3 separate projects.

#### Amendment 3 Element 3

In December of 2004, MoDOT's Transportation Planning Division requested each district to identify projects of high need that currently were not funded. They received over 200 projects. The districts were then asked to limit the list of projects to those of high need for both the district and the state.

The Central District worked with the five Regional Planning Commissions (RPCs) and the two Metropolitan Planning Organizations (MPOs) within the district to determine the highest need projects. Central District staff took a unique approach by asking the RPCs and MPOs to present the projects they felt should be included. Not only did this provide more local input into the process, it also allowed the local and regional leaders to provide ways the counties could partner with the state. One of the selling points for the

Background *(cont'd.)*

St. Martins to California Route 50 segment was that the local counties agreed to take over the old Highway 50 and the new outer roads. With the counties agreeing to maintain all but the new 4-lanes of Highway 50, MoDOT will save money in maintenance and snow removal costs for those roadways. With the local-state partnership on the project, the counties were able to get a new four-lane roadway and the state was able to turn over the existing roadway instead of increasing the miles of road it maintained.

Through the Planning Framework process, MoDOT formed a "Major Project Task Force" to help select the final projects that would receive funding from Amendment 3 element 3. The task force had one member from each district, the director of System Management, the director of Program Delivery, and the director of Transportation Planning. The available funding was broken into two groups: rural major transportation projects and urban major transportation projects.

The district engineer from each district presented their list of projects to the Major Project Task Force and explained why each particular project was important to Missouri. The first round of presentations was held on February 15, 2005. Those projects that made the cut were again presented at an April 13 meeting. From that meeting a final prioritized list of projects and recommendations were sent to the Missouri Highways and Transportation Commission. The Route 50 Project from St. Martins to California was third in priority for rural major transportation projects.

The Project

In recent years, MoDOT has made public involvement a priority in planning and constructing projects. The Route 50 project is a good example of how MoDOT and the public can come together to make a project more successful. In June of 2005, public hearings were held in St. Martins and California. Over 500 people attended generating 87 comments; opposition was minimal.

The Route 50 project relocates the highway and provides four new lanes near St. Martins to just west of California, Missouri. The design team worked hard to accelerate the project. They knew if they completed the project plans early enough, it would not go out to bid at the same time as other Amendment 3 projects. When there are fewer projects in a bid letting there is more competition among contractors and the lowest bids are received. The project required over 500 plan sheets and was let nine months ahead of schedule.

The Route 50 project was 11 miles long and required the acquisition of 68 parcels of right of way. With the accelerated schedule, the Right of Way Division worked hard and was able to acquire all the property in 11 months. Only two parcels were condemned.

Concurrent to the planning stages, Hurricane Katrina hit and construction prices skyrocketed. The bid for another District 5 job, Highway 5 in Camdenton, came in several million above the estimate. Central Office required updates on estimates of all big projects. Despite being faced with a crisis, Practical Design enabled the district to deliver a project that met the needs of the public in the budget they were given.

## Practical Design

Before Practical Design, most projects followed strict guidelines on the parameters of a project. All roadways with the same classification type and traffic volume would have the same depth of pavement, same shoulder type, etc. The concept of Practical Design was initiated in 2005, which required designers to start looking at projects on a case-by-case basis instead of strictly adhering to standards. Another aspect of Practical Design was that the road would be built to meet the

Prepared by
Organizational Results Division
Missouri Department of Transportation

Practical Design Case Study
May 2007
page 3

Practical Design *(cont'd.)*

needs, not necessarily to the highest of standards used if there was an unlimited budget. Although it should be noted that one of the fundamental principles of Practical Design is that safety will never be compromised. While the concept of Practical Design was in place prior to Hurricane Katrina, the increased construction costs amplified the need to locate cost-saving measures wherever possible.

MoDOT projects are initiated at the state level and the district level, and there are separate funds for each. Prior to Practical Design, when a state level project went over or under budget, the excess money was taken from, or returned to the statewide pool of money. An added incentive for districts to institute Practical Design was that all the money saved when a project came in under budget would be returned to the district for future projects in that district. Concurrently, if a project goes over budget, the money is taken from the district budget. The only exception is for major river bridges where the economies of scale make it impractical.

The design team for the Route 50 project was in a constant state of cutting costs and applying Practical Design concepts while still satisfying the needs of the project. One area that allowed significant cost savings was with the pavement thickness. In the past, concrete roads for this type of roadway were designed to be 12" to 14" thick. With Practical Design many concrete roadway thicknesses have decreased to 10." However, when looking at the specific site conditions, it was determined the roadway thickness for Route 50 would further decrease to 8". A couple factors led to this decision. Most importantly, the roadway was on a solid rock base. Unlike most roadways in Missouri, the Route 50 project has a very stiff fill below the roadway. Another factor was that MoDOT's Pavement Engineering staff was using a new design method, the Mechanistic-Empirical (M-E) approach. MoDOT is the first DOT in the United States to adopt this new method because it more realistically characterizes in-service pavements and improves the reliability of designs.

The St. Martins to California stretch of Route 50 does not have a large volume of truck traffic. The projected number of trucks for this section of Route 50 in 2008 was around 1,500 per day compared to the 10,000 or more trucks per day on Interstate 70 through the region. The limited truck traffic added to the decision to decrease the pavement thickness and also allowed several other areas of the project to be scaled back. The pavement slab narrowed from 28 feet to 26 feet, and the shoulder thickness was reduced from 5 ¾" to either 3 ¾" asphalt or 4" of concrete (alternate bid).

Providing alternates was another way the project team decreased the project costs. Mainline and outer road pavements and shoulders could be bid as asphalt or concrete or a combination. The winning contractor chose to use concrete for Route 50 and asphalt for the outer roads. Prospective bidders were also allowed to choose alternates to the traditional materials and construction for the drainage pipes and structures.

Other Practical Design elements included eliminating 2,000 feet of outer road. The original project called for outer roads along the entire route. Outer roads were eliminated in areas where existing roads provided adequate access, and the grade was increased where the outer road could not be eliminated. Instead of using the standards set for the four lanes of Route 50, the outer roads and connections were designed to match the existing conditions as long as a minimum 5 ¾" roadway thickness was maintained. In some areas ditches were narrowed to reduce excavation costs.

Some non-design related factors played a part in decreasing the construction costs as well. The Smooth Roads Initiative, element 1 of

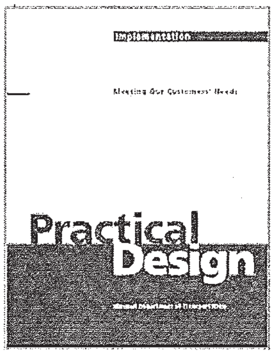
Practical Design *(cont'd.)*

Amendment 3, was completed on December 8, 2006 a full year ahead of schedule. With the successful completion of SRI projects there was more competition in the bidding environment. The roadway was relocated which decreased the impact on traffic; therefore during the bidding process, contractors did not have to plan for traffic control and mobility costs during the project. The terrain for the project was fairly mild which decreased structures and provided an excellent base for the roadway. The passage of HB 1944, eminent domain legislation, right-of-way costs increased over $220,000, however the utility relocation costs were under budget, which offset the right-of-way overruns.
A condensed list of project information and Practical Design components can be found in Appendix A.

## Results

The construction budget was $35.3 million. Illinois Valley Paving came in with the low bid of $29.9 million. The result, $5.4 million under construction budget! This cost savings goes back to District 5, allowing them to take care of other needs and projects within their district. The Route 50 job is an excellent example of the cost savings that can be achieved by applying the Practical Design concept to each component of a project.

Appendix A




# *Fast Projects That Are of Great Value*

**Route 50**
**St. Martins to California, Cole and Moniteau Counties**
**J5P0632A**
**Bid Opening - December 15, 2006**
**Budget = $35.3 million** *(Amendment 3 funds)*

**Project Description**

- 11 mile 4 – lanes on relocation.
- Project accelerated **9 months** (originally September 2007)
- 68 R/W parcels required, 2 condemned **(11 months acquisition)**
- Moniteau and Cole Counties have agreed to take over existing Route 50 and new outer roads.
- In-house design with over 500 plan sheets. **(12 months for final design)**.

**Practical Design Components**

- 12' driving lanes with 4' inside and 10' outside shoulders.
- Pavement slab narrowed from 28' to 26'.
- Mainline pavement thickness reduced from 13" asphalt or 10" concrete to 8"asphalt or 8" concrete.
- Shoulder pavement reduced from 5 ¾" asphalt or concrete to 3 ¾"asphalt or 4" concrete.
- Mainline and outer road pavements and shoulders could be bid as asphalt or concrete or combination. (Bidders choice)
- Eliminated a 2000' outer road and increased grades on all outer roads.
- Matched existing pavement thicknesses and widths on all outer roads or roads being tied into.
- Narrowed ditches, which reduced excavation cost in some areas.
- Allowed drainage pipes and structures bid as traditional materials and construction or alternative.

**Other factors**

- Bidding environment (SRI finished, contractors not carrying work, fuel prices)
- Mild terrain, minimal impact to traffic due to relocation, minimal structures, etc.
- R/W cost have overrun due to HB 1944 but utility relocation costs are under budget enough to offset.

**Low Bid = $29.87 million** *(Illinois Valley Paving)*

**Practical Design Results = $5.4 million under construction budget**

That's $5.4 million to meet other district needs!

# APPENDIX E

## Idaho DOT Memorandum on Practical Design

MEMORANDUM NO. 32
Page 1 of 2

DIRECTOR'S OFFICE

DATE: January 1, 2011

SUBJECT: Practical Solutions Initiative

FOR ATTENTION OF: Chief Engineer
Assistant Chief Engineers
District Engineers

DATE OF REVIEW: January 1, 2013

Practical Solutions is intended to challenge traditional standards and to develop safe and efficient solutions to solve today's project needs. ITD's philosophy is to build cost-effective projects to achieve a good, safe, efficient transportation system. Innovation, creativity, and flexibility are necessary for us to accomplish our growing transportation challenges.

To accomplish Practical Solutions, we must properly define the project scope by focusing on achieving the project purpose and need, while considering the surroundings of each project. We must be sensitive to where the project is located, and implement standards that are appropriate to the context of the surroundings. Our goal is to get the best value for the least cost. Life cycle cost must be considered. It is not our goal to shift burdens to maintenance.

**Project Development Activities**

District Engineers may approve concepts, design exceptions, design reviews, final designs, design study reports, materials reports, official ROW plans, and other internal engineering documents relating to project development that require a professional engineer's license.

Responsible Engineers shall place their Professional Engineer's Seal on all original documents in such a manner that such seal, signature and date are reproduced when the original document is copied. The application of the licensee's seal and signature and the date shall constitute certification that the work thereon was done by the responsible engineer or under the engineer's responsible charge. Each plan or drawing sheet shall be sealed and signed and dated by the licensee or licensees responsible for each sheet (See IC 54-1215).

District Engineers shall sign the title sheet of the plans and other documents approved by the District Engineer for ITD.

Effective June 1, 2011 the following additional duties are delegated to the District Engineer.

**Agreements**

Railroad Agreements, Utility Agreements, and Professional Service Agreements may be approved by the appropriate District Engineer, Division Administrator, or delegate

**Construction**

District Engineers shall assume change order and claim approval authority equivalent to the Assistant Chief Engineer (Operations) and the State Construction Engineer.

Headquarters Subject Matter Experts will continue to be available for consultation in document and plan preparation, and to assist in any or all reviews and standards approvals. Headquarters' sections are available to travel to the districts to assist with concept development, project reviews, etc. at the district's request. Copies of all Design Exception documentation, concepts, preliminary reviews, FDR reviews, materials reports, official ROW plans, etc., and approval documents will be sent the appropriate headquarters sections for record keeping to ensure that project history will be available when obligations of funds are needed, and when projects are submitted for PS&E.

To allow for continuous process improvements, periodic reviews will be performed by headquarters on district-approved projects.

**FHWA Oversight**

Projects on the Full Oversight Projects List and Design Exception on the NHS require approval from FHWA and shall be coordinated through the appropriate headquarters' sections.

Signed

Brian W. Ness
Director

# APPENDIX F

## Kentucky Transportation Cabinet Memorandum on Practical Solutions

**TRANSPORTATION CABINET**
Frankfort, Kentucky 40622
www.transportation.ky.gov/

**Steven L. Beshear**
Governor

**Joseph W. Prather**
Secretary

**STATE HIGHWAY ENGINEER POLICY # 2008-07**

**MEMORANDUM**

**TO:** Chuck Knowles
Ray Polly
Bill Gulick
Chief District Engineers
Division Directors

**FROM:** O. Gilbert Newman, P.E.
State Highway Engineer

**DATE:** April 25, 2008

**SUBJECT:** Guidance for the Use of **"Practical Solutions"** to Project Delivery

The Kentucky Transportation Cabinet (KYTC) is continually challenged with looking for ways to improve the way we conduct business. As a part of that continuous improvement process, efforts are underway to re-emphasize many of the fundamentals that go into the development and delivery of the KYTC's roadway projects. As many of you are aware, one of the main challenges we face today is to find a way to **"do more with less!"** While this phrase may begin to sound somewhat "worn out," this fundamental concept needs to be taken into consideration as an integral part of the decision-making process during all phases of project development and delivery. One of the first steps with any project is to identify the "purpose and need" and the subsequent project scope. It is at this early stage that we have been asked to focus our efforts to ensure that the project scope developed is appropriate and fulfills the initial purpose and need. This initiative, currently labeled **"Practical Solutions,"** is how the KYTC hopes to use the limited resources available to meet the transportation needs of this state.

The concepts of **"Practical Solutions"** is not something new to the KYTC. Components of the "Context-Sensitive Design" initiative emphasize the economics of projects and "right sizing" design parameters on projects that are compatible with other segments of the adjacent roadways and existing topography when appropriate.

Kentucky UNBRIDLED SPIRIT

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**STATE HIGHWAY ENGINEER POLICY # 2008-07**
Page 2
April 25, 2008

**"Practical Solutions"** is intended to take these fundamentals to the next level. The Project Team will be given the task of addressing the purpose and need, while at the same time refining the project scope and subsequent design such that the project remains within realistic fiscal parameters. A good example of ways the KYTC is already adapting this type of project approach is the typical rural bridge replacement project. By focusing on replacement of the bridge and limiting work on the approaches using the design exception process, the KYTC has been able to extend our abilities to replace more substandard bridges. It is hoped that through the use of **"Practical Solutions,"** the KYTC will be able to use our limited resources to adequately address the purpose and need for all projects for the whole roadway system.

The primary defining variable in the development and presentation of geometric design criteria is the "design speed" selected for the project. In general, the Project Team must correlate the selection of the "design speed" with the functional classification of the roadway, the actual and anticipated operating speeds, topography, anticipated land use, and the desirable degree of safety, mobility, and efficiency within the constraints of environmental quality, economics, aesthetics, and social or political impacts. In any event, the selected "design speed" should be consistent with both present and future driver expectations. For example, for routes with very little growth expected in the corridor, existing geometric features, as well as crash data, will prove beneficial in: (a) identifying locations and the scope for possible needed safety or capacity improvements, (b) selection of a "design speed" for the project that will provide a consistent approach in relation to driver expectations as well as "match" the appropriate "design speed" criteria to the project and existing conditions. In this example, the purpose and need and the scope of the project is to provide "betterment" to the overall route by identifying and correcting the major deficiencies, as well as working towards providing a corridor where the driver expectations are more consistent.

The selection of the traffic volumes to be used for design purposes is also a primary component of the design. Traditionally, 20-year forecasts are used for this. The Project Team has the flexibility to utilize intermediate years, such as a 10-year forecast, if it is consistent with the purpose and need for the project. Attached please find "Practical Solutions Geometrics" for the various functional classifications of roadways that will provide guidance to the Project Team as they use the **"Practical Solutions"** approach to meet the purpose and need for the project. In general, this provides the Project Team with the flexibility it needs to adapt critical design elements, such as pavement widths, shoulder widths, and horizontal and vertical alignments, to be consistent with the purpose and need for the project.

**STATE HIGHWAY ENGINEER POLICY # 2008-07**
Page 3
April 25, 2008

With the need for road safety and mobility improvements and, the relative availability of financial resources for such improvements diminishing, it is imperative to look at our road design approaches more critically. Some public decision makers and citizens have begun to question the over design/building of previously inadequate and unsafe facilities. This is a common theme throughout much of the United States. Developing a design that yields up to the maximum margin of return for the investment requires an approach that takes into account specific safety issues and the commensurate design elements for each roadway. It is essential that our basic premise must be to find the balance among operational efficiency, safety, and cost in order to design the suitable roadway to meet the transportation needs of Kentucky. It is the intent of this office that future guidance and training be developed to assist in achieving this goal. However, due to the importance of this endeavor, every effort is being made to keep all informed of the progress we have made and need to make in order to be successful and to make the most of the resources we have available.

I have assigned the development and coordination of this effort to Bill Gulick in the State Highway Engineer's Office.

OGN:BG:SLC

Attachment

# PRACTICAL SOLUTIONS GEOMETRICS: TWO LANE RURAL ARTERIALS

<table>
<tr><th rowspan="3"></th><th rowspan="2">Design Speed (5)</th><th rowspan="3"></th><th colspan="8">Traffic Volume (ADT)</th></tr>
<tr><th colspan="2">Under 400</th><th colspan="2">400 to 1500</th><th colspan="2">1500 to 2000</th><th colspan="2">2000 to 5000</th></tr>
<tr><th></th><th>Pavement Width</th><th>Graded Shoulder Width</th><th>Pavement Width</th><th>Graded Shoulder Width</th><th>Pavement Width</th><th>Graded Shoulder Width</th><th>Pavement Width</th><th>Graded Shoulder Width</th></tr>
<tr><td rowspan="15">Pavement Width and Graded Shoulder Width (Feet) (4)</td><td rowspan="3">30</td><td>Level</td><td rowspan="3">20</td><td rowspan="3">2 to 4</td><td rowspan="3">20</td><td rowspan="3">2 to 4</td><td>20 to 22</td><td rowspan="3">3 to 5</td><td rowspan="3">20 to 22</td><td>4 to 6</td></tr>
<tr><td>Rolling</td><td rowspan="2">20</td><td rowspan="2">3 to 5</td></tr>
<tr><td>Mountain</td></tr>
<tr><td rowspan="3">35</td><td>Level</td><td rowspan="3">20</td><td rowspan="3">2 to 4</td><td rowspan="3">20</td><td rowspan="3">2 to 4</td><td rowspan="2">20 to 22</td><td rowspan="3">3 to 5</td><td rowspan="3">20 to 22</td><td rowspan="3">4 to 6</td></tr>
<tr><td>Rolling</td></tr>
<tr><td>Mountain</td><td>20</td></tr>
<tr><td rowspan="3">40</td><td>Level</td><td rowspan="3">20</td><td>3 to 5</td><td>20 to 22</td><td rowspan="2">3 to 5</td><td rowspan="3">20 to 22</td><td>4 to 6</td><td rowspan="2">20 to 22</td><td rowspan="2">4 to 6</td></tr>
<tr><td>Rolling</td><td rowspan="2">2 to 4</td><td rowspan="2">20</td><td rowspan="2">3 to 5</td></tr>
<tr><td>Mountain</td><td>2 to 4</td><td>NA</td><td>NA</td></tr>
<tr><td rowspan="3">45</td><td>Level</td><td rowspan="3">20</td><td rowspan="2">3 to 5</td><td>20 to 22</td><td rowspan="2">3 to 5</td><td rowspan="2">20 to 22</td><td rowspan="2">4 to 6</td><td rowspan="2">22 to 24</td><td rowspan="2">6 to 8</td></tr>
<tr><td>Rolling</td><td>20</td></tr>
<tr><td>Mountain</td><td>2 to 4</td><td>NA</td><td>NA</td><td>NA</td><td>NA</td><td>NA</td><td>NA</td></tr>
<tr><td rowspan="3">50</td><td>Level</td><td rowspan="2">20 to 22</td><td rowspan="2">4 to 6</td><td>20 to 22</td><td>4 to 6</td><td>22 to 24</td><td>6 to 8</td><td rowspan="3">NA</td><td rowspan="3">NA</td></tr>
<tr><td>Rolling</td><td rowspan="2">NA</td><td rowspan="2">NA</td><td rowspan="2">NA</td><td rowspan="2">NA</td></tr>
<tr><td>Mountain</td><td>NA</td><td>NA</td></tr>
<tr><td>Min. Clear Roadway Width of New and Reconstructed Bridges (3)</td><td>All Speeds</td><td colspan="9">Approach Roadway Width</td></tr>
<tr><td rowspan="6">Minimum Radius (Feet)</td><td>Design Speed</td><td colspan="3">eMAX. 4%</td><td colspan="3">eMAX. 6%</td><td colspan="3">eMAX. 8%</td></tr>
<tr><td>30 MPH</td><td colspan="3">300</td><td colspan="3">275</td><td colspan="3">250</td></tr>
<tr><td>35 MPH</td><td colspan="3">420</td><td colspan="3">380</td><td colspan="3">350</td></tr>
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<tr><td>45 MPH</td><td colspan="3">730</td><td colspan="3">660</td><td colspan="3">600</td></tr>
<tr><td>50 MPH</td><td colspan="3">930</td><td colspan="3">835</td><td colspan="3">760</td></tr>
<tr><td>Normal Pavement Cross Slopes</td><td colspan="10">Rate of Cross Slope = 2%</td></tr>
<tr><td>Normal Shoulder Cross Slopes</td><td colspan="5">Earth = 8 to 10%</td><td colspan="5">Paved = 4 to 6%</td></tr>
</table>

# PRACTICAL SOLUTIONS GEOMETRICS: TWO LANE RURAL ARTERIALS

Traffic Volume (ADT)

| | Design Speed | | Under 400 | 400 to 1500 | 1500 to 2000 | 2000 to 5000 |
|---|---|---|---|---|---|---|
| Maximum Grade (Percent) | 30 | Level | 7 | 7 | 6 | 6 |
| | | Rolling | 10 | 9 | 7 | 7 |
| | | Mountain | 12 | 10 | 8 | 8 |
| | 35 | Level | 7 | 7 | 6 | 5 |
| | | Rolling | 10 | 9 | 8 | 6 |
| | | Mountain | 12 | 10 | 9 | 7 |
| | 40 | Level | 7 | 6 | 5 | 5 |
| | | Rolling | 10 | 8 | 6 | 6 |
| | | Mountain | 12 | 10 | 8 | NA |
| | 45 | Level | 7 | 6 | 5 | 5 |
| | | Rolling | 10 | 8 | 6 | NA |
| | | Mountain | 12 | NA | NA | NA |
| | 50 | Level | 7 | 6 | 5 | NA |
| | | Rolling | 10 | NA | NA | NA |
| | | Mountain | NA | NA | NA | NA |

| | Design Speed | 30 | 35 | 40 | 45 | 50 |
|---|---|---|---|---|---|---|
| Minimum Stopping Sight Distance (1) | (Feet) | 200 | 250 | 305 | 360 | 425 |
| Minimum Passing Sight Distance (2) | (Feet) | 1090 | 1280 | 1470 | 1625 | 1835 |

1) MINIMUM STOPPING SIGHT DISTANCES ARE BASED ON A HEIGHT OF EYE OF 3.5 FT AND HEIGHT OF OBJECT OF 2.0 FT. BOTH HORIZONTAL AND VERTICAL ALIGNMENTS ARE CONSIDERED.

(2) MINIMUM PASSING SIGHT DISTANCES ARE BASED ON A HEIGHT OF EYE OF 3.5 FT AND HEIGHT OF OBJECT OF 3.5 FT. BOTH HORIZONTAL AND VERTICAL ALIGNMENTS ARE CONSIDERED.

(3) NORMAL PAVEMENT CROSS SLOPES ON BRIDGES SHALL BE 2%

(4) WIDEN 3 FT FOR GUARDRAIL

(5) JUSTIFICATION FOR THE DESIGN SPEED SHALL BE BASED UPON COMPREHENSIVE ANALYSIS OF EXISTING ROADWAY GEOMETRICS, ADJACENT ROADWAY FEATURES, AND PURPOSE AND NEED FOR THE PROJECT. DOCUMENTATION SHALL BE INCLUDED IN THE DESIGN EXECUTIVE SUMMARY.

(6) "NA" REFERS TO "BETTERMENT STANDARDS ARE NOT APPLICABLE" WITHOUT ADDITIONAL ANALYSIS.

# PRACTICAL SOLUTIONS GEOMETRICS: RURAL COLLECTORS

Traffic Volume (ADT)

| | Design Speed (5) (7) | | Under 400 | | 400 to 1500 | | 1500 to 2000 | | 2000 to 5000 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Pavement Width | Graded Shoulder Width | Pavement Width | Graded Shoulder Width | Pavement Width | Graded Shoulder Width | Pavement Width | Graded Shoulder Width |
| Pavement Width and Graded Shoulder Width (Feet) (4) | 20 | Level | 18 to 20 | 2 to 4 | 18 to 20 | 2 to 4 | 18 to 20 | 2 to 4 | 18 to 20 | 3 to 5 |
| | | Rolling | | | | | | | | |
| | | Mountain | | | | | | | | |
| | 25 | Level | 18 to 20 | 2 to 4 | 18 to 20 | 2 to 4 | 18 to 20 | 2 to 4 | 18 to 20 | 4 to 6 |
| | | Rolling | | | | | | | | 3 to 5 |
| | | Mountain | | | | | | | | |
| | 30 | Level | 18 to 20 | 2 to 4 | 18 to 20 | 2 to 4 | 18 to 20 | 2 to 4 | 18 to 20 | 4 to 6 |
| | | Rolling | | | | | | | | |
| | | Mountain | | | | | | | | 3 to 5 |
| | 35 | Level | 18 to 20 | 2 to 4 | 18 to 20 | 2 to 4 | 18 to 20 | 3 to 5 | 18 to 20 | 4 to 6 |
| | | Rolling | | | | | | 2 to 4 | | |
| | | Mountain | | | | | | | | |
| | 40 | Level | 18 to 20 | 2 to 4 | 18 to 20 | 3 to 5 | 18 to 20 | 3 to 5 | 20 to 22 | 4 to 6 |
| | | Rolling | | | | 2 to 4 | | | 18 to 20 | |
| | | Mountain | | | | | | | NA | NA |
| | 45 | Level | 18 to 20 | 2 to 4 | 18 to 20 | 3 to 5 | 18 to 20 | 4 to 6 | 20 to 22 | 4 to 6 |
| | | Rolling | | | | | | 3 to 5 | NA | NA |
| | | Mountain | | | NA | NA | NA | NA | | |
| | 50 | Level | 18 to 20 | 2 to 4 | 18 to 20 | 3 to 5 | 18 to 20 | 4 to 6 | NA | NA |
| | | Rolling | | | NA | NA | NA | NA | | |
| | | Mountain | NA | NA | | | | | | |
| Min. Clear Roadway Width of New and Reconstructed Bridges (3) | All Speeds | Approach Roadway Width | | | | | | | | |

| | Design Speed (7) | eMAX. 4% | eMAX. 6% | eMAX. 8% |
|---|---|---|---|---|
| Minimum Radius (Feet) | 20 MPH | 125 | 115 | 105 |
| | 25 MPH | 205 | 185 | 170 |
| | 30 MPH | 300 | 275 | 250 |
| | 35 MPH | 420 | 380 | 350 |
| | 40 MPH | 565 | 510 | 465 |
| | 45 MPH | 730 | 660 | 600 |
| | 50 MPH | 930 | 835 | 760 |
| Normal Pavement Cross Slopes | Rate of Cross Slope = 2% | | | |
| Normal Shoulder Cross Slopes | Earth = 8 to 10% | | Paved = 4 to 6% | |

# PRACTICAL SOLUTIONS GEOMETRICS: RURAL COLLECTORS

| | Design Speed (7) | | Traffic Volume (ADT) Under 400 | 400 to 1500 | 1500 to 2000 | 2000 to 5000 |
|---|---|---|---|---|---|---|
| Maximum Grade (Percent) | 20 | Level | 10 | 8 | 7 | 7 |
| | | Rolling | 12 | 10 | 10 | 9 |
| | | Mountain | 14 | 12 | 12 | 10 |
| | 25 | Level | 8 | 7 | 7 | 7 |
| | | Rolling | 10 | 10 | 10 | 8 |
| | | Mountain | 12 | 12 | 11 | 9 |
| | 30 | Level | 7 | 7 | 7 | 7 |
| | | Rolling | 10 | 9 | 9 | 7 |
| | | Mountain | 12 | 10 | 10 | 8 |
| | 35 | Level | 7 | 7 | 7 | 7 |
| | | Rolling | 10 | 9 | 8 | 7 |
| | | Mountain | 12 | 10 | 10 | NA |
| | 40 | Level | 7 | 7 | 7 | 6 |
| | | Rolling | 10 | 9 | 8 | 7 |
| | | Mountain | 12 | 10 | NA | NA |
| | 45 | Level | 7 | 7 | 7 | 6 |
| | | Rolling | 10 | 8 | 8 | 7 |
| | | Mountain | 12 | NA | NA | NA |
| | 50 | Level | 7 | 6 | 6 | NA |
| | | Rolling | 10 | NA | NA | NA |
| | | Mountain | NA | NA | NA | NA |

| | Design Speed (7) | 20 | 25 | 30 | 35 | 40 | 45 | 50 |
|---|---|---|---|---|---|---|---|---|
| Minimum Stopping Sight Distance (1) | (Feet) | 115 | 155 | 200 | 250 | 305 | 360 | 425 |
| Minimum Passing Sight Distance (2) | (Feet) | 710 | 900 | 1090 | 1280 | 1470 | 1625 | 1835 |

1) MINIMUM STOPPING SIGHT DISTANCES ARE BASED ON A HEIGHT OF EYE OF 3.5 FT AND HEIGHT OF OBJECT OF 2.0 FT. BOTH HORIZONTAL AND VERTICAL ALIGNMENTS ARE CONSIDERED.

(2) MINIMUM PASSING SIGHT DISTANCES ARE BASED ON A HEIGHT OF EYE OF 3.5 FT AND HEIGHT OF OBJECT OF 3.5 FT. BOTH HORIZONTAL AND VERTICAL ALIGNMENTS ARE CONSIDERED.

(3) NORMAL PAVEMENT CROSS SLOPES ON BRIDGES SHALL BE 2%

(4) WIDEN 3 FT FOR GUARDRAIL

(5) JUSTIFICATION FOR THE DESIGN SPEED SHALL BE BASED UPON COMPREHENSIVE ANALYSIS OF EXISTING ROADWAY GEOMETRICS, ADJACENT ROADWAY FEATURES, AND PURPOSE AND NEED FOR THE PROJECT. DOCUMENTATION SHALL BE INCLUDED IN THE DESIGN EXECUTIVE SUMMARY.

(6) "NA" REFERS TO "BETTERMENT STANDARDS ARE NOT APPLICABLE" WITHOUT ADDITIONAL ANALYSIS.

(7) For Projects with an ADT of 400 or less, please refer to AASHTO's "Guidelines for Geometric Design of Very Low-Volume Local Roads" for additional guidance

# PRACTICAL SOLUTIONS GEOMETRICS: RURAL LOCAL ROADS

| | Design Speed (5) (7) | | Traffic Volume (ADT): Under 50 | | 50 to 250 | | 250 TO 400 | | 400 to 1500 | | 1500 to 2000 | | 2000 to 5000 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Pavement Width | Graded Shoulder Width | Pavement Width | Graded Shoulder Width | Pavement Width | Graded Shoulder Width | Pavement Width | Graded Shoulder Width | Pavement Width | Graded Shoulder Width | Pavement Width | Graded Shoulder Width |
| Pavement Width and Graded Shoulder Width (Feet) (4) | 15 | Level<br>Rolling<br>Mountain | Match Exist. | 2 | Match Exist. | 2 | 16 to 18 | 2 to 4 | 16 to 18 | 2 to 4 | 18 to 20 | 2 to 4 | 18 to 20 | 2 to 4 |
| | 20 | Level<br>Rolling<br>Mountain | Match Exist. | 2 | Match Exist. | 2 | 16 to 18 | 2 to 4 | 18 to 20 | 2 to 4 | 18 to 20 | 2 to 4 | 18 to 20 | 3 to 5 |
| | 25 | Level<br>Rolling<br>Mountain | Match Exist. | 2 | 16 to 18 | 2 | 16 to 18 | 2 to 4 | 18 to 20 | 2 to 4 | 18 to 20 | 2 to 4 | 18 to 20 | 4 to 6<br>3 to 5 |
| | 30 | Level<br>Rolling<br>Mountain | 16 to 18 | 2 | 16 to 18 | 2 | 16 to 18 | 2 to 4 | 18 to 20 | 2 to 4 | 18 to 20 | 2 to 4 | 18 to 20 | 4 to 6<br>3 to 5 |
| | 35 | Level<br>Rolling<br>Mountain | 16 to 18 | 2 | 16 to 18 | 2 | 18 | 2 to 4 | 18 to 20 | 2 to 4 | 18 to 20 | 3 to 5<br>2 to 4 | 18 to 20 | 4 to 6 |
| | 40 | Level<br>Rolling<br>Mountain | 16 to 18 | 2 | 16 to 18 | 2 | 18 | 2 to 4 | 18 to 20 | 3 to 5<br>2 to 4 | 18 to 20 | 3 to 5 | 20 to 22<br>18 to 20 | 4 to 6 |
| | 45 | Level<br>Rolling<br>Mountain | 16 to 18 | 2 | 18 | 2 | 18 | 2 to 4 | 18 to 20 | 3 to 5 | 18 to 20 | 4 to 6<br>3 to 5 | 20 to 22<br>NA | 4 to 6<br>NA |
| | 50 | Level<br>Rolling<br>Mountain | 16 to 18 | 2 | 18 | 2 | 18 | 2 to 4<br>NA | 18 to 20<br>NA | 3 to 5<br>NA | 18 to 20<br>NA | 4 to 6<br>NA | NA | NA |
| Min. Clear Roadway Width of New and Reconstructed Bridges (3) | All Speeds | Approach Roadway Width | | | | | | | | | | | | |

| | Design Speed (7) | eMAX. 4% | eMAX. 6% | eMAX. 8% |
|---|---|---|---|---|
| Minimum Radius (Feet) | 15 MPH | 70 | 65 | 60 |
| | 20 MPH | 125 | 115 | 105 |
| | 25 MPH | 205 | 185 | 170 |
| | 30 MPH | 300 | 275 | 250 |
| | 35 MPH | 420 | 380 | 350 |
| | 40 MPH | 565 | 510 | 465 |
| | 45 MPH | 730 | 660 | 600 |
| | 50 MPH | 930 | 835 | 760 |

| | | |
|---|---|---|
| Normal Pavement Cross Slopes | Rate of Cross Slope = 2% | |
| Normal Shoulder Cross Slopes | Earth = 8 to 10% | Paved = 4 to 6% |

# PRACTICAL SOLUTIONS GEOMETRICS: RURAL LOCAL ROADS

| | Design Speed (7) | | Traffic Volume (ADT) Under 50 | 50 to 250 | 250 TO 400 | 400 to 1500 | 1500 to 2000 | 2000 to 5000 |
|---|---|---|---|---|---|---|---|---|
| Maximum Grade (Percent) | 15 | Level | 10 | 10 | 10 | 9 | 7 | 7 |
| | | Rolling | 12 | 12 | 12 | 12 | 10 | 9 |
| | | Mountain | 16 | 16 | 16 | 14 | 12 | 10 |
| | 20 | Level | 10 | 10 | 10 | 8 | 7 | 7 |
| | | Rolling | 12 | 12 | 12 | 11 | 10 | 9 |
| | | Mountain | 16 | 16 | 14 | 13 | 12 | 10 |
| | 25 | Level | 8 | 8 | 8 | 7 | 7 | 7 |
| | | Rolling | 11 | 11 | 11 | 10 | 10 | 8 |
| | | Mountain | 15 | 15 | 14 | 13 | 11 | 9 |
| | 30 | Level | 8 | 8 | 7 | 7 | 7 | 7 |
| | | Rolling | 10 | 10 | 10 | 10 | 9 | 7 |
| | | Mountain | 14 | 14 | 14 | 13 | 10 | 8 |
| | 35 | Level | 8 | 8 | 7 | 7 | 7 | 7 |
| | | Rolling | 10 | 10 | 10 | 10 | 8 | 7 |
| | | Mountain | 14 | 14 | 12 | 12 | 10 | NA |
| | 40 | Level | 8 | 8 | 7 | 7 | 7 | 6 |
| | | Rolling | 10 | 10 | 10 | 9 | 8 | 7 |
| | | Mountain | 13 | 13 | 13 | 12 | NA | NA |
| | 45 | Level | 8 | 8 | 7 | 7 | 7 | 6 |
| | | Rolling | 10 | 10 | 10 | 9 | 8 | 7 |
| | | Mountain | 12 | 12 | 12 | NA | NA | NA |
| | 50 | Level | 8 | 8 | 7 | 6 | 6 | NA |
| | | Rolling | 10 | 10 | 10 | NA | NA | NA |
| | | Mountain | 12 | 12 | NA | NA | NA | NA |

| | Design Speed (7) | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 |
|---|---|---|---|---|---|---|---|---|---|
| Minimum Stopping Sight Distance (1)(7) | (Feet) | 80 | 115 | 155 | 200 | 250 | 305 | 360 | 425 |
| Minimum Passing Sight Distance (2) | (Feet) | NA | 710 | 900 | 1090 | 1280 | 1470 | 1625 | 1835 |

1) MINIMUM STOPPING SIGHT DISTANCES ARE BASED ON A HEIGHT OF EYE OF 3.5 FT AND HEIGHT OF OBJECT OF 2.0 FT. BOTH HORIZONTAL AND VERTICAL ALIGNMENTS ARE CONSIDERED.

(2) MINIMUM PASSING SIGHT DISTANCES ARE BASED ON A HEIGHT OF EYE OF 3.5 FT AND HEIGHT OF OBJECT OF 3.5 FT. BOTH HORIZONTAL AND VERTICAL ALIGNMENTS ARE CONSIDERED.

(3) NORMAL PAVEMENT CROSS SLOPES ON BRIDGES SHALL BE 2%

(4) WIDEN 3 FT FOR GUARDRAIL

(5) JUSTIFICATION FOR THE DESIGN SPEED SHALL BE BASED UPON COMPREHENSIVE ANALYSIS OF EXISTING ROADWAY GEOMETRICS, ADJACENT ROADWAY FEATURES, AND PURPOSE AND NEED FOR THE PROJECT. DOCUMENTATION SHALL BE INCLUDED IN THE DESIGN EXECUTIVE SUMMARY.

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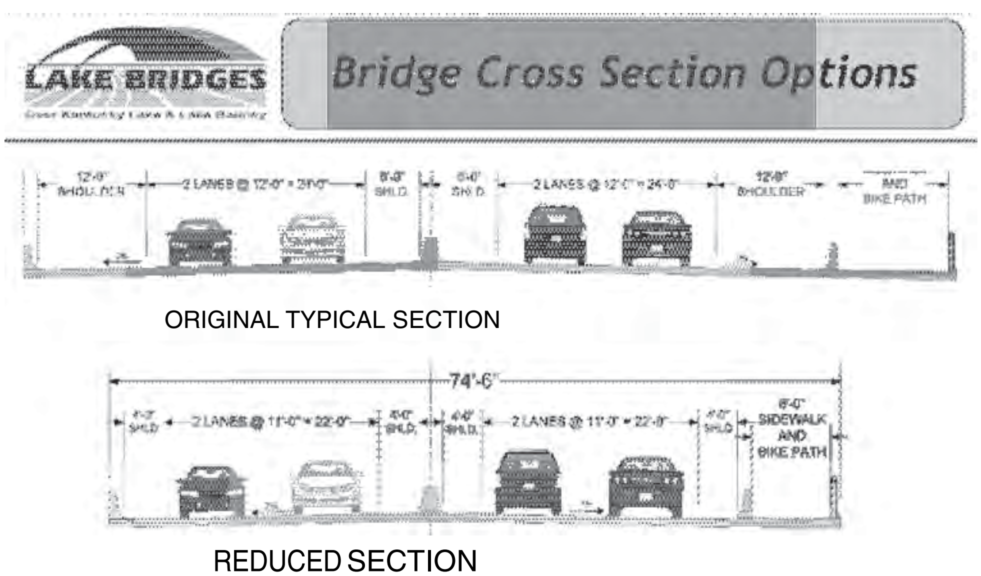
# APPENDIX G

## Case Examples of Practical Solutions for Kentucky Transportation Cabinet

PROJECT #1: NEW BRIDGES OVER LAKE BARKLEY & KENTUCKY LAKE; US 68 / KY 80

DESCRIPTION: The “Lake Bridges” project was well under way by the time the Practical Solutions initiative came along. However, after hearing about Practical Solutions the design team felt challenged and decided to take a look at their project through a Practical Solutions lens. The team realized that their bridge section was too big. They reduced the width to a more practical width, which resulted in an estimated $140 million savings. As shown in the illustration below, this was accomplished by reducing the cross-section from 102’6” to 74’6” segmented as follows:

| | From | To |
|---|---|---|
| Inside shoulder width | 6’0” | 4’0” |
| Travel lanes | 12’0” | 11’0” |
| Outside shoulder width | 12’0” | 4’0” |
| Sidewalk and bike path | 12’0” | 8’0” |



PROJECT #2: BRIDGE REPLACEMENT ON KY 3459 OVER MARTIN'S FORK OF CUMBERLAND RIVER

DESCRIPTION: This bridge was determined to be structurally deficient (SR=14.6) and was to be replaced. The approach road is a rural local road with 10 ft lanes and 1 ft shoulders. The road had a current ADT of 3,730 vehicles per day. AASHTO recommends 12 ft lanes and 8 ft shoulders for rural local roadway with an ADT of the current volume and a 35 mph design. This would require a bridge clear width of 40 ft to accommodate this recommended template. With the existing roadway serving the area having a total width of 10 ft, the project team did not see the benefit of constructing the bridge and approaches to this typical full design. The right-of-way impacts would be tremendous due to the location of buildings within the limits of the project. Due to the width of the existing roadway and trying to better match what is there, the project team requested that the consultant evaluate the effects of using 10 ft lanes with 2 ft shoulders and 11 ft lanes with 4 ft shoulders and not even consider utilizing 12 ft lanes with 8 ft shoulders.

The project team decided to go with 10 ft lanes with 2 ft shoulders. The width doubles the existing bridge and approach widths at this location, the right-of-way and utility impacts are minimized and the designers were able to tie the approach roadway widths back to existing in a shorter distance, thus reducing the overall project length and impacts. By selecting this design compared to the AASHTO-based design, the construction cost was reduced from $1,075,650 to $878,000, realizing a savings of $197, 650

PROJECT #3: ROADWAY IMPROVEMENT FOR 3.23 MILE SECTION OF KY 2158

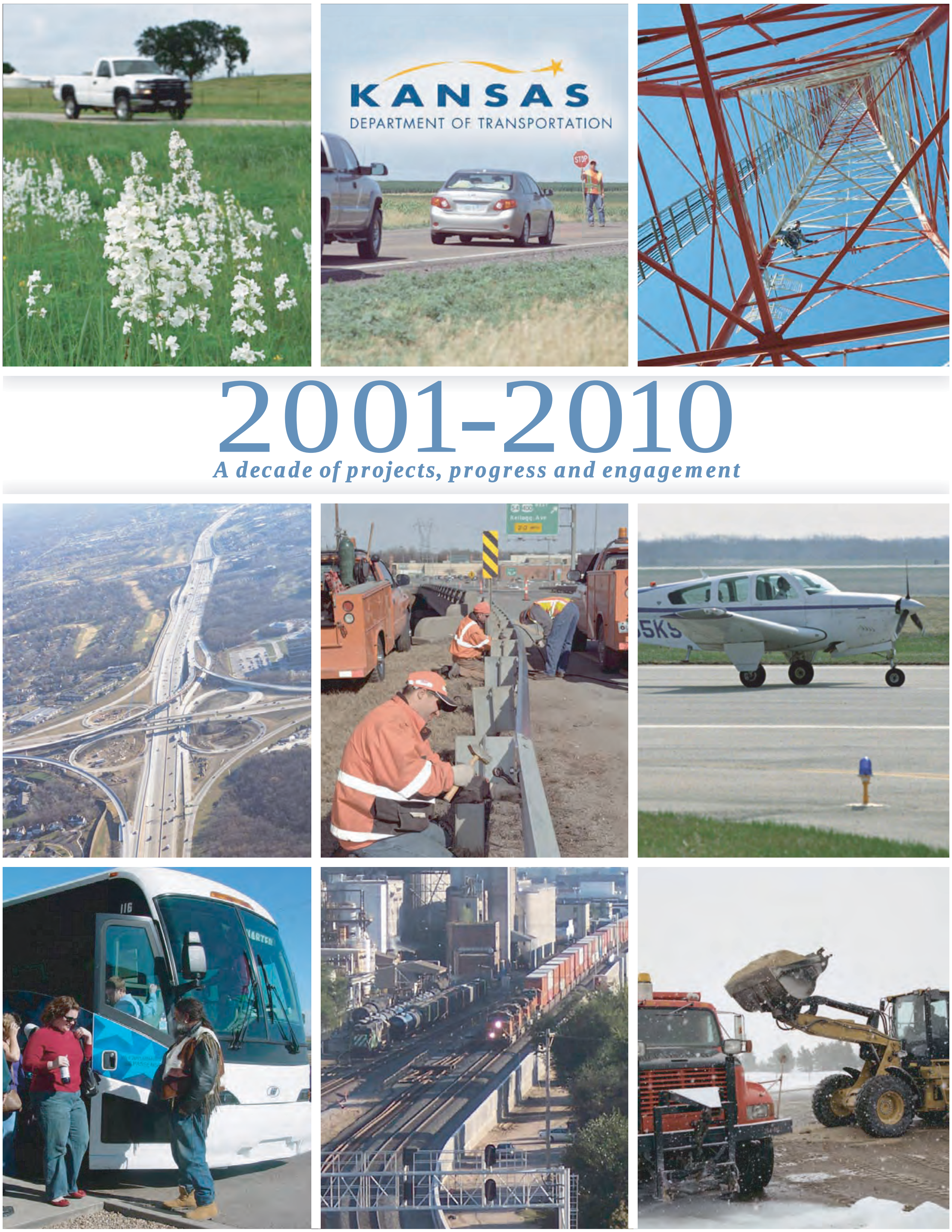
DESCRIPTION: This improvement for a section of KY 2158 was originally slated to be a “super 2 lane” meaning using 12 ft lanes and 8 ft shoulders. A portion of this road has commercial development with higher traffic volumes. The remainder of the project is residential and farm land. The project team recognized that this was not practical. Therefore, they elected to reduce the rural section to 11 ft lanes and 2 ft shoulders, which was considered appropriate to the context of the rural area. This decision resulted in a $2.1 million savings from the original cost of $6.6 million.

PROJECT #4: IMPROVE THE CAPACITY AND SAFETY OF THE INTERSECTION OF KY 720 & HORSESHOE BEND ROAD

DESCRIPTION: As seen by the photograph below the problem was limited visibility through the intersection area. The improvement project was originally developed as intersection realignment. After several alignment plans were prepared, it was suggested that removing the trees at the intersection corner would provide enough visibility. This option was pursued. The realignment design would have cost $780,000; tree cutting cost $13,500.

## APPENDIX H

## Excerpt from 2011 Decade Report, Kansas DOT



*"Freeways and super-2s are nice, but we're very happy to have these (practical) improvements, and we would welcome more improvements like this."*

– Bart Briggs, Gove County Commissioner

## Practical Improvement

Transportation needs and wants will always outpace available resources, so KDOT must do all it can to get the most from its investment. During the challenging economic times of the past decade, KDOT developed a new project design approach that allows the agency to maximize the cost-benefit ratio of transportation investments.

The new approach – called practical improvement – gives engineers and others the flexibility to use lower-cost alternatives to the full-scale complement of improvements that had been the standard in earlier years. A few examples of cost-savings measures KDOT teams now consider include:

- Narrowing the footprint of projects on the drawing board, thereby reducing the amount of right of way to be purchased.
- Identifying less-expensive means of maintaining traffic flow through construction zones.
- Narrowing paved shoulder-width (which reduces both construction and maintenance costs).
- Construction of passing lanes.

Practical improvement is used successfully in several other states, including Missouri, Wyoming, Pennsylvania and New Jersey, and in just a few years, KDOT has had its own practical improvement successes.

- Travelers and residents of Hodgeman County had long expressed concern about


***Before*** improvements were made along K-156, a sloping dirt shoulder didn't allow motorists adequate room to pull off of the highway.

# $59 million

## More than $59 million is expected in practical improvement savings by 2012

K-156 over the lack of shoulders, some steep drop-offs from the driving lanes and a perception that the highway was too narrow. In 2008, using a practical improvement approach, KDOT built 12-foot driving lanes, added one-to-three feet of asphalt outside the white edge line and ground rumble strips into the lines. The improvements on the low-traffic highway provided some of the safety benefits of a standard shoulder without the cost of buying additional right of way to build a full shoulder. As a result, more miles of the road were improved.

■ In 2010, the same approach was taken on a similar preservation project on K-23 in Gove County. Using practical improvement standards, KDOT was able to stretch the dollars allocated to Kansas under the American Reinvestment and Rehabilitation Act. Local leaders praised KDOT's use of practical improvement. "Freeways and super-2s (two-lane roads built to higher standards) are nice, but we're very happy to have these (practical) improvements, and we would welcome more improvements like this," said Gove County Commissioner Bart Briggs.


***After*** improvements along K-156 in Hodgeman County, the benefits include a wider shoulder, rumble strips and a gentler side slope.

Practical improvement can't be used on every road modernization project. But engineers in Kansas and elsewhere know that less expensive projects, without the full package of improvements, will free more money to improve more miles of the state highway system.

# APPENDIX I

## Case Examples of Practical Improvements for Kansas DOT

## Example 1: Considering Alternate Scopes

One recent example of considering alternate scopes was for a project on K-23, a low volume highway in Gove County. The section of K-23 chosen for improvement was constructed in the 1930's and 1940's and has not undergone major reconstruction since its initial construction. It has a fairly straight and flat existing alignment with little to no shoulders, and the pavement is deteriorating. The side slopes are generally 3:1 with relatively low fills tying into gentle to rolling terrain. The alternate scopes considered varied from "reconstruction" of the alignment to meet AASHTO criteria to "pavement replacement." Proposed typical sections are depicted in the following figures.

**Figure 1: "Reconstruction" Typical Section**

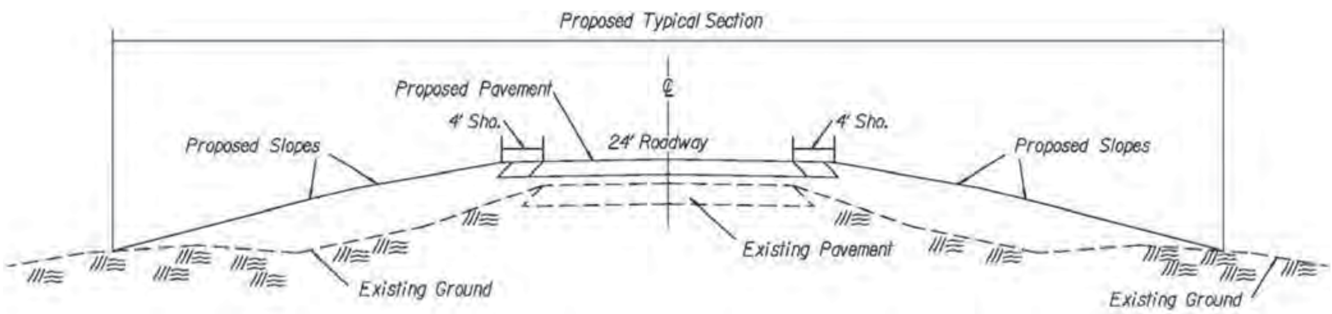
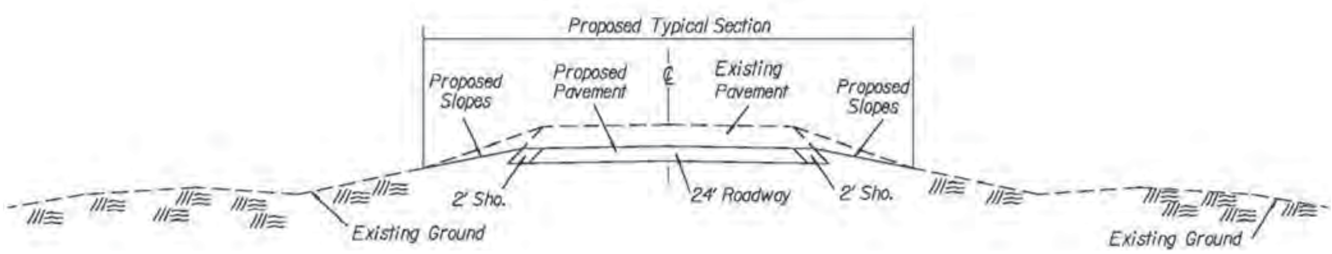



**Figure 2: "Pavement Replacement" Typical Section**




For the "reconstruction" scope, K-23 would be rebuilt to meet current criteria. The horizontal alignment and the grade of the vertical alignment would only need slight adjustments to achieve geometric improvements. The existing side slopes would be flattened to increase the safe recovery zone (clear zone) and the existing pavement would be completely replaced. The proposed roadway would consist of two 12' lanes and 4' shoulders (3' paved and 1' turf). This option would take considerably longer to build than the "pavement replacement" scope and would cost approximately $1.2 million per mile to build.

The "pavement replacement" scope would remove the existing pavement and lower the vertical alignment allowing a two-foot shoulder (with rumble strips) to be added. The proposed roadway would consist of two 12' lanes and 2' paved shoulders. Replacing the existing pavement would allow the superelevation on the two horizontal curves to be improved. Since this scope would use the existing horizontal alignment, the existing side slopes would only need to be minimally altered to tie into the lowered vertical alignment. In addition the ditches would typically not be disturbed. Minimal to no disturbance of the slopes and ditches greatly reduces the time needed for environmental clearances and permits and the acquisition of right of way.

To further investigate the "pavement replacement" scope, District Construction staff met with local officials. They agreed that K-23 in Gove County could be closed while the entire roadway surface was replaced. This would reduce the time to complete construction and reduce traffic handling expenses. This option would take less time to construct and would be less expensive than the "total reconstruction" scope.

After comparing the alternate scopes, the "pavement replacement" scope was chosen for some of the following reasons. The existing geometrics and roadside slopes were favorable to remain in place. The simple action of pavement replacement along with lowering the profile would increase the shoulder width by approximately 2 ft. The "pavement replacement scope" would provide a safety improvement in less time and for approximately $7 million dollars less when compared to the "reconstruction" scope.

## Example 2: Constructability Issues

An example of considering constructability issues when choosing a scope occurred on a K-7 reconstruction project in Johnson County. This section of K-7 is a 4-lane divided highway carrying high traffic volumes in a densely urbanized area. This projecti ncludes the construction of an interchange that replaces the current at grade intersection at K-7 and Johnson Drive. Iti s predicted thatt he existing ground on the south side of the interchange will settle due to the weight of the fill used to constructt he bridge embankments. It is anticipated that 90% of this settlement will occur in 11 months. Thus the construction of the bridges would be delayed 11 months unless another construction method could be utilized. Three different scopes were considered.

The first option would construct all bridge abutments using piles and would involve an 11 month waiting period before constructing the bridges. Construction sequencing would include first constructing the bridge embankments. The bridge abutment work on the north side could begin without delay. The bridge abutment work on the south side would wait for the embankment to settle for 11 months. After this timeframe, the piles could be driven into the embankments and the southern bridge abutments constructed. The next step would be constructing the bridges and the roadways on the southern bridge approaches. After completion, the project would open to traffic. This option would be the least expensive to construct but would take the longest and would incur delay related costs to KDOT such as paying twice for contactor mobilization. The 11 month settlement period would significantly Increase the amount oft ime that side road traffic is closed and movements from K-7 are restricted. In addition, the 11 month period with only minimal work being observed could create negative perceptions for the roadway users, area businesses and residents.

The second option would use drilled shafts to constructt he south bridge abutment and would avoid waiting 11 months before bridge construction could begin. The construction sequence would include constructing the bridge embankments followed by the abutments and then the bridges without delay. Settlement would still occur in the south side embankment but with this option, the bridge could be constructed during this settlement period. Due to the use of rigid pavement, paving the roadway on the southern bridge approaches could not occur until after the settlement period. Being able to construct the bridge without delay greatly shortens or eliminates the delay to advancing to the next phase of construction. Although this option is more expensive than using piles for both abutments, it would incur less if any delay related costs, take less time to construct and would be anticipated nott o create the negative perceptions associated with the 11 month settlement period.

The third option would construct the bridges in the same manner as the second option but would avoid any delay in opening the roadway to traffic. To avoid the delay, this option would utilize paving the southern approach oft he Northbound (NB) bridge with temporary asphalt pavement. The asphalt pavement on the approach could handle the settlement with minimal distress. The NB bridge could then be opened without delay to two way traffic during the settlement period. After the settlement period, the southbound (SB) bridge approach could be paved with concrete and when ready, all traffic switched to the SB bridge. The temporary asphalt pavement on the NB bridge approach would be removed and replaced with concrete. Carrying traffic through construction during the settlement period would provide the least delay to the traveling public but would require additional traffic accommodation and pavement costs to KDOT. This option is the most expensive but would take the least time to construct.

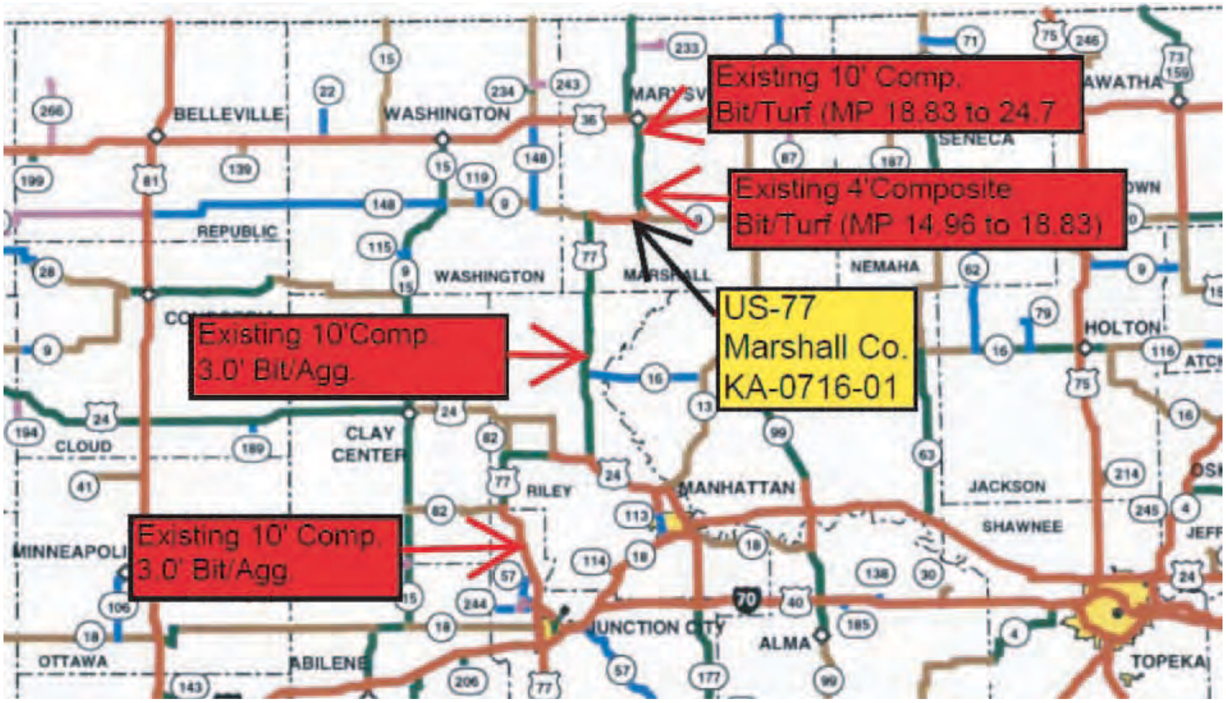
After comparing the scopes, the option utilizing the drilled shafts without carrying traffic through the settlement period was chosen. This option was the second most expensive, had the second shortest construction timeline, and little to no delay related expenses. Thus the foreseeable impact oft he delay in completing a project for a facility carrying such high traffic volumes was considered to outweigh the additional construction costs associated with Option 2.

## Example 3: Roadside Options

When developing alternate scopes, the width and type of shoulders, clear zone widths, and foreslopes should be evaluated. One example of evaluating these features was the bridge replacement project over the Big Blue River on US-77 in Marshall County.

When evaluating the shoulder widths, the existing shoulder widths in the area of consideration and the current criteria were compared. The Big Blue River Bridge consists of two 12’ lanes and 1’ shoulders. In the vicinity close to the bridge, the existing roadway consists oft wo 12’ lanes and 8’ composite shoulders. The existing shoulders on other routes in the area are depicted on the KDOT Shoulder Map below. For this portion of US-77, the current KDOT Shoulder Map suggests a 10’ shoulder width. The AASHTO Green book suggests an 8’ shoulder width.

**<u>Design Shoulder Widths Based on Projected Traffic – Adopted 4/98</u>**




Legend: 4 ft. 6 ft. 8 ft. 10 ft.

When evaluating the foreslopes, the existing conditions and the current criteria were compared. In the project area, US-77 was built with 4:1 foreslopes. Current criteria suggest using foreslopes in the range of 6:1 to 4:1.

Pulling all these roadside options together, several typical section scenarios were evaluated. See Typical Section table below.

Typical Sections Evaluated:

| Option | Shoulder Width | Foreslope Rate | Clear Zone Width | Construction Cost |
|---|---|---|---|---|
| A | 10’ | 6:1 | 30’ | $8,670,000 |
| B | 10’ | 4:1 | 34’ | $8,340,000 |
| C | 8’ | 6:1 | 30’ | $8,350,000 |
| D | 8’ | 4:1 | 34’ | $7,930,000 |

The typical section selected included an 8’ composite shoulder with 4:1 side slopes and a 34’ clear zone. The proposed typical section matches into the existing roadway smoothly and stays within current criteria ranges. This option could potentially save approximately $740,000 in roadway and bridge costs.

## Example 4: Traffic Handling and Accommodation

On a project under development on US-36 in Norton County, traffic handling and accommodation played a parti n determining the project's scope. A 4.5 mile section of US-36 with 2 lanes, 10 foot composite (3' asphalt pavement and 7' turf) shoulders, and deteriorating pavement was selected for improvement. Current traffic counts are 3300 vehicles per day (AADT) with 21% trucks. Scopes considered for this project were "pavement replacement" and "pavement rehabilitation." In addition, when considering possible scopes for the project a typical section with 10' fully paved or composite shoulders and 4:1 or 6:1 foreslopes was evaluated.

For the "pavement replacement" scope, the pavement recommendation is 11" asphalt surfacing. For the "pavement rehabilitation" scope, the pavement recommendation is 4" of cold in place recycle (CIPR) with a 5" asphalt overlay. Regardless of scope, the existing horizontal and vertical alignments meet current criteria and would not need to be modified. Since both scopes would replace or modify the existing pavement, the superelevation could be improved where needed. When comparing construction costs, items such as earthwork, structure extensions, etc., were considered comparable since both scopes don't adjustt he existing alignment and would improve the foreslopes in a similar manner. Thus only the pavement costs were calculated and compared. This cost comparison estimated that the "pavement rehabilitation" scope is $1,800,000 less than the "pavement replacement" scope.

Under the "pavement replacement" scope traffic on US-36 would be redirected on a state route detour with 20 miles adverse travel. A portion of this detour would be on K-9. In the detour area, K-9 is a low volume highway with a 24' roadway width with little to no shoulders. It would not be preferred to add the current traffic of US-36 (especially with 21% trucks) onto K-9. For the "pavement rehabilitation" option, the traffic would be carried through construction. Due to the length of adverse travel and existing roadway width of K-9, it would be preferred to carry these traffic volumes through construction.

A typical section with 10' fully paved or composite shoulders and 4:1 or 6:1 foreslopes were evaluated for both scopes. The use of 10' wide shoulders would comply with current criteria but the use of composite shoulders would not comply with KDOT's current shoulder policy. A 10' composite shoulder would match the existing shoulders on adjacent segments of US-36. For either scope, using composite shoulders could save approximately $1,060,000. The use of either 4:1 or 6:1 foreslopes would comply with current criteria. For either scope, the use of 4:1 foreslopes versus 6:1 foreslopes could save approximately $234,000. A summary of the potential savings in FY 2012 dollars is given below.

Potential Savings:

| Option | Savings (FY 2012 dollars) |
|---|---|
| Pavement Rehabilitation vs. Pavement Replacement* | $1,800,000 |
| 10’ Composite Shoulder vs. 10’ Fully Paved Shoulder | $1,060,000 |
| 4:1 foreslopes vs. 6:1 foreslopes | $234,000 |

*Does not consider life cycle costs.

After evaluating the alternatives, the “pavement rehabilitation” scope utilizing a typical section with 10’ composite shoulders and 6:1 foreslopes was chosen for some of the following reasons:

- Estimated initial construction cost savings of approximately $2,860,000
- Traffic can be carried through construction (preferred)
- Existing vertical and horizontal alignments comply with existing criteria and can be left in their present condition
- The 10’ composite shoulder matches the existing shoulders on adjacent segments of US-36
- The 10’ shoulder width complies with existing current criteria
- Low cost ($234,000 for entire project length) to improve from 4:1 to 6:1 foreslopes

# APPENDIX J

## Example of Charter for Oregon DOT

# CHARTER (Sample 1) OR206
# Deschutes River Bridge November 15, 2009

- **Charter is assigned by:** Gary Farnsworth (Central Area Manager), Sam Wilkins ( District 9 Manager), and Bert Hartman (Bridge Program Unit Manager); to: Mike Darling (Project Leader)

- **Brief, general description of the Project Assignment:** Provide a construction project on highway OR206 at the Deschutes River Bridge No. 00332, that will strengthen the structure such that load limits will be removed. The charge includes delivery of this project within the specified budget, with construction to occur in the 2012 construction season, while at the same time adhering to the mobility and delay commitments that have been made to the freight industry and traveling public with regards to this section of highway.

- **Problem Description:** The bridge is currently load rated. And although the average daily traffic using this structure is low, the bridge is part of a route designated as an alternate route for interstate I-84 during emergency situations. Strengthening the structure so that there are no load limits remaining will maintain and enhance mobility by allowing unrestricted use during emergency situations. Resolving this problem is important, because it's our responsibility to:

1. Maintain and enhance mobility by allowing unrestricted use during emergency events as an alternative to interstate highway I-84.
2. Protect assets by providing maintenance and retrofits. This includes life-cycle cost-benefit and environmental stewardship and sustainability as high priorities.
3. Be responsive to local/regional economic and livability needs and interests that create long term benefits for both ODOT and the affected area. This section of highway OR206 is used for recreation, and the bridge is used as an angling platform. So, for example, with this project, delay in addressing the existing and near-term deteriorating bridge condition beyond 2012 will result in a decrease in safety for the traveling public, an increase in maintenance and life-cycle costs.
4. Maintain construction-related traffic mobility as a top priority commitment by ODOT to the trucking industry, as part of the OTIA III program, and as part of ODOT's support to Oregon's economy.

- **<u>All or any expectations and outcomes:</u>** The priority order of the project deliverables are as follows:
  1. Strengthen the bridge superstructure
  2. Resurface the bridge deck
  3. Reconstruct guardrail approaches
  4. Upgrade bridge railing
  5. Perform seismic upgrades

  Involvement and informed consent with identified stakeholders such as ODOT Bridge Engineering, ODOT maintenance, Wasco County, Sherman County, Emergency Services, Statewide Mobility Committee, Columbia River Gorge commission, Oregon Parks and Recreation Department, and local businesses, for such items as bridge design, safety improvements, construction staging, and construction related traffic and freight mobility.

  On-time delivery into construction for 2012 construction season, meeting at least the top project scope priorities, within budget (at reasonable cost).

  Satisfied maintenance, bridge, and construction staff (and contractor) regarding maintainability and constructability of the design / contract documents, including the project development to construction hand-off process.

- **<u>All parameters (conditions, boundaries, constraints, design criteria) r elevant to the effort:</u>**

  Construction is expected to be completed within existing right-of-way, and completed within the timeframe noted above. There are no other expectations for bridge design outside of current ODOT guidelines.

  STIP assigned PE and CN Budget is $2.948 million of STP funds.

- **<u>Clearly described decision-making authority boundaries and flexibilities between the Sponsor(s) and the PL/Team:</u>**

  Mike is authorized to make the following decisions within the Project Team structure:

  1. Setting and changing project oversight and involvement expectations: Team operating guidelines (covenants) and dynamics (e.g., frequency of meetings), work-flow and timing, and other tools to implement successful project delivery within the above expectations.
  2. Strategies to work with other internal and external stakeholders, although Sam Wilkins and Gary Farnsworth will be particularly interested in strategies for Wasco County, Sherman County, the adjacent business and property owners, emergency services, and Statewide Mobility Team.
  3. Technical /design decisions within the above expectations and within established ODOT technical business practices (e.g., regulatory, professional registration).

*Sample 1: p 2*

Specific Project decision-making authorities are as follows:

1. All project scope decisions/changes: ODOT Region 4 Management Team, with concurrence by the Bridge Program Manager.
2. Project Budget decisions: Area Manager (up to $250,000), Region 4 Project Delivery, Management Team (up to $500,000), Region 4 Management Team (over $500,000) for Region 4 funding, with concurrence by the Bridge Program Manager.
3. Project Schedule decisions: Area Manager (up to 90 days, within FFY), Region 4 Project Delivery Management Team (beyond 90 days, within FFY), Region 4 Mgt Team (beyond FFY) with concurrence by the Bridge Program Manager.
4. Design Acceptance: Area Manager, Tech Center Manager.

- **Method by which the Sponsor(s) PL/PM/Team will communicate with and support each other:**

  Routine verbal communication between Mike Darling (Project Leader) and Sam Wilkins, Gary Farnsworth and Project Team members as Mike and Sam see are needed.

  Routine informational emails, draft Change Requests, email/letter cc's on correspondence with stakeholders, any project highlight or change discussions at PDMT, etc.

  Meeting opportunities within stakeholder/citizen participation strategies (e.g., public meetings), or invitations by the Team to join a Team Meeting.

  The sponsors will provide support to Mike and the Team with other Region 4 Management Team members, Statewide Mobility Team, other stakeholders, and in Tech Services, etc.

- **Perspectives and expectations on how to go about the work:**

  Incorporate into initial team meetings review of the current Region 4 Design Acceptance Checklist, Region Design Acceptance Memo template, the Office of Preletting's current PS&E submittal forms, and at least Chapter 2 of the Highway Mobility Operations Manual for work planning and assignment purposes. Mike will also ensure the following are developed, maintained, and updated with the Project Team throughout project development:

  a. Project Team Agreement*
  b. Traffic Management Plan (TMP)
  c. Project Information Paper (PIP)
  d. Public Involvement Plan which integrates with the TMP and schedule
  e. Cost-budget status spreadsheet
  f. Prospectus consistent with items II and III above, MS Project Schedule (w/staff resources), all other Operational Notice (e.g., PD-02, PD-03) deliverables.

  Apply the Region 4 Change Request tool for communication and justification of scope, schedule, and budget changes.

*Sample 1: p 3*

- **<u>Names, roles and responsibilities of all team members, management sponsors, etc:</u>**

  Region 4 Tech Center (through Tech Center Manager Jon Heacock), The Dalles Construction Office and District 9 staff for oversight, production, decision-making, and review support as needed. Support from Rex Holloway (Community Liaison) and Peter Murphy (Public Information Officer) as needed. Current staff assignments include:
  - Fred Gomez will serve as Roadway Designer/Engineer of Record
  - Robert Tovar (Region 1 Structural Design Engineer)
  - Alan Hart (Roadway/Specifications Engineer)
  - Curtis Ehlers (Senior Engineering Geologist)
  - Traffic Operations Rep (Dave Foster)
  - Teresa Brasfield (Region Environmental Coordinator)
  - Greg Saurbier or Joseph Rodriguez(Roadway Drafter)
  - Terry Pistole (Right of Way)
  - Jim Bryant (Planning)
  - Dan Serpico (Access Management)

- **<u>Signature Blocks:</u>**

  Gary Farnsworth (Area Manager) ______________________________

  Sam Wilkins (District 9 Manager) ______________________________

  Bert Hartman (Bridge Program Unit Manager) ______________________________

  Mike Darling (Interim Project Leader) ______________________________

**Each Project Charter should also be supplemented by a Project Team Agreement. Created by the Project Team, such an Agreement will provide the operating guidelines to support successful delivery on the Charter, such as: encouraged group behaviors and norms, meeting frequency, conflict strategies, and roles of the team. Working through this will help the team address problems in advance. The Agreement should address the following questions the team members should be asking themselves as they form and interact:*

1. *Are we good at decision-making (what decision-making processes will be used, e.g., consulting, voting, consensus, PLUS)?*
2. *Do we understand and agree with authorities, roles, responsibilities, and expectations?*
3. *Do we do a good job documenting who does what, by when, and the follow-up?*
4. *Do we hold one another accountable, and are we accountable to each other?*
5. *Do we have good, healthy communication with each other during meetings, and day-to-day?*
6. *Do we know how to effectively communicate with management sponsors, and our potentially affected interests (internal and external customers)?*

# APPENDIX K

## Utah DOT Memorandum on Implementation of Practical Design

State of Utah

GARY R. HERBERT
*Governor*

GREG BELL
*Lieutenant Governor*

DEPARTMENT OF TRANSPORTATION

JOHN R. NJORD, P.E.
*Executive Director*

CARLOS M. BRACERAS, P.E.
*Deputy Director*

**MEMORANDUM**

**Date:** 2/02/2011

**To**: Region Directors, Group Leaders, Preconstruction Engineers, Design Squad Leaders, District Engineers, Traffic Operations Engineers, Program Managers, Project Managers, and Consultant Project Managers

**From:** Lisa Wilson, P.E.
Engineer for Preconstruction

**Re:** Implementation of Practical Design

---

**Practical Design Guide**

UDOT is implementing Practical Design, effective immediately. Practical Design supports UDOT's continuing emphasis on innovation, cost savings, and providing the public with the transportation system that meets their needs. The goal of Practical Design is to only build "right sized" projects that meet focused needs. This allows UDOT to spread limited resources more effectively throughout the transportation system.

Please refer to the Practical Design Guide for more information on the implementation and benefits of Practical Design. Refer to the Practical Design Savings Summary - Documenting Instructions for instructions on reporting Practical Design savings. Jesse Sweeten will be working with the regions on implementation and tracking savings for Practical Design as well as providing assistance in any way you feel may be helpful. Please feel free to contact him at 801-965-4986 with any questions.

LW/JRS

Central Preconstruction • Telephone (801) 965-4173 • Facsimile (801) 965-4796 • www.udot.utah.gov
Calvin Rampton Complex • 4501 South 2700 West • Mailing Address P.O. Box 148460 • Salt Lake City, Utah 84114-8460

# APPENDIX L

## Example of Design Exception Report for Utah DOT

## Utah Department of Transportation
## Design Exception / Design Waiver from UDOT Standards

www.udot.utah.gov/go/designexceptionprocess

**Type of Request:** (select one or both) ☒ Design Exception ☒ Design Waiver

### *Project Information:*

Project No: S-0252(7)0 PIN: 9413

Location: State Route: SR-252 from: .00 to: 6.77 for: 6.77

Concept: Reconstruction - Added Capacity

### *Roadway Characteristics and Traffic Data:*

| | | | | | |
|---|---|---|---|---|---|
| Functional Class: | Urban Arterial | | | Pavement Type: | Flexible |
| Current Year: | 2011 | AADT = | 14,700 | Current % Trucks: | 10 % |
| Projected: | 10 Years | AADT = | | Projected % Trucks: | % |
| Projected: | 20 Years | AADT = | 30,600 | Projected % Trucks: | 10 % |
| Terrain: | Level | | | Posted Speed: | 40-50 mph |
| Project Design Life: | 20 Years | | | Design Speed: | 45-55 mph |
| Design Vehicle: | WB-67 | | | | |

### *Geometric Data:*

| | | | |
|---|---|---|---|
| Number of Lanes: | 3-5 | Clear Zone Distance: | 24-26 ft. |
| Pavement Width: | 60-92 ft. | ROW Width: | 99-150 ft. |
| Shoulder Width: | 10 ft. | Shoulder Type: | Paved |

### *Accident History as documented in the OSR:*

| | Actual Rate | Expected Rate |
|---|---|---|
| Accident History | 1.60 | 3.23 |
| Severity | 1.49 | 1.42 |

Accident History Years: 2003-2005

Date of OSR: 9/23/2008

Remarks:

# Utah Department of Transportation
# Design Exception / Design Waiver from UDOT Standards

www.udot.utah.gov/go/designexceptionprocess

9413 S-0252(7)0 State Route: SR-252 from: .00 to: 6.77 for: 6.77

## *Adjoining Section Geometry Compatibility:*

### Programmed Future Improvements:

---

### *Cost Data:*

| | |
|---|---|
| Project Cost as Proposed: | $15,922,846.60 |
| Additional Project Cost to Attain FHWA 13 Critical Elements (Design Exceptions): | $391,208.13 |
| Additional Project Cost to Attain Other Standards (Design Waivers): | $846,062.50 |
| Project Cost Savings Identified Using Practical Design (This amount may be part of or all of the above amounts for Design Exceptions and/or Waivers): | $846,062.50 |

Attached Detailed Estimate:

Comments:

---

# Utah Department of Transportation
# Design Exception / Design Waiver from UDOT Standards

www.udot.utah.gov/go/designexceptionprocess

9413 S-0252(7)0 State Route: SR-252 from: .00 to: 6.77 for: 6.77

## *Exceptions to FHWA's 13 Critical Elements:*

| | | | | |
|---|---|---|---|---|
| 1. Design Speed | 2. Lane Width | 3. Shoulder Width | 4. Horizontal Alignment | 5. Vertical Alignment |
| 6. Grades | 7. Stopping-Sight Distance | 8. Cross Slopes | 9. Superelevation | 10. Structural Capacity |
| 11.Bridge Width | 12. Vertical Clearance (Notify FHWA on any changes on the NHS and STRAHNET routes. See detailed instructions for more information.) | | 13. Lateral Offset to Obstruction | |

| Design Exception #1 | | Additional information in attached file: | | |
|---|---|---|---|---|
| Element: | Shoulder Width | Existing | UDOT Standard | Proposed |
| Location: | 2500 North alignment right side | Varies 1.5' to 7' on right side | 10' | 4' |

Mitigation: The shoulder is combined with Acceleration/Deceleration lanes within an area with a posted speed limit of 40 mph.

Remarks: Traffic conditions necessitate the inclusion of a free right right turn/acceleration lane at 1000 West and a right turn/deceleration lane at 600 West. Based upon the design speed and resulting tapers from/to the acceleration lane and deceleration lane this would leave only a short length of standard 3 lane cross section. Based upon this condition it was determined by UDOT to continue the acceleration lane into a continuous lane that would end in the lane drop/right turn lane at 600 West. In conjunction with this lane a 4 foot shoulder is proposed. As the area is developed as part of continued urbanization the 4 foot shoulder is planned to be widened to 10 feet thru local planning processes. The 4' shoulder prevents the need to impact additional wetlands and the work related thereto. Due to speed limits and traffic volumes, SR-252 has been specifically identified by local planners as a corridor on which bicycle use will neither be encouraged or designed for. Rumble strips are not proposed due to the rapid urbanization of the area.

# Utah Department of Transportation
# Design Exception / Design Waiver from UDOT Standards

www.udot.utah.gov/go/designexceptionprocess

9413 S-0252(7)0 State Route: SR-252 from: .00 to: 6.77 for: 6.77

## *Waivers of Additional Design Criteria:*

| | | | | |
|---|---|---|---|---|
| 1. Acceleration Lanes | 2. Deceleration Lanes | 3. Clear Zone | 4. Intersection Sight Distance | 5. Ramp Terminal Sight Distance |
| 6. Shoulder/Travel Way (Gutter Pan) | 7. Gores | 8. Ramp Terminals | 9. On Ramp Design | 10. Off Ramp Design |
| 11. Curb Configuration | 12. Guardrail Bridge Connection (See next section) | 13. Traffic Control | 14. Rumble Strips | |

| Waiver #1 | | Additional information in attached file: | | |
|---|---|---|---|---|
| Element: | Curb Configuration | Existing | UDOT Standard | Proposed |
| Location: | STA 242+00 - 324+00, 336+00 - 350+00 | Varying curb types | Curb type B1 to be used with design speed up to 40 mph or in urban areas where mountable curb may be used with design speeds up to 50 mph. | Type B1 in 55 mph design speed area |

Mitigation: Full 10' shoulders provide enhanced recovery area. 4:1 side slopes rather than 3:1 will be used behind sidewalk.

Remarks: Additional Right-of-Way would be required for cut/fill slopes. This is a rapidly urbanizing area where curb and gutter is planned throughout. The use of curb and gutter is consistent with the previous SR-252 project, Phase I, that had similar land use conditions. The posted speed is 50 mph and due to the rapid urbanization the speed is unlikely to go up and more likely to go down to be consistent with the existing 40-45 mph posted speeds in the fully urbanized portions of the corridor. Additionally, the use of curb and gutter is consistent with local community plans and has been utilized on other Region One projects with similar speed and land use conditions.

| Waiver #2 | | Additional information in attached file: | | |
|---|---|---|---|---|
| Element: | Deceleration Lanes | Existing | UDOT Standard | Proposed |
| Location: | * 200 North to 400 North intersections<br>* 500 North to 600 North intersections | Non standard deceleration SB approaching 200 North, SB approaching 500 North, and NB approaching 600 North. No existing turn lane at 400 North. | 385' for 45 mph per AASHTO and DD15A2 | Shorter deceleration for left turn lanes for Northbound traffic approaching 400 North and for southbound traffic approaching 200 North, also for Southbound traffic approaching 500 North and Northbound traffic approaching 600 North. |

Mitigation: Signal at 200 North. Speeds expected to be < 45 mph.

Remarks: No additional distance is available to meet UDOT Standards. Between 200 North and 400 North intersections, as well as 500 North and 600 North intersections the lengths of deceleration lanes at a posted speed of 45 mph is limited by the available distance between the 2 intersections. Both deceleration lanes will be shortened to accommodate the existing distance constraints.

# Utah Department of Transportation
# Design Exception / Design Waiver from UDOT Standards

www.udot.utah.gov/go/designexceptionprocess

9413 S-0252(7)0 State Route: SR-252 from: .00 to: 6.77 for: 6.77

## *Waivers of Additional Design Criteria – Bridge Rail or Parapet:*

Structure Number: ______ Sufficiency Rating: (from Structures Division) ______

Mainline or Overcrossing: ______

Location: ______

## *Existing Systems:*

| | Bridge | | Approach | |
|---|---|---|---|---|
| Rail Type* | | | ◯ Guardrail | ◯ Precast Barrier |
| Height | | | | |
| Attached | | | ◯ Yes | ◯ No |
| Meets Standards | ◯ Yes | ◯ No | ◯ Yes | ◯ No |
| Total Width | | | | |
| Lane Width | | | | |
| Shoulder Width | | | | |
| Condition | | | | |
| 3 Year Accidents | Actual Rate | Expected Rate | Actual Rate | Expected Rate |
| | | | | |

*Attach Sketch of Rail Type

Remarks:

______

# Utah Department of Transportation
# Design Exception / Design Waiver from UDOT Standards

www.udot.utah.gov/go/designexceptionprocess

9413 S-0252(7)0 State Route: SR-252 from: .00 to: 6.77 for: 6.77

***Approval / Signatures:***

Prepared and Submitted by: Kyle J. Comer

PROFESSIONAL ENGINEER
08/31/11
No. 183972
Kyle J. Comer
ELECTRONIC SEAL
STATE OF UTAH

Kyle J. Comer

Digitally signed by Kyle J. Comer
DN: email=kcomer@civilscience.com, c=US, st=UT, l=Lehi, ou=http://www.usertrust.com/cps, cn=Kyle J. Comer
Date: 2011.08.31 09:30:02 -06'00'

8-31-2011

UDOT Project Manager

Comments:

2011.08.31
16:38:56
-06'00'

Region Pre-construction Engineer

Comments:

cn=John Leonard, o=Utah Department of Transportation, ou=Div of Traffic and Safety, email=jleonard@utah.gov, c=US
2011.09.29 09:42:44 -06'00'

Statewide Traffic and Safety Engineer

Comments:

Issues have been coordinated with local planners for the ultimate build-out of the facility.

Digitally signed by George C Lukes
DN: c=US, o=TrustID personal certificate, ou=Utah, cn=George C Lukes, email=glukes@utah.gov, 0.9.2342.19200300.100.1.1=A01413E0000131D8A1B3EF00013CC9
Date: 2011.09.29 14:49:29 -06'00'

Statewide Pre-construction Engineer

Comments:

FHWA Approval*

(*If required per current Stewardship and Oversight Agreement)

Comments:

**Approval of Design Exceptions for all highway improvement projects on the NHS or Interstate System is considered to be a Federal Administrative** Action as specified in 23 CFR 771.107, and as such must comply with the National Environmental Policy Act (NEPA). For Design Exceptions on a Federal-Aid project (or state funded project where a NEPA action was taken), the Design Exception is covered by the previous NEPA action. For Design Exceptions on projects where there has been <u>no previous NEPA action</u> FHWA intends to programmatically classify these actions as Categorical Exclusions (CE) pursuant to 23 CFR 771.117(a), provided there are no unusual circumstances (23 CFR 771.117(b)) or significant environmental impacts. Signature above by the Statewide Pre-construction Engineer confirms that NEPA has been completed for approved Design Exceptions.

Abbreviations used without definitions in TRB publications:

| | |
|---|---|
| AAAE | American Association of Airport Executives |
| AASHO | American Association of State Highway Officials |
| AASHTO | American Association of State Highway and Transportation Officials |
| ACI–NA | Airports Council International–North America |
| ACRP | Airport Cooperative Research Program |
| ADA | Americans with Disabilities Act |
| APTA | American Public Transportation Association |
| ASCE | American Society of Civil Engineers |
| ASME | American Society of Mechanical Engineers |
| ASTM | American Society for Testing and Materials |
| ATA | American Trucking Associations |
| CTAA | Community Transportation Association of America |
| CTBSSP | Commercial Truck and Bus Safety Synthesis Program |
| DHS | Department of Homeland Security |
| DOE | Department of Energy |
| EPA | Environmental Protection Agency |
| FAA | Federal Aviation Administration |
| FHWA | Federal Highway Administration |
| FMCSA | Federal Motor Carrier Safety Administration |
| FRA | Federal Railroad Administration |
| FTA | Federal Transit Administration |
| HMCRP | Hazardous Materials Cooperative Research Program |
| IEEE | Institute of Electrical and Electronics Engineers |
| ISTEA | Intermodal Surface Transportation Efficiency Act of 1991 |
| ITE | Institute of Transportation Engineers |
| MAP-21 | Moving Ahead for Progress in the 21st Century |
| NASA | National Aeronautics and Space Administration |
| NASAO | National Association of State Aviation Officials |
| NCFRP | National Cooperative Freight Research Program |
| NCHRP | National Cooperative Highway Research Program |
| NHTSA | National Highway Traffic Safety Administration |
| NTSB | National Transportation Safety Board |
| PHMSA | Pipeline and Hazardous Materials Safety Administration |
| RITA | Research and Innovative Technology Administration |
| SAE | Society of Automotive Engineers |
| SAFETEA-LU | Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005) |
| TCRP | Transit Cooperative Research Program |
| TEA-21 | Transportation Equity Act for the 21st Century (1998) |
| TRB | Transportation Research Board |
| TSA | Transportation Security Administration |
| U.S.DOT | United States Department of Transportation |