Quantifying the Benefits of Context Sensitive Solutions

DETAILS

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NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

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Quantifying the Benefits of Context Sensitive Solutions

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FOREWORD

By Edward T. Harrigan
Staff Officer
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This report presents guidelines for quantifying the benefits of applying the principles of Context Sensitive Solutions (CSS) to transportation projects. The report will be of immediate interest to the staff of state and municipal agencies with responsibility for planning, programming, developing, and operating transportation projects of all types and sizes.

As more organizations apply CSS principles, evidence continues to grow that measurable benefits result from this broadly informed and flexible approach to all phases of transportation decision making. Involving stakeholders in decision making yields transportation solutions that balance environmental, engineering, community, mobility, funding, and safety needs with the minimum of delay and controversy.

The strategic, appropriate application of CSS principles is expected to yield significant quantifiable benefits. However, evaluation of the benefits of transportation programs is often limited to those that are most easily measured, such as cost savings accrued from reduced travel times, emissions, environmental impacts, and operations. Such evaluations can produce an abundance of data that may address a particular mode, for example, transit or highways, and specific, easily quantifiable aspects such as ridership, noise levels, wetland impacts, and arterial capacity. Data on less readily quantifiable aspects are often lacking. Thus, the overall economic impacts of CSS, in terms of achieving value-added benefits and reducing costs and delays, are not well documented, despite their great potential value to agencies and stakeholders working to deliver real-world projects and advance the national implementation of CSS.

The objective of this research was to quantify the benefits of the strategic, appropriate application of CSS principles in transportation planning, programming, project development, and operations. This objective was accomplished through the development of (1) recommended guidelines for quantifying the benefits of applying CSS principles on a continuous basis in all aspects and stages of a transportation project; (2) reliable performance measures to gauge the principle-based, benefit-justified process and enable its continuous improvement; and (3) supporting commentary and training materials for state and municipal transportation agencies to use in applying the guidelines to their own projects.

The research was performed by the University of Kentucky, Lexington, Kentucky. The report fully documents the identification of a wide range of CSS cases studies and the results of the forensic analyses of the case studies to support the development of a sound methodology to estimate specific benefits accruing from the application of a defined set of CSS principles.

The report includes a separate, independent document providing specific guidelines for agencies wanting to continually, concurrently assess the benefits of applying the set of CSS principles to their own transportation projects. This guidelines document is under consideration for possible adoption by the AASHTO Highway Subcommittee on Design.

PREFACE

This document, produced in fulfillment of NCHRP Project 15-32, "Context Sensitive Solutions: Quantification of the Benefits in Transportation," consists of the following:

- A final report, which presents information collected and analyzed as part of the study, including, in particular, identification of a wide range of context sensitive solutions (CSS) cases studies and the results of the forensic analyses of the case studies to support the development of a sound methodology to estimate specific benefits accruing from the application of a defined set of CSS principles; and
- Guidelines for agencies wanting to continually and concurrently assess the benefits of applying the set of CSS principles to their own transportation projects.

Chapter 5 of this final report describes the layout of the Guidelines. It serves as a bridge to the Guidelines, an introduction to their content, and a description of training materials available to state DOTs for use in training their staffs.

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SUMMARY

Quantifying the Benefits of Context Sensitive Solutions

In recent years, Context Sensitive Solutions (CSS) has been promoted by both AASHTO and FHWA as a best practice for project development. CSS provides a systematic and comprehensive approach to project development from inception and planning through operations and maintenance. The ability to categorize and measure the benefits of CSS projects is vital to the long-term success of this approach.

The objective of this project is to develop a guide for transportation officials and professionals that identifies a comprehensive set of performance measures of CSS principles and quantifies the resulting benefits through all phases of project development. To develop these CSS performance measures, a two-phased approach has been employed. The first phase involved a review of literature; a review of existing (documented) case studies; identification of potential examples; and the development of a methodology for data collection and analysis. In the second phase, the selected example cases were closely evaluated and analyzed using measurement tools to be developed and applied to determine the benefits of applying CSS in a range of contexts. A guide was developed based on the understanding of these case studies and the issues identified throughout the process.

The literature review indicated that while some relevant research has been conducted, there have been few attempts to systematically develop metrics for quantifying the benefits from applying CSS before, during, and after project development. However, there are models and tools that could be adapted from other customer-oriented processes and business management approaches. The reviewed documents regarding the CSS principles assisted in developing and refining the principles used in this research. Most of the agencies that have experience with CSS applications have attempted to define principles that will guide their actions. However, there have been few coherent efforts to identify the applicable principles from the outset of a project and track their impact on the goals of reduced time and costs.

A fundamental aspect of this research effort is the identification of CSS action principles and their potential benefits. Based on past experience and efforts from other transportation agencies, a set of principles was developed along with associated benefits. A matrix that correlates benefits to specific CSS principles was also generated to allow for the development of appropriate metric indicators for each benefit. A set of primary benefits for each principle was identified to capture the essence of each principle and to identify and analyze a manageable number of benefit metrics.

The next step entailed identification of candidate projects for consideration as sources for performance measure evaluation. A group of 33 cases was identified that provides for adequate coverage of practice based on several selection criteria, such as geographic distribution, principle and benefit coverage, modes used, and project phases completed.

A set of metric indicators for each primary benefit was identified to allow for quantifying the benefits accrued from the application of each CSS principle. The set, as constituted,

includes a series of quantitative and semi-quantitative indicators. Tools necessary for the data collection have been developed and are discussed along with the targeted audience.

Guidelines for benefit analysis have been developed to provide transportation agencies with a set of recommended practices for assessing benefits of CSS projects. Central to these practices is the understanding and use of CSS principles that guide project development and delivery. Once the benefits of the principles are identified, associated metrics can be determined to quantify the effect of these actions for the agency and the community. Therefore, the guidelines emphasize the fact that CSS is a principle-driven, benefit-justified effort that can enhance an agency's goals and interaction with stakeholders and the public. The need exists to be able to analyze and measure the benefits of CSS and its impact on projects (e.g., cost and delay) in order to demonstrate a best use of agency resources. This need has been addressed with a guide that provides transportation agencies with a recommended method and appropriate tools.

Each transportation project is unique in terms of the nature, scope and importance of issues addressed. Those factors impact project purpose and need, community and environmental concerns, topographic and geometric conditions, traffic, safety history, and public priorities. Moreover, the uniqueness of transportation projects determines the intensity with which principles are applied to the project. All principles are intended to apply to all projects (small and large scale) but their intensity changes based on scope, scale, and context. Consequently, the opportunities to realize benefits will vary as well among projects. Thus it is necessary to have an assessment approach capable of accounting for both realized benefits and realized opportunities. This guide allows the benefit analysis to be tailored specifically to an individual project while at the same time providing meaningful data for agency-wide evaluation.

Focusing only on project outcomes will allow for an analysis of benefits, but will not allow for an understanding of how these outcomes were achieved. However, by applying the CSS principles on a project and identifying their potential benefits, a direct link between project actions and benefits can be readily identified. A proactive project approach uses this linkage by setting targets to be achieved for selected benefits and determining principle driven actions that must be made throughout the project development process to achieve these benefits. As a result, the CSS principles provide the foundation for a systematic approach to project development and benefit analysis.

CHAPTER 1

Introduction and Research Approach

Problem Statement

In recent years, Context Sensitive Solutions (CSS) has been promoted by both AASHTO and FHWA as a best practice. CSS provides a systematic and comprehensive approach to project development from inception and planning through operations and maintenance. Its goal is to achieve a project development process that provides an outcome harmonizing transportation requirements with community needs and values. CSS aims to address the question "How do people in this community want to live" before investigating mobility and access solutions. The ability to categorize and measure the broad scope of benefits within projects is vital to the long-term success of CSS in meeting livability and mobility goals. Transportation agencies currently lack the capability and tools that allow them to accomplish this. The development of performance measures will enable evaluation of the benefits of the process and allow state and local transportation agencies to gauge the value of employing CSS and the progress they are making to improve project development.

A key factor in developing benefit evaluation tools is the recognition that transportation projects are unique in terms of the nature, scope and importance of issues addressed. Those impact project purpose and need, community and environmental concerns, topographic and geometric conditions, traffic, safety history, and other public priorities. Moreover, there are guiding principles for CSS and a core of essential elements common to most projects. Those should be identified and considered when conducting CSS project benefit evaluations, since such principles are the cornerstone of the unique project solutions to be developed. A range of measures must be examined to determine those most appropriate for assessing various types of project results and benefits.

Research Objectives and Approach

The objective of this project is to develop a guide for transportation officials and professionals that identifies a comprehensive set of performance measures of CSS principles and quantifies the resulting benefits through all phases of project development. This research effort will provide transportation agencies with CSS project examples and tools for identifying and quantifying the benefits of applying CSS principles.

To address CSS performance measures, a two-phased approach was developed. The first phase involved a review of literature, review of existing (documented) case studies, identification of potential examples, and the development of a methodology for data collection and analysis to be used. In the second phase, the selected example cases were evaluated and analyzed using measurement tools developed and applied to determine the benefits of CSS in a range of contexts. Specifically, the work was completed through the following tasks accomplished in two phases:

Phase I

- Task 1: Review of literature and research work relevant to quantification of CSS benefits in transportation planning, programming project development and operations, and identification of potential case studies for review.
- Task 2: Development of a work plan to quantify benefits of CSS applications in a range of examples among those identified in Task 1.
- Task 3: Development of an interim report and work plan.

Phase II

- Task 4: Acquisition of the appropriate case study data and analysis of the data to estimate CSS benefits.
- Task 5: Development of guidelines that could be used by professionals in applying CSS principles and estimating benefits from their application.
- Task 6: Preparation of final report.

This research envisioned the estimation of the benefits from the application of the CSS approach. The team accomplished this by first establishing the action principles required to accrue benefits for CSS projects and then developed a process that

allows transportation agencies to systematically collect data to accomplish such evaluations. This process is envisioned to be applied in all types and sizes of projects. The use of case studies to determine and estimate benefits resulted in a forensic approach, which proved to be a difficult process to obtain sufficient data to allow for a comprehensive estimation of such benefits. Consequently, this research strongly suggests a more concurrent time-linked approach for estimating the benefits to accrue from the application of CSS principles. Moreover, this research identified steps to be taken and good practices that could be followed in order to improve the use of a principle-based, benefit-justified process. Therefore, the results presented here provide the foundation for a continuous performance evaluation and opportunity for process improvement for transportation agencies using CSS.

Organization of the Report

This report documents the findings of the research work completed in establishing a procedure for identifying CSS principles and measuring associated benefits from CSS applications. The results of this research are included along with recommendations for future research. The components of this report are as follows:

- Chapter 2 Literature Synthesis—presents the current knowledge on benefits and other issues relative to CSS approach.
- Chapter 3 Research Approach—documents the methodology followed to develop the approach and analyze the collected data.
- Chapter 4 Findings—includes a discussion of principles and benefits developed and presents the framework for estimating benefits as well as results from the analysis.
- Chapter 5 Guidelines—presents the proposed guidelines for the CSS principles and benefits as a result of this research.
- Chapter 6 Conclusions—includes a summary of the study objectives, project findings, and recommendations for future research work.

CHAPTER 2

Literature Synthesis

Agencies involved in transportation project development usually seek to create a safe facility and system that provides adequate transportation choice, mobility and access, and that is financially feasible and contributes to community economic development. There are traditional means of measuring project results including changes in delays and safety, environmental impacts and total project cost. Other outcomes are not addressed for a variety of reasons including the lack of appropriate measures and systematic means to collect needed data. In an era where many governmental decisions are viewed from a results-oriented business perspective, measures need to be established to evaluate the final product. That requires the identification and evaluation of metrics that can address the entire project development process. Quantifiable and semi-quantitative metrics can demonstrate the utility and value-added potential of CSS principles to improve the entire process. That includes action principles, such as bringing together the transportation agency with the project's stakeholders in the early phases of project development not commonly considered in benefits analysis for transportation projects.

Quantitative and qualitative summaries of CSS principle-driven data are needed to allow transportation agencies to understand and evaluate benefits that accrue from projects incorporating CSS. Little information exists that provides tools for transportation agencies interested in evaluating the benefits of CSS applications. However, most state and other transportation agencies have developed some performance measures for their internal operations. Those procedures can be used to provide narrowly defined status information. This was a major finding of the recently completed NCHRP Project 20-24(30) and one of the recommended areas for future research (*1*). In the business sector, many useful performance measures that have been identified could be adopted for use in various aspects of project development.

The following section of this synthesis discusses some of the general CSS project development issues followed by a review of CSS principles and benefits and other information on performance evaluation and benefit assessment.

CSS Project Development

The importance of employing CSS principles on all transportation projects was emphasized in the FHWA Flexibility in Highway Design Guide (*2*). Subsequently, CSS principles were included in the Vital Few Goals of the FHWA (*3*) and in the *AASHTO Guide for Achieving Flexibility in Highway Design* (*4*). Those documents promote the concept of flexible design. They emphasize a holistic approach using multidisciplinary teams and involving all stakeholders early, often and throughout the project development process. A series of feedback loops are needed to bring project team members and stakeholders together. As with any goal-oriented initiative, there should be a way to measure the benefits. Presently there is no systematic way to measure success from the application of a CSS process. This lack of formal benefit analysis may have contributed to skepticism among some transportation agencies reluctant to employ CSS due to concerns of added costs and project development time.

Multimodalism has become more prominent in the development of new projects. A problem for evaluating this multimodal approach is the lack of a means that could estimate the levels of choice, access and mobility of all users of the system. Another shortcoming is the lack of a proper measurement of transportation impacts on livability and land uses along the corridor. The current system of rating transportation is Level of Service, which is concerned exclusively with vehicle mobility. Evaluation of transportation needs based solely on this criterion often leads to construction of larger roadways which may not always be necessary or desired by the community. A recent method to better estimate the mobility levels of all users of a transportation system has been developed through a real world demonstration of a tool designed to measure accessibility to various modes of transportation (*5*). Neighborhoods are

graded using the Real Accessibility Index (RAI), a tool created by students and faculty at the University of Virginia School of Architecture, but not yet applied to actual project development. The RAI is a method of scoring automobile, bicycle, transit, and pedestrian travel links between residents and services and also within neighborhoods. Each mode is given equal weight in the overall score, which will be converted to a letter grade for easy comprehension. Localities using this method can determine priorities for improvements on measured criteria and work towards creating a truly balanced transportation system.

Another element that has been considered vital to CSS project development is the successful implementation of environmental commitments. A recently completed domestic scanning tour identified actions of several state highway agencies to ensure successful implementation of such commitments (*6*). The FHWA considers proper implementation of those commitments to be a key for proper environmental stewardship. This includes actions in both project delivery and maintenance & operations. Seven states had actions/tools that were identified as being helpful in environmental commitment implementation. Those were: (1) promoting an agency environmental stewardship ethic, (2) appropriate environmental staffing, (3) environmental training for project consultants, (4) guidance documents promoting addressing environmental issues, (5) commitment assurance (tracking of commitments), (6) commitment tracking tools, (7) public involvement, and (8) interagency cooperation. Taken together, these provide a comprehensive set of actions to document and ensure public satisfaction with implementation of most CSS-related commitments.

CSS Principles and Benefits

"Context Sensitive Design" and "Thinking Beyond the Pavement" were the early terminology used to define the context sensitive approach because emphasis was placed on roadway design. To address the wider spectrum of context sensitive issues that exist from planning through construction (and beyond), the terminology has evolved into Context Sensitive Solutions. Several qualities that define excellence in transportation design projects were identified in the seminal Maryland workshop (*7*). They are the following:

- The project satisfies the purpose and needs agreed to by the full range of stakeholders. The agreement is forged in the earliest phase of the project and amended as warranted.
- The project is a safe facility for both the user and the community.
- The project is in harmony with the community, and preserves environmental, aesthetic, historic, and natural resource values of the area.
- The project exceeds expectations of designers and stakeholders and achieves a level of excellence in people's minds.
- Project involves efficient and effective use of resources (time, budget, community) of all involved parties.
- The project is designed and built with minimal disruption to the community.
- The project is seen as having added lasting value to the community.

Various transportation agencies have used these as a foundation for developing and customizing principles associated with CSS. The Minnesota DOT has developed the following as their CSS principles:

- "Balance safety, mobility, community, and environmental goals in all projects.
- Involve the public and affected agencies early and continuously.
- Address all modes of travel.
- Use an interdisciplinary team tailored to project needs.
- Apply flexibility inherent in design standards.
- Incorporate aesthetics as an integral part of good design" (*8*).

The Kentucky Transportation Cabinet (KyTC) has developed a set of CSS operational principles that include the following:

- Create a multidisciplinary project team having a trained project manager and both an environmental coordinator and public information officer assigned to support the team.
- Develop a public and stakeholder involvement process through a unique public involvement plan/program for each project.
- Prepare purpose and need statement that includes context issues and concerns along with the transportation problems that becomes a true litmus test for gauging project solutions.
- Consider all the laws and regulations regarding highway facility development.
- Apply the flexibility available in roadway design guidelines.
- Provide esthetic treatments and enhancements where appropriate to the context.
- Meet all the promises made throughout the planning, project development, and construction phases.
- Provide a safe facility for both users and community.
- Coordinate and collaborate with stakeholders and other government entities for continued facility maintenance (*9*).

It is apparent that most of the agencies experienced with CSS applications have attempted to either develop or refine existing statements of principles that will guide their actions and address their particular shortcomings. However, there have been no documented coherent efforts where CSS prin-

ciples were set from the outset of a project such that outcomes could be measured as a result of applying those principles. For most transportation agencies, the primary goals are decreased time and costs for projects delivered. Those goals often guide actions to realize them, but sometimes such actions are developed in an ad hoc manner. In addition, the focus on these two goals often disregards other potential benefits that could result from the application of other CSS principles that could be equally important. Such additional benefits often are of prime importance to stakeholders and the public and consequently the transportation agency. Moreover, there have been no methodical project evaluations where projects incorporating CSS were compared to conventional projects. Such comparisons may permit evaluations and benefit ratio estimations, but care must be exercised in ascertaining the equivalence of the subject projects. With or without comparisons in mind, it is therefore important to establish outcome-based performance measures that will allow for a structured way to evaluate benefits from the application of CSS principles. To establish such a process, principles should be identified, associated benefits determined, and metrics formulated prior to the outset of a project to allow for a systematic assessment of the process.

NCHRP Report 480: A Guide to Best Practices for Achieving Context Sensitive Solutions provides a statement of CSD/CSS vision (drawn from the Maryland workshop) in terms of project qualities and process characteristics (*10*). The report presents a detailed view of CSS as developed in four major "project-focused" categories:

- Effective Decision Making,
- Reflecting Community Values,
- Achieving Environmental Sensitivity, and
- Ensuring Safe and Feasible Solutions.

The report provides two further levels of classifications for each of those categories resulting in an extensive collection of CSS principles and objectives.

The CSS approach typically does not require the creation of steps beyond those normally employed in the project development process. However, significant changes are required in the focus and extent of all project development process actions and especially in these dealing with public input and involvement. For example, all stakeholders must be identified and involved from the outset of a project and throughout its development process until the ribbon-cutting day which may also require enhancement of the public involvement process. Adherence to CSS principles requires transportation agencies to solicit meaningful input from the public and stakeholders in order to identify potential issues and concerns, to inform stakeholders of the tools and opportunities, and to seek "informed consent" of all participants. Consequently, those concerns can be resolved early in a project to produce increased community satisfaction and avoid costly delays.

Transportation agencies are becoming aware of the need to develop more business-like practices to improve customer satisfaction and to reduce product delivery time and costs (*10*). State transportation agencies will benefit from additional efficiency and effectiveness as that contributes to trust and accountability. Those will accrue over multiple projects/time through better project predictability, reduced project delivery times, improved public image, better relations with resource agencies, and more complete community building projects. The decision to adopt CSS can be shown to be a sound business decision if performance measures are applied although it can appear to be a public relations policy that wastes resources. Regardless of how all such business-like initiatives are viewed, they provide transportation agencies with favorable outcomes that can be evaluated and/or measured to assess performance and develop goals/actions that can improve performance.

Of interest in measuring the benefits of public involvement is the potential difference in the perception of the expectations and reality for a given project. Past work has documented that such a difference exists and it could be measured with a tool developed by Arnstein that utilizes an eight-step scale characterizing levels of public involvement in planning (*11*). These steps are shown in Figure 1.

Arnstein's Ladder is well known to the professional planning and design community and has been recently used as an index for measuring perceptions of public involvement in transportation projects (*12*). Data collected for several projects in three states attempted to evaluate the level of difference

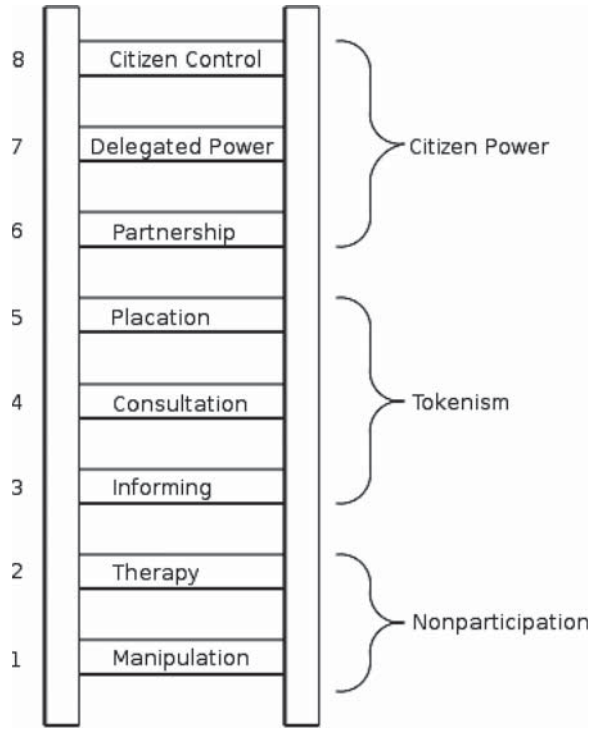


Figure 1. Arnstein ladder of public participation.

between the current status of public involvement and the desirable level for future projects. The results showed that even though the current situation is not ideal, actual public confidence in public involvement and input solicitation is not at rock bottom. The mean of the responses lies at 3.6, i.e., somewhere between "informing" and "consultation." The data for the desirable level of public involvement indicated a strong agreement that, across all types of projects and circumstances, the closest named step on the Ladder to the ideal point is "partnership." This finding suggests that the public clearly recognizes the expert domain of engineers and planners, which is in contrast to what commentators and academics have often assumed that the most desirable condition is the top rung of "citizen control" (*13*). The difference between the perceived and desired positions is called the *Arnstein Gap,* which is a heuristic metric by which the existing quality deficit of public involvement can be measured.

Another aspect that Baily et al. (*12*) identified with the Arnstein Ladder approach was the difference in opinions between the public and transportation professionals. The comparison between the professionals' results with the public polling data indicated that the professionals believe that public involvement is more effective than the public does. The tests indicate that there is a significant difference between the responses of the professionals and the public noting that the public evaluates the quality of public involvement differently than professionals.

There have been few cases where CSS practices have been documented indicating the application of some of the principles discussed here and the realization of some benefits. A post-construction review of the Glenwood Canyon section of I-70 in Colorado was completed to provide a perspective of the benefits achieved through the innovative and collaborative processes followed during its design and construction in the early 1990s (*14*). The review showed recognition for the benefits achieved by an early CSS project, even before the term was coined. This widely recognized and lauded CSS project was reviewed to determine whether it had met it goals of: (1) improved mobility; (2) reduced congestion; (3) environmental and aesthetic harmony with the existing environment; (4) better multi-modal access (for bikers) and pedestrians (hikers); and (5) improved accommodation for tourists. Some criteria such as crash reduction and improved mobility were evaluated quantitatively. Others, such as environmental impacts and tourist access were based upon opinions of project participants and resource agency representatives. This review indicates that certain benefits for a project completed more than 10 years earlier can be measured as long as the data is available. In some instances, a nominal amount of time must elapse after project completion to determine the success of certain CSS outcomes such as safety improvements, environmental actions, multi-modal accommodation, and recreational enhancements.

Performance Evaluation and Benefit Assessment

Transportation agencies have focused on the mechanics of CSS and consider it to be unique to the transportation sector. They have overlooked analogous practices that predate CSS and that have existed in government and other sectors. These have sufficient similarity and function to be studied and, where applicable, adopted by transportation agencies for CSS applications. Prior to the introduction of CSS, roadway design was typically left to the state transportation agency that was responsible for all aspects of a road including its size, alignment, appearance, construction, and maintenance. Primary factors governing design were safety, mobility, cost, and available funds. This was not untypical in the private industry where design decisions were made by design and production engineers independent of any customer input. A famous example of this is when Ford provided Model Ts only painted in black (which dried more quickly than other colors). Fixation on simplifying production and reducing cost opened the door to competitors such as General Motors. For many years, the design process and function of any manufactured item was solely left to the province of the engineer, and customer input was not sought. If the customer was dissatisfied with a product, the problem was addressed after production, if at all. CSS entails early contact with the public and other stakeholders to get input. It also incorporates a flexible design to provide roads that meet public/stakeholder requirements, some of which have a substantial legal basis. The "voice of the public/stakeholder" has become as important in CSS as the "voice of the engineer."

The quality management approach also has been extensively used in the business world (and by transportation agencies for pavement management). In part, quality management is used to determine goals and identify metrics used in performance measurement. Quality management employs quantitative analysis and analytical approaches in assessing performance or improvement initiatives. The use of such an approach will improve quality, operational efficiency, and profits; in the case of transportation agencies, it can create better use of limited (public) funds.

For many years government agencies have dabbled with performance measurement. Nearly every major federal entity has periodically developed mission and vision statements and subsequent strategic goals and objectives. Thereafter, they have established performance measures in order to gauge their progress. This phenomenon is not new nor is it limited to federal agencies; it has been applied to specific federal programs and to state and local governments and their programs. Concerns about government performance have led to investments in advanced management tools for outcome-based measurement according to the National Center for Public Productivity. They have prepared a guide for developing performance measurement systems (*15*). The GAO's long standing defini-

tion of public sector performance states that it includes measures of (1) productivity, which quantifies outputs and inputs; (2) effectiveness, comparing outputs with intended accomplishment; (3) quality, which examines an output by (actual or perceived) attributes; and (4) timeliness, the time involved in producing the appropriate output. Specific kinds or sets of performance measurement indicators (input, output, efficiency, effectiveness, and productivity measures) have been developed to focus on each of these performance types. According to the Center's guide, the criteria for "a good set of performance measures" includes the following:

- Valid,
- Reliable,
- Understandable,
- Timely,
- Resistant to perverse behavior,
- Comprehensive,
- Non-redundant,
- Sensitive to data collection cost, and
- Focused on controllable facets of performance.

State transportation agencies have not been immune to these management improvement initiatives. For example, California, Minnesota, Oregon and Texas experimented with performance measures at programmatic levels and on the state's transportation system (*16, 17*).

Estimating user benefits and costs from transportation projects are not new concepts. Significant efforts by AASHTO in developing such guidance date to 1977 with the *User Benefit Analysis for Highway and Bus Transit Improvements* (i.e., Red Book) (*18*). The objective of the original and new (2003) manuals is to identify mechanisms used to measure user benefits that come from improvements to transportation facilities. These benefits pertain to changes in travel time, operating costs, and crashes. The presence of additional benefits and costs that result from a transportation improvement is noted. However, estimation of such items is considered outside of the scope of the manual. Despite that omission, the potential to evaluate the impact of a transportation facility on additional elements, such as satisfying the stakeholder, achieving the original purpose and need, and developing projects that add value to communities, has been recognized by transportation agencies.

NCHRP sought to obtain a guide for assessing the socioeconomic effects of transportation projects (*19*). The resulting guide defined the effects of transportation projects, which included changes in travel times, safety, vehicle operating costs, and the means to measure them. It also included the social and economic effects from such projects, which include community cohesion, economic development, traffic noise, visual quality, and property values. Means to estimate these effects were also identified and discussed. The guide also provided information on determining the applicability of the measures to various scenarios, the steps to be taken for the analysis, and the appropriate methods for analysis. Though some of these could be used to measure the benefits of CSS, they have not been applied in a consistent, comprehensive manner. Therefore, these approaches have not yet been applied to CSS projects, and thus their effectiveness has not been documented. It is reasonable to assume that some of these metrics could be useful in this research. Among the areas that show some promise are the metrics suggested for safety, transportation mode choice, community cohesion, and aesthetic value of the project. (An extended summary of the relative sections of the report to this study is presented in Appendix A.)

In another study, a set of guidelines was developed for analyzing investments in bicycle facilities (*20*). The study developed a basic analysis tool for estimating the costs associated with various bicycle facilities and the potential resulting benefits from such applications. This tool was developed for transportation planners to get a basic cost-benefit estimate for including bicycle facilities. The study developed estimates for associated benefits in health, mobility, and recreation and provides transportation agencies with a tool in supporting their decisions regarding the provision of bicycle facilities.

The Florida DOT has recently developed a guide for *Measuring the Effectiveness of Community Impact Assessment* (*21*). This guide used the project qualities defined in the Maryland workshop to identify the key areas where measures could be used to assess the impact of the community involvement during project development. The guide identified the required data for each of these measures and suggested analysis techniques to evaluate the impact of each measure. It is probably one of the few documents that has a direct correlation to this research, since the key areas identified are very closely related to several CSS principles used here. (A more detailed description for each element is presented in Appendix A.)

Several transportation agencies have formulated measures that could evaluate the benefits from CSS applications. The Maryland State Highway Administration uses a performance measurement tool (a set of forms) to collect data for evaluating CSS projects (*7*). Included are survey forms for both stakeholders and project team members. A list with the data to be collected for project performance evaluation is included along with metrics that could facilitate an economic analysis of project impacts. In a similar effort, the Kentucky Transportation Cabinet is developing the Kentucky CSS Project Archive, which is an electronic database of all CSS projects completed in Kentucky. A benefits assessment will be obtained through lessons learned and it will identify outcomes that should be evaluated for performance measures (*22*).

After the passage of the ISTEA legislation in 1991, an NCHRP study was conducted to develop a guide for performance-based transportation planning (*23*). The guide was intended to aid transportation agencies in developing transportation

plans. Performance measures were to be developed that would allow those agencies to monitor and enhance planning practices. Benefits from that approach include the ability to direct resources to projects that have the best potential investment returns, an improvement in the decision-making process, and better accountability and performance reporting. Some measures described in this report related to outputs and outcomes. An output measure "reflects the quantity of resources used, the scale or scope of activities performed by an organization, and the efficiency in converting those resources into some type of product." These types of measures basically evaluate how well resources are used. Outcome measures attempt to show how well stated goals and objectives are met. These measures also examine customer satisfaction. Having both output and outcome measures can be very valuable in evaluating performance in a transportation project.

The report also discusses the required steps for identifying the data needed to evaluate those measures, the analytical tools available and finally reporting the results. Data sources include surveys, traffic monitoring, customer satisfaction and perception data, highway performance monitoring system and the analytical process associated with a project, and intelligent transportation systems. Analytical tools discussed in the report include urban travel demand forecasting models, statewide travel models, travel survey manuals, benefit/cost models, and incident-related effects and incident management strategies. While this report does not discuss specific measures for quantifying the successes or otherwise for context-sensitive solutions, it does provide some background on the methods that could be used for determining those measures, as well as analytical methods for evaluating such measures.

Another NCHRP report examined the benefits from implementing bicycle facilities and determined methods to estimate such benefits (*24*). Bicycling is an alternative transportation mode and therefore measuring the benefits of adding bicycle facilities can be a useful metric in examining CSS benefits. Some of the benefits of bicycling include direct benefits of mobility, health, and safety, and indirect benefits to society such as increased livability, decreased externalities, and fiscal savings. Methods for collecting data for analyzing these benefits include preference surveys, crash histories, utility models, score cards, and project costs. Many bicycle facility types (i.e., bike lanes) provide up to 22 benefits for all highway users. Thus, it is essential that when facility types are considered, they are not based solely on the need to serve bicyclists, but, instead, as part of an overall quality highway design that benefits all users.

A report by Thompson (*25*) documents development of a model for estimating the impact of environmental and cultural amenities on highway projects. It allows transportation planners to estimate the value of an amenity by selecting the environmental or historic amenity impacted, the magnitude/intensity of the impact (number of acres impacted), and the setting/context (urban or rural). The amenity groups that were examined and their value estimated included wetlands, farmland, endangered species, vacant lots, parks, view sheds, and historic buildings. This may be one of the few research efforts that have attempted to provide economic values to elements that have been traditionally difficult to quantify.

The Oregon DOT has established and is monitoring a significant number of performance measures for the Oregon Bridge Delivery Program (*26*). Those performance measures address: maintaining freight mobility and traffic management, expedient and cost-efficient delivery, economic stimulation, context sensitive and sustainable solutions, workplace safety, workforce diversity, and customer satisfaction. These measures are being used to evaluate this long-term program and may be used to indicate the need for modifications. They are also being used to develop program-level incentive and disincentive clauses for construction contracts.

Summary

The literature review indicated that while some relevant research has been conducted, there have been few attempts to develop metrics for quantifying the benefits from applying CSS before, during, and after the project development. However, there are models and tools that could be adapted from other customer-oriented processes and businesses management approaches.

"Customer" satisfaction is the goal for several of the processes examined, and this could be extended to the transportation agencies as well. To gauge such satisfaction, surveys or score cards are commonly utilized, and these will be the main tools for data collection in this research. Customizing these tools and then standardizing their application for estimating the desired metrics is essential in obtaining accurate information.

The reviewed documents regarding the CSS principles will also be of assistance in developing and refining the principles to be used in this research. Most of the agencies that have experience with CSS applications have attempted to systematically define principles that will guide their actions. However, there have been few coherent efforts to identify the applicable principles from the outset of a project and track their impact on the goals of reduced time and costs. Moreover, there have been no methodical project evaluations that could compare these impacts to other projects where the principles were not applied. Where comparisons are desired, it is important to establish an outcome-based performance evaluation that allows for a structured approach to evaluate benefits from the application of the CSS principles.

CHAPTER 3

Research Approach

This chapter presents the methodology followed for the completion of the research. The first section presents the development of the principles and associated benefits while the following section presents the case study selection process criteria and the data collection and analysis approach.

Principles and Benefits

A fundamental aspect of this research effort is the identification of CSS principles. As noted previously, several efforts have been completed to date that attempted to identify and document such principles. The team considered the project development process and identified associated actions that could be considered the cornerstone for the activities to be completed in each phase as a starting point. These actions include the identification of the appropriate project players including the team members to participate in project development and the stakeholders that could have an influence on the project, along with the definition of the process to be followed for the project development, the goals to be achieved through this process as a result of the process, and the actions required to assure that the project was a success. Using the team's multidisciplinary expertise a set of principles was developed during a half-day work session and presented in Table 1.

The next step in this process involved the identification of potential benefits that could result from the application of each specific action principle. The benefits were grouped in two basic categories based on who receives the benefits, i.e., the agency or the users/community. It is important to distinguish benefits based on the potential beneficiaries, since some of these benefits are internal to the agency's operations and will have no direct impact on users. This provides a distinct separation for the agency to determine those benefits that could be internal to the agency as well as those that the users/community will receive. The list is provided in Table 2 (the first 11 are agency benefits and the last 11 are benefits primarily associated with users/community).

At the same time, AASHTO had also developed a set of principles that were reviewed and considered in this research (*27*). As a general guideline for performance measuring, a principle should be concisely focused, self explanatory, and capable of conveying intended actions. Therefore, it was deemed appropriate to define a comprehensive framework that could be used by AASHTO in CSS language that includes action principles. In order to coordinate and combine this research with their work, a hierarchical structure was developed, where the CSS Goal is defined as the very general statement of what a project should target followed by the CSS Core Strategies (the five AASHTO "principles"), the CSS Action Principles (the 15 principles presented in Table 1), and the fundamental CSS Benefits (a "select few" of the 22 benefits in Table 2). This new description concept is presented in Table 3.

This approach allows for a unified format where the core strategies (AASHTO's broad "principles") are first stated followed by the action principles needed to achieve them and concluding with the fundamental benefits to be measured to assure the proper implementation of the process. It should be noted that the fundamental benefits capture mostly those that are perceived by the users/community and are considered essential in delivering a contextual solution.

Case Study Selection Process

The development of the performance measures in this research effort is based upon the identification of case studies and the collection of data to demonstrate the estimation of such benefits from applying the CSS principles. Therefore, candidate projects were identified for consideration as sources for performance measure evaluation. A large number of such candidate projects were initially developed based on a variety of sources and included more than 100 cases. The projects

Table 1. CSS principles.

1.	Use interdisciplinary teams.
2.	Involve stakeholders.
3.	Seek broad-based public involvement.
4.	Use full range of communication strategies.
5.	Achieve consensus on purpose and need.
6.	Address alternatives and all modes.
7.	Consider a safe facility for users and community.
8.	Maintain environmental harmony.
9.	Address community and social issues.
10.	Address aesthetic treatments and enhancements.
11.	Utilize full range of design choices.
12.	Document project decisions.
13.	Track and meet all commitments.
14.	Use agency resources effectively.
15.	Create a lasting value for the community.

included in the preliminary list were derived from the following sources:

- The 2005 and 2006 submissions for the AASHTO Center for Environmental National Context Sensitive Solutions Competition;
- A 2002 report by Kentucky Transportation Center under contract with FHWA titled "Context Sensitive Design Case Study Documentation" (*28*);
- Cases on the www.contextsensitivesolutions.org web site;
- Cases submitted by the NCHRP panel members; and
- Cases from Kentucky, Pennsylvania, and Florida submitted by team members.

The next step involved the identification of candidate cases that could be useful in the development of performance measures for CSS projects. Prior to their selection, the following criteria were established to allow for selecting cases that will be representative of a variety of conditions and contexts:

- Addressing principles and benefits identified;
- Providing for a geographical representation to assure consideration of terrain, climate, and other key factors;
- Including a variety of development context within urban and rural areas;
- Considering the current phase of the project;
- Including a variety of transportation modes; and
- Representing a range of project scopes, sizes, and types.

Using those criteria, the team evaluated each project in the original list of 112 cases and identified the cases for potential consideration in Phase II. The team reviewed available documentation to develop a basic understanding of each project, created a short summary for each project, and identified the principles used and benefits accrued from the application of CSS. A focus group approach was then undertaken to review all projects and collectively determine the appropriateness of each project. The focus group consisted of a transportation planner, roadway design engineer, safety expert, and project development expert. Each member presented the cases assigned for review and provided an assessment on whether the case is suitable for further consideration. Following a discussion and deliberation, the focus group reached a consensus on including 49 cases in Phase II for further consideration.

Some cases were eliminated from the list because they demonstrated limited scope, inadequate coverage of CSS principles, minor stakeholder and public involvement, or few potential benefits. Several cases were considered marginal because they involved a limited number of principles or they were in geographic regions providing cases with more clearly defined and stronger CSS applications.

Once the list of candidate projects was refined, representatives from the project's transportation agencies were contacted to determine the level of cooperation that could be provided for data collection in Phase II. A telephone contact was initiated where the scope of the research was explained, the project was reviewed, and an assessment of the willingness to cooperate was made. As noted above, a short case description was prepared by each team member that included an assessment of the principles and benefits for each project. This description was provided to the contacted person for verification and evaluation of the accuracy of the information. This allowed for accurately determining the context of the project and the principles applied and benefits accrued. This process also provided a preliminary indication of the cooperation to be achieved during Phase II for the data collection.

Table 2. CSS potential benefits.

1.	Improved predictability of project delivery.
2.	Improved project scoping and budgeting.
3.	Improved long-term decisions and investments.
4.	Improved environmental stewardship.
5.	Optimized maintenance and operations.
6.	Increased risk management and liability protection.
7.	Improved stakeholder/public feedback.
8.	Increased stakeholder/public participation, ownership, and trust.
9.	Decreased costs for overall project delivery.
10.	Decreased time for overall project delivery.
11.	Increased partnering opportunities.
12.	Minimized overall impact to human and natural environment.
13.	Improved mobility for users.
14.	Improved walkability and bikeability.
15.	Improved safety (vehicles, pedestrians, and bikes).
16.	Improved multi-modal options (including transit).
17.	Improved community satisfaction.
18.	Improved quality of life for community.
19.	Improved speed management.
20.	Design features appropriate to context.
21.	Minimized construction-related disruption.
22.	Improved opportunities for economic development.

Data Collection

The data to be collected for this effort has two different forms: (1) quantitative, based on data provided by the agencies

Table 3. CSS principle driven and benefit justified.

Primary Goal: Find a "best fit" transportation solution for the context that meets expectations of the transportation agency, stakeholders, and community.
Core Strategies: • Establish a shared stakeholder vision to provide a basis for decisions. • Demonstrate a comprehensive understanding of context. • Foster continuing communication and collaboration to achieve mutual success. • Exercise flexibility and creativity to shape transportation solutions. • Preserve and enhance community and natural environments.
Action Principles: • Use interdisciplinary teams. • Involve stakeholders. • Seek broad-based public involvement. • Use full range of communication methods. • Achieve consensus on purpose and need. • Address alternatives and all modes. • Consider a safe facility for users & community. • Maintain environmental harmony. • Address community & social issues. • Address aesthetic treatments & enhancements. • Utilize full range of design choices. • Document project decisions. • Track and meet all commitments. • Use agency resources effectively. • Create a lasting value for the community.
Fundamental Benefits: • Increased stakeholder/public participation, ownership and trust. • Improved community satisfaction. • Design features appropriate to context. • Decreased costs for overall project delivery. • Minimized overall impact to human and natural environment. • Improved mobility for users. • Improved safety (vehicles, pedestrians and bikes). • Improved quality of life for community.

on specific benefit metrics; and (2) semi-quantitative, based on survey responses from persons involved in each project. A different set of tools is needed for each type of data to properly collect the required information. In general, a set of forms and tables to be completed by the agency was the main collection tool for the quantitative data and a web-based survey to be distributed to the project team members and stakeholders was the data collection tool for the semi-quantitative data.

The approach considered for collecting the data to be used in the analysis of quantitative data was to request all possible documents and pertinent data from team members and for them to complete forms that would allow for their quantification. This approach was considered more appropriate than requiring team members to identify the pertinent information and complete the forms, since the latter could have resulted in a lower response rate. A list of potential data items to be used for collecting the required quantitative data was developed (Table 4). The various data items requested assist in understanding the conditions of each case and documenting the associated elements including extent of public involvement, role of stakeholders, creation of an interdisciplinary project team, community impacts, environmental impacts, and application of design flexibility. Project team members identified which data were available and the answers were cross referenced to identify the person(s) who could be contacted for providing the required data. This approach allowed for identifying alternates in case the original request was not fulfilled. These data were requested from the appropriate team members with an initial e-mail sent indicating the required data items with a request for a transmittal in any available form (electronic or paper).

A set of web-based surveys was developed for estimating the required semi-quantitative data. The goal of the surveys was to solicit the expert opinions of the project team and stakeholders on the level of satisfaction from the application of the CSS principles on the project and the interaction between the team and the stakeholders. For the project team survey, two versions were developed: one for the team leader/project manager and a second for the team members. Both surveys have a common section that solicits opinion and level of satisfaction from the application of the CSS principles and their associated benefits as well as the levels of interaction between the team and the stakeholders. Both surveys have an additional section where the respondent addresses the availability level of the required data to complete the benefit quantification. This part of the survey was a critical element for two reasons. First, the answers of the team leader/project manager

Table 4. Data list for quantitative elements.

Stakeholder meetings documentation (date, agenda, attendance and minutes/summary).
Public involvement meetings documentation (date, agenda, attendance and minutes/summary).
Public involvement tools used (list and/or samples).
Record of cost estimates and final costs (by phases).
Scope change(s) documentation.
Change order(s) documentation.
Scheduled and actual completion dates (by phase).
Memorandums of agreement with regulatory agencies or other stakeholders.
Alternative and modal options analysis documentation.
Design options analysis documentation (including design exceptions if applicable).
NEPA related documentation (such as Executive Summary, FONSI, EA or EIS).
Capacity analysis documentation.
Crash data by severity and type.
Design speed data.
Operating speed data.
Maintenance of traffic plans (construction phase).
Construction phasing alternatives study.
Maintenance/operating cost records (Before).
Maintenance/operating cost records (After).
Legal actions, decisions or findings documentation.
Project decisions and commitments logs/records.

allowed for determining whether a project would be part of the final case study database. Second, the answers of the team members allowed for determining who should be contacted to obtain the specific data required for the possible quantification of the stated benefits. The survey for the project team members included a more targeted set of questions regarding data availability. It was determined that any requests for available data will be better handled if it was distributed among the various project team members and not solely requested from the team leader/project manager. This way the person who may be able to provide the data was identified. These surveys were pilot-tested and refined appropriately, and a sample is provided in Appendix B.

The survey for the stakeholders requests only opinions on the benefits of the project and their level of satisfaction with their interaction with the project team (Appendix B). Limiting the survey only to benefits was considered more appropriate for the stakeholders, since they most likely could not relate to the CSS principles that the team may have applied. In addition, it was unlikely that stakeholders would have data related to the project, therefore further justifying omission of this section from the survey.

Team leaders/project managers were requested to provide the names and contact information for the project team members and the stakeholders involved in the project. This provided the required information to initiate the surveys to collect the opinion of the team members and the stakeholders' satisfaction regarding the project. The results from the team leader/project manager surveys were used to select the final candidate cases based on the potential availability and coverage of data, since the initial project screening was not sufficiently detailed due to the limited time available for identifying the potential case studies.

All surveys included a set of questions that could be used to evaluate potential differences in the level of satisfaction between project team members and stakeholders to establish the magnitude of the Arnstein gap (which is the difference in the perception or satisfaction of application between the project team and the public).

Data Analysis

As noted above, the approach taken in this research for quantifying the CSS benefits is principle-driven. This implies that the benefits derived from application of CSS principles need to be determined and then quantified in an efficient and practical manner to allow for estimating the magnitude of these benefits. Therefore, the focal point becomes the identification of the most appropriate CSS performance measures as they are manifested through the application of CSS principles. In essence, the key questions become the following:

- What were the CSS principles applied and resulting benefits?
- What is the evidence for having achieved these benefits?
- What are the real-world benefits?

Some benefits yield quantitative metric results (comprised of numerical values that are standard units of measure using a ratio level integer scale with equal magnitude and a fixed zero point) measured in terms of dollars saved, time saved, or an increase or enhancement results in terms of acres or lineal feet. Many economic studies are available to provide

a means to estimate the dollar values of some of the benefits of interest including the value of preserving wetlands and minimizing disruption. Also, economists have developed impact assessment tools that can also assign primary/secondary benefits (in dollar terms) to society for some benefit types including environmental. Benefit can be determined in some instances using principles of benefit-cost analysis such as the case of determining the value of timely completion.

Many benefits can only be evidenced through semi-quantitative assessments which are, none-the-less, real benefit measures. The research team used semi-quantitative methods whenever possible to supplement the other metrics. These semi-quantitative metric methods derive numerical values from rating or ranking scales expressing opinion, attitude, or perception. These metrics are values expressed as integers simply indicating a relative scale position with no absolute zero. Industry uses many such devices to determine customer satisfaction and preference. These methods have become systematic and standardized to provide semi-quantitative measures for before/after comparison, trend analysis, and inter-industry comparison. These same approaches can work for estimating CSS benefits and were employed here using basic statistics that establish maximums, minimums, and averages and to provide for cross-tabulation analysis. The research team intended to develop, test, and provide benchmarks (numerical ranges and/or averages) for many benefit metrics based on the selected series of case studies.

CHAPTER 4

Findings

This chapter presents the findings of the research conducted. First, the principles and benefits are defined and related to each other, and the rationale for their relationships is presented. The final cases selected are presented and then followed by a summary of the quantitative and semi-quantitative results of the collected data.

Principles

The first step in this process was to develop definitions for each principle and identify criteria for application of the principle. This could form the basis for the development of the principles that an agency is willing to apply and determine the fundamental effort level required for their application. Even though each principle is nearly self-explanatory, a definition was deemed appropriate to clearly state the intent of each principle and avoid any misconceptions. The development of the definition and application criteria was also central in the development of the guidelines and used as a brief introduction of each principle. These definitions and application criteria are presented below in the following paragraphs.

1. Use of Interdisciplinary Teams

An interdisciplinary project development team is established early based on the needs of the specific project and is utilized appropriately throughout the project planning, design and construction phases. Criteria for application include the following:

- All appropriate disciplines and team members are identified during each phase of the project, beginning with scoping, and in accordance with the context, extent, and impact of the project.
- Project professionals have the necessary, diverse, and appropriate expertise to move the project successfully through all project phases.
- Team members understand their project role, and the roles of team members vary throughout the project in accordance with their expertise and the project phase.
- Timely, open, two-way communication is maintained among team members.
- Input by all team members is given due consideration.

2. Involve Stakeholders

A full range of stakeholders is involved with the transportation agency as deemed appropriate and preferably beginning in the early stages of the project. Stakeholders to be included are resource agencies, elected officials, citizen/neighborhood organizations, business, and community and interest group representatives. Criteria for application include the following:

- All affected stakeholders are identified at the appropriate phase of the project and solicited for input/updated throughout.
- All stakeholder input is given due consideration.
- Processes are in place to ensure participation by stakeholders is meaningful, timely and can provide informed project decisions.

3. Seek Broad-Based Public Involvement

Involvement is fostered from all interested and affected persons throughout the project development process utilizing a variety of means to solicit participation beyond any required public hearings. Criteria for application include the following:

- The project team identifies all interested and affected persons early in the project development process.
- The project team proactively identifies what information they need from the public and the methods needed to solicit that input.
- Opportunities for public involvement are provided throughout the entire project development process.

- A transparent and rational decision-making process is in place to incorporate public input.

4. Use Full Range of Communication Strategies

A variety of approaches to appropriately engage and solicit input from the stakeholders/public is used in the project development process. Criteria for application include the following:

- The project team employs a full range of communication techniques appropriate to the purpose of the communication and the nature of the participants.
- Communication methods must be used to both disseminate and collect needed information.
- Communication is continued throughout the project and beyond.

5. Achieve Consensus on Purpose and Need

The purpose and need of the project has been established by a full range of stakeholders, the public, the agency, and the project team. Criteria for application include the following:

- The purpose and need statement is developed early in the project development process and is revised as warranted during planning and preliminary design.
- The purpose and need statement is based on consensus of the project team and the interested and affected stakeholders/public.
- The purpose and need statement establishes measures of effectiveness to guide the decision-making process.

6. Address Alternatives and All Modes

All appropriate modes are considered in the evaluation of alternatives and addressed given the project's purpose and need. Criteria for application include the following:

- Alternatives encouraging mode choice capable of addressing the issues in the purpose and need statement are identified and developed.
- Each alternative is developed to its fullest potential appropriate to the stage of the project.
- The "No Build" alternative is considered and is provided as a genuine alternative.
- Alternative evaluation criteria are objective.

7. Consider a Safe Facility for Users and Community

The resulting project creates a safe facility for the project users and the community by addressing any safety issues. Criteria for application include the following:

- A safety review is conducted at each phase of the project with consideration of the needs for all users.
- Input from all modal user groups is sought to better understand their safety needs.
- The project team develops a solution addressing safety concerns.

8. Maintain Environmental Harmony

The resulting project is in agreement with its physical and social setting and minimizes disruption during construction and operations. Criteria for application include the following:

- All natural, human and cultural resources within the study area must be identified and considered in the project development process as early as possible.
- Environmental harmony is determined both by the stakeholders/public and appropriate studies.
- The project strives to enhance resources, not merely maintain them.

9. Address Community and Social Issues

The resulting project addresses the issues identified through stakeholder/public involvement and provides a solution that preserves/enhances the community's resources and values. Criteria for application include the following:

- Through public interaction, the project team investigates and documents the context of the project in terms of community and social resources and how the project may affect that context.
- Proposed solutions are sensitive to the community values and various cultures within the community.
- The project team is open-minded and considers non-traditional solutions that fit the community.

10. Address Aesthetic Treatments and Enhancements

The project develops aesthetically pleasing solutions that result in improvements compatible with community preferences and project context. Criteria for application include the following:

- The process for selecting various elements for aesthetic design consideration involves the appropriate team members and the stakeholders/public.
- Design elements are selected in accordance to the context of the project and reflect the character of the area.

11. Utilize Full Range of Design Choices

All appropriate design options are considered and evaluated by the project team based on agreed project context criteria

and input of the stakeholders/public. Criteria for application include the following:

- Alternative design choices/options are developed that meet the purpose and need of the project.
- Design options developed must avoid, minimize or mitigate impacts to natural, human and cultural resources and attempt to enhance these resources where possible.
- The project designs are sensitive to the community values and various cultures within the community.
- Stakeholder and public input is collected and integrated into design options.

12. Document Project Decisions

All project decisions are documented to create a clear and open record, assure continuity through all project phases, and provide a framework for measuring results. Criteria for application include the following:

- Input from the project team, stakeholders and public involvement activities documenting:
  – The purpose and need statement,
  – Project constraints and their impact on design choices,
  – The full range of alternatives considered in the project,
  – All natural, human and cultural resources within the study area,
  – Potential safety concerns and their treatment,
  – The selection process and design values chosen for each design element, and
  – Construction activities and commitments.

13. Track and Meet All Commitments

All commitments made in the various phases of the project to the stakeholders/public are documented and tracked to assure that they were met in the final solution. Criteria for application include the following:

- Identify and document project commitments in all project phases.
- Ensure that all project commitments are satisfactorily addressed prior to project completion.
- Maintain all project commitments throughout the project development process and over the service life of the facility.

14. Use Agency Resources Effectively

The project has used time, expertise, and budget in an effective way to deliver the project and conserve resources. Criteria for application include the following:

- The project is developed in a timely manner.
- Expenditures are appropriate for the project scope/context.
- The project team has the appropriate support and resources to effectively carry out their task.

15. Create a Lasting Value for the Community

The resulting solution becomes an asset to the community with involved parties agreeing that it meets or exceeds expectations and is compatible with the long term vision of the community. Criteria for application include the following:

- The project meets the purpose and need statement.
- The project is compatible with long range community plans.
- The project incorporates solutions that move beyond addressing mobility and address quality of life issues and community values.
- The project is sustainable in terms of social, economic, and ecological impacts.

Principles and Benefits

The next step in the process was to define the relationship between principles and benefits. While it is reasonable to assume that the application of a principle could result in several benefits, performing such analyses may prove impractical due to the range and quantity of data required. Any performance based measurement should be capable of determining whether the specified benefits are achieved by collecting and analyzing a few key metrics. To produce a useful and usable guide, it was deemed reasonable to identify those benefits that have a strong relationship to each principle. This was more appropriate in capturing the essence of each principle, since it allows for developing specific metrics for a smaller number of targeted benefits. This in turn will limit data collection and analysis encouraging more agencies to utilize the proposed benefit assessment. Some benefits will have multiple indicators that could be used to measure their impact and effectiveness and therefore the potential exists for an agency to have to monitor a large number of indicators. Any tool to be developed should have a reasonable number of principle-benefit combinations and, eventually, metrics.

To develop a manageable tool, a matrix of principles and benefits was developed with each team member identifying five benefits believed to demonstrate a strong relationship with the application of each CSS principle. The rationale for this approach was to use the collective multi-disciplinary expertise of the team to identify the potential benefits for each principle using their discipline-specific perspective. An engineer will likely identify different benefits for a principle than a landscape architect or an environmental coordinator would

identify. This approach led to balancing the number of benefits used for each principle by identifying the overall benefits with a strong relationship to each principle. The recommendations by each member were mapped on a composite matrix display and assisted in identifying the benefits with a high level of consensus (6 or more of the 12 members agreed on the benefit as a top five for the principle). These benefits were considered as primary benefits, i.e., having a strong relationship to the principle. All other benefits that were identified by team members, but had a lower level of agreement, were considered as secondary benefits, i.e., having a moderate relationship to the principle. Finally, all other benefits could conceivably be realized from the application of the principle and are considered as tertiary, i.e., having a weak relationship to the principle. A matrix was developed indicating these three levels of relationship between benefits and principles (Table 5). This matrix was refined based on input received by the panel as well as when the case studies were completed.

For each principle, one of the primary benefits was considered to be fundamental and thus a single indicator could capture the importance of applying the principle. This allows an agency to perform a targeted evaluation of the CSS application in the event that resources are not available to complete a full-scale evaluation and benefit assessment. It is anticipated that this fundamental indicator will provide the basis for evaluating the application of the CSS principle in a basic format and allow for feedback in improving the project delivery process.

An aspect of the matrix provided in Table 5 is its flexibility to be adjusted to an agency's needs and perspectives. The pairings provided here resulted from the input of the multidisciplinary team members while considering the data obtained from the case studies. An agency can follow a similar approach to the one described above to determine their priorities and associations and therefore develop a different set of principle-benefit interactions.

Benefits

Each benefit was further defined to provide the basis for understanding the elements to be collected and measured. The rationale for the association of each benefit as fundamental for various principles was also defined, since the benefit can be used alone to capture the magnitude of benefits resulting from the principle application. These concepts are presented below for each benefit. For each benefit presented here, only the principles for which it is considered fundamental are shown (noted in Table 5).

1. Improved Predictability of Project Delivery

This relates to the ability of a transportation agency to reliably program and deliver projects within set time limits. Projects may have elements of controversy including potential environmental and community impacts. Stakeholder/public concerns can also exist due to the depredations of previous projects. These can result in vocal opposition, political pressure and/or litigation that can stall or stop project development. Short delays can extend project development. Long delays may impact agency project programming. CSS can effectively ameliorate opposition/concerns allowing project development to proceed within predictable time limits. The following principles have this as a fundamental benefit:

Seek broad-based public involvement. The use of broad-based public involvement will permit identification of all possible areas of concern and their proper resolution. That has the potential to eliminate potential delays and improve predictability of project delivery.

Achieve consensus on purpose and need. Achieving consensus on purpose and need will address potential conflicts from the outset of the project by defining their impact and influence on the solution to be sought thus reducing any unexpected delays.

2. Improved Project Scoping and Budgeting

CSS projects properly address all transportation, environmental, and community issues in a thorough, balanced manner. All vital concerns are effectively identified, appropriate actions incorporated, and project costs estimated prior to lettings. This results in minimal construction change orders and projects that are completed on budget. The following principles have this as a fundamental benefit:

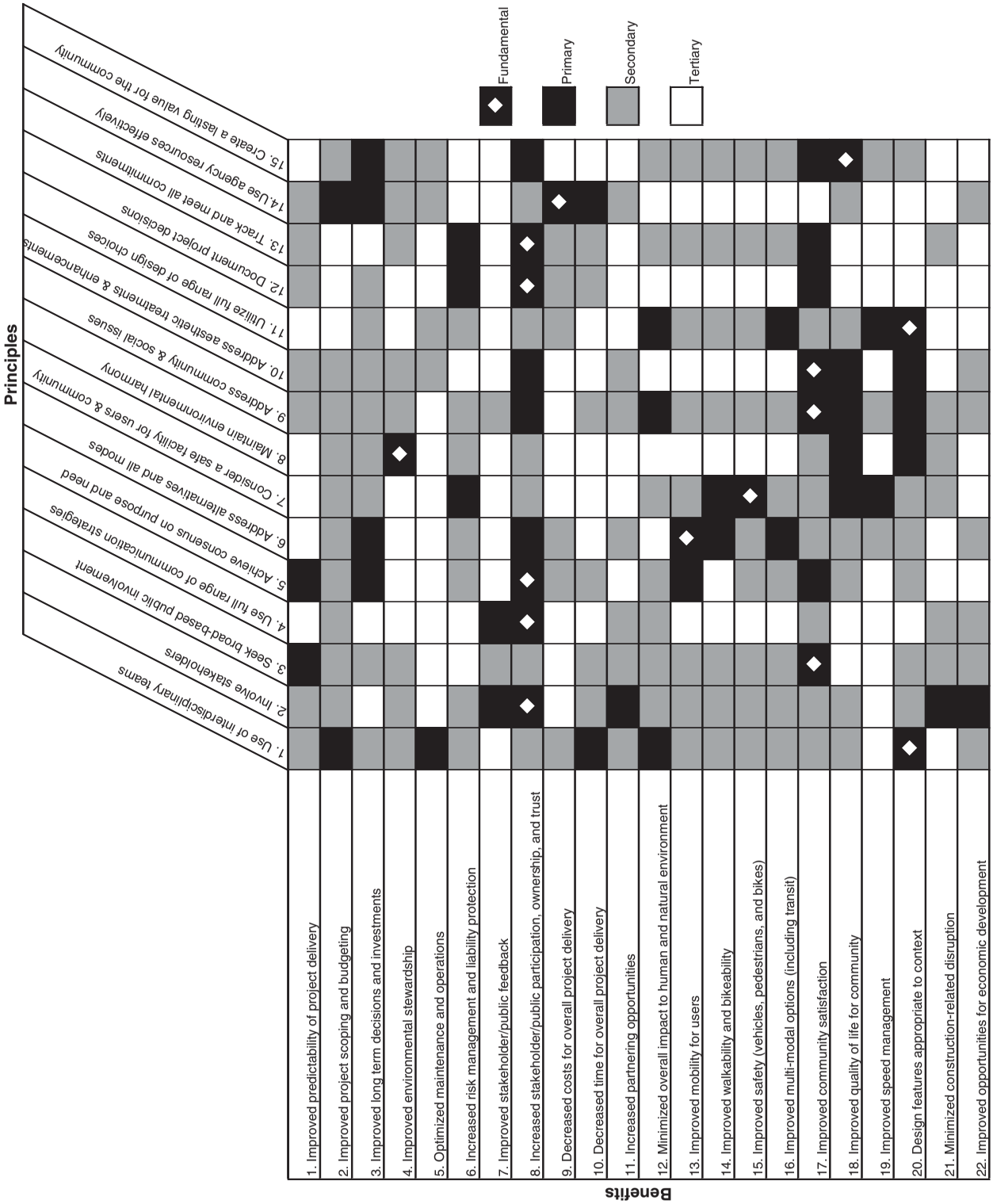
Use of interdisciplinary teams. The use of interdisciplinary teams will allow for input from all members as the design is developed and will employ the special knowledge and skills of team members to provide optimum solutions and promote a complete, balanced project.

Use agency resources effectively. The effective use of project team members and other resources applied to properly develop CSS projects will provide optimum project solutions. The effective use of all agency resources will promote a project that addresses all issues and will result in a project that is completed in a timely manner without cost overruns.

3. Improved Long-Term Decisions and Investments

This benefit relates to agency actions that promote the environment, the economy and social equity. Environmental improvements relate to partnering actions with resource agencies that improve the environment on a local or regional basis. On a global basis, it can include actions that constitute

Table 5. Principles and associated benefits.



improvements to the biosphere (e.g., the implementation of mass transit to alleviate air pollution). Economic benefits include stimuli to local economy (both short- and long-term benefits). Social equity improvements include training and creating jobs for disadvantaged minorities and remedying social problems created by previous transportation projects. The following principles have this as a fundamental benefit:

Achieve consensus on purpose and need. Achieving consensus on the purpose and need will allow the agency to identify the long-term goals for the project and lead in sound investments.

Address alternatives and all modes. Consideration of all alternatives with input from stakeholders and public will promote the development of a project providing decisions that are sustainable and promote social equity, and the identification of potential investment opportunities resulting from the project.

Use agency resources effectively. Effective use of all resources will improve sustainable decision making and investments, since it will allow for a better attainment of community vision and goals (e.g., design that promotes/addresses community needs such as business growth).

Create a lasting value for the community. A project that will create a lasting value for the community will be the result of improved long-term decisions and sound investments.

4. Improved Environmental Stewardship

The resulting project balances transportation, the environment, and communities. It promotes ecologically sound outcomes that minimize negative impacts while promoting long-term sustainable environmental benefits including agency actions in maintenance and operations. The following principle has this as a fundamental benefit:

Maintain environmental harmony. Seeking to maintain environmental harmony will demonstrate the agency's commitment to environmental concerns and issues and improve the agency's environmental stewardship.

5. Optimized Maintenance and Operations

This benefit can affect all parties involved with a transportation facility. The agency obtains lower maintenance costs, fewer environmental complications, and improved operational efficiency. Communities and businesses can rely on the facility to continually meet their transportation needs. Other stakeholders can be confident of the agency's continued compliance with their interests and regulations. Maintenance and operations activities can impact a community far longer than those derived from the design and construction processes. Proper consideration of maintenance and operational issues during project development can provide significant cumulative benefits once a facility is completed and in service. The following principle has this as a fundamental benefit:

Use of interdisciplinary teams. The inclusion of agency traffic operations and maintenance personnel as team members will allow for more streamlined operations for the facility and facilitate any future special needs for facility upkeep.

6. Increased Risk Management Protection

Context sensitive design and resulting solutions can be achieved in many cases with the application of flexible design or through the introduction of "lower-than-typical" design values commonly shown in the Green Book or other design guidelines. When using this approach, nearly every aspect of the geometric design can be adjusted or modified to meet specific conditions or desired limits specific to a roadway. Typically, a formalized process is required to document the deliberations and the justification to deviate from the recommended design. Written justification is a significant part of the process of ensuring that designers limit their liability when using flexible design and varying from adopted guidelines. The documentation of design exceptions provides the means for the designer to go on record regarding a recommended context-sensitive design solution. In addition, the necessary information is recorded in sufficient detail to support the transportation agency's decision and deviate from the typical design. The following principles have this as a fundamental benefit:

Consider a safe facility for users and community. Considering a safe facility will result in an improved safety level for all users which in turn will increase risk management protection. The efforts to provide for a safer facility will reduce unfavorable consequences from crashes and also contribute to decreased risk.

Document project decisions. Documentation of project decisions will result in improved protection against risk, since there will be a record of the decisions made throughout the project development and it could be used to support all choices made and prevent misunderstandings.

Track and meet all commitments. Tracking all commitments will reduce the risk associated with litigation, since all commitments made and their justified associated solutions will be documented and recorded.

7. Improved Stakeholder/Public Feedback

This benefit relates to a transportation agency obtaining information from stakeholders/public about specific transportation project needs or about the suitability of proposed transportation project details. Those can include the type of project, a proposed project corridor, the project footprint, design details/components, community/environmental impacts and project commitments. That information will enable a transportation agency to make more informed project decisions that yield facilities that improve transportation networks and fit well in communities and the natural environment. The following principles have this as a fundamental benefit:

Involve all stakeholders. Stakeholder/public involvement will provide the opportunity for a more appropriate and organized feedback process through an interactive, highly engaging process with the project team.

Use full range of communication strategies. The use of a full range communication strategies will allow the stakeholders/public to fully understand the issues and elements of the project and thus enhance their ability to provide the appropriate feedback.

8. Increased Stakeholder/Public Participation, Ownership, and Trust

This benefit relates to a high degree of stakeholder/public involvement in the transportation project development process that results in consensus approval of transportation agency decision making. It entails stakeholders/public having a significant role in project development that results in a feeling of project ownership/identification. Stakeholders/public must not only believe that they have significant project input, but also they must trust the final decisions and resulting actions of the transportation agency. When this occurs, stakeholder/public opinion about the transportation agency improves creating a reservoir of goodwill and trust for future transportation projects. The following principles have this as a fundamental benefit:

Involve all stakeholders. Stakeholder involvement will provide the opportunity for a more appropriate and organized feedback process through an interactive, highly engaging process with the project team.

Use full range of communication strategies. The use of full range communication strategies will allow stakeholders to completely understand the issues and elements of a project, enhancing their ability to provide appropriate feedback.

Achieve consensus on purpose and need. Achieving consensus on purpose and need with stakeholder involvement will foster their ownership of the project, since the purpose and need will reflect their input and values.

Address alternatives and all modes. Consideration of all alternatives and modes will improve stakeholder participation (since their input will be sought to identify potential alternatives and modes to be considered), ownership of the project (since their input will be solicited and considered in project decision making), and trust in the process (since their input will be solicited, considered, and dealt with during the project development process).

Address community and social issues. Consideration of community and social issues will generally require stakeholder/public input, ownership (since their comments and suggestions will be considered in the project's solution), and trust (since their input will be seriously considered in project decision making).

Address aesthetic treatments and enhancements. Providing aesthetic treatments will improve stakeholder participation (since their input will be sought to identify potential treatments to be considered), ownership of the project (since their input will be solicited and considered in project decision making), and trust in the process (since their input will be solicited, considered, and dealt with during the project development process).

Document project decisions. Documentation of project decisions will increase stakeholder trust in the process, since there will be a record of the decisions made throughout the project development. That record can be used to support all choices made and prevent missteps or misunderstandings.

Track and meet all commitments. Tracking and meeting project commitments will increase stakeholder/public ownership (since it will demonstrate that agency commitments made during the various project phases were met), trust (since the commitments made were followed through), and possibly participation in future projects (since it will indicate that the agency will stand by its word).

Create a lasting value for the community. A project that creates a lasting value to the community will improve stakeholder/public ownership (since the project reflects their input), trust (since it will demonstrate that the input was considered and addressed), and possibly participation in future projects (since their participation was valued and considered).

9. Decreased Costs for Overall Project Delivery

This benefit relates to reduced total agency costs for transportation project development compared to conventional

non-CSS projects. This can be direct cost savings (elimination of expensive features such as grade-separated interchanges). It can also be derived by CSS-related right-sizing of facilities (reduction in the number of lanes or in the ROW footprint). Other savings can be achieved by avoidance actions (reducing the environmental clearance from an EIS to an EA/FONSI). Other savings can be estimated from avoidance of opposition (historic project cost information due to litigation/delays). Oftentimes, transportation agency officials believe that CSS projects are expensive when they actually avoid higher agency costs due to opposition/litigation/delays. The following principles have this as a fundamental benefit:

Use agency resources effectively. Effective use of all project resources will result in the decreased cost for overall project delivery, since it will optimize all resources (interdisciplinary team, stakeholder, and public) to their maximum potential.

10. Decreased Time for Overall Project Delivery

This relates to reduced total agency time for transportation project development. It can be time savings achieved by avoidance actions (reducing an environmental clearance from an EIS to an EA/FONSI). Other savings can be estimated from avoidance of delays due to opposition/controversy (historic project programming information due to litigation/delays). Oftentimes, transportation agency officials believe that CSS projects take too long when they actually save overall time by eliminating opposition/litigation/delays. The following principles have this as a fundamental benefit:

Use of interdisciplinary teams. Interaction between team members will allow resolution of issues that may arise in the subsequent phases of the project development process reducing the time requirements for succeeding phases and the entire project.

Use agency resources effectively. Effective use of all project resources will have as an immediate result the decreased time for overall project delivery, since it will optimize all resources (interdisciplinary team, stakeholders, and public) to their maximum potential.

11. Increased Partnering Opportunities

Involving stakeholders throughout the entire project development process using many feedback loops will increase the stakeholder engagement, involvement, and participation (since their input will be solicited at certain points of the process), improve trust of stakeholders in the process (since their opinion will be valued and considered), and enhance ownership of the project (since their concerns will be addressed and their input considered). Stakeholder involvement will enhance the opportunities for joint development because the interaction between the project team and the stakeholders could identify possible areas where outside funds could be jointly pursued, opportunities for leveraging mitigation/enhancement funds with other grants, and development loans or other opportunities. The following principles have this as a fundamental benefit:

Involve stakeholders. Stakeholder involvement will enhance the opportunities for partnering because the interaction between the project team and the stakeholders could identify possible areas where such activities could be jointly pursued.

12. Minimized Overall Impact to Human and Natural Environment

This benefit results from a project that has limited intrusion on natural resources and existing communities. Direct effects include takings and constructive use. For example, they may include choosing a corridor and/or design that minimizes the project footprint causing fewer household/business relocations or reducing acreage of land disturbed. These effects can be permanent or occur only during construction. Indirect impacts include avoidance and mitigation actions. The indirect impacts may also include cumulative impacts that occur over time (e.g., sprawl growth). That can be minimized by a combination of access control and zoning. In the past, new roads have seriously impacted communities and their environments. This benefit accrues when an interdisciplinary project team focuses on transportation solutions that include addressing community/social issues and maintaining environmental harmony. The following principles have this as a fundamental benefit:

Use of interdisciplinary teams. The use of these teams will allow for input from all members while the design is developed. It employs the skills and experience of team members to produce a balanced transportation solution that limits negative impacts and maximizes positive ones.

Utilize full range of design choices. The use of a full range of design choices will allow for identification of all potential impacts to the human and natural environment and develop solutions for addressing these impacts.

Maintain environmental harmony. Maintaining environmental harmony will result in minimum impacts to the natural environment since the project solution will properly address all potential environmental concerns.

Address community and social issues. Considering community and social needs will minimize impacts to human

environment, since all appropriate issues and solutions will be addressed in the final project design.

13. Improved Mobility for Users

This benefit addresses improving mobility for transportation facility users and providing a balanced mobility for all users according to the purpose and need of the project. This entails addressing the practical range of transportation options that can be practically applied on a project and that can materially enhance mobility for all potential users including the economically disadvantaged. The need to allow for and encourage the various modes can be identified through applying principles of CSS in the early stages of project development. While there may be macro issues involving the accommodation and even substitution of transit there are other concerns that may have a minor impact on the project but result in a major improvement for the mobility of individuals in a community. Concern for modal connectivity can also be an important goal in considering achieving improved mobility. The following principles have this as a fundamental benefit:

Achieve consensus on purpose and need. Achieving consensus on purpose and need will allow for improving the mobility of the transportation system users since the goals of the project regarding the modes to be addressed will be identified and agreed upon.

Address alternatives and all modes. Consideration of all transportation modes is vital for the identification and inclusion of those in projects where they can materially serve the community.

14. Improved Walkability and Bikeability

Improving both walkability and bikeability, as part of a transportation project, are generally supplementary concerns. Sometimes those improvements can be very beneficial to overall transportation goals and community development. Occasionally, this benefit takes on greater significance—improved walkability and bikeability may help achieve a benefit on a human scale in an urban setting by improving community health and reducing traffic demand. It may also enhance sustainability by helping to reduce fuel usage/air pollution, promoting tourism and serving the economically disadvantaged. Such improvements may also improve the livability of a community and even contribute to improved safety. No principle had this benefit as fundamental.

Address alternatives and all modes. Consideration of all transportation modes is vital for the identification and inclusion of the pedestrian and bicyclist aspects that are required to improve the service for these users.

Consider a safe facility for users and community. Considering a safe facility will result in an improved safety level for pedestrians and bicyclists, since the design will reflect elements aimed at improving safety for these users.

15. Improved Safety (Vehicles, Pedestrians, and Bikes)

The benefit is improved safety for vehicles, pedestrians, and bikes as appropriate to a project. While safety is not preeminent among the considerations that must be balanced in a successful transportation project, it is always important. A project's major needs may include improving safety. No solution would be acceptable that reduced safety or had the prospect of creating untenable conflicts among vehicles-pedestrians-bikes. Considering a safe facility for users and the community through planning and design can achieve this benefit. When employed along with other applicable principles, it can result in a successful CSS project. The following principle has this as a fundamental benefit:

Consider a safe facility for users and community. Considering a safe facility will result in improved safety levels for all users, since the design will reflect elements that aim to improve the safety level, reduce the number and severity of crashes, and minimize conflicts between the facility users.

16. Improved Multi-modal Options (Including Transit)

Improving multi-modal options (including transit where appropriate) is a benefit from properly applying CSS. Accommodating those options and their connectivity can be achieved by thoughtfully considering a range of modal options at the appropriate stage of project development. Identifying workable modal options and accommodating their deployment may be achieved through pursuing the principles associated with addressing alternatives and all modes and utilizing a full range of design options. Where appropriately considered, these can benefit a community and achieve a unique transportation solution. The following principles have this as a fundamental benefit:

Address alternatives and all modes. Consideration of all alternatives and modes will improve their connectivity and identify potential new modes that could be part of a project. This will improve the modal choices for the facility users.

Utilize full range of design choices. Utilizing a full range of design choices will help identify all potential modes that could be part of the project and their potential utilization in and benefit to a project. This will improve modal options for the community.

17. Improved Community Satisfaction

A successful CSS project will provide a community with a high level of satisfaction. A CSS project will be integrated into the community and, over time, it will be perceived as an enhancement. Community satisfaction may be achieved by delivering what the community wants and needs or, at a minimum, what it will accept. In some cases, the level of community satisfaction with a CSS project can be assessed by the level of community dissatisfaction with proposed alternatives. The following principles have this as a fundamental benefit:

Seek broad-based public involvement. Consideration of comments received during the public involvement process will increase community satisfaction with the process and the resulting solution as well as enhance an agency's image for future projects.

Achieve consensus on purpose and need. Achieving consensus on purpose and need will facilitate developing a project that is in sync with the community vision as it will reflect their input and vision. This will result in a project that will satisfy the community.

Address community and social issues. Incorporating community and social issues based on public input will result in a project solution that is more acceptable to a community and increases community satisfaction.

Address aesthetic treatments and enhancements. Providing aesthetic treatments will improve community satisfaction, since the final design solution will address the community desires formed during the public and stakeholder input meetings.

Document project decisions. Documentation of project decisions will improve community satisfaction since it will demonstrate that the choices were made based on community and stakeholder input and provide a rational support for each choice made.

Track and meet all commitments. Tracking and meeting project commitments will improve community satisfaction, since it will demonstrate that their input and commitments solicited during the public involvement process were addressed resulting in a project conforming to community vision and values.

Create a lasting value for the community. A project that creates a lasting value for the community will improve community satisfaction, since it will result in solutions that will provide a project appropriate to its context.

18. Improved Quality of Life for Community

A successful CSS project improves the overall quality of life for members of a community. This benefit may be primarily transportation-related: by decreasing delays, providing new mobility options, and/or improving safety for roadway users, pedestrians, residents and others. Special enhancements may be applied to a project that contributes to a multitude of other life aspects including recreation, education, shopping and work. The following principles have this as a fundamental benefit:

Consider a safe facility for users and community. Considering a safe facility will result in an improved quality of life for the community, since a safer facility will reduce unfavorable consequences from crashes.

Maintain environmental harmony. Achieving environmental harmony will result in improved quality of life for the community, since the natural environment is a critical component of the community.

Address community and social issues. Consideration of community and social issues will improve the quality of life since comments and input from public involvement, addressed in the final project design, will result in a project that will enhance their quality of life.

Address aesthetic treatments and enhancements. Providing aesthetic treatments will improve quality of life for the community, since the final design solution will provide an aesthetically pleasing environment that represents value to the community.

Create a lasting value for the community. A project that creates lasting value for the community will improve quality of life, since it reflects the community vision and addresses the public and stakeholder issues and concerns.

19. Improved Speed Management

Proper speed management provides a roadway that influences speeds that motorists employ while properly accommodating those speeds by design. Matching operational and design speeds provides a safer roadway for both the motorists and non-users living and working adjacent to the roadway. A key element of speed management is identifying the context of the roadway and determining what an appropriate speed would be as well as understanding that the context may change along a roadway, and the design and speed needs to be flexible to meet the changing needs of the community and

context. The following principles have this as a fundamental benefit:

Utilize full range of design choices. Examination of the full range of design choices will result in a better understanding of the issues pertaining to speeds. An appropriate solution can be developed for the project context considering preferences between local or through traffic and thus enhance speed management.

Consider a safe facility for users and community. Considering a safer facility will result in improved speed management, since the design elements incorporated in the project design will consider speed issues in their selection process to fit the project context.

20. Design Features Appropriate to Context

Obtaining a facility that matches the context of the area in which it is placed is a fundamental benefit of CSS. Each project has unique requirements that must be aligned with the setting in which it resides in terms of community, environmental resources, topography, etc. To achieve this, trade-offs are necessary between project/facility requirements and the environs in which it is placed. A key element of designing to the appropriate context is an understanding that the context may change along a project and a design needs to be flexible to meet the changing needs of the community and context. Ultimately this approach may lead to varying cross-sections, design speeds, and differing alignments. The following principles have this as a fundamental benefit:

Use of interdisciplinary teams. The use of these teams will allow for input from all members while the design is developed, employ the special knowledge skills of different team members to provide optimum solutions and promote a complete balanced project, and allow for addressing the specific elements required by each team member as they may influence design.

Utilize full range of design choices. Utilization of a full range of design choices will aid in developing a customized solution for the project with features that are appropriate to the project context.

Maintain environmental harmony. Maintaining environmental harmony will provide a project solution with design features appropriate to the context since the environmental concerns will be considered and addressed in a proper manner.

Address community and social issues. Consideration of community and social issues will result in a project solution with features appropriate to the project context since these solutions will be based on public input.

Address aesthetic treatments and enhancements. Providing aesthetic treatments will improve the appropriateness of the design features, since the final design solution will address the community desires formed during the public and stakeholder input meetings to develop an acceptable solution.

21. Minimized Construction-Related Disruption

Temporary, construction work can severely impact motorists, communities, and the environment. Steps necessary to minimize construction disruption should be developed prior to the onset of work and included in the project commitments. Construction disruptions typically include traffic impacts related to delays, detours, closures and environmental impacts related to noise, light, dust, and visual as a result of the construction activities. Traffic disruptions are a primary concern on most projects involving reconstruction of existing roads or on new roads where they tie into existing ones. It is important to identify acceptable and unacceptable disruptions for the project which may often vary considerably between different communities or even within the same community. Construction disruptions typically involve contractor activities but may also include utility relocation or other activities. Some construction-related environmental impacts may be addressed by resource agency permits or Memoranda of Understanding dealing with storm water runoff/ground water protection plans, disposal of organic waste (burning) and impacts to endangered species habitats. The following principles have this as a fundamental benefit:

Involve stakeholders Stakeholder involvement has the potential to identify approaches for reducing the disruption to the community by identifying desirable closure periods for construction and/or providing suggestions for alternative routes.

22. Improved Opportunities for Economic Development

Stakeholder involvement will enhance the opportunities for economic development because the interaction between the project team and the stakeholders could identify possible areas where such opportunities (e.g., improved business due to better access to stores or improved opportunities for local employment due to industry brought by new roads) can arise. The following principles have this as a fundamental benefit:

Involve stakeholders. Stakeholder involvement will enhance the opportunities for joint development because the interaction between the project team and the stakeholders

could identify possible areas where funds could be jointly pursued.

Metric Indicators

Using the information provided in Table 5, quantitative and semi-quantitative indicators were developed to capture and measure the impact of each primary benefit. These metric indicators are summarized in Table 6 and their associated tools for collecting the data are presented in the guidelines. The proposed pairing of principles and benefits was developed to identify and analyze a manageable number of metrics, and the matrix in Table 5 is provided to facilitate this approach. The identification of the secondary benefits will allow any agency that deems such benefits important to their CSS principle application to be able to collect and evaluate data pertaining to the specific principle/benefit couple that they consider of significance. Metrics have been developed for all benefits and therefore transportation agencies have the ability to customize the data collection and analysis. The rationale for associating

Table 6. Benefit metrics.

Benefit	Indicators
1. Improved predictability of project delivery	Difference in project duration in months to complete. Semi-quantitative assessment of opinion.
2. Improved project scoping and budgeting	Number and cost of change orders/scope changes. Semi-quantitative assessment of opinion.
3. Improved long-term decisions and investments	Semi-quantitative assessment of opinion.
4. Improved environmental stewardship	Increased or enhanced mitigation beyond regulatory mandates. Semi-quantitative assessment of opinion.
5. Optimized maintenance and operations	Annual cost, hours or closures in dollars. Semi-quantitative assessment of opinion.
6. Increased risk management protection	Number and cost of legal action taken against project. Semi-quantitative assessment of opinion.
7. Improved stakeholder/public feedback	Number of stakeholder/public responses. Semi-quantitative assessment of opinion.
8. Increased stakeholder/public participation, ownership, and trust	Stakeholder involvement measures. Semi-quantitative assessment of opinion and satisfaction level.
9. Decreased costs for overall project delivery	Decreased dollar cost amount for project delivery. Number and cost of change orders/scope changes. Semi-quantitative assessment of opinion.
10. Decreased time for overall project delivery	Number of months by project phases and total duration. Number and cost of change orders/scope changes. Semi-quantitative assessment of opinion.
11. Increased partnering opportunities	Number of Memorandum of Agreements or grants established. Semi-quantitative assessment of opinion.
12. Minimized overall impact to human and natural environment	Percentage of human and environmental impacts of project. Semi-quantitative assessment of opinion.
13. Improved mobility for users	Each modal facility element inclusion and extent. Semi-quantitative assessment of opinion.
14. Improved walkability and bikeability	New and expanded options for pedestrians and bicyclists. Semi-quantitative assessment of opinion.
15. Improved safety (vehicles, pedestrians, and bikes)	Change in crashes, crash rate and severity. Semi-quantitative assessment of opinion.
16. Improved multi-modal options (including transit)	New and/or expanded modal choices. Modal connectivity (count/volume). Modal safety (crash/severity). Semi-quantitative assessment of opinion.
17. Improved community satisfaction	Semi-quantitative assessment of opinion.
18. Improved quality of life for community	Semi-quantitative assessment of opinion. Alignment with community plans (semi-quantitative).
19. Improved speed management	Operating speed (expected/actual). Semi-quantitative assessment of opinion.
20. Design features appropriate to context	Semi-quantitative assessment of opinion.
21. Minimized construction related disruption	Work zone, lane closings and detour duration in days. Semi-quantitative assessment of opinion.
22. Improved opportunities for economic development	Number of Memorandum of Agreements/grants established. Semi-quantitative assessment of opinion.

benefits to principles was also defined and presented in Appendix C.

To eliminate any possible misunderstandings and provide consistency in the common use of certain terms, it was considered essential to provide a dictionary of the terms to be used in the following metric indicators:

- **Satisfaction level**—A method for establishing the level of satisfaction for an element by a person typically measured with a scale.
- **Opinion**—A method for establishing the level of agreement to a concept by a person that is typically measured with a scale (mostly agree, agree, disagree, and mostly disagree).
- **Expert opinion**—A method for establishing the level of agreement to a concept by a project team member (expert) that is typically measured with a scale (mostly agree, agree, disagree, and mostly disagree).

Case Studies Selected

The initial list of candidate cases was refined twice based on willingness of contacts to provide the available list of contacts for the project team members and stakeholders and the level of completion of the surveys and data items received. The list of the final case studies selected is presented in Table 7, grouped according to the four AASHTO Regions. More detailed case descriptions for each of the projects listed in Table 7 are presented in Appendix D. A short justification for each case study selected is also included to allow for a quick review of the types of cases selected and the rationale for their inclusion.

Data Analysis

For each of these case studies semi-quantitative data was collected from the surveys of the project team members and stakeholders. Initially, it was envisioned that benchmarks for the application of principles and the accrual of benefits would be developed. These benchmarks and ranges were to be developed based on the scores obtained in the surveys. However, this was not possible due to the varied nature of each case study completed and the large variance in the number of participants for each case study. Moreover, it was determined that benchmarks must be set with regard to the goals and context of the individual project. Therefore it was deemed more appropriate to examine these scores within each case study and develop general observations for the set of cases completed.

The analysis of the scores noted in the survey is based on a 4.0 scale, where 4.0 is Strongly Agree, 3.0 is Agree, 2.0 is Disagree, and 1.0 is Strongly Disagree. No value is recorded for those who did not respond and is not calculated in the average score for the question. A summary of the scores for each case study is provided in Appendix E and the general findings (from all case studies) are discussed below.

In general, the results from the project team members indicated that all principles were present for the project. Most principles had a score of 3.0 or greater, i.e., most respondents agreed that at least the principle was applied (Table 8). There are several principles for which there is agreement among the 32 case studies that the principle was applied with a high level of agreement (average score of 3.5 or higher), even though there is a great diversity among the cases examined. There are several principles for which there are a significant number of cases where the score was between 3.0 and 3.5 indicating that the principles were applied less fully. These principles include "Use full range of communication strategies" (15 of the 33 cases); "Achieve consensus on purpose and need" (15 cases); "Maintain environmental harmony" (13 cases); "Address community and social issues" (15 cases); and "Document project decisions" (14 cases). Finally, there were a few principles for which most of the cases had a score below 3.5 indicating that the principle was in general not fully applied. These principles include "Address alternatives and all modes" (23 of the 33 cases); "Utilize full range of design choices" (25 cases); "Track and meet all commitments" (23 cases); and "Use agency resources effectively" (20 cases). These data are indicative of the fact that certain CSS principles are not widely applied especially those dealing with the development of alternatives and project documentation.

In general, team members indicated that most of the 22 benefits accrued as a result of the CSS process as most cases had a score above 3.0 for each benefit. This was true for at least two-thirds of the cases examined (Table 9). There is a small number of benefits for which the team strongly agreed (scores 3.5 or above) that the benefit accrued. These benefits include the "Improved mobility for all users" (19 cases), "Improved safety" (19 cases), and "Design features appropriate to context" (18 cases). Of interest here is the fact that there are several benefits that have a large number of cases where the team members did not agree that the benefit was materialized (scores between 2.5 and 2.9). These benefits include "Improved project scoping and budgeting" (11 cases) and "Improved multi-modal options" (11 cases). Finally, the scores for benefits "Decreased costs for overall project delivery" and "Decreased time for overall project delivery" showed a large number of cases (18 and 13, respectively) where the team members did not agree (scores below 2.5) that the benefit accrued. However, this was not substantiated from any data provided and thus could only be their perception. This could be also influenced by the lack of any complete data on the time and cost of the project of the respondents and possible knowledge of the data only for specific project delivery phases.

The analysis of the benefits as scored by the stakeholders showed a different perspective than the team members where

Table 7. Case studies.

State	Project Name	Rationale
		West
AZ	SR 179 Reconstruction-Sedona, Coconino County, AZ	A road reconstruction project complete through the planning phase for a mixed urban, rural and parkland multi-modal corridor (transit, pedestrian, bicycles) addressing 12 CSS principles including excellent use of interdisciplinary teams and stakeholders with excellent public involvement and demonstrating stakeholder, shared funding, environmental, community, multi-modal, and safety benefits.
CA	Mandela Pkwy Corridor Improvement, Oakland, CA	An under construction roadway reconstruction project with 14 CSS principles including excellent use of interdisciplinary team, very good stakeholder involvement, demonstrating stakeholder, joint development opportunities, environmental, safety, multi-modal, and community benefits.
CO	US 40 Berthoud Mt. Pass Reconstruction-Clear Creek Co., CO	An interstate reconstruction and environmental improvement project completed for a rural/parkland corridor involving 14 CSS principles including good use of interdisciplinary teams, excellent use of stakeholders and good public involvement and demonstrating stakeholder, multi-modal, safety, environmental, maintenance & operations and community benefits.
CO	US 285, Denver, CO	A road reconstruction project complete through the planning phase for a rural corridor involving all 15 CSS principles including excellent use of interdisciplinary teams, involving all stakeholders, broad-based public involvement, achieving consensus on purpose and need and maintaining environmental harmony, considering a safe facility for users & community, documenting project decisions, and creating lasting value for the community.
CO	Transportation Expansion (T-REX) Project, Denver, CO	A completed urban multi-modal corridor (public transit, pedestrians and bicycles) with 10 CSS principles including excellent use of interdisciplinary teams and stakeholder involvement, and excellent public involvement plan demonstrating stakeholder, safety, project delivery time, multi-modal mobility and community benefits.
MT	SR 69, Main Street Reconstruction, Boulder, MT	A completed urban main street reconstruction project in a multi-modal corridor (pedestrian and bicycles) with 10 CSS principles including excellent use of interdisciplinary teams, good involvement of stakeholders, and excellent public involvement plan demonstrating stakeholder, construction and project costs, safety, project delivery and community benefits.
ND	North Dakota-Four Bears Bridge-Ft. Berthoud Reservation, ND	A road reconstruction/bridge replacement project completed for a multi-modal rural corridor (pedestrian, bicycles) involving 14 CSS principles including excellent use of interdisciplinary teams, excellent use of stakeholders and excellent public involvement demonstrating stakeholder, safety, environmental and community benefits.
TX	FM 1120, Low Water Crossing, Real County, TX	A completed rural, low water crossing replacement over the Frio River with 15 CSS principles including excellent multidisciplinary team, stakeholder involvement, and public involvement plan; demonstrating reduced project costs and time, environmental, stakeholder, multi-modal and community benefits.
UT	12300 South Design Build Project, Draper and Riverton, UT	A completed urban highway reconstruction project with 15 CSS principles including excellent use of interdisciplinary teams, excellent involvement of stakeholders, and excellent public involvement demonstrating stakeholder, joint development opportunities, environmental, and community benefits.
WA	SR 99 Pacific Hwy South Reconstruction, Des Moines, WA	A completed multi-modal roadway reconstruction project in a multi-modal corridor (transit, pedestrian and bicycle) with 12 CSS principles including good use of interdisciplinary teams, excellent stakeholder involvement, and excellent public involvement plan demonstrating stakeholder, joint development opportunities, environmental, multi-modal, and community benefits.
WA	Bridgeport Way Reconstruction, University Place, WA	A road diet completed urban project in a multi-modal corridor (transit, pedestrian, bicycles) with 9 CSS principles including very good use of interdisciplinary teams, excellent involvement of stakeholders, and excellent public involvement plan and demonstrating stakeholder, community and multi-modal benefits.
WY	US 14/16/20, Reconstruction, Cody - Yellowstone N.P., WY	A completed rural roadway reconstruction project in a park setting with 10 CSS principles including excellent use of interdisciplinary teams, excellent stakeholder involvement, and very good public involvement plan demonstrating stakeholder, environmental, project delivery costs, safety, and community benefits.

(continued on next page)

Table 7. (Continued).

		Southeast
AR	Rt. 215, Ozark National Forest (NW Arkansas), AR	A completed rural highway project in a national forest corridor using seven CSS principles (and associated benefits) including good use of interdisciplinary teams, excellent involvement of stakeholders, excellent consensus on purpose and need and excellent environmental harmony demonstrating stakeholder, environmental and quality of life benefits.
FL	I-4 Reconstruction, Tampa, FL	An interstate/local roads/overpass reconstruction project under construction (2007 est. completion) for a multi-modal urban corridor (transit, pedestrian, bicycles) in a metropolitan area involving 14 CSS principles including excellent use of interdisciplinary teams, excellent use of stakeholders and excellent public involvement demonstrating stakeholder, shared funding, environmental, community, safety, and project delivery cost benefits.
KY	US27/68 Paris Pike, Reconstruction, Lexington - Paris, KY	A completed rural roadway reconstruction project with 10 CSS principles including excellent use of an interdisciplinary team, excellent stakeholder involvement, and excellent public involvement plan demonstrating stakeholder, environmental, project delivery costs, safety, and community benefits.
KY	Kentucky-Cemetery Road Reconstruction-Bowling Green, KY	A road reconstruction/interchange-overpass construction project completed for a multi-modal urban corridor (pedestrian, bicycles) involving 12 CSS principles including excellent use of interdisciplinary teams, excellent use of stakeholders and excellent public involvement demonstrating stakeholder, shared funding, environmental, community, project delivery costs, and safety benefits.
KY	Transportation Tomorrow, TARC, Louisville, KY	A planning study for light rail in the preliminary design phase involving 10 CSS principles including excellent use of interdisciplinary teams, excellent use of stakeholders and excellent public involvement demonstrating stakeholder, community, and multi-modal benefits.
NC	Smith Creek Parkway, Wilmington, NC	A completed coastal urban highway and rail project using 14 CSS principles and associated benefits including good use of interdisciplinary teams, excellent involvement of stakeholders, and excellent public involvement demonstrating stakeholder, environmental, community and safety benefits.
SC	Cooper River Bridge Replacement Project, Charleston, SC	A bridge replacement project in Charleston Harbor, SC, with multi-modal (pedestrian and bicycle) facilities utilizing 9 CSS principles including interdisciplinary teams, involve all stakeholders, broad-based public involvement, full range of communication methods, consider all alternatives and modes, community & social issues, aesthetic treatments & enhancements, safe facility for users & community, and use all resources effectively.
TN	SR 73/US 321, Gateway Project, Gatlinburg, TN	A completed 5-lane retrofit rural project in a tourist area with a multi-modal corridor (pedestrian and bicycle) with 8 CSS principles including excellent stakeholder involvement, excellent public involvement plan, and very good interdisciplinary team; as well as demonstrating stakeholder, aesthetic (retaining walls and plants), multi-modal, and community benefits.
		Northeast
CT	Oyster River Roundabout, West Haven, CT	A completed roundabout installation project maintaining environmental harmony, addressing aesthetic treatments (gateway) and enhancements with excellent stakeholder involvement, excellent public involvement for delivering a safe facility that improves mobility for all users and meeting all commitments.
DC	M St. & Wisconsin Ave. Sidewalk Reconstruct, Georgetown, DC	A coordinated sidewalk reconstruction/utilities upgrading project currently under construction for a historic corridor involving 4 CSS principles including good use of interdisciplinary teams, excellent use of stakeholders and good public involvement demonstrating stakeholder, project delivery costs, environmental, and community benefits.
MD	MD 75, Rehabilitation, Town of Union Bridge, MD	A rehabilitation and improvement of a Main Street completed urban project in a pedestrian corridor with 9 CSS principles including very good use of interdisciplinary teams, excellent involvement of stakeholders, and excellent public involvement plan demonstrating community, partnering, stakeholder, and project savings benefits.
MD	US 1, Planning Study, College Park, MD	A planning study to improve an urban section in a multi-modal corridor (transit, bicycles, and pedestrians) with 8 CSS principles including excellent use of interdisciplinary teams, excellent involvement of stakeholders, and excellent public involvement plan demonstrating stakeholder, multi-modal, and community benefits.

Table 7. (Continued).

ME	Rt. 26, Shaker Village Bypass, Sabbathday Village, ME	A completed rural (small community) roadway improvement project in a historic corridor with 13 CSS principles including excellent use of interdisciplinary teams, excellent involvement of stakeholders, and excellent public involvement plan demonstrating stakeholder, environmental, safety, project delivery and community benefits.
PA	Mon/Fayette Expressway, PA	A project in preliminary design in a multi-modal corridor (pedestrian and bicycles) using 14 CSS principles including excellent stakeholder involvement, excellent use of interdisciplinary teams, and very good public involvement demonstrating stakeholder, environmental, safety, community, and project delivery benefits.
	Mississippi Valley	
IA	Highway 1, Keosauqua Bridge, IA	A completed historic bridge replacement project that exemplifies the utilization of a full range of design choices involving stakeholders and public while maintaining environmental harmony, addressing aesthetic treatments and enhancements, considering a safe facility for users and the community and improving safety along with bikeability and walkability.
IL	Prairie Pkwy Phase 1 Engineering Study-Kane, Kendall, Will LaSalle and DeKalk Counties, IL	A preliminary engineering study to identify multi-modal rural and urban corridors (transit) involving 12 CSS principles including good use of interdisciplinary teams, good use of stakeholders and excellent public involvement demonstrating stakeholder, project delivery costs, environmental, multi-modal, safety and community benefits.
MI	US 131, kitcS-curve Replacement, Grand Rapids, MI	A completed urban bridge reconstruction adjacent to a multi-modal corridor (pedestrian and bicycles) with 15 CSS principles including excellent use of interdisciplinary teams, excellent involvement of stakeholders, and excellent public involvement plan demonstrating stakeholder, environmental, safety, multi-modal, project delivery and community benefits.
MN	TH 61 North Shore Dr., Reconstruction, Good Harbor Bay, MN	A completed rural roadway reconstruction project with 10 CSS principles including a very good use of an interdisciplinary team, excellent stakeholder participation, and very good public involvement demonstrating stakeholder, environmental, safety, and community benefits.
OH	Euclid Corridor Transportion Project, Clevealnd, OH	A transit improvement project in the planning phase with 10 CSS principles including a very good use of multi-disciplinary team, excellent involvement of stakeholders, and excellent public involvement demonstrating stakeholder, multi-modal, joint development, and community benefits.
OH	Eastern Corridor, Southwestern OH	A regional planning study examining long range transportation improvements including light-rail, bicycle facilities and expanded transit services, that utilized 7 CSS principles including involve all stakeholders, seek broad-based public involvement, use full range of communication methods, consider all alternatives and modes, community & social issues, provide a safe facility for users & community, and a lasting value for the community.

Table 8. Summary of scores for principles.

Principles	Number of cases with scores	
	3.0-3.4	3.5+
1. Use interdisciplinary teams	3	30
2. Involve stakeholders	5	27
3. Seek broad-based public involvement	8	25
4. Use full range of communication strategies	15	17
5. Achieve consensus on purpose and need	15	17
6. Address alternatives and all modes	23	10
7. Consider a safe facility for users and community	4	29
8. Maintain environmental harmony	13	20
9. Address community and social issues	15	18
10. Address aesthetic treatments and enhancements	8	25
11. Utilize full range of design choices	25	7
12. Document project decisions	14	19
13. Track and meet all commitments	23	10
14. Use agency resources effectively	20	9
15. Create a lasting value for the community	11	22

Table 9. Summary of scores for benefits—team members.

Benefits	Number of cases with scores			
	<2.5	2.5-2.9	3.0-3.4	3.5+
1. Improved predictability of project delivery	3	9	15	6
2. Improved project scoping and budgeting	2	11	16	4
3. Improved long-term decisions and investments	1	2	25	5
4. Improved environmental stewardship	0	2	23	8
5. Optimized maintenance and operations	4	6	18	5
6. Increased risk management protection	1	8	18	6
7. Improved stakeholder/public feedback	1	0	19	13
8. Increased stakeholder/public participation, ownership, and trust	1	3	20	9
9. Decreased costs for overall project delivery	18	4	4	7
10. Decreased time for overall project delivery	13	7	7	6
11. Increased partnering opportunities	0	5	18	8
12. Minimized overall impact to human and natural environment	0	1	22	10
13. Improved mobility for users	2	1	13	19
14. Improved walkability and bikeability	0	5	15	11
15. Improved safety (vehicles, pedestrians, and bikes)	5	1	13	19
16. Improved multi-modal options (including transit)	1	11	10	7
17. Improved community satisfaction	1	1	16	15
18. Improved quality of life for community	3	1	17	14
19. Improved speed management	0	4	20	6
20. Design features appropriate to context	2	0	15	18
21. Minimized construction-related disruption	2	2	21	8
22. Improved opportunities for economic development	3	3	20	7

the stakeholders typically provided a lower score. It should be noted here that there were only 23 cases where stakeholders provided input. For a large number of cases the stakeholder scores are lower than 3.5, indicating that the stakeholders believe that the benefit was not fully materialized (Table 10). The exception to this general trend (score was equal to or greater than 3.5) was noted for the benefits of "Improved mobility for users" (11 of 23 cases), and "Improved quality of life for community" (9 cases). For most cases the values were in the middle category (with scores between 3.0 and 3.4) indicating that most benefits materialize as a result of the process followed and the project delivered. Examination of each individual case showed that in general the magnitude of the score differences between team members and stakeholders varied, but it was consistently lower than the score the team members provided. This is an indication of the difference in opinions between the project team members and stakeholders regarding the benefits that result from projects, where the professionals typically have a different view point than the stakeholders considering that the project resulted in greater and more widespread benefits.

A final aspect of the semi-quantitative data collected is the comparisons between team members and stakeholders regarding the evaluation of their relationships. Each survey queried

Table 10. Summary of scores for benefits—stakeholders.

Benefits	Number of cases with scores			
	<2.5	2.5-2.9	3.0-3.4	3.5+
1. Improved predictability of project delivery	6	5	9	3
8. Increased stakeholder/public participation, ownership, and trust	2	8	10	3
11. Increased partnering opportunities	2	6	9	4
12. Minimized overall impact to human and natural environment	0	4	13	4
13. Improved mobility for users	4	5	7	11
14. Improved walkability and bikeability	3	7	6	6
15. Improved safety (vehicles, pedestrians, and bikes)	5	1	9	9
16. Improved multi-modal options (including transit)	4	5	9	3
17. Improved community satisfaction	3	3	9	7
18. Improved quality of life for community	2	3	7	9
19. Improved speed management	1	2	15	3
20. Design features appropriate to context	2	4	10	8
21. Minimized construction-related disruption	3	6	12	2
22. Improved opportunities for economic development	1	3	15	2

Table 11. Satisfaction survey—team members.

Question	Number of cases with scores				
	1.5-2.0	2.0-2.4	2.5-2.9	3.0-3.4	3.5+
Satisfaction with relationship with stakeholders	0	1	0	18	14
Satisfaction with relationship with interested public	0	0	1	24	8
Satisfaction with procedures for input	0	0	0	25	8

team members and stakeholders on their perspective regarding the level of interaction and satisfaction level working with the other. The team member survey indicated that in general they were satisfied with both the stakeholders and interested public (Table 11). For almost all cases, the scores were above 3.0 indicting agreement with the statement. There was a greater level of satisfaction working with stakeholders (14 cases over 3.5) than working with interested public (8 cases over 3.5). This may be indicative of the fact that team members have a larger number and greater frequency of interactions with stakeholders and thus are more familiar working with them. Another possible explanation for these higher scores is the possibility that team members have a better understanding of the position and the issues that stakeholders may raise for a given project and thus feel more comfortable and are in a better position to deal with them. Both of these aspects are typically not present when dealing with the public, which may explain the lower scores noted here.

Team members were also queried regarding their relationship with stakeholders and the public. This analysis is also based on a 4.0 scale, where 1.0 is for "We established an informational relationship," 2.0 is for "We established a consultation relationship," 3.0 is for "We established a partnership," and 4.0 is for "We allowed them to provide direction." The scores for the relationship of the team members with the stakeholders and interested public showed a similar trend, i.e., "better" relationship with stakeholders (Table 12). The scores for most cases noted that the relationship with the stakeholders was between consultation (score of 2.0) and partnership (score of 3.0). A large number of cases (10.0 or approximately one-third) were noted with scores above 3.0 indicating a tendency for allowing the stakeholders to provide direction to the project. This could be viewed either as a positive aspect, where collaboration and input of stakeholders was greatly appreciated and utilized, or as a negative perception from team members, where the input was viewed as intrusive in their decision-making ability. However, neither of these possibilities could be verified and future survey questions may require clarification on this question. The scores for the relationship with the public were more in the consultation range (approximately one-half of the cases were below 2.5) and a small number was even below 2.0 indicating more of an informational relationship.

Similar questions were also posed to the stakeholders and results were mixed for their scores when compared to the similar questions posed to the team members (Table 13). In general, stakeholders were satisfied with their relationship with the project team for most cases (17 of 23 cases with score over 3.0), which is a positive aspect of the processes followed. This indicates a greater level of satisfaction from the stakeholders due to an improved relationship between them and the team and thus could further support the presence of the benefit of "Improved stakeholder/public participation, ownership, and trust," especially for the participation. This is further supported by the scores for the satisfaction regarding the procedures for providing input to the team. For this statement also more than one half (15 of 28 cases) the scores were above 3.0 and several cases had scores over 3.5 indicating a strong agreement on satisfaction with the procedures followed. The scores for these two statements could also benefit agencies regarding the level of trust by stakeholders towards the agency and could be viewed as benefits of CSS procedures. Finally, the scores for the relationship with the project team were between consultation and partnership and there are a large number of cases (approximately one-fourth) with scores over 3.0 indicating a perception of providing direction in the project. In general, the scores noted here are indicative of a positive level of satisfaction with the team members noting a possible improvement in relationships between teams and stakeholders as a result of CSS applications.

Significant efforts were devoted in gathering data that would allow for the quantification of the benefits from CSS

Table 12. Relationship survey—team members.

Question	Number of cases with scores				
	1.5-2.0	2.0-2.4	2.5-2.9	3.0-3.4	3.5+
Relationship with stakeholders	2	5	13	10	1
Relationship with interested public	5	15	5	3	0

Note: The rankings are based on a 4.0 scale with 4: They allowed us to provide direction; 3: We established a partnership; 2: We established a consultation relationship; and 1: We established an informational relationship.

Table 13. Satisfaction and relationship survey—stakeholders.

Question	Number of cases with scores				
	1.5-2.0	2.0-2.4	2.5-2.9	3.0-3.4	3.5+
Satisfaction with relationship with project team	0	1	5	9	8
Satisfaction with procedures for input	0	1	7	8	7
Relationship with project team[1]	4	6	6	5	2

Note: The rankings are based on a 4.0 scale with 4: They allowed us to provide direction; 3: We established a partnership; 2: We established a consultation relationship; and 1: We established an informational relationship.

applications. It was anticipated that the data to be provided would allow for demonstrating the magnitude and potential for time and cost benefits from CSS applications. However, the overall conclusion from the data collected was that this forensic examination of a project does not allow for a complete documentation of all data elements and provides only a partial picture of the benefits achieved and principles applied. There was no case study where data for all quantifiable metrics was obtained and for most metrics and benefits there were no more than a couple of case studies with data. The team determined that the available quantifiable data obtained for each case study was sparse and would not allow for a systematic evaluation of determining the level of principle application and benefits materialized from the CSS processes. The data provided for most of the case studies indicated that data was very dependent on the person submitting the information, with their area of interest or expertise being the one that was mostly documented.

A couple of examples of the data collected are provided in the following paragraphs to demonstrate their importance in quantifying benefits for the process applied.

Kentucky-Cemetery Road Reconstruction-Bowling Green, KY. The project reported a reduction in crashes based on a before and after comparison. Over a period of 3 years, the study showed a reduction of 20 injury crashes, one fatality, and 51 property damage crashes. The benefits converted in dollars can be estimated based on the available values for the various crashes by FHWA (*29*). Using these values, the total gains are estimated to be $7,110,000 over a three-year period (or $3,000,000 if one excludes the fatality due to rarity of such events).

Mandela Pkwy Corridor Improvement, Oakland, CA. The project resulted in the development and upgrade of 1.3 mi of sidewalks, multi-use path, and new bicycle lanes. Indirect benefits to health, recreation, and mobility could be estimated for this project as noted in NCHRP Report 552: *Guidelines for Analysis for Investments in Bicycle Facilities* (*20*).

These case studies indicate that the benefits can be quantified but often require either additional effort or proper data collection.

It is important to stress at this point that for an agency to properly measure and quantify CSS benefits, the data requirements must be specified and collection efforts should be initiated from the outset of the project. In addition, the project team should establish the target values for the benefits to be achieved at the outset of the project to allow for determining whether the benefit has been achieved. This may be done by developing a memorandum of agreement based on the objectives of the purpose and need statement that outlines the specific targeted goals with detailed measures and quantifiable thresholds for acceptable performance. For example, instead of the generic term "improve safety," the memorandum of agreement could specify that "the goal is to produce a design that results in reduction of the crash rate on the project below the statewide average of 2.1 crashes per MVM." This approach does not only specify what the metric will be to determine whether the goal was achieved but also allows for determining the required data to be collected to allow for the proper evaluation and direct quantification of the project benefits. As it is understood that all CSS projects are unique, it therefore stands that the benefits gained by each will be unique and should be measured in terms of the targeted project performance and not in an arbitrary standard of project performance.

Another issue that requires attention is that the agency needs to determine the intensity with which each action principle will be applied and determine their associated benefits and their metrics from the early stages of the project. Each agency can customize the approach to their specific needs and thus determine the appropriate benefits to be measured based on the scale and type of project. Moreover, each agency could determine a set of benefits that could be collected for all projects to assist them in their continuous quality improvement efforts. Both of these concepts will be presented in the introduction of the guidelines, which are presented in the next section.

Summary

The development of a set of principles and associated benefits was accomplished utilizing existing past efforts as well as the multi-disciplinary expertise of the research team. These principles and benefits will be used to develop a set of guidelines that transportation agencies could use in measuring benefits from CSS applications. The foundation of this approach was presented here and it will be further discussed in the next section.

Thirty-three cases of projects throughout the USA that qualify as following a CSS approach were identified. For all these cases, team members and stakeholders were surveyed to determine their opinion on the application of CSS principles as well as the potential accrual of benefits as a result of these processes. The analysis of the surveys indicated that team members believe that most principles were present for their project. Most principles had a score of 3.0 or greater, i.e., most respondents agreed that at least the principle was applied in the process followed. The results also indicated that certain CSS principles are not widely applied especially those dealing with the development of alternatives and project documentation.

The analysis of the benefits resulting from CSS applications showed a wider variability among team members. In general, team members indicated they agree that most of the benefits accrued as a result of the CSS process, and in most cases, the score is above 3.0 indicating that at least they agree with the statement provided, i.e., the benefit was present. This was the case for approximately two-thirds of the 22 benefits identified. Among the benefits that team members showed no agreement for their presence were those associated with reductions in costs and time of the project delivery and improvement of project scoping. It should be noted that data was not provided to substantiate these opinions and thus could be only their perception. This could be also influenced by the lack of any complete data on the time and cost of the project of the respondents and possible knowledge of the data only for specific project delivery phases. The results from the stakeholders showed a different perspective especially for the scores in the common questions between team members and stakeholders where the stakeholders provided a lower score. In general, stakeholders showed less agreement in the presence of benefits, which may be indicative of the professionals typically believing that the project resulted in greater and more widespread benefits.

The level of satisfaction with the relationships between team members and stakeholders was also examined to determine whether there are any differences and issues on how each other perceives these interactions. In general, both team members and stakeholders were satisfied with the relationship with the other and viewed this relationship as somewhere between consultation and partnership. However, team members showed a lower level of satisfaction dealing with the public. Both groups also noted a high level of satisfaction with the processes used for soliciting their input. In general, the scores noted here point to a positive level of satisfaction of the interaction between team members and stakeholders, which could be considered as a significant benefit for CSS applications.

An effort was also undertaken to collect additional data that could be used to quantify such benefits. However, this approach was less successful than the semi-quantitative data collected from the survey. The use of the forensic examination of a project followed here did not allow for a complete documentation of all data elements and provided only a partial picture of the benefits achieved and principles applied. The data provided for most of the case studies indicated that data was not gathered and in cases where it was available it was more dependent on the agency focus or area of interest. This absence of quantifiable data significantly limited the efforts to quantify the benefits. However, it clearly demonstrated the need for a systematic data collection effort in the early stages of a project, if there is a desire to quantify the benefits from the CSS applications.

CHAPTER 5

Guidelines

This section describes the general issues regarding the use of the proposed guidelines for estimating and quantifying benefits from CSS applications. The guidelines are presented in a separate document accompanying this report. The guidelines contain a brief introduction, followed by the application of the benefit analysis with a brief discussion on various issues associated with principles and benefits and their application, the suggested matrix, and the guidelines for both benefits and principles. An element included and emphasized in the discussion is that all principles apply in all projects but their intensity changes relative to scope, scale, and context. In addition, the agency needs to determine which benefits it will monitor and outline a process of documenting metrics to determine their associated benefits from the early stages of the project. The guidelines document is envisioned to be a comprehensive source of information that provides agencies with the required approach and methodology for measuring benefits from CSS projects.

Introduction

The primary outcome of this research effort is a practical set of recommended practices for transportation professionals to use for assessing benefits of a completed CSS project. To achieve this goal, a set of guidelines was developed that would clearly demonstrate the metrics to be used with each principle. As discussed previously (Table 5), there are certain benefits that could be achieved with the implementation of each CSS action principle. It is also reasonable to assume that there may be some relative importance among these benefits for a variety of reasons including ease of data collection, data availability, resources required, and level of commitment.

The guidelines developed consider these issues and identify the benefits and their associated metrics in a manner that allows for prioritization. This approach provides an agency with the ability to do a basic or targeted evaluation, where it could be possible to collect fewer selected metrics and thus evaluate associated CSS principles, or perform a more thorough analysis, where several metrics could be used requiring additional data collection and analysis effort. Based on this concept, the benefits and their metrics are categorized into three groups: primary, secondary, and tertiary as shown in Table 5. Metric indicators for each benefit have been identified in Table 6. Among these benefits, a fundamental benefit was identified that is capable of capturing the essence of the principle and in most cases requires minimal data collection and analysis. The remaining primary benefits capture the most basic performance measures for estimating the CSS application and require additional data collection and analysis. The secondary benefits allow for a more thorough analysis and performance evaluation, and they require additional monitoring and data collection than those used for the determination of the primary benefits. For these benefits, the metric indicators developed for the primary benefits could be employed and adjusted appropriately to become able to capture the essence of the CSS principle. Finally, the tertiary benefits could provide an agency the opportunity to use them if their usefulness could be viewed as contributing to estimation of CSS benefits.

The notion of flexibility in applying these combinations for identifying benefits relative to principles applied is also emphasized in the guidelines. An agency should view the principle-benefit matrix in Table 5 as a recommended starting point and adjust accordingly based on its view and perspectives. It is therefore possible that an agency can develop a completely new matrix identifying different fundamental, primary, and secondary benefits for each principle than those presented in Table 5. The metrics developed for each benefit are generic and thus could be used to measure the magnitude of the same benefit for each principle.

The guidelines provide several benefits and associated metrics that can be used to measure project outcomes. Both the benefits and metrics vary in terms of data collection efforts and

address various aspects of the project and project development process. It is anticipated that the benefit analysis may be used for the following four distinct applications (Figure 2):

1. **Justification of CSS Project/Project Elements.** Benefits are measured to allow for the project team to justify specific project elements (design or activities) throughout the project development process. Direct measuring and quantification of project benefits is used to address concerns about the project outcomes. These measured outcomes allow for greater acceptance of the project and can be used as an example in future projects.
2. **Justification of Agency CSS Program.** Benefits are measured to allow for an agency to justify and evaluate the effectiveness of an agencywide CSS program or process. The use of agencywide measured outcomes allows for determining the appropriateness of CSS in project development and for demonstrating the benefits to the agency, to the legislature, and to interested public parties.
3. **Continuous Improvement of Agency Process.** Benefits are measured to be used in conjunction with the principle-benefit matrix as a tool for a continuous improvement of the agency's project development process. The benefit analysis can identify where improvements in project development have been made as well as identify opportunities for improvement. The measured outcomes are used to determine the benefits not accrued based on the agency's desires and to then initiate a review of the process to determine actions that directly beget those benefits.
4. **Continuous Improvement of the Project.** Benefits are measured in conjunction with the principles-benefit matrix as a tool for a continuous improvement of the project itself. Measured outcomes for benefits accruing throughout the project development process are monitored to identify problems in the project approach and/or outcome prior to completion of the project allowing for corrective actions before the completion of the project.

Another key element presented in the introduction is the relative "importance" between CSS principles and their interaction. For example, involving all stakeholders (and the public) will have a significant influence in achieving informed consent on purpose and need as well as shaping the (full) range of communication methods to be used. The relationships and influences among principles are identified and assessed, since their presence could alter the resulting benefits and affect their magnitude. Not including all stakeholders will result in revisiting the purpose and need once all stakeholders are identified and invited. A delayed identification of stakeholders could affect the level of the disruption (a benefit for involving all stakeholders) or the stakeholder feedback (a benefit from utilizing a full range of communication tools).

To further examine these relationships, each principle was reviewed as it could impact other principles. The 15 CSS principles could then be examined based on the affected or involved groups and thus create distinct categories of influence. There are two major categories that these principles apply to, and are defined as follows:

- **Project Team.** The principles affecting the project team composition, coordination and project development include use of interdisciplinary teams (principle 1); addressing alternatives and all modes (principle 6); considering a safe facility for all users and community (principle 7); maintaining environmental harmony (principle 8); addressing community

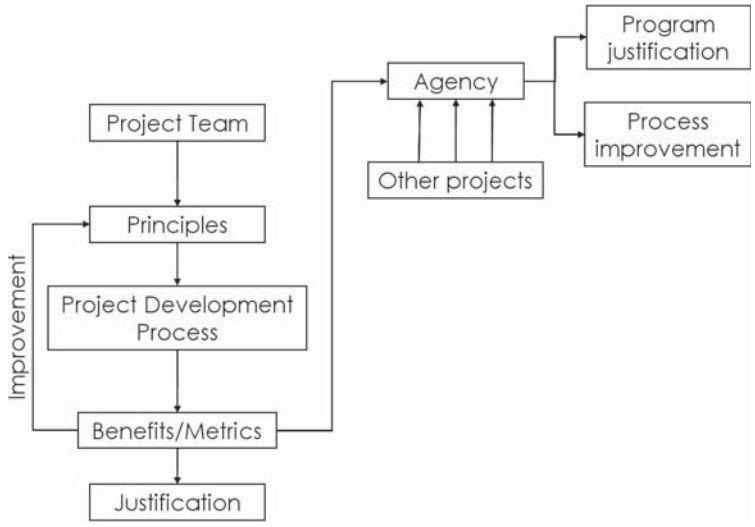


Figure 2. Benefit analysis.

and social issues (principle 9); addressing aesthetic treatments and enhancements (principle 10); utilization of full range of design choices (principle 11); documentation of project decisions (principle 12); tracking and meeting all commitments (principle 13); and use of agency resources effectively (principle 14).

- **Stakeholders/Public.** The remaining principles relate to involvement and input solicitation from stakeholders and the public. These principles include: involving stakeholders (principle 2); seeking broad-based public involvement (principle 3); using full range of communication strategies (principle 4); achieving consensus on purpose and need (principle 5); and creating a lasting value for community (principle 15).

Some principles build on each other and have what appear to be hierarchal, cause-effect relationships. For example, principles 2 (involve stakeholders) and 3 (seek broad-based public involvement) will have a significant influence on principle 5 (achieve consensus on purpose and need) as well as shaping principle 4 (use full range of communication methods). Understanding the principles and their interaction promotes knowledge of CSS fundamentals and process relations and comprehension of how CSS projects are developed.

A good representation of these relationships is provided in Figure 3 showing the dependencies among principles as a building. The foundation of the building consists of the three Fundamental Principles of CSS:

- Use interdisciplinary teams,
- Involve stakeholders, and
- Seek broad-based public involvement.

The floor is comprised of the four Basic Transportation Agency Principles that exist for every project:

- Use a full range of communication strategies,
- Achieve consensus on purpose and need,
- Address alternatives and all modes, and
- Consider a safe facility for users and community.

The six pillars of the CSS building are the six Agency-Enabling Principles and Context-Sensitivity Enablers that provide for and ensure context sensitivity:

Context-Sensitivity Enablers

- Maintain environmental harmony,
- Address community and social issues, and
- Address aesthetic treatments and enhancements.

Agency Action Enablers

- Utilize full range of design choices,
- Document project decisions, and
- Track and meet all commitments.

The lintel and roof of the building of CSS have the following Long-Range Project Principles (Goals):

- Use agency resources effectively and
- Create a lasting value for the community.

Projects vary, and the intensity with which CSS principles are used will vary as well. The three Fundamental Principles must be applied to have a CSS project development process. The four Basic Transportation Agency Principles are present regardless of whether or not a project employs CSS. The six enabling principles are the tools that enable a project team to

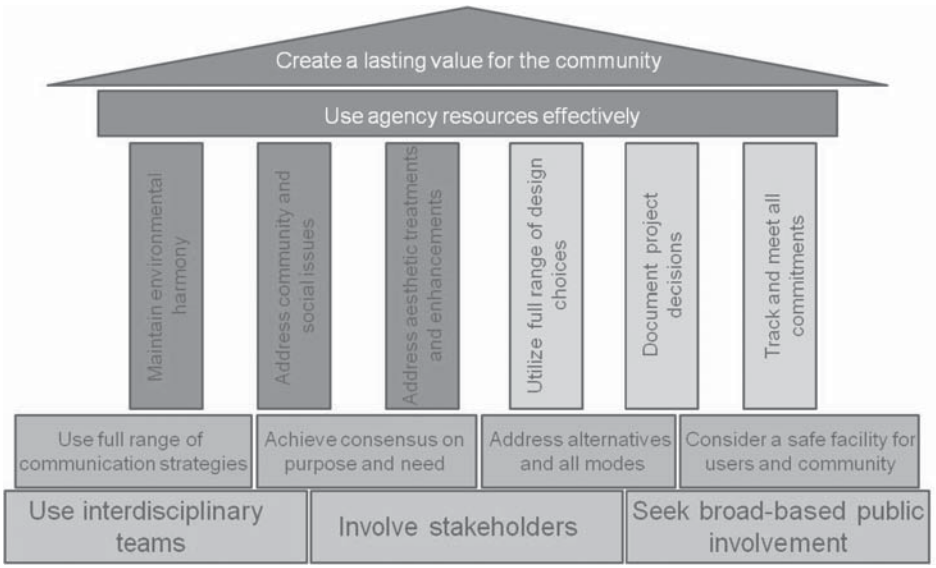


Figure 3. The building of CSS principles.

create a lasting value for the community and use agency resources effectively, which should be the aim of all projects. While all principles will be present on any project, their relative intensity (as applied) will vary between projects. Similarly all benefits will be present; however, resulting benefits will vary accordingly.

The relative intensity of each principle should be examined, since the magnitude of benefits to be realized will be affected. This relative intensity is to be determined by the scope, scale, and context of the project. For example, for a small project, there may be a limited number of stakeholders involved, which will affect the extent and type of communication methods employed and the level of public involvement required. Extensive public involvement efforts may not be necessary to provide measurable benefits. On large, complex projects affecting many parties, greater stakeholder and public involvement may be required to achieve an equivalent level of benefits.

Layout

The guidelines first provide a brief overview and discussion of the application process that an agency should undertake while attempting to estimate benefits from CSS applications, followed by the principles to be used and their associated benefits along with metrics for measuring their magnitude. An example project is also presented to demonstrate the approach and provide insight in the application process.

The application process describes the use of the benefit analysis and defines the implementation process to be followed. Benefit analysis may be used by the project team to justify project elements or to improve processes for the project. Transportation agencies can use the same benefit analysis to justify the agency program or use it as part of a continuous improvement process. For successful benefit analysis, the evaluation approach should be established from the outset of the project so that principles are properly applied, data is timely collected, and benefits are measured. This process is as follows:

1. Determine the appropriate intensity of each principle based on the scope, scale, and context of the project.
2. Determine the benefits to be measured and their metrics based on the desired benefit analysis.
3. Establish benchmarks for comparing measured outcomes for benefits.
4. Collect, maintain and make accessible pertinent data for benefit evaluation.
5. Conduct a benefit analysis and evaluation.

The guidelines continue with information for each principle and document the associated benefits and their metrics. For each principle, a series of short tables is included that provide a brief snapshot of the principle with its definition and benchmark elements for its application. This is followed by a discussion on the concepts of the principle as well as the applicable phases and elements that will contribute to the proper application of the principle. The associated benefits are presented in a short table referring the reader to the detailed discussion of each benefit and its metrics in the next section of the guidelines. Finally, cases where the application of the principle was properly demonstrated are identified.

The use of the table from points presented in the beginning of the guideline is viewed as a quick summary of the major points of the principle (definition and basic issues for application) that could provide an overview of what is needed. This could be viewed as the 1-min summary of the principle focusing on transmitting the basic requirements for its application. The remaining discussion and examples provide a more detailed approach and explanation on how to implement the principle.

The benefits associated with the principle are presented only in a summary form for two reasons. First, several benefits are used in various principles and it was determined that the guidelines will become repetitive and lengthy without offering any additional insight. Even though this approach requires the reader to use two separate sections of the guidelines, it is believed that this format will be more beneficial to the user. Second, the relationship between principles and benefits, and especially the identification of fundamental, primary and secondary levels, is fluid. The use of the principles-benefits matrix is a suggested one, and each agency can restructure it to their satisfaction. The two section format in the guidelines allows for this flexibility.

Guidelines for benefits were also developed where each benefit is introduced with a brief statement indicating the objectives and rationale for the benefit. The set of associated primary principles are presented with a short justification for their use followed by a list of the secondary principles associated with the benefit. Finally, both quantitative and semi-quantitative metrics required for measuring the benefit are presented. The semi-quantitative measures present the proposed questions that could be used in a survey identifying the appropriate audience, i.e., team members or the stakeholders/public. Tables are also provided that could be used in identifying the appropriate data to be collected, collecting the quantitative data, and summarizing the data.

An example is provided that demonstrates the application of the various principles and the benefits achieved for the project. The example is a hypothetical study developed as a composite project from the various case studies reviewed. The example describes how each principle was applied in the project, the actions taken by the project team to complete the project, and the results of the benefit measurement. Lessons learned from the application of the recommended approach are also discussed.

CHAPTER 6

Conclusions and Suggested Research

Conclusions

The primary outcome of this research effort is a practical set of recommended guidelines for transportation professionals to use for assessing benefits of a CSS project. To achieve this goal, a set of principles was identified with associated benefits to which metrics can be applied for measuring the magnitude of the benefits.

The guidelines developed provide a methodology for completing a systematic quantification of benefits of using the CSS approach for project development. The guidelines present a comprehensive approach for implementing assessment and provide a set of instructions on how to conduct a benefit quantification effort. It is apparent that a systematic approach needs to be undertaken where data will be collected periodically in order to provide the basis for evaluating individual projects and identifying areas for agency CSS improvement. The benefit quantification is a process that any agency can undertake in order to first determine the effectiveness of their efforts on a specific project, conduct a program evaluation, and use the lessons learned to improve specific actions for future projects. This allows for continuous improvement effort that could be undertaken to positively impact project development and delivery operations using agency resources more effectively.

The guidelines have also been designed with the realities of project scope, size, and extent. A project team has the ability to identify and customize the principle intensity applied in the project based on the specific needs of the project. This provides the ability to vary principles applications in terms of magnitude and allows for a flexible project development process that provides a broadened ability to the agency and project team to achieve desired outcomes. Moreover, the project team can also select the anticipated benefits and determine those that are to be monitored and measured. This allows for an evaluation procedure that is customizable to a process which provides flexibility to the agency and project team to achieve desired outcomes. To determine whether a benefit accrued, the project team can develop benchmarks that would be specific for the project developed and customize data collection to determine them. The evaluation and comparison of the collected data to these benchmarks allows for identifying successful application of principles and improvement actions for future applications of principles that were not successfully employed. These efforts could be then used by the agency to improve the development process of other projects.

The principle-benefit matrix provides an agency with a linkage of direct actions to improve both project and program performance as well as to determine future process improvement opportunities. Once the agency targets benefits to be measured by all projects, associated metrics could be determined and the agencywide target threshold values could be established. The collected data could then be used to identify the remedial actions required to meet or exceed the thresholds set through an identification of the appropriate actions for improving each principle by examining the corresponding application criteria. For example, if an agency is experiencing an extreme lack of trust it can identify several actions, using the associations established by the matrix, that it might take to remedy that situation. The use of the matrix in this fashion will allow agencies to improve their overall performance and project development and delivery process.

The action principles' criteria provide a level of detail that operationally defines the necessary CSS actions. This level of detail needs to be expanded and tailored to the circumstances of the agency. This represents the working level of the project development and delivery processes. Agencies wishing to pursue CSS must wrestle with the requirements of these criteria. This is the level of knowledge that is important to the development of project managers/leaders and to the various members of the core project team. Additional project team specialists that are brought on board will require some understanding of CSS at this level to perform their functions adequately. The matrix can also be very important in educating new transportation professionals or the project team specialist on

the project development and delivery process and the specific actions (and expertise) needed to accomplish a successful project.

Conducting targeted assessment of specific project development processes is difficult, but can be accomplished if conducted in a real-time proactive manner. Using standardized surveys to acquire expert opinions and assess stakeholder/community satisfaction is possible and very informative. Project leaders can use this information during a project to determine effectiveness and program managers can use the information from multiple projects to make procedural adjustments and determine possible improvement actions that may include, for example, improving process handoffs or training.

The use of the case studies identified a number of issues that would currently limit the widespread application of the proposed method for benefit quantification and these are discussed here. Issues include the inefficiency, if not impossibility, of a forensic approach for data collection, the need for systematic data collection, and the commitment of the agency to conduct such evaluations.

The most important aspect encountered is that a systematic and well organized data collection effort should be undertaken from the outset of the project. The forensic approach implemented in this research showed that it is almost impossible to identify and collect data after the completion of the project. Such data is likely to be incomplete, not adequately cover the required metrics, and not have the necessary statewide comparisons data available. The identification of the benefits to be monitored along with their metrics from the outset of the project is essential. This will allow for identifying the specific metrics to be monitored and allow for timely data collection and the building of comparison data. It is important for an agency to identify data collection needs from the outset of the project and include it in the project development process to ensure that critical windows of opportunity are not missed. Critical assessment data must be collected appropriately, maintained adequately, and be readily available.

Some benefits cannot be easily quantified and not all metrics can be converted to dollar values in order to determine the level of benefit accrual. The research concluded that most case studies benefits cannot be easily quantified, but need to be compared to the goals set forth in the purpose and need statement of the project. For example, benefit 13 "Improved mobility for all users" is measured by identifying the extent of new or improved facilities included in the project. For some case studies, this benefit accrued once a bike lane was added for the entire length of the project or a new bus line was incorporated with bus stops along the route. The presence of the facility is a positive benefit of the project, since it was part of the purpose and need statement, but does not allow for converting this to a value to be added to time and cost savings and determine the extent of benefit accrual for the project.

Another issue regarding difficulties with benefit quantification is the fact that benefits are relative to the project scope, size and goals. It is reasonable to assume that the magnitude of the benefits will be smaller for projects with limited scope or small size; this does not lessen the importance of achieving these benefits for a project. Also, such data should be collected to allow for inclusion of the project in the agency aggregation and estimation of benefits for potential agency continuous improvement efforts. The fact that goals vary by project create an obstacle for comparison of benefits across projects.

The results from the study indicate that agencies do not systematically collect data to evaluate project performance and develop benefit-cost information for projects. It is apparent that data is collected only when individual project teams consider it appropriate for documenting their actions to possibly avoid future difficulties with either stakeholders or the community. This approach does not allow for the development of a systematic data collection effort across all projects for an agency nor for the establishment of a database that could be accessible to any interested party. The data requested in the case studies was not made available even when individuals noted that they had access to it. Therefore, there is a need for commitment by agencies to systematically collect such data and maintain a database to allow for benefit assessment and/or establishing a continuous quality improvement effort.

Data from the case studies collected indicted that very few agencies and teams routinely document project decisions and actions and maintain a project file that includes data to be used for quantification of the potential project-related benefits once the project is completed. Several projects are typically completed over a long period of time and during their lifetime there may be a turnover of project personnel. Even though transportation agencies may bring new personnel up to speed internally, the need for developing project documents is essential for retaining the knowledge developed and commitments made in the project. An issue that the research team faced was that team members noted the potential for benefit accrual but were not capable of presenting the appropriate documentation to validate and quantify these benefits.

Future Research

The work completed here also identified areas where additional research is needed to provide answers to the questions posed but were not addressed due to data limitations. The following areas of future research are recommended as a result of the issues raised here:

1. A longitudinal case study could be undertaken where the implementation of the proposed approach for benefit quantification could be applied. This will require the identification of projects in their initial stages to allow for the

development of the process and establishment of benefits to be monitored from the outset of the project and allow for a systematic evaluation of the proposed benefit quantification approach.

2. Another effort could be the identification of a select set of case studies among those used here for a detailed evaluation and documentation of potential benefits. This approach will allow site visits and data collection in order to complete data for all metrics.
3. The linkage between CSS and Practical Design/Solutions should be explored and determined. The new initiatives by Missouri and Kentucky in the area of Practical Design/Solutions are considered as a new approach for project development. However, these efforts could be viewed as a subset of the CSS approach, since they still follow many of the same principles but the decisions are guided more by financial and budgetary constraints. Therefore, the effects of this effort on CSS should be investigated.

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Appendices

The following Appendices are not published herein. To find Appendices A through E for this report, go to www.trb.org and search for "NCHRP Report 642."

Appendix A: Literature Review Summaries

Appendix B: Team Member and Stakeholder Surveys

Appendix C: Rationale for Principle-Benefit Association

Appendix D: Documentation of Case Studies

Appendix E: Case Study Scores

Guidelines for Quantifying the Benefits of Context Sensitive Solutions

CONTENTS

PART I

PART II

Principles

Benefits

PART I

Preface to the Guidelines

The Guide's Purpose and Use

This guide was developed for project teams and their responsible agencies to quantify the transportation benefits of principal actions taken during the project development and delivery process. It was especially designed to capture those principal actions associated with Context Sensitive Solutions (CSS) initiatives in addition to other traditional actions.

This guide is useful to program managers, project leaders or managers and project team members. Managers can use this guide to develop the data needed to justify actions taken during project development and to establish benchmarking procedures for a continuous improvement initiative. Project leaders or managers can use it to provide progress feedback during the project stages and to determine the quantitative benefits of specific principle-driven actions. Project team members can use the principle-benefit approach to understand the purpose and consequences of their activity throughout the life of the project. This is especially important if the project is expected to achieve CSS.

Agencies deciding to conduct these evaluations must be willing to collect the data in a timely manner using standardized methods, maintain a data/analysis archive and have a way to make this information readily available.

Why Is This Guide Needed?

In an age of accountability and scarce funding, there are many that believe government project actions and process changes should be based on a business case justification. Such justifications are numbers driven using either quantitative or semi-quantitative data. The methods used require clear objectives or action intentions to be specified and then coupled with describable and quantifiable benefits.

This guide provides the robust framework and tools needed to carry out the quantification of benefits from the principle-driven actions of a project development/delivery process intending to achieve CSS. It is a complete systematic approach that standardizes the collection and analysis of data needed to quantify benefits and/or establish benchmarks for continuous improvement initiatives.

How Is This Guide Best Used?

Program managers can use this guide to determine the quantifiable benefits of principle-driven project actions that were taken during the various stages of the project development process. The

data can be used to justify types of actions and/or to establish benchmarks upon which to base process improvement decisions as part of an agency's continuous improvement initiative. It is recommended that this approach be applied to all projects; it can be applied to a certain few and/or the focus can be on selected principle-driven actions of the project development process. This allows the agency a considerable amount of flexibility in using this benefit quantification approach.

Team leaders and members can use this guide to determine the quantifiable benefits of principle-driven actions that are taken during the various stages of a project's development process as part of their agency's justification and/or benchmarking assessments. Also, the approach allows for interim assessment of some principle-driven actions that could facilitate changes in action intensity during the progress of the project to more closely achieve the benefit level desired.

What Are the Key Topics Covered?

The key topics of this guideline are the following:

- Introduction to the approach of benefit quantification for projects;
- Application requirements, standardized methods and data collection tools;
- Project evaluation example illustrating a complete application;
- The action principles of CSS project development; and
- The principle-associated benefits of CSS.

The Guide's Development

The research and case study required to develop this guide was carried out over a 3-year period. The process included: (1) the development of a framework of principle-driven actions and associated benefits; (2) the determination of the necessary data/information elements and development of the necessary survey and data collection forms; and (3) the application of the structured approach and standardized assessment tools to selected case study projects throughout the United States. Over 100 potential projects were examined from 40 states. Thirty three projects were chosen for further study. Based on this experience, the approach and methods were refined and the entire sequence of work was documented in NCHRP Report 642.

The study team and reviewers involved 18 individuals. All individuals had experience with the project development process and specifically the steps required to ensure CSS. This group was multidisciplinary, with some from the private sector and some from government. The group's members had experience working in many states. While the core research team members were university based, the majority of those involved in this project were practitioners having extensive transportation agency experience.

The Challenge

Once the systematic evaluation approach is established then data can be collected and analyzed. The steps must be established beforehand and the data collected in a timely manner as actions progress—it is most difficult to do this exercise forensically. Conducting a data-dependent business case justification that assesses benefits of project development actions requires establishing a systematic approach in advance. If a project team or responsible agency wants to determine the level of justification for selected project development actions then this guide will serve that purpose well. It can also provide the data needed to conduct continuous improvement initiatives at the project and program levels. This is desperately needed in transportation agencies.

Any transportation project development/delivery process should be principle-driven and benefit-justified. This guide provides a way to meet that need and can serve as a tool to continually improve the project processes to achieve effective and efficient transportation facilities.

Glossary of Key Definitions

To eliminate any possible misunderstandings and provide consistency in the common use of certain terms, it is essential to provide a dictionary of the following terms used in the guidelines:

- **Program manager:** The person responsible for certain project functional phases, such as director of planning, design, maintenance, and operations but not necessarily directly involved in the specific project.
- **Project manager:** The responsible lead person who coordinates various activities throughout (or at various stages of) the project development process and may be the decision authority on the final project solution.
- **Project team:** The persons involved in the various development phases of a project and have most frequently a specific field of expertise needed to develop a best fit project solution.
- **Stakeholder:** All local governments and resource agencies, development agencies and groups with special standing that could be involved in the project and can have an influence in completing and/or providing permits for certain project phases.
- **Public:** Any potential user of the project or person of the community that may be impacted by the project whose input and opinion should be solicited and considered at appropriate points throughout the project development process.
- **Principle intensity:** The breadth and depth of the application of a principle based on the project attributes (scope, scale, and context).
- **Benefit analysis:** A systematic process for identifying and measuring project outcomes to be applied in the desired evaluation process.
- **Satisfaction level:** A method for establishing the level of satisfaction for an element by a person typically measured with a scale.
- **Opinion:** A method for establishing the level of agreement to a concept by a person that is typically measured with a scale (mostly agree, agree, disagree, and mostly disagree).
- **Expert opinion:** A method for establishing the level of agreement to a concept by a project team member (expert) that is typically measured with a scale (mostly agree, agree, disagree, and mostly disagree).

Introduction

The primary objective of these guidelines is to provide transportation agencies with a set of recommended practices for assessing benefits of Context Sensitive Solutions (CSS) projects. Central to these practices is the understanding and use of CSS principles that guide projects. Once these principles are identified, associated benefits from their application can be identified and measured to quantify the effect of these actions for the agency and the community. Therefore, CSS is a principle-driven, benefit-justified effort that can enhance an agency's goals and interaction with stakeholders and the public. The need exists to be able to analyze and measure the benefits of CSS and its impact on projects (e.g., cost and delay) in order to demonstrate a best use of agency resources. This guide provides transportation agencies with a method and the tools that will allow them to accomplish this.

Each transportation project is unique in terms of the nature, scope, and importance of issues addressed. Those factors impact project purpose and need, community and environmental concerns, geometric conditions, traffic, safety history, and public priorities. Moreover, the uniqueness of transportation projects determines the intensity with which principles are applied to the project as well the benefits to be measured. Consequently, the opportunities to realize benefits will vary as well among projects. Thus it is necessary to have an assessment approach capable of accounting for both realized benefits and realized opportunities. This guide allows the benefit analysis to be tailored specifically to an individual project while at the same time providing meaningful data for agency-wide evaluation.

Focusing only on project outcomes will allow for an analysis of benefits but will not allow for an understanding of how these outcomes were achieved. However, by applying the CSS principles on a project and identifying their potential benefits, a direct link between project actions and benefits can be readily identified. A proactive project approach uses this linkage by setting targets to be achieved for selected benefits and determining principle-driven actions that must be made throughout the project development process to achieve these benefits. As a result, the CSS principles provide the foundation for a systematic approach to project development and benefit analysis.

The next section of the guidelines provides a brief overview of the application process that an agency should undertake while attempting to estimate benefits from CSS applications. This is followed by an example project demonstrating this approach and providing insight in the assessment process. The guidelines also include two reference sections identifying and discussing (1) the CSS principles and their proper use, and (2) their associated benefits with metrics for measuring their magnitude.

Application

Use of Benefit Analysis

Several benefits and associated metrics can be used to measure project outcomes. Both the benefits and metrics vary in terms of data collection efforts and address various aspects of the project and project development process. Benefit analysis may be used for the following four distinct applications (Figure 1):

1. **Justification of CSS Project/Project Elements.** Benefits are measured to allow for the project team to justify specific project elements (design or activities) throughout the project development process. Direct measuring and quantification of project benefits is used to address concerns about the project outcomes. These measured outcomes allow for greater acceptance of the project and can be used as an example in future projects.
2. **Continuous Improvement of the Project.** Benefits are measured in conjunction with the principles-benefit matrix as a tool for continuous improvement of the project itself. Measured

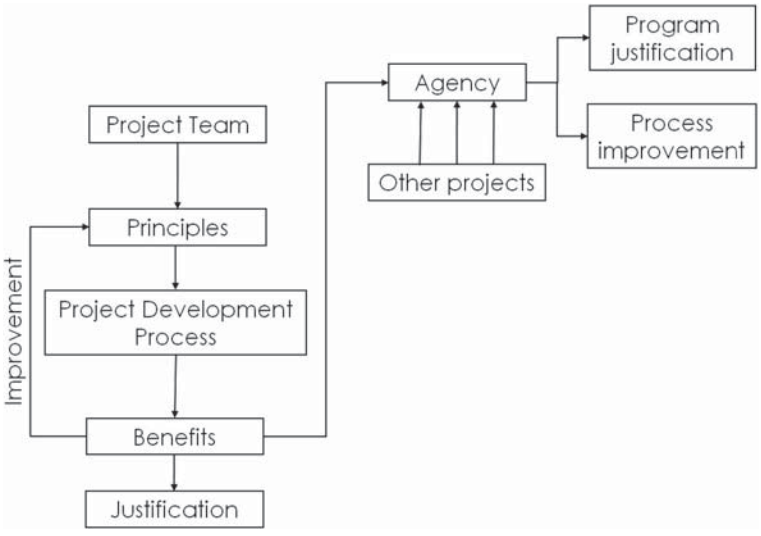


Figure 1. Benefit analysis.

outcomes for benefits accruing throughout the project development process are monitored to identify problems in the project approach and/or outcome allowing for corrective actions before the completion of the project.

3. **Justification of Agency CSS Program.** Benefits are measured to allow for an agency to justify and evaluate the effectiveness of an agencywide CSS program or process. The use of agencywide measured outcomes allows for determining the appropriateness of CSS in project development and demonstrating the benefits to the agency, the legislature, and interested public parties.
4. **Continuous Improvement of Agency Process.** Benefits are measured in conjunction with the principle-benefit matrix as a tool for continuous improvement of the agency's project development process. The benefit analysis can identify where improvements in project development have been made as well as identify opportunities for improvement. The measured outcomes are used to determine the benefits not accrued based on the agency's desires and to then initiate a review of the process to determine actions that directly produce those benefits.

Principles

The project development/delivery process was examined to determine the discrete actions needed for a successful CSS project. These actions are stated as principles and they drive the activities and tasks needed to be completed during the project development process. It is these principles to which benefits can be associated and measured. The review of the project delivery process defined 15 principles to be used in the process as shown in Table 1.

Some principles build on each other and have what appear to be hierarchal, cause-effect relationships. For example, principles 2 (involve stakeholders) and 3 (seek broad-based public involvement) will have a significant influence on principle 5 (achieve consensus on purpose and need) as well as shaping principle 4 (use full range of communication methods). Understanding the principles and their interaction promotes knowledge of CSS fundamentals and process relations and comprehension of how CSS projects are developed.

A good representation of these relationships is provided in Figure 2 showing the dependencies among principles as a building. The foundation of the building consists of the following three Fundamental Principles of CSS:

- Use interdisciplinary teams;
- Involve stakeholders; and
- Seek broad-based public involvement.

Table 1. CSS Principles.

1. Use interdisciplinary teams.
2. Involve stakeholders.
3. Seek broad-based public involvement.
4. Use full range of communication methods.
5. Achieve consensus on purpose and need.
6. Address alternatives and all modes.
7. Consider a safe facility for users and community.
8. Maintain environmental harmony.
9. Address community and social issues.
10. Address aesthetic treatments and enhancements.
11. Utilize full range of design choices.
12. Document project decisions.
13. Track and meet all commitments.
14. Use agency resources effectively.
15. Create a lasting value for the community.

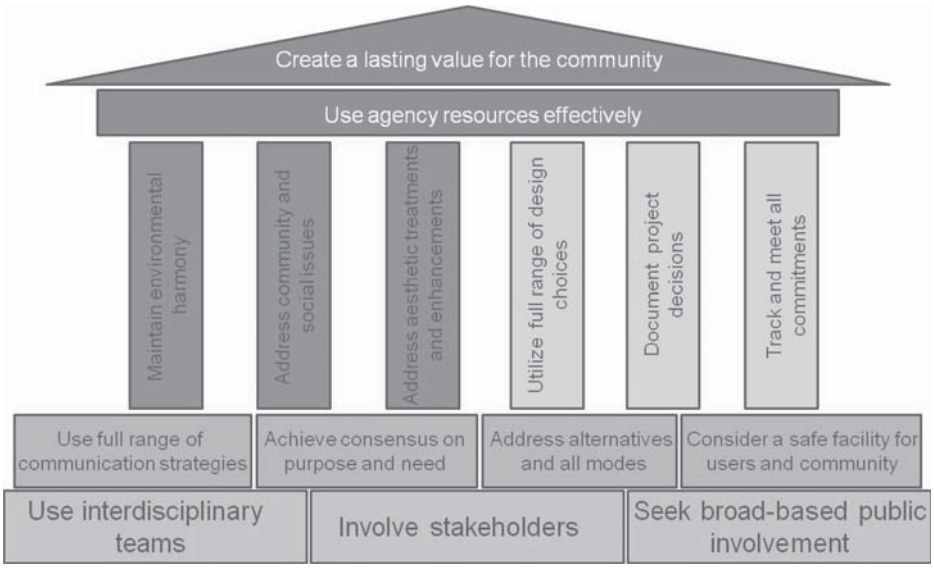


Figure 2. The building of CSS principles.

The floor is comprised of the following four Basic Transportation Agency Principles that exist for every project:

- Use full range of communication strategies;
- Achieve consensus on purpose and need;
- Address alternatives and all modes; and
- Consider a safe facility for users and community.

The six pillars of the CSS building are the six Agency Enabling Principles and Context-Sensitivity Enablers that provide for and ensure context sensitivity.

The following are the Context-Sensitive Enablers:

- Maintain environmental harmony;
- Address community and social issues; and
- Address aesthetic treatments and enhancements.

The following are the Agency Action Enablers:

- Utilize full range of design choices;
- Document project decisions; and
- Track and meet all commitments.

The lintel and roof of the building of CSS are the following Long-Range Project Principles (Goals):

- Use agency resources effectively; and
- Create a lasting value for the community.

Projects vary, and the intensity with which CSS principles are used will vary as well. The three Fundamental Principles must be applied to have a CSS project development process. The four Basic Transportation Agency Principles are present regardless of whether or not a project employs CSS. The six enabling principles are the tools that enable a project team to create a lasting value for the community and use agency resources effectively, which should be the aim of all projects. While all principles will be present on any project, their relative intensity (as applied) will vary between projects. Similarly all benefits will be present; however, resulting benefits will vary accordingly.

The relative intensity of each principle should be examined, since the magnitude of benefits to be realized will be affected. This relative intensity is to be determined by the scope, scale, and context of the project. For example, for a small project, there may be a limited number of stakeholders involved, which will affect the extent and type of communication methods employed and the level of public involvement required. Extensive public involvement efforts may not be necessary to provide measurable benefits. On large, complex projects affecting many parties, greater stakeholder and public involvement may be required to achieve an equivalent level of benefits.

Benefits

A total of 22 specific potential benefits are identified as a result of applying the 15 CSS principles (Table 2). The benefits are grouped into two basic categories based on who accrues the benefits, i.e., the agency or the users. This is needed since some of the benefits are internal to the agency's operations and have no clearly understood benefit to the users. This differentiation provides the agency with the ability to determine those other benefits and that the users will best recognize and use to judge the agency's project development process performance.

Principle-Benefit Matrix

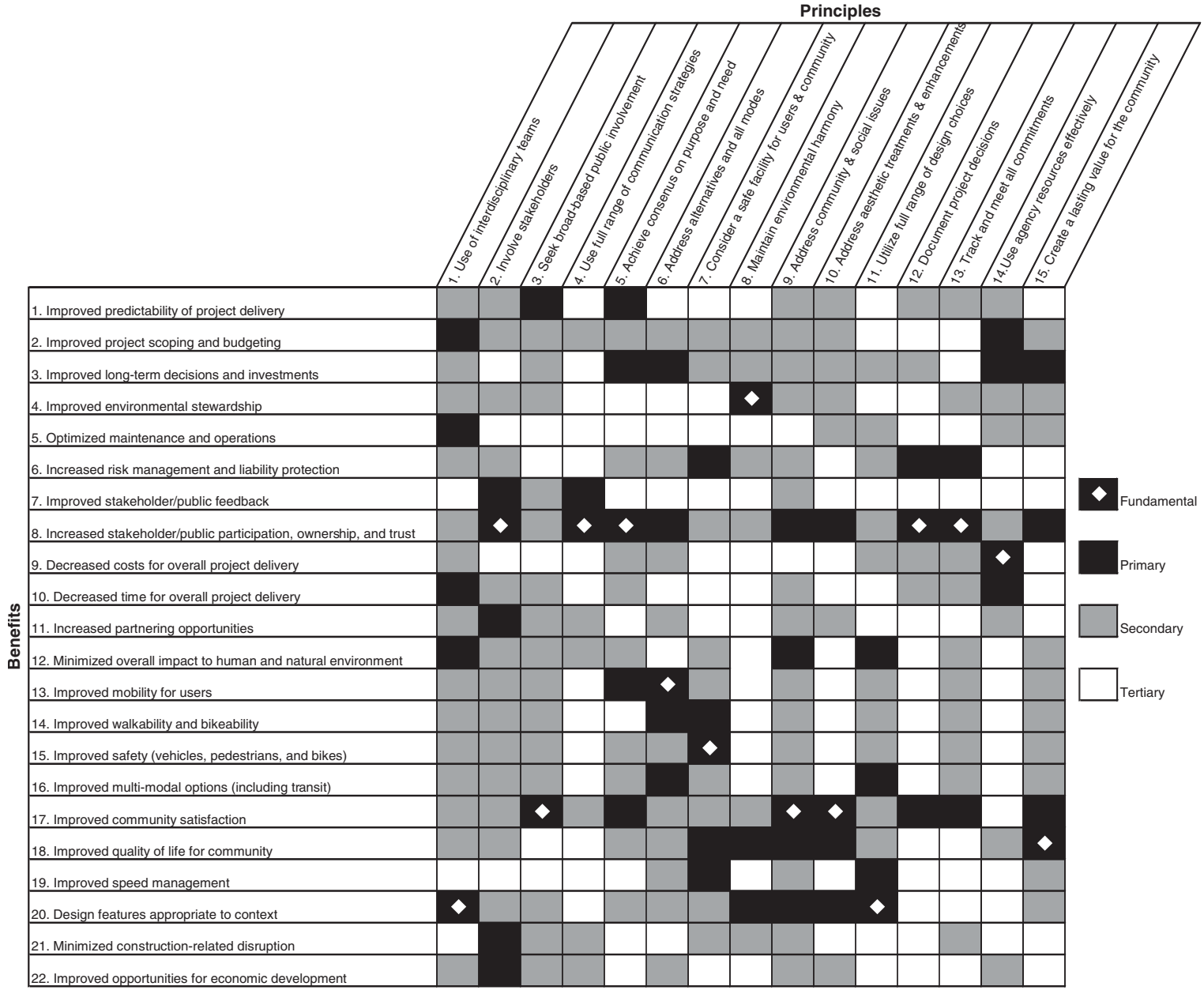
A matrix of principles and benefits was developed to identify the relationship between benefits with the application of each CSS principle (Table 3). The matrix uses three levels of relationship between benefits and principles. Benefits having a strong relationship to a principle designated are identified as "primary benefits." Additional benefits having a potentially lower level of associated impact are designated as "secondary benefits." Other benefits conceivably realized from the application of a principle are designated as "tertiary benefits."

For each principle one primary benefit is designated *fundamental* providing a single indicator to capture the benefit of applying the principle. The fundamental benefit allows an agency to perform a focused evaluation of a CSS project in the event that resources are not available to complete a full-scale evaluation of all associated benefits.

Table 2. CSS potential benefits.

1.	Improved predictability of project delivery.
2.	Improved project scoping and budgeting.
3.	Improved long-term decisions and investments.
4.	Improved environmental stewardship.
5.	Optimized maintenance and operations.
6.	Increased risk management and liability protection.
7.	Improved stakeholder/public feedback.
8.	Increased stakeholder/public participation, ownership, and trust.
9.	Decreased costs for overall project delivery.
10.	Decreased time for overall project delivery.
11.	Increased partnering opportunities.
12.	Minimized overall impact to human and natural environment.
13.	Improved mobility for users.
14.	Improved walkability and bikeability.
15.	Improved safety (vehicles, pedestrians, and bikes).
16.	Improved multi-modal options (including transit).
17.	Improved community satisfaction.
18.	Improved quality of life for community.
19.	Improved speed management.
20.	Design features appropriate to context.
21.	Minimized construction-related disruption.
22.	Improved opportunities for economic development.

Table 3. Principles and associated benefits.



The principle-benefit matrix provided in Table 3 was developed with careful consideration and captures the extent of the principle-benefit relationships based on case study findings. It is amenable to review and revision by users (where substantial experience indicates that other principle-benefit relationships are of more significance). However, wholesale changes are not recommended without a sufficient background research.

Implementation

Benefit analysis may be used by the project team to justify project actions or to improve processes for the project. Transportation agencies can use the same benefit analysis to justify the agency program or use it as part of a continuous improvement process. For successful benefit analysis, the evaluation approach should be established from the outset of the project so that principles are properly applied, data is timely collected, and benefits are systematically measured. This process is as follows:

1. Determine the application intensity of each principle using the project attributes.
2. Select the benefit(s) to be measured and the quantitative and/or semi-quantitative measures to be used.
3. Establish benchmarks for comparing measured outcomes for benefit accrual.
4. Collect data/information using a standardized format (forms and surveys), acquire the data/information in a timely manner, and record it in an appropriate format.
5. Analyze (using comparison, benchmarks and dollar conversions) and evaluate benefit accrual, and report data/information.

The following sections identify key considerations in each of the above steps in the applications process.

Principle Intensity

All 15 CSS principles presented in Table 1 should be applied on all projects. However, unique project attributes (scope, scale, and context) require that the application intensity of each principle should be determined to meet the unique characteristics of the project. Each of these can directly affect the intensity (depth and breadth) of the principle application. The effect of these attributes is demonstrated for principle 1 using an interdisciplinary team.

Scope. As the scope of the project increases, the number of involved disciplines expands, requiring increased members on the team. A resurfacing project may only involve a construction engineer and maintenance engineer in addition to the contractor. On the other hand a new construction project would require expertise in planning, highway design, construction, maintenance, and other appropriate disciplines.

Scale. As the scale of the project increases, the demands on the project increase as well. This may require new expertise to coordinate the project, as well as require multiple persons to perform the work. A major new construction effort may require multiple highway design engineers, with individuals focused solely on specific project aspects. Conversely on a small project, a single engineer may be able to address all of these issues at once.

Context. The varying context of the project has a direct impact on the project as well. As new constraints and resources are encountered or impacted the appropriate team members must be identified. This would include environmental specialists, historic preservationists, special user groups and others as needed.

Table 4 compares relative intensity levels of all CSS principles for two projects. One is a small bridge resurfacing project in a rural area and the other a new facility construction in a suburban

Table 4. Principle intensity level.

Principles	Small rural bridge replacement	New suburban facility
1. Use interdisciplinary teams	L	H
2. Involve stakeholders	L	H
3. Seek broad-based public involvement	L	M
4. Use full range of communication strategies	L	M
5. Achieve consensus on purpose and need	M	H
6. Address alternatives and all modes	L	M
7. Consider a safe facility for users and community	M	M
8. Maintain environmental harmony	H	H
9. Address community and social issues	L	M
10. Address aesthetic treatments and enhancements	L	M
11. Utilize full range of design choices	M	H
12. Document project decisions	M	H
13. Track and meet all commitments	M	H
14. Use agency resources effectively	M	H
15. Create a lasting value for the community	L	M

Note: "L" is for low, "M" is for medium, and "H" is for high intensity.

area. The individual attributes of each project require different intensities of principle application in order to achieve the CSS goal of finding a "best fit" transportation solution for the context that meets the expectations of transportation agency, stakeholders and community.

For each of the 15 principles, a set of criteria for application are provided to assist the project team in the implementation of the principles within the project. These criteria (Part II, Principles) guide the team in determining the appropriate intensity of the principle. As an example, one of the criteria of application for principle 6—address alternatives and all modes—is stated as "Multiple alternatives including various modes, capable of addressing the issues in the purpose and need statement, are identified and developed."

This criterion directly references the purpose and need statement and as such is limited by the defined scope of the project therein. As discussed above, the scale and context of the project should also be considered in its application. A resurfacing project applying this criterion may only examine the feasibility of construction phasing alternatives to reduce construction impacts. If the roadway is heavily utilized by cyclists, i.e., it has a different context, the addition of a bicycle lane may be considered. The expanded scope of a corridor planning study, however, requires that many more alternatives be considered to address the full extent of such a project. This may include (1) the examination of multiple modal options along the corridor including transit, pedestrian and cycling; (2) roadway alternatives such as two or four lanes, divided or undivided highways; and (3) construction phasing alternatives.

Benefit Selection

It is anticipated that not all benefits will be measured on all projects. Benefits to be measured should be selected based on the need to determine project or agency goals. Such a selective approach will allow for focusing on specific measured outcomes and limit unnecessary data collection. Benefits to be measured should be carefully selected based upon the purpose of the benefit analysis and the availability of data to measure project outcomes (and the commitment to collect and store the data). A focused evaluation plan enables the agency or project team to measure pertinent benefits, collect all necessary data, and conduct the appropriate evaluation.

Benefit selection considerations for the four primary assessment methods are discussed here. For project-related evaluations (justification or continuous improvement), benefits need to be

specific and tailored to the project, element, or activity to be measured. For the continuous improvement of the project, targeted benefits are those quickly accruing and those allowing monitoring of the application of principles in order to permit adjusting the principle intensity in real time. For agency-related evaluations (justification of program or continuous improvement of process), benefit measures need to be standardized to allow for summarizing and comparing data for all projects. This can be achieved with data that is obtainable for all projects without extensive data collection and could be limited to measures of fundamental or primary benefits, since they capture the essence of CSS. For continuous improvement of agency processes, a broader range of benefits may be needed to capture the entire spectrum of project outcomes depending on the focus of the continuous improvement initiative. However, a wide range of benefit analysis will allow agency flexibility in dealing with future funding constraints and political realities.

Establish Benefit Benchmarks

The most critical element of the benefit analysis is the establishment of benchmarks for judging benefit accrual. Traditional analysis may use as benchmarks the difference in the measured outcome between before and after conditions or between CSS and non-CSS projects. However, such an analysis is often impractical due to lack of available data (either before conditions or non-CSS project). Benchmarks also vary greatly among agencies and projects, as well as, the purpose for which the benefit is being measured. For instance, if benefits are being measured for use in the continuous improvement of the agency process, the benchmark will be the measured outcome from the previous iteration. For benefits being measured to justify a CSS project, the benchmark is established relative to the project goals. It is therefore impractical to establish a single benchmark for each benefit metric to cover these benefit analysis options.

For benefit analysis on a single project, measures of effectiveness and their benchmarks should be explicitly stated in the purpose and need statement or in a memorandum of agreement or understanding (MOA/MOU). This approach allows for collecting only the required data for comparison and reduces data collection demands. These benchmarks should be both specific and tailored to the project and its context. Specificity is achieved by stating the desired benchmark to be targeted. For example, if the purpose and need statement calls for improved mobility, the specific target of decreased travel time by 20 percent compared to the existing conditions should be stated. Customization is achieved also this way, since benchmarking is specific to the project and agreed upon by team members and stakeholders. In the same example, an agency-wide goal of reducing travel time by 30 percent may be inappropriate for the context of this project.

As part of the continuous improvement of the agency process, a moving benchmark is established which is related to the measured outcomes of the previous round of projects. The evaluation is therefore established by determining the relative improvement of the process as it compared to the "benchmark" established by previous projects.

Data Collection, Maintenance, and Accessibility

A data handling plan must be in place from the project outset. The plan identifies the data to be collected along with when it is to be collected. In addition, how that data will be maintained and made accessible to users is also determined. Data needed to evaluate benefits is obtained throughout the project development process and often is available only for a short time. As an example, attendance level at stakeholder meetings is only available at the meeting. If pertinent data is not collected at that time, it may never again be obtainable. In addition, a system must be in place to maintain the data and make it accessible to those conducting the evaluation. For

project-specific benefit analysis, storage and accessibility may be less formal and available only to project team members. However, agency-wide efforts must have standardized data formats and provide a centrally located and catalogued data source so that others may access and analyze the data.

Evaluation

Once the data is collected it should then be analyzed by several methods depending on the nature of the metric and its intent.

Quantitative data allows for establishing benchmarks and making direct ordinal comparison (using standard measures) and in some cases conversion to dollar amounts.

Semi-quantitative data allows for making broad relational comparisons based on expert opinion and customer satisfaction. It can also be used to compare the views of the project team to the stakeholders/public. This information can be important as other data if, for instance, there is a goal to improve the public trust.

Principles

Criteria of application for each principle are provided in Table 5. As discussed above, these criteria assist the project leader in determining the appropriate intensity and application of the 15 principles. A discussion on the concepts of the principle, the applicable phases and elements that will

Table 5. Principles and application criteria.

Principle	Criteria for application
1. Use interdisciplinary teams	• All disciplines and team members are identified; • Project professionals have the necessary expertise; • Team members understand their role on the project; • Two-way communication is maintained; and • All input is given due consideration.
2. Involve stakeholders	• All stakeholders are identified; • All input is given due consideration; and • Participation is meaningful.
3. Seek broad-based public involvement	• All interested and affected persons are identified; • The project team identifies information needed from the public; • Opportunities for public involvement are provided; and • Decision making process is in place.
4. Use full range of communication strategies	• A full range of communication techniques is employed; • Communication is used to disseminate and collect information; and • Communication is continuous.
5. Achieve consensus on purpose and need	• Purpose and need is developed early; • Agreement on purpose and need goals is achieved; and • Measures of effectiveness are established.
6. Address alternatives and all modes	• Modal alternatives are identified; • Each alternative is developed to its fullest potential; • The “No Build” alternative is a genuine alternative; and • Alternative evaluation criteria are objective.

Table 5. (Continued).

Principle	Criteria for application
7. Consider a safe facility for users and community	• Safety review is conducted; • Input from all modal user groups is sought; and • Solution addressing safety concerns is developed.
8. Maintain environmental harmony	• All resources must be identified and considered early; • Stakeholders/public determine environmental harmony; and • The project strives to enhance resources.
9. Address community and social issues	• Solutions are sensitive to the community values; • The effect of the project on the community is documented; and • The project team is open-minded.
10. Address aesthetic treatments and enhancements	• Appropriate aesthetic design is implemented and • Aesthetic design involves team and stakeholders/public.
11. Utilize full range of design choices	• Design choices/options meet the purpose and need; • Design options minimize impacts; • Project designs are sensitive to the community; and • Input is integrated into design options.
12. Document project decisions	• Project team documents ○ The purpose and need statement; ○ Project constraints and their impact on design choices; ○ The full range of alternatives considered in the project; ○ All natural, human, and cultural resources within the study area; ○ Potential safety concerns and their treatment; ○ The selection process and design values chosen for each design element; and ○ Construction activities and commitments.
13. Track and meet all commitments	• Identify and document project commitments; • Ensure project commitments are addressed; and • Maintain all project commitments.
14. Use agency resources effectively	• The project is delivered in a timely manner; • Expenditures were appropriate for project; • Expenditures were appropriate for system optimization; and • Project team has appropriate support.
15. Create a lasting value for the community	• Project meets purpose and need; • Project is compatible with community plans; • Project addresses quality of life issues; and • Project is sustainable.

contribute to the proper application of the principle, the associated benefits, and cases where the application of the principle was properly demonstrated are detailed in Part II, Principles.

Benefits

The metrics to be used for each of the 22 benefits are summarized in Table 6. The objectives and rationale for each benefit, the justification of associated primary principles, and the quantitative and semi-quantitative metrics required for measuring the benefit are detailed in Part II, Benefits. The semi-quantitative measures present the proposed questions that could be used in a survey identifying the appropriate audience, i.e., team members or stakeholders/public. Tables are also provided that could be used in identifying the appropriate data to be collected, collecting the quantitative data, and summarizing the data.

Table 6. Benefit metrics.

Benefit	Indicators
1. Improved predictability of project delivery	Difference in project duration in months to complete. Semi-quantitative assessment of expert opinion.
2. Improved project scoping and budgeting	Number and cost of change orders/scope changes. Semi-quantitative assessment of expert opinion.
3. Improved long-term decisions and investments	Semi-quantitative assessment of expert opinion.
4. Improved environmental stewardship	Increased or enhanced mitigation beyond regulatory mandates. Semi-quantitative assessment of expert opinion.
5. Optimized maintenance and operations	Annual cost, hours or closures in dollars. Semi-quantitative assessment of expert opinion.
6. Increased risk management protection	Number and cost of legal action taken against project. Semi-quantitative assessment of expert opinion.
7. Improved stakeholder/public feedback	Number of stakeholder/public responses. Semi-quantitative assessment of expert opinion.
8. Increased stakeholder/public participation, ownership and trust	Stakeholder involvement measures. Semi-quantitative assessment of opinion and satisfaction level.
9. Decreased costs for overall project delivery	Decreased dollar cost amount for project delivery. Number and cost of change orders/scope changes. Semi-quantitative assessment of expert opinion.
10. Decreased time for overall project delivery	Number of months by project phases and total duration. Number and cost of change orders/scope changes. Semi-quantitative assessment of expert opinion.
11. Increased partnering opportunities	Number of Memorandum of Agreements or grants established. Semi-quantitative assessment of expert opinion.
12. Minimized overall impact to human and natural environment	Percentage of human and environmental impacts of project. Semi-quantitative assessment of opinion and satisfaction.
13. Improved mobility for users	Index of quality of travel for all modes. Semi-quantitative assessment of opinion and satisfaction.
14. Improved walkability and bikeability	New and expanded options for pedestrians and bicyclists. Index of quality of travel for pedestrians and bicyclists Modal safety (crash/severity). Semi-quantitative assessment of opinion and satisfaction.
15. Improved safety (vehicles, pedestrians and bikes)	Number of crashes, crash rate and severity. Semi-quantitative assessment of opinion and satisfaction.
16. Improved safety (vehicles, pedestrians (including transit)	Each modal facility element inclusion and extent. Modal connectivity (count/volume). Modal safety (crash/severity). Semi-quantitative assessment of opinion and satisfaction.
17. Improved community satisfaction	Semi-quantitative assessment of opinion and satisfaction.
18. Improved quality of life for community	Semi-quantitative assessment of opinion and satisfaction. Alignment with community plans (semi-quantitative).

Table 6. (Continued).

Benefit	Indicators
19. Improved speed management	Operating speed (expected/actual). Semi-quantitative assessment of opinion and satisfaction.
20. Design features appropriate to context	Semi-quantitative assessment of opinion and satisfaction.
21. Minimized construction-related disruption	Work zone, lane closings and detour duration in days. Semi-quantitative assessment of opinion and satisfaction.
22. Improved opportunities for economic development	Economic development indicators. Semi-quantitative assessment of expert opinion.

Case Study

The following case study is a fictional composite project consisting of elements and features from the cases reviewed in NCHRP Project 15-32. The example demonstrates the application of principles and steps to monitor and quantify benefits from the application of a CSS process.

Setting

In the state's current 6-year highway facilities improvement plan, the Department of Highways has programmed for a widening and realignment project for US 462 in Happi County. The section of US 462 is a 10-mi segment between Rushmore and Pleasantville with a projected ADT of 20,000 vehicles per day (Figure 3).

Although only in its early stage of planning (funding availability was just announced), the project is already generating controversy and opposition. Critics of road construction express concern for the integrity and esthetic appeal of the region's rural character. Many opponents of

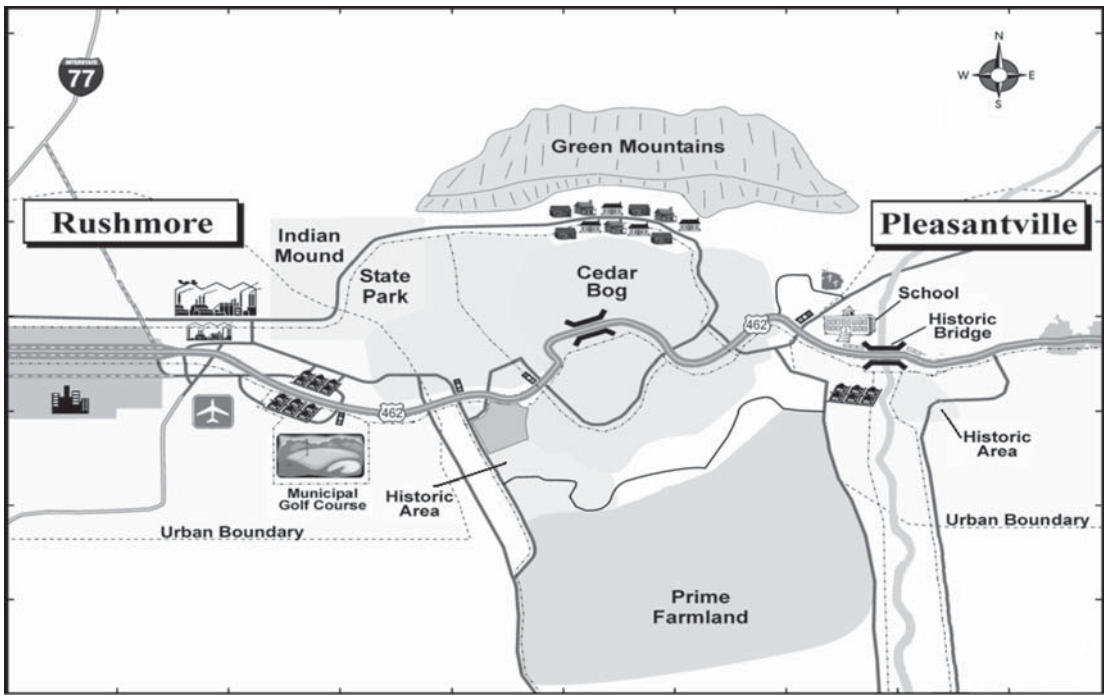


Figure 3. Schematic diagram of existing conditions.

the project attended the first meeting to study feasibility. So the press is closely following the controversy. For their part, supporters of the project point to the greater transportation needs arising from the economic growth and dynamism of the region. In addition, supporters, as well as the Department of Highways, are concerned about the potential safety and capacity shortcomings of not constructing a roadway as some roadway opponents demand.

Given its mission to serve the public, the Department of Highways is now in the middle of the debate between the contending parties. The search for consensus will undoubtedly call for much flexibility in the process. The opposition is organized and can generate support among the general public by pointing out previous department projects that ignored the social, historical, and environmental needs of communities. Maintaining the public's trust and support will require serious effort. The major issues and concerns of the project setting are discussed in the following paragraphs.

Economic growth. For many years, Happi County roads have been considered adequate for the volume of traffic they had to accommodate. In the past, the bulk of the traffic consisted of local motorists and a few commercial vehicles (mainly agricultural). Two years ago, Pleasantville attracted a meat processing plant that currently employs 300 people. In rural areas of Happi County, a significant amount of logging is being conducted. Heavily loaded logging trucks travel constantly on US 462 to access the sawmill east of Pleasantville. Last year, a rock quarry/asphalt plant was opened 3 mi west of Rushmore along US 462.

Environmental concerns. There are several environmental concerns for the Happi County and Rushmore area including a large area of prime farmland that needs to be preserved; several wetlands that are habitat for the Tennessee bat (an endangered species); the deer, wild turkeys, pheasant, and waterfowl that motorist frequently delight in seeing; the traditional farmhouses and rustic barns that dot the landscape; the fear that the proposed project will lead to the destruction of the bog and encourage housing development in the prime farmland and therefore eliminate the area's rural charm; and a woodland, east of the wetland, with many old growth trees.

Safety. Some of the roadway opponents claim that the existing roadways are adequate to address the future needs for the factory. Unfortunately, some of the attributes that give the existing road its pleasing, rural character may present hazards to motorists. US 462 has two 10-foot lanes, and in some locations, there are no shoulders. There are 10 at grade intersections along US 462 and a number of residential driveways. Many trees and several stone walls are located very close to the roadway. Some of the existing congestion on the roadways in the area are attributed to older drivers and farm equipment who often drive at slow speeds (30–35 mph) and cause traffic to back up for up to a quarter of a mile even during off-peak hours. Motorists have complained about the aggressive behavior of truckers using the road, especially when traffic becomes congested.

Public/stakeholder concerns. Not all residents of Rushmore and Happi County are pleased with the changing character of the region. Landowners along US 462 are unhappy with the increase in traffic, especially the rising number of large trucks. They claim the road project will generate much additional traffic, leading to further deterioration in the region's livability. A historic preservation group (Rushmore Forever) is opposed to the loss of any historic structures and landmarks and especially the Antioch Church and Cemetery. It recently petitioned the keeper of the National Register of Historic Places, the U.S. Park Service, to designate the church area a historic district. Most environmentalists are opposed to the new road. They believe the home of the bats will be disturbed and they have formed a group called "Friends of the Bog." They favor either a few small improvements along the current route or a no-build alternative, since

they are afraid that any road will take more of the wetland or prime farmland. But, opposition extends far beyond those whose land is directly affected. Included in the ranks of opponents are: a variety of environmentalists; anti-urban sprawl advocates; and historic preservationists. In addition, many residents are unhappy about the growing suburbs outside Rushmore and Pleasantville. They fear that the proposed project will mean more undesirable growth in the form of more subdivisions, strip malls, and manufacturing plants, as well as a spillover of growth into the prime farmland. Many residents cherish the beauty of their rural lifestyle, which they believe to be imperiled by the proposed project. They envision the loss of scenic farmlands and woodlands. In addition, some people that commute between the two towns are unhappy with the prospects of long delays during the several years of work on the road.

Highway department. For more than 5 years, local politicians have pressed the state legislature to provide funds for improving US 462. Last year, funds were finally appropriated. When this project was first discussed in the 1990s, Department and local officials anticipated that it would generate opposition. They held several preliminary discussions about mitigating potential resistance and building a public consensus supporting the project. However, the rapid emergence of vocal opposition forces was unexpected, as was the range of contentious issues. Department officials are confronted now by a difficult situation. Detractors of the project have been outspoken. Due to the variety of issues they have raised, the Department of Highways cannot deal with the opposition by showing that only one argument against the project is false or overstated. That is, department officials must address stakeholder objections on a wide range of both general and specific issues. In addition, the barrage of negative publicity about the project appears to have intimidated the large number of people in favor of the project. Many supporters, even some local politicians who favor the project, have yet to state their support publicly. Even when they have good arguments, they hesitate to counter some of the opponents' claims. The opposition forces are well organized and are in touch with nationally organized environmental groups. In contrast, no group is trying to assemble a vocal support base in the region. Still, despite the articulate opposition of opponents and the relative silence of supporters, Department officials believe that a majority of local residents want to see a new road with greater capacity and safety built.

Fiscal constraints. At the same time, the department of highways budget has been cut due to decreased tax revenues. Many political opposition groups have begun to heavily scrutinize highway projects by identifying waste and "pork barrel" projects of the local politicians and highway contractors. As a result the department has a need to justify all elements of the project as being necessary in order to demonstrate the need for utilizing these elements. The available budget for the project is $65 million.

Application of Principles

The Department of Highways determined that the traditional approach to roadway planning and design will not work on this project due to the contentious atmosphere surrounding the project. If it is to be built, the public must be consulted, and their desires factored into the planning and design processes (i.e., the situation calls for public participation in roadway design). Persuasion, negotiation, and compromise are necessary. The final roadway alignment and design may be shaped as much by considerations of esthetics and historic preservation as by the terrain and alignment factors traditionally considered in roadway design. It is clear, then, department officials cannot assume that the project is a "done deal." They must anticipate that there will be many challenges, beginning with the first articulation of purpose and need for this project in the public forums. Thus, it is to be expected that some stakeholders will challenge every aspect of the project, even traffic counts and crash statistics. Therefore, officials from the Department of Highways must be prepared to address questions concerning safety, economic growth,

impact on subdivision construction and location, alternative alignments, design of roadway components, and other related issues. New, nontraditional issues may arise in the planning, design, and/or construction phases of this project. Therefore the Project Team chose to pursue a CSS approach whereby all principles were applied at full intensity to address the many issues present on the corridor.

Use of Interdisciplinary Teams

The Department determined that a team should be assembled to deal with the project in order to assure that all pertinent issues and aspects of the project will be addressed. An interdisciplinary Project Team was established to provide the proper knowledge and expertise to be applied to the project development process and the alternatives that may be considered. This depth of knowledge will ensure that the Project Team identifies and examines all potential solutions and critical issues that may arise. A core team was established that included a highway designer, an environmental specialist, a construction engineer, a planner, a traffic operations engineer, a maintenance representative, a right of way specialist, and a public relations expert. At various stages of the project, additional expertise will be sought from landscape architects, historic preservation experts, anthropology professionals, community involvement specialists, and biology professionals.

Involve Stakeholders and Seek Broad-Based Public Involvement

The appropriate stakeholders were also identified and an Advisory Committee was created to assure that all issues are discussed and addressed in a timely fashion. Project stakeholders included regulatory agencies and elected officials; U.S. Forest Service; U.S. Fish and Wildlife Service; Corps of Engineers; State Division of Wildlife; State Historic Preservation Office; and the mayors of Rushmore and Pleasantville. In addition, special interest citizen groups were included on the advisory committee to provide a voice for all points of view on the project including the Cedar Bog Watershed Group and Partners for Access to the Green Mountains. Additional civic, business and other interest groups will be identified with the assistance of the Advisory Committee to be involved in the project through meetings and membership in the project advisory task forces. The various interested and affected parties will be identified through the cooperation of the Project Team and the Advisory Committee. Land owners along the corridor as well as potentially affected areas will be sought out to provide input in the process.

Use Full Range of Communication Strategies

The Project Team with the assistance of the Advisory Committee developed a public involvement plan to be followed in this project. Professionals who are familiar with the tools, techniques, and methods of successful public engagement were also identified to closely work with the Project Team. It was decided that first, neighborhood and focus group meetings will be conducted in a structured format to solicit input regarding issues and concerns about the project. Design charrettes will be also conducted to gauge the public/stakeholder view of the project followed by a structured public involvement to consolidate the proposed designs from the charrettes. Several informational meetings will be held after this to present the chosen alternative and solicit additional input from the public. Information will be provided throughout the construction period with updates and road closure information. A web site will be established where information on the project status and activities will be updated on a regular basis and throughout the project.

Achieve Consensus on Purpose and Need

The Project Team worked with the Advisory Committee to develop a concise and agreed upon purpose and need for the project. The document developed identified the most critical problem(s) and other concerns that are important to keep in balance, made the consensus-based business case that the intended project is worthwhile, and established the measures of effectiveness for measuring the project performance. The lead paragraph of the purpose and need developed was as follows:

> The purpose of the proposed project is to provide a major improved transportation linkage of some 15 miles between the city of Rushmore and the town of Pleasantville. The existing two-lane Route 60 has a higher crash rate than the state's average and there are some intersections that have had an unusually high number of crashes that have resulted in deaths. The existing alignment of the highway through the rural countryside has several sharp curves, some sight distances are short and there is a lack of adequate shoulders in many areas. Commuter traffic (people living in Pleasantville and working in Rushmore) has increased beyond expectation and there is a growing percentage of truck traffic on the route which is expected to continue. The proposed project is expected to improve commute time and reduce the potential for crashes while preserving the rural character of the surrounding landscape including its natural and social environment in a cost effective manner.

Based on the understanding of the issues in the study area, the advisory committee also established in the purpose and need statement the metrics that they would use to measure the success of the project and direct the design of the appropriate solution. These established measures are stated in the following paragraphs:

- Crash rates in the study area should be at or below the state average for both roadway sections and intersections.
- The project should provide mobility for all users including (1) commuters, (2) industrial/truck traffic, and (3) agricultural equipment.
- Travel time between Rushmore and Pleasantville should not exceed 25 min during peak travel times.
- The project should preserve at least 80 percent of available farm land and 90 percent of the bog.
- Access to the bog and state park should be maintained and/or enhanced to showcase the natural resources of the area.

Address Community and Social Issues and Maintain Environmental Harmony

In order to address the community and social issues, the Project Team worked with the advisory committee to identify the various concerns from all interested parties. Also included in this summary were environmental resources that have been identified as having special value to the area and/or are protected by national or state regulations. This allowed the Project Team to map the "Red Flags" and constraints within the study area, that provided the context for the project (Figure 4). By thoroughly documenting these constraints at the beginning of the project, it allowed the Project Team to proceed with the design, without running into any pitfalls further in the process.

Address Alternatives and All Modes

The Project Team was committed to identify alternatives and address all modes in order to find the "best" solution to the problem. To proceed with this approach, the No-Built alternative was identified to be used as the basis for any comparisons. The recently developed Access Management Plan of the state will be applied throughout the development of the project. Options of Travel Demand Management, such as staggered work hours and promotion of alternative modes

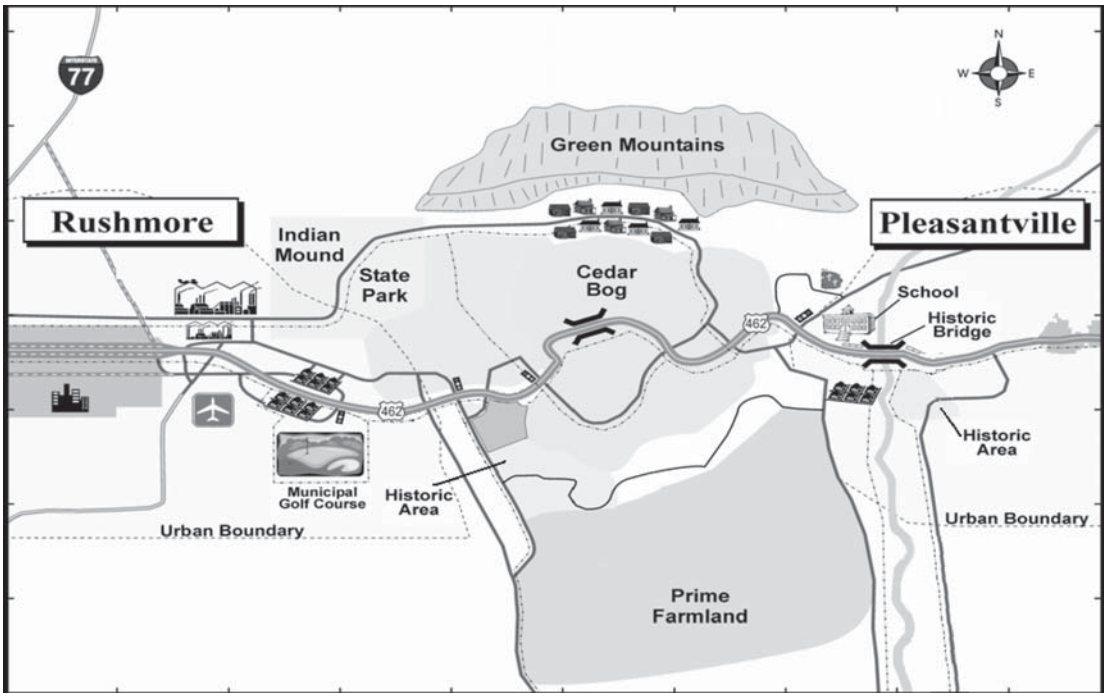


Figure 4. Project Red Flags.

of transportation, will be evaluated especially for the suburban areas of Rushmore. Modal alternatives including light rail and improved bicycle facilities will also be examined. The build alternatives will evaluate the option of roadway improvements along the existing corridor as well as the development of a new facility. These conceptual alternatives are shown in Figure 5 and were presented and discussed with the Advisory Committee as well as to the public through a structured involvement process. Another important aspect for addressing community and social issues

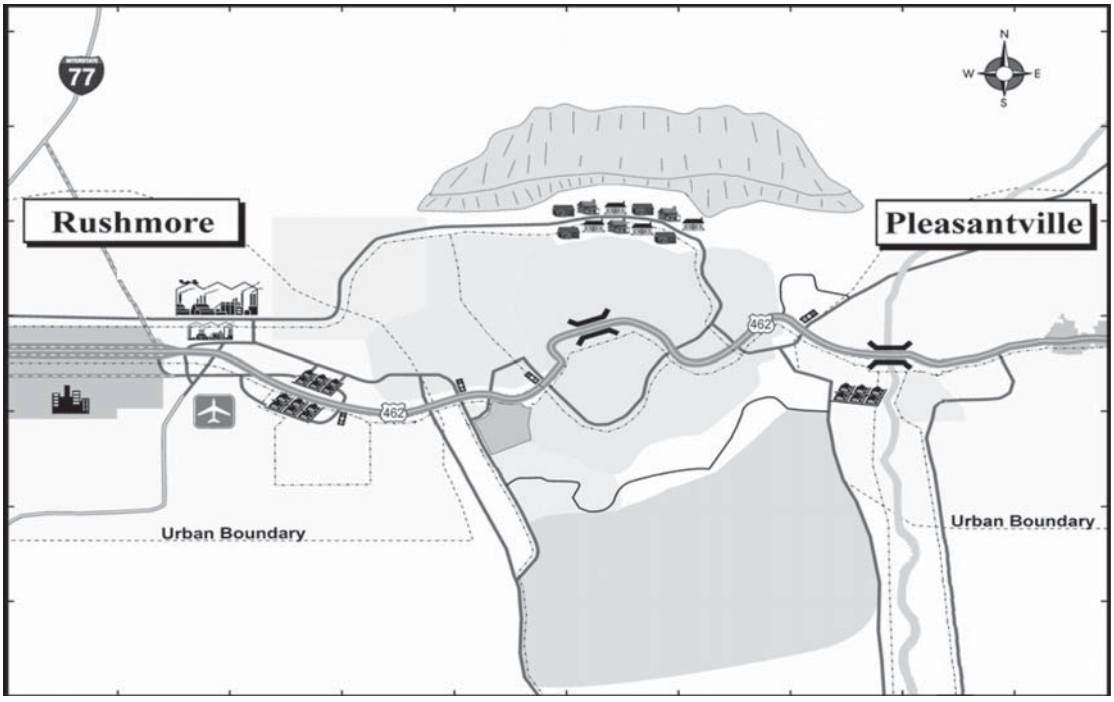


Figure 5. Conceptual alternatives.

was the commitment of the transportation agency to accept, consider, and evaluate non-traditional solutions, such as the use of roundabouts, the provision of a bike facility and the maintenance of the existing facility as a multiuse path. All of the alternatives were then to be evaluated against the mobility, safety, and cultural criteria established in the purpose and need statement.

Utilize Full Range of Design Choices

The Project Team based on input received from the public meetings and in cooperation with the Advisory Committee determined that a new facility was the preferred option. The next step was to identify potential corridors for further investigation. Based on the community and social constraints as well as other issues of significance submitted by regulating resource agencies (U.S. Soils Conservation Service, U.S. Department of Agriculture, U.S. Fish and Wildlife Service, State Historic Preservation Office, State Environmental Protection Agency) the Team identified potential corridors for the new facility (Figure 6). These corridors were established to avoid the major pitfalls, as well as to meet the project goals, such as to preserve a majority of the prime farmland, as can be seen in Figure 7.

Once the corridors were identified, further investigation of areas of concern and environmental constraints were explored to provide direction for potential alignments. These investigations identified several wetlands near the river, as well as, an area of hazardous soils where farming equipment and materials were stored for many years. Additionally, individual farm tracts were identified to prevent them from being bifurcated due to the proposed project. Based on these refined constraints, potential alignments were identified aimed to minimize and mitigate potential impacts (Figure 4). Each alternative will provide a separate parallel bicycle facility and adequate sidewalks in the areas within the urban boundaries. The existing US 462 will be

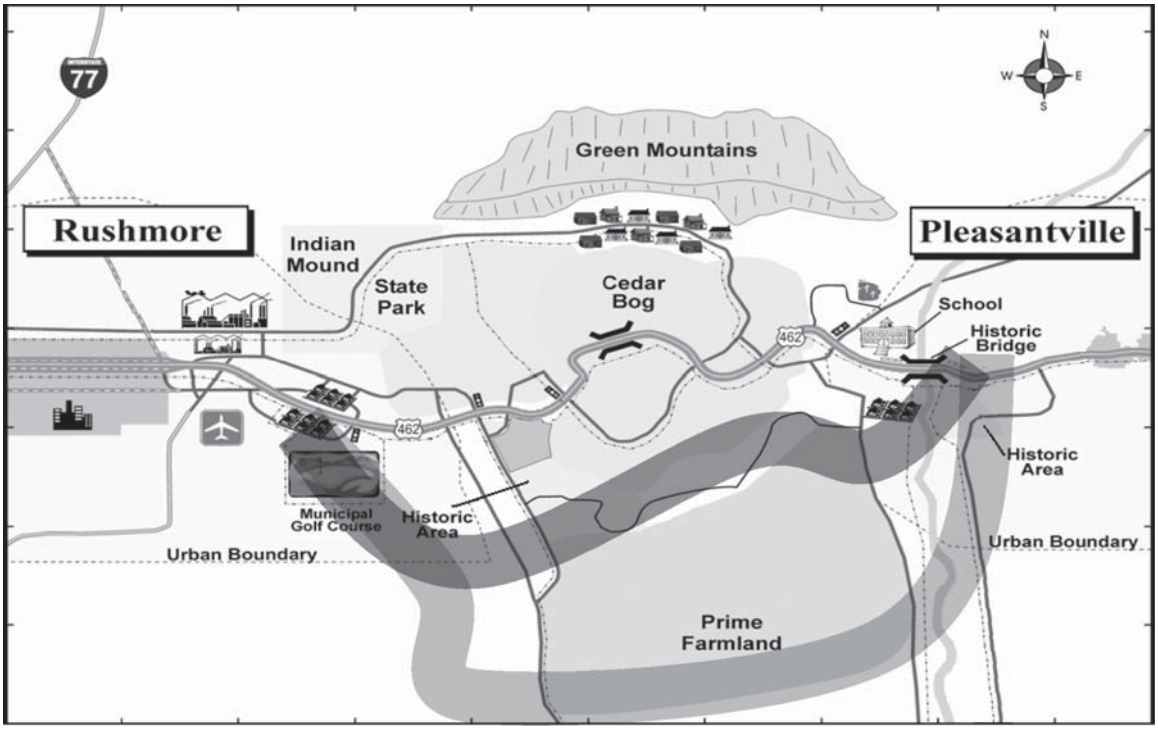


Figure 6. Proposed corridors.

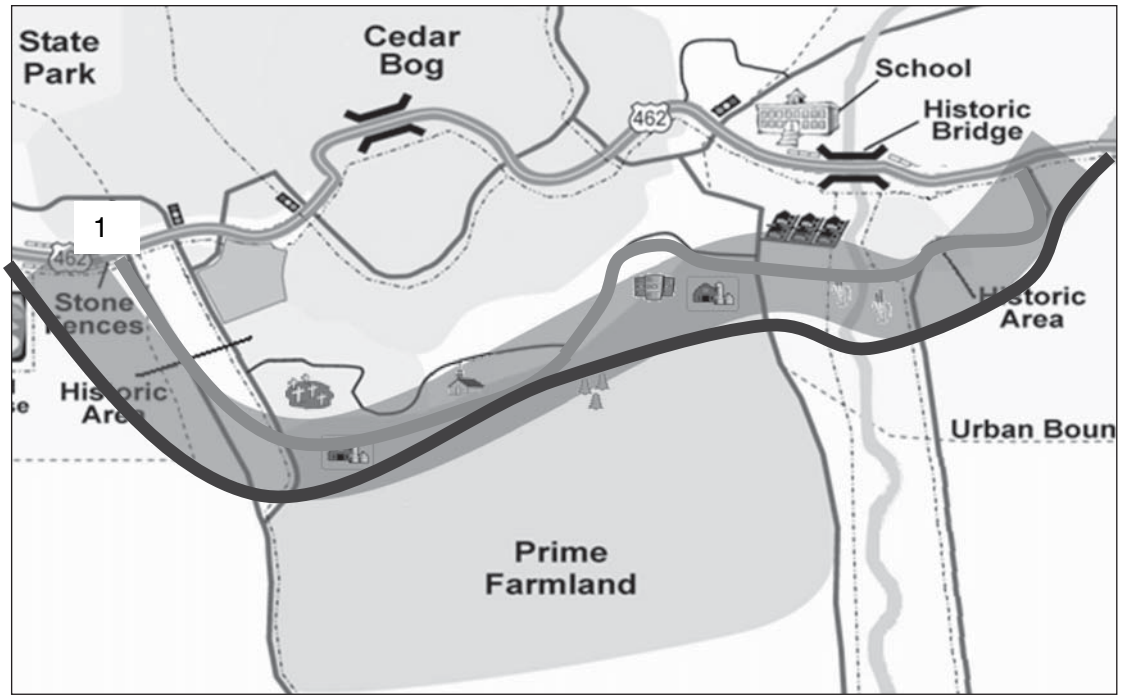


Figure 7. Potential alignments within preferred corridor.

removed and maintained as a multiuse path (pedestrian and bicycle). The new facility will be designed as a two-lane roadway with a design speed of 45 mph to address speed concerns raised at the public meetings and noted in the web surveys. There will be also three-lane segments to allow for adequate passing as well as pull-off areas for farm equipment once queues start forming. Roundabouts will be used as entry/gateway points both at Rushmore and Pleasantville and at the intersections entering and exiting the historic areas. The sidewalks along the historic areas as well as in the built up areas of Rushmore and Pleasantville will use brick overlay based on the requests of the Historic Preservation Society and the neighborhood associations. A scenic view area will be developed to allow for a view of Cedar Bog in the north and of the scenic barns in the south. Improved access through the historic areas will assist the economic development of new and existing businesses.

Consider a Safe Facility for Users and Community

The safety of the proposed alternative alignments was evaluated with the use of the Highway Safety Manual to determine the anticipated number of crashes. A safety review of the alignments was also conducted as a separate and independent element of the project to assure that the evaluation has been conducted properly and all potential issues have been adequately addressed and resolved. A well-documented process was followed, where all potential issues identified were listed along with an explanation describing why these were considered by the Project Team to be (or not be) a safety issue. The list should also include the corresponding potential solutions, as well as, a description of how these issues were addressed within the project constraints. For example, the safety of pedestrians in the built up area of Rushmore was identified as an issue and the solution proposed was to provide greater separation between the roadway and the sidewalk by increasing the buffer zone to 10 feet and considering the use of shrubbery. The crashes at the signalized intersection of US 462 (intersection 1 in Figure 7) were addressed with a roundabout reducing the number of conflict points as well as speeds through the intersection.

Address Community and Social Issues

The approach taken by the Project Team focused on providing a transportation solution that considers and addresses all factors including safety, environment, community, capacity, mobility, and budget. These factors were defined through a continuous and sincere involvement of the public and stakeholders. The concerns and issues as they pertain to the project were addressed in a timely fashion within the appropriate project phase and allowed for developing a solution that considered and addressed all pertinent issues. Another important aspect for addressing community and social issues was the commitment of the transportation agency to accept, consider, and evaluate non-traditional solutions, such as the use of roundabouts, the provision of a bike facility, and maintenance of the existing facility as a multiuse path.

Address Aesthetic Treatments and Enhancements

The proposed alignment considered the roadway environment, both natural and human, in order to develop a solution without disturbing but rather complementing them. This translates to an alignment that follows closely the natural terrain and promotes scenic views from the roadway as well. The roundabouts used are landscaped appropriately and they will be maintained by the local agencies. The use of steel reinforced wooden guardrails was utilized to preserve the rural feeling of the area. Stone fences that were in disrepair were rebuilt through an agreement with the State Historic Preservation Office where the alignment intentionally was brought closer to the property to use highway funds for repairs and showcase the historic structures of the town through the road project. The development of the scenic overlook for the Cedar Bog is also a significant enhancement of the project.

Document Project Decisions

All project meetings and discussions were thoroughly documented to ensure proper communication between the Project Team, the Advisory Committee, and the public. Minutes for all public involvement activities were developed and followed with actions by the appropriate responsible person. Documentation identifying all alternatives considered, environmental studies conducted, and the thought processes behind the evaluation was also developed to clearly demonstrate the process followed to reach the final recommendation. All project commitments made throughout the various project phases were documented and were available to the construction bidders. These project commitments were considered integral to the project completion and were not value-engineered out of the project during construction, since they were part of the solution that allowed the project to be constructed.

Track and Meet All Commitments

The Project Team developed and maintained a list of the project commitments made in the various phases of the project and tracked them as the project was developed and constructed. Such commitments included the use of a landscape architect and arborist for landscaping the roundabouts, the conversion of the existing US 462 to a multiuse path, the provision of a separate bicycle facility parallel to the roadway, and the accommodation of local traffic during construction. Once each item was accomplished, it was noted as complete in the list originally developed.

Create a Lasting Value for the Community

The final project developed meets the transportation needs into the foreseeable future and incorporates features important to the community. It does not conflict with the intent of community

development plans, but rather provides support for the community's planned development vision. The project creates some form of enhancement to the valued resources of Cedar Bog and historical areas, provides an opportunity to expand the value of the historic district with the improved access, it provides a visual "gateway" at the point of entry for Rushmore and Pleasantville, and promotes alternative modes of transportation. These goals were achieved based on the transportation needs and related values of the community that were part of the purpose and need statement defined from the beginning of the project.

Use Agency Resources Effectively

From the outset of the project development process the entire team was given the responsibility to achieve a successful outcome. The team and its leader or project manager must seek to use all resources effectively including knowledge and experience of team members as well as the project's stakeholders; time available (deadline) for project delivery; and the available funding. A team charter was developed which made clear the objective, members of the team, how they will operate (process) and communicate, and the boundaries and available resources. Communication between the Project Team members and with all the stakeholders/public was open and two-way to ensure that all issues were brought forth and understood by all. Open communication allowed for all questions and concerns to be identified and addressed before the project moves forward. This saved valuable resources by avoiding the need to go back and revisit alternatives or problems that were not fully addressed at earlier stages of the design process.

Quantification of Benefits

Due to the increased scrutiny of political concerns and those trying to prevent government waste, it was determined that any aesthetic treatments and/or compromises implemented on the project could be targets for attack. This includes those treatments such as the bog viewing areas and replacement of historic structures that were brought into the project to keep it moving forward. Therefore, it was necessary for the Project Team to develop a plan to document and measure project outcomes that were a result of enhancements and the principle-driven, benefit-justified CSS approach followed.

In order to link the project actions directly to the specific needs of the area, the Project Team chose to monitor benefits associated with the targeted goals identified in the MOU developed in conjunction with the purpose and need statement. The goals included and the associated benefits are identified in Table 7.

In addition to those benefits identified above, the Project Team decided to conduct a web-based survey that aimed in gauging their success on completing this project targeting both team members and stakeholders. The survey was completed by most team members (12 of the 14) and 15 stakeholders. The results are presented in Tables 8 and 9.

The Project Team indicated that in general all principles were present, since all had a score of 3.0 or greater (i.e., agreed that at least the principle was there). The principles with the lowest scores were "Use agency resources effectively" (3.1) and "Address alternatives and all modes" (3.1).

The project included an interdisciplinary team that covered all anticipated (required) areas and it seemed to have functioned exceptionally well. The responses received came from team members who identified themselves as transportation planners, design engineers, structural engineers, public relations specialists, construction engineers, environmental scientists, historic preservation specialists, safety engineers, program managers, and project managers. All were involved in the design phase of the project, and several were involved in project planning and construction as well. There were at least four members that were involved in all phases of the

Table 7. Benefits to be monitored.

MOU Goals	Monitored Benefits
Crash rates in the study area should be at or below the state injury average of 65 crashes/100 million VMT for both roadway sections and intersections.	Improved safety (vehicles, pedestrians, and bikes).
The project should provide mobility for all users including (1) commuters, (2) industrial/truck traffic, and (3) agricultural equipment.	Improved modal options. Improved walkability and bikeability.
Travel time between Rushmore and Pleasantville should not exceed 25 min during peak travel times.	Improved mobility for all users.
The project should preserve at least 80% of available farm land and 90% of the bog.	Improved sustainable decisions and investments.
Access to the bog and state park should be maintained and/or enhanced to showcase the natural resources of the area.	Minimized overall impact to human and natural environment. Improved environmental stewardship.

project. Approximately one-half of the respondents had long experience with CSS (over 6 years) while the remaining were evenly split between those with little experience (0–3 years) and some experience (3–6 years). Finally, all team members had more than 10 years of relevant experience.

There are three principles that the team was in agreement that they were highly met. These include "Consider a safe facility for users & community" (3.9); "Involve stakeholders" (3.8); and "Create a lasting value for the community" (3.8). This strong agreement was also highlighted in several of the comments provided. In particular, the involvement of the stakeholders was discussed by several members and was noted as a significant lesson-learned from the process followed.

Overall, both stakeholders and team members indicated that several benefits materialized as a result of the process followed. Almost all benefits have a score greater than 3.0 indicating that the survey participants at least agree that the benefit was achieved. Benefits that had high scores (equal or greater than 3.7, indicating that most of the participants strongly agree) include "Improved

Table 8. Semi-quantitative results for principles.

CSS Principle	Project Team
1. Use of interdisciplinary teams	3.6
2. Involve stakeholders	3.8
3. Seek broad-based public involvement	3.7
4. Use full range of communication strategies	3.4
5. Achieve consensus on purpose and need	3.5
6. Address alternatives and all modes	3.1
7. Consider a safe facility for users & community	3.9
8. Maintain environmental harmony	3.5
9. Address community & social issues	3.7
10. Address aesthetic treatments & enhancements	3.6
11. Utilize full range of design choices	3.4
12. Document project decisions	3.5
13. Track and meet all commitments	3.3
14. Use agency resources effectively	3.1
15. Create a lasting value for the community	3.8

Note: The project team scores are based on the survey results of a 4.0 scale (4.0: strongly agree; 3.0: agree; 2.0: disagree; and1.0: strongly disagree).

Table 9. Semi-quantitative results for benefits.

CSS Benefit	Measured	
	Stakeholders	Team
1. Improved predictability of project delivery	2.5	2.6
2.1. Improved project scoping	NA	2.9
2.2. Improved project budgeting	NA	2.8
3. Improved long-term decisions and investments	3.5	3.7
4. Improved environmental stewardship	NA	3.4
5. Optimized maintenance and operations	NA	3.2
6. Increased risk management and liability protection	NA	3.0
7. Improved stakeholder/public feedback	NA	3.4
8.1. Increased stakeholder/public participation	3.0	3.4
8.2. Increased stakeholder/public ownership	3.0	3.6
8.3. Increased stakeholder/public trust	3.0	3.4
8.4. Increased stakeholder/public participation compared to other projects	NA	3.4
9. Decreased costs for overall project delivery	NA	2.3
10. Decreased time for overall project delivery	2.0	2.8
11. Increased partnering opportunities	2.0	3.0
12.1. Minimized overall impact to human environment	3.0	3.3
12.2. Minimized overall impact to natural environment	3.0	3.3
13. Improved mobility for all users	3.5	3.5
14.1. Improved walkability	3.5	3.9
14.2. Improved bikeability	3.5	3.9
15. Improved safety (vehicles, pedestrians, and bikes)	3.5	3.7
16. Improved multi-modal options	3.0	3.4
17. Improved community satisfaction	3.0	3.8
18. Improved quality of life for community	4.0	3.8
19. Improved speed management	3.0	3.3
20. Design features appropriate to context	3.5	3.5
21. Minimized construction-related disruption	3.0	3.1
22. Improved opportunities for economic development	3.0	3.4

Notes: The project team and stakeholder scores are based on the survey results of a 4.0 scale (4.0: strongly agree; 3.0: agree; 2.0: disagree; and1.0: strongly disagree); NA: not applicable—question was not asked in stakeholder survey.

quality of life for community," "Improved walkability and bikeability," "Improved community satisfaction," "Improved safety," and "Fit with local government land use plan." These benefits indicate that the project resulted in a better environment for the community and there is an agreement between team members and stakeholders on these issues.

There are a few benefits that had a score below 3.0 that indicate that the respondents believe that the benefit was marginally materialized. These include "Decreased costs for overall project delivery," "Decreased time for overall project delivery," "Improved predictability of project delivery," and "Improved project scoping and budgeting." These answers indicate that the respondents perceive that the process resulted in longer time and higher costs for the project and had no significant effects on predictability neither of the completion nor in its budgeting and scoping.

An apparent trend of the benefits materialized is the consistent difference between the perspective of the team and the stakeholders, where for all common benefits the team scored them higher. In general, these differences are not large and they confirm prior research findings where team members were more positive about project-related benefits and activities.

In addition to the semi-quantitative scores obtained above, the following quantitative metrics were obtained for those benefits target in the MOU (noted in Table 10).

Table 10. Quantitative benefits.

CSS Benefit	Metrics
Improved environmental stewardship	Aesthetic treatments to mitigate visual impacts; use of existing US 462 as multiuse path; reduced roadway footprint.
Minimized overall impact to human environment	No impacts.
Minimized overall impact to natural environment	No impacts.
Improved mobility for all users	New wider sidewalks, a new bike lane and multi-purpose paths serve those traveling for both pleasure and necessity between the two towns, and increases safety for all users by separating traffic. The new road provided a decreased travel time from 45 min to 20 min between Rushmore and Pleasantville.
Improved walkability	1.3 mi of new sidewalk and 8 mi multiuse path.
Improved bikeability	1.3 mi on new bike lanes and 8 mi of multiuse path.
Improved safety (vehicles, pedestrians, and bikes)	New injury crash rate is 40 crashes/100 million VMT.
Improved multi-modal options	New wider sidewalks, a new bike lane and multiuse paths.

The data supports the semi-quantitative results noted in Table 8 and indicates that the high scores for the various improvements noted are indeed true. However, the available data reputes the perception for those benefits that had the lower scores (below 3.0).

The Project Team decided to quantify in dollars those benefits for which cost data was readily available. These included the travel time reduction for improved mobility and crash reduction for improved safety. The travel time reduction resulted in 433,000 hours of saved travel time based on 25 min per trip for each of the peak hours resulting in $8,660,000 per year (based on TRB Research Circular 477). Crashes were similarly reduced by 25 crashes per 100 million VMT (vehicles miles travelled) resulting in 18.25 injury crashes less per year for a total savings of $2,485,000 per year (based on FHWA HRT-05-51).

The team also wanted to show the economic benefit for the inclusion of the bike and multiuse path, since it was such a significant aspect of the project. The team consulted *NCHRP Report 522: Guidelines of Analysis for Investments in Bicycle Facilities* to customize the benefits from this application to the local conditions. Based on the available information, the new paths will provide a total benefit of $1,000,000 per year in health, recreation, and mobility areas.

The last item of comparison was the evaluation of the relative view and perceptions between the stakeholders and the team to determine whether both have the same experience and level of satisfaction. Again the team showed higher levels of satisfaction working with both stakeholders and public. The stakeholders also showed a reasonable level of satisfaction working with the team. There is a difference of opinion regarding the level of satisfaction between the team and stakeholders regarding the means with which input was included in the project (Table 11). The team members showed a greater satisfaction with almost an even split between those who agreed and those who strongly agreed. On the other hand, the stakeholders showed a split choice between agreeing and disagreeing and the comments provided did not allow for any further elaboration on this issue.

The question on the level of relationship between team and stakeholders also showed a slightly different perspective (Table 12). The team members indicated that they viewed the relationship somewhere between consultation and partnership, while the stakeholders noted that it was a consultation relationship. The difference noted here is similar to what one may expect where team members tend to view things slightly different and more optimistic than the stakeholders. An interesting observation is that there were three team members that viewed this relationship as letting stakeholders provide direction.

Table 11. Project team and stakeholder/public interaction.

Arnstein Question	Stakeholders	Team
I am satisfied with the relationship we had with project team.	3.0	NA
I am satisfied with the relationship I had with the stakeholders.	NA	3.6
I am satisfied with the relationship I had with the interested public.	NA	3.5
I am satisfied with the procedures and methods that allowed input to project decisions.	2.5	3.3

Note: The project team and stakeholder scores are based on the survey results of a 4.0 scale (4.0: strongly agree; 3.0: agree; 2.0: disagree; and 1.0: strongly disagree).

Lessons Learned

The results from the Project Team survey were used to provide a summary of the lessons learned. These are grouped in the following categories:

Communication. Early and continuous communication between the Project Team and the Advisory Committee as well as the city of Rushmore resulted in a successful project. This was more important for this project, since it was eventually turned over to the city for maintenance and upkeep. The help provided by the city was viewed both as consulting (they facilitated the landscape subcommittee) and as team members (worked on designs and solutions) resulting in a project that was properly designed for its context. The public involvement process was critical to gaining the agreement of the community to use a total closure and detour, rather than partial closure during construction.

Public and stakeholder input. Early involvement of the public resulted in designs that were more appropriate. Formation of relationships between the Department of Highways and the public as well as keeping the public informed were viewed as strong aspects of the project. Public interaction allowed for a focused attention to develop solutions. Involvement of stakeholders (the City and all other interested parties) from the earliest stage possible was viewed as a positive aspect of the process that had a positive effect on the development of the final project designs.

Project development process. Some members noted that the process may take longer (especially in the planning/design stages), but it resulted in a project that had more satisfied "customers" and may have avoided design do-overs or legal action during construction. More flexible designs were evaluated because of the interactions with the public and the understanding that a two-lane roadway with three-lane sections was adequate to address mobility. The project delivery schedule is important as to when and what type of CSS may be effective. It was noted that if CSS becomes an afterthought, then the project scope and schedule will still drive the process.

Utilization of Benefits

The Project Team was originally under attack by those trying to prevent waste for the inclusion of the bikeway and multi-use path in this project. Their reasoning was that the path represented a poor use of transportation funds as it would be underutilized and not serve a distinct purpose on

Table 12. Project team and stakeholder/public relationship.

Arnstein Question	Stakeholders	Team
My relationship with the project team was best described as	2.0	NA
My relationship with the stakeholders was best described as	NA	2.6
My relationship with the interested public was best described as	NA	2.4

Note: The project team and stakeholder rankings are based on the survey results of a 4.0 scale (4.0: They allowed us to provide direction; 3.0: We established a partnership; 2.0: We established a consultation relationship; and 1.0: We established an informational relationship).

the project. However, the documentation of the strong desire of the community for the facility and incorporation of the facility in the purpose and need of the project demonstrated the need for the development of the project. The high satisfaction ratings by the stakeholders for its inclusion in the project support also this decision and justify the cost of the element. The project meets the demands of all users, drivers, pedestrians, and bicyclists, and provides a facility that is well utilized by all.

In addition to the quantifiable benefits, the semi-quantitative data collected was forwarded to the Central Office of Design of the Highway Agency. This office is responsible for implementing CSS and justifying the additional expenses associated with CSS activities. The office uses this semi-quantitative data to demonstrate the improved satisfaction of stakeholders on CSS projects when stakeholders are heavily involved in the process as compared to those projects still performed with a traditional design approach.

In the future, the Office of Design plans to use such data to further refine its approach to CSS as well as implement a principle-driven, benefit-justified project approach on all projects. At this time the office is investigating ways in which it can further encourage increased partnering and sharing of resources on highway projects, as this element received the lowest satisfaction score of all surveyed benefits. Monitoring the level of satisfaction for this benefit will help the office to identify ways in which they need improve to meet their customer needs.

Finally the Project Team utilized the data to review their performance as well. The note of concern from the Project Team was that the majority of the stakeholders felt that the project was not completed as expected and took too long for completion. The Project Team has expressed interest in this as the project timeline and schedule actually met their expectations and in fact was better than they expected due to the high amount of controversy in the project. It has been suggested that had the Project Team had this survey information during the course of the project they could have worked with the stakeholders to better explain the anticipated schedule and potential complications so that this would not be a point of frustration for the stakeholders. On their next project the team would like to perform the survey at additional points throughout the project development process so that they can monitor the perceived progress and benefits of the project by the stakeholders and address timely any issues that may arise.

Summary

This guide helps one to establish a formidable evaluation procedure for assessing a project development process aimed at one or more of the following purposes:

- **Justification of CSS Project/Project Elements**—Benefits are measured to allow for the project team to justify specific project elements (design or activities) throughout the project development process.
- **Continuous Improvement of the Project**—Benefits are measured in conjunction with the identified principles-benefit matrix as a tool for a continuous improvement of the project itself.
- **Justification of Agency CSS Program**—Benefits are measured to allow for an agency to justify and evaluate the effectiveness of an agencywide CSS program or process.
- **Continuous Improvement of Agency Process**—Benefits are measured to be used in conjunction with the principle-benefit matrix as a tool for a continuous improvement of the agency's project development process.

Once the purpose of the evaluation is determined, the benefit analysis procedure includes the following steps:

1. Determine the action principle(s) to be assessed and their application intensity using the project attributes.

2. Select the benefit(s) to be measured and the quantitative and/or semi-quantitative measures to be applied.
3. Establish benchmarks for comparing measured outcomes for benefit accrual.
4. Collect data/information using a standardized format (forms and surveys), acquire the data/information in a timely manner, and record it in an appropriate format.
5. Analyze (using comparison, benchmarks, and dollar conversions) and evaluate benefit accrual, and report data/information.

The procedure is designed to be tailored in the following three ways:

- Purpose of the evaluation,
- Action-benefit focus selection, and
- Metrics/tools to be employed.

The procedures in this guide enable project teams and agencies to assess the entire project development/delivery process as it relates to a single project by focusing on a complete set of action principles and singling out a few benefits to assess. Each action principle has a limited number of associated benefits—with some considered primary benefits and one being designated a fundamental benefit. Each of these has a set of assessment metrics that provide quantitative and semi-quantitative data for determining benefits. Some can be converted to dollar equivalents and others can be compared to benchmarks. Using the techniques and tools presented in this guide, one can establish a principle-driven, benefit-justified approach for a business case justification of actions and/or have the information needed to establish a continuous improvement initiative for project development/delivery.

The guide provides an example application to illustrate how the evaluation works. Also provided are in-depth discussions of action principles, resulting benefits, and the metrics/tools. A robust evaluation procedure is provided and sufficiently detailed to allow an agency to tailor it to their needs. Details regarding concepts and application methods for the principles and benefits in order to establish the principle-driven, benefit-justified approach are presented in Part II.

PART II

Principles

1. Use Interdisciplinary Teams

Use of interdisciplinary teams throughout the project development process.

Definition

An interdisciplinary project development team is established early based on the needs of the specific project and is utilized appropriately throughout the project planning, design and construction phases.

Criteria for Application

- All appropriate disciplines and team members are identified during appropriate phases of the project, beginning with scoping, in accordance with the context, extent, and impact of the project.
- Project professionals have the necessary, diverse, and appropriate expertise to move the project successfully through all project phases.
- Team members understand their role on the project and the roles of team members vary throughout the project in accordance with their expertise and the project phase.
- Timely, open, two-way communication is maintained among team members.
- Input by all team members is given due consideration.

Principle Concepts and Project Phases

The use of an interdisciplinary project team helps assure that the proper knowledge and expertise are applied to project development. Team members may certainly change over the life of a project's development. Yet some membership continuity is desirable along with the thorough documentation of project decisions and commitments that are made along the way. The core members of a typical interdisciplinary team should include personnel from the following areas:

- Planning,
- Environmental science,
- Design,
- Right of way acquisition,
- Construction,

- Maintenance,
- Traffic operations, and
- Public relations.

The "team" approach attempts to avoid the possibility of throwing work over the wall from planner to designer to construction manager and much of the redo work typically incurred. Having an environmental coordinator assures communication with appropriate stakeholders, and having a public relations specialist assures broader public involvement and use of multiple communication methods.

Additional disciplines to be included based on the project type and complexities include the following disciplines:

- Landscape architecture,
- Historic preservation,
- Anthropology,
- Plant and tree science,
- Community involvement, and
- Biology.

Administratively teams need certain functions to be covered as they perform their work including (1) Team Leader (or Project Manager); (2) Record and/or Gate Keeper; and (3) Facilitator, especially for large teams. Each of these are needed in order for the team to function well. Team Leaders or Project Managers (PMs) need special skills beyond their traditional knowledge and experience. Several transportation agencies have formally recognized the need to train those who will lead project teams and be PMs.

Teams work best when the number of members is reasonably small, members have complementary skills, their goal is commonly accepted, and they hold each other accountable for performance. Teams run well when all the knowledge needed is available, the members have some degree of interpersonal skills (they can work together) and the team uses rational processes for problem-solving and decision-making.

Each transportation agency has its policy and procedural differences. However, there are several decision points in the project development process that the team needs to address that include the following:

- Project purpose and need;
- Establishing the range of alternatives (options);
- Alternative investigation and analysis;
- Selection of the desired alternative;
- Various plan/specification reviews; and
- Performance measures or measures of effectiveness for the project.

Teamwork requires some face-to-face meetings, but other work must be carried out individually and communicated between meetings using email or web project sharing resources. Many agencies have established electronic databases as project management tools, yet robust project progress tracking and control tools are generally lacking. It remains important to document progress and project decisions throughout the project development process. At least one agency has included a component in its project management system to document and track all project commitments made to stakeholders and the public to ensure that they get implemented.

The entire team has the responsibility to achieve a successful outcome. The team and its leader or PM must seek to use all resources effectively. These scarce resources include knowledge and experience of team members as well as the project's stakeholders; time available (deadline) for project delivery; and the available funding.

Every team must understand its responsibilities and every team member their role. The resources needed and available should be clear as well as any boundaries or constraints. Having a written and established charter may be helpful. The charter should make clear the objective, members of the team, how they will operate (process) and communicate, and the boundaries and available resources. The process may include a work breakdown structure, key team decision points, and specify interim/final product timeline and budget.

In order for the principle to have achieved the benchmark level, the core team presented above should be assembled at the beginning of the project development process. The roles and level of involvement of each member will vary based on the phase of the project, but all should be minimally involved during each phase of the project.

Proper Use

The core team should be assembled at the beginning of the project development phase and remain constant throughout the entire process, if feasible. The team operating rules should be established at the first meeting and a project leader should be determined. The rules should identify the decision making process and any other rules pertinent to the operation of the team. Frequent, regular meetings should be established to provide regular updates on progress and allow the team to address any issues that arise.

Benefits

Table 1 provides an overall summary of benefits, the rationale for selection, and their indicators. Additional discussion on each metric can be found in the following chapter on benefit guidelines.

Table 1. Summary of benefits for use in interdisciplinary teams.

Benefits	Rationale	Indicators
Design features appropriate to context	The use of such teams will allow for input from all members while the design is developed and allow for addressing the specific elements required by each team member as they may influence design.	• Semi-quantitative assessment of opinion and satisfaction level
Decreased time for overall project delivery	The interaction between team members will allow for resolution of issues that may arise in the subsequent phases of the project development process and therefore reduce the time requirements for each phase and the entire project.	• Number of months by project phases and total duration • Semi-quantitative assessment of expert opinion
Minimized impact to human and natural environment	The use of such teams will allow for input from all members while the design is developed and allow for addressing the specific human and natural concerns by each team member as they may influence the project design.	• Percentage of human and environmental impacts of alternative used for project compared to other alternatives • Semi-quantitative assessment of opinion and satisfaction level
Optimized maintenance and operations	The inclusion of traffic operations and maintenance as team members will allow for more streamlined operations for the facility and facilitate any future special needs for the upkeep of the facility.	• Annual cost in dollars • Semi-quantitative assessment of expert opinion

Case Studies

The following case studies utilized the application of this principle and a brief description of the principle application is provided here.

Mandela Parkway Corridor Improvement, Oakland, CA

The interdisciplinary team assembled for this project included all appropriate and required disciplines. The Office of Landscape Architecture took the lead for this project and the other departments within Caltrans provided functional support—this included Civil, Hydraulics, Traffic, Highway Operations, Electrical, Environmental Engineering, Cultural Resources, and Right of Way. Caltrans worked closely with the City of Oakland's Public Works Agency and the various impacted departments such as Parks and Recreation, Electrical, Traffic, ADA Commission, and the City Council. Representing the West Oakland neighborhood were three community members called the Landscape Subcommittee of the Community Advisory Board, who regularly attended meetings throughout the design process and still give their input. Participants of the survey indicated that all team members were involved extensively in the design phase. The participants also noted that several also worked in the planning and construction phases.

T-REX, Denver, CO

The interdisciplinary team assembled for this project included all appropriate and required disciplines. The Colorado DOT worked with a consulting firm to assemble a team that included several engineering disciplines (design, traffic, construction, and maintenance), planning, biologist, and cultural resource specialists. The project team also included landscape architects, public relations specialists, environmental scientists, right of way specialists, light rail engineers, and legal advisors, who were included in the appropriate phases of the project. The project included an interdisciplinary team that covered all anticipated (required) areas, and it seemed to have worked well. The responses received came from team members who identified themselves as design engineers, landscape architects, public relations specialists, construction engineers, traffic engineers, environmental scientists, right of way specialists, light rail engineers, legal advisors, and project managers. Most were involved in the planning and design phases of the project and all were involved in construction. There were a few team members that were involved throughout the entire project development process and they served as the core team.

SR 73/US 321 Gateway Project, Gatlinburg, TN

The project team was led by representatives of the Tennessee DOT (TDOT), with support services provided by consultants. Consultants from the firm of PBS&J were employed to provide facilitation with the citizens' resource team and to develop context sensitive solutions for the project after consensus was reached between the DOT and the resource team. Landscape architects developed numerous renderings of the proposed project revisions as part of the public meeting presentation. A muralist painted example concrete panels to demonstrate the view expected for the retaining walls after project completion. A 15-member multi-disciplinary citizen's resource team (Community Based Resource Team [CBRT]) was established to provide guidance to TDOT and design specialists to ensure a parkway theme that blended into the scenic surroundings, and not compete with the natural environment. The team operated through a consensus process and the consultant facilitation did an excellent job of managing the process and developing a "team spirit" throughout. The team collected information for their own decision-making through design and landscape experts, provided by TDOT and the consultant. The team also held meetings to inform and gather information from the public to assist them in the design concept.

2. Involve Stakeholders

Involve the appropriate stakeholders during all the phases of the project development process.

Definition

A full range of stakeholders is involved with the transportation agency as deemed appropriate and preferably beginning in the early stages of the project. Stakeholders to be included are resource agencies, elected officials, citizen/neighborhood organizations, business, and community and interest group representatives.

Criteria for Application

- All affected stakeholders are identified at the appropriate phase of the project and solicited for input/updated throughout.
- All stakeholder input is given due consideration.
- Processes are in place to ensure participation by stakeholders is meaningful, timely, and can provide informed project decisions.

Principle Concepts and Project Phases

One of the unique things about CSS is its concern for the entire project development process. So it is with the CSS principles to "involve stakeholders" and "seek broad-based public involvement." These are meant to apply at differing, but appropriate levels *throughout the process.* Also, the CSS principle to "use a full range of communication methods" is important in achieving success especially with regard to broad-based public involvement. Some resource agency stakeholders and others that work regularly with DOTs may have prescribed ways and times of communicating during the project development process. Not adhering to these or missing a temporal check point may cause a breakdown in trust. There are many potential benefits to carrying out these principles in project development, and they certainly can result in increased public/stakeholder ownership and trust and community satisfaction.

Early participation in the process helps the project team discover the potential legal "landmines" from stakeholders such as resource agencies and important community interests and concerns of a social, cultural or natural environment nature. Gaining access to a broad base of the potentially affected and interested public may require using a multi-media approach from door hangers to a local talk radio spot to announce an informational meeting. Traditional newspaper announcements and articles are becoming less effective for broad outreach. The four major concerns with carrying out any event of (1) **when;** (2) **where;** (3) **how;** and (4) **why** also govern stakeholder/public involvement activities.

Some transportation agencies require the early development of a public involvement plan or program for CSS projects. This should involve professionals who are familiar with the tools, techniques and methods of successful public engagement. Those trained in communication, mass media and facilitation of public meetings working closely with or as part of the project team are particularly important. That is not to say that these tasks can be turned over to someone else to be carried out and documented to meet the "obligation." It is extremely important that the entire

team be involved in the engagement of the stakeholders/public and that the communication tools and methods used be tuned to producing useful guidance for the project team. Such guidance should, as an example, provide not just laundry lists of possible issues, but prioritized concerns that are important to achieving community satisfaction and assist the project team in achieving a design with features appropriate to the context. The Florida DOT has developed a useful public involvement manual and the FHWA has prepared a catalogue of public involvement tools and methods. Resources such as these should be consulted as they pertain to a large range of stakeholders.

The potential participants along the spectrum of stakeholder/public involvement all have some kind of legal standing (Figure 1). However, some resource or regulatory agencies have professional staff and regulatory responsibilities that require permits; while other participants simply have the right to be heard. These latter participants can gain standing by banning together and forming informal or formal groups. Transportation agencies even bring some resource agency representatives on as ad hoc project team members and form citizen or community advisory committees as a part of the project development process. These actions have the effect of increasing the "standing" of these participants and assure that their voices are heard. Further structured public involvement has been carried out on large or otherwise highly sensitive projects that require developing specialized "metric" approaches that may help planners and designers in finding broadly acceptable project solutions. Such approaches allow the public to be involved in both setting criteria and choosing or recommending solutions. The definition of stakeholder simply is an independent party that has something at issue or has an involvement, concern, or interest.

When working with stakeholder entities that may include other government agencies (state or national) and other government or quasi-government organizations (such as towns and cities, counties, and multi-county area development councils), the communication methods may be unique and the timing of involvement in the project development process pre-specified. The range of communication and involvement could include having a representative as an ad hoc member of the project team or as a special member of a project advisory committee. Some communication may be one-to-one such as from an agency staff member on the project team to the representative of the agency. However, it might also be the project team leader communicating directly with a government official such as a mayor. The communication might be through a face-to-face meeting or by letter. Agreements that are reached should be documented and made part of the project record. The form of this might be a MOU or MOA that is approved by both parties or some special permit or formal authorization. The working relationships with some agencies or organizations may be highly specified or programmatically formalized where the levels of trust are high and the relationship is ongoing—beyond a single project. Some of the kinds of stakeholder officials, agencies and organizations are listed below:

Figure 1. Range of stakeholder/public involvement participants.

- Elected and Appointed Officials
  - City mayor, council;
  - County judge;
  - Metropolitan Planning Organization (MPO);
  - State representatives;
  - SHPO (State Historic Preservation Officer);
  - Planning boards;
  - Historic preservation boards; and
  - MPO Advisory boards.
- Agencies
  - Fish and Wildlife Department;
  - Environmental Protection Agency;
  - Public Health Department;
  - Area District Development (multi-county);
  - Regional Planning Agencies;
  - Water management agencies;
  - Public utility agencies;
  - Housing authorities;
  - Federal agencies (including the Corps of Engineers);
  - Departments of Highway Safety and Motor Vehicles; and
  - Agriculture Department.

Some of these may have professional staff dedicated to work as liaison for transportation issues and concerns or professional transportation staff that may include planners and engineers that will want and have some right (specified legal standing) to be engaged in the project development process.

Examples of Involvement During Project Phases

Please note that the broad definition of stakeholder suggests that all tax providing citizens and highway users have a "stake" in the project meaning they have given financial support to it. And most importantly some stakeholders have some financial risk associated with the project's construction and outcome. Others have a legal obligation and mission to protect some particular resource that may be compromised or endangered on behalf of the public interest that they serve. Some examples follow:

- Project Planning—During the development of the purpose and need statement input should be solicited from stakeholders/public to assure that issues that go beyond transportation to the environment and the community get properly addressed.
- Project Design—During preliminary design input and guidance should be solicited from appropriate resource agencies in order to ensure proper solutions are proposed and the necessary permits are received.
- Project Construction—During the early stages of construction or just before construction impacted residents and businesses should be involved so that construction phasing can minimize those impacts.

Proper Use

The identification and involvement of stakeholders should be viewed as an integral part of the project development process. Some stakeholders can be considered as part of the project team and others can be given standing by creating a citizens or project advisory committee. The proper use of this principle can improve or maintain trust with stakeholders as well as improve the efficiency

of the project development process by decreasing the potential for "do-overs" and increasing the potential for meeting several other principles of CSS with their commensurate benefits.

The values these various voices represent when combined with the voice of the engineer regarding mobility and safety can be balanced in a design to achieve a cost-effective transportation solution. Society's need (and expectation) for safe mobility within limited public resources is bounded also by specific laws and regulations dealing with a range of other societal issues and concerns including historical buildings and areas, scenic resources, water and air quality, wildlife and environmental resources. Many of these interests are represented by regulatory or resource agencies that have legal standing in the project development process. The transportation agency has the challenging responsibility of bringing these voices together along with the voice of the customer/user to find and develop a unique transportation solution through the project development process.

Benefits

Table 2 provides an overall summary of benefits, the rationale for selection, and their indicators. Additional discussion on each metric can be found in the benefit guidelines.

Case Studies

The following case studies utilized the application of this principle and demonstrated the presence of the benefits associated with this principle.

SR 179 Reconstruction, Sedona, AZ

In addition to the Arizona DOT (ADOT) and FHWA, the stakeholder groups included the Big Park Regional Coordinating Council, Yavapai County, Coconino National Forest, City of Sedona and Coconino County. Those stakeholders worked cooperatively with the ADOT on Executive, Public Outreach, and Project Management Teams and on the Segment Concept Design panels. As a consequence there was close cooperation and involvement with ADOT in the early phases of project development. Stakeholder initiatives including grants were an outgrowth of this interaction/cooperation.

Table 2. Summary of benefits of involving stakeholders.

Benefits	Rationale	Indicators
Increased stakeholder/public participation, ownership and trust	Involving stakeholders throughout the project development process will increase their participation, since their input will be solicited at certain points of the process; improve trust in the process, since their opinion will be valued and considered; and enhance ownership of the project, since their concerns will be addressed and their input considered.	• Stakeholder involvement measures • Semi-quantitative assessment of opinion and satisfaction level
Improved stakeholder/public feedback	The involvement of stakeholders will allow for a more appropriate and organized feedback process, since it has the potential to be customized.	• Economic development indicators • Semi-quantitative assessment of expert opinion
Minimized construction-related disruption	The stakeholder involvement has the potential to identify means for reducing the disruption to the community by identifying desirable closure periods for construction and/or providing suggestions for alternative routes.	• Work zone, lane closings and detour duration in days • Semi-quantitative assessment of opinion and satisfaction level

US 40 Berthoud Mt. Pass Reconstruction, Clear Creek Co., CO

Project stakeholders included: U.S. Forest Service, U.S. Fish and Wildlife Service, Corps of Engineers, Colorado Division of Wildlife, Upper Clear Creek Watershed Group, Clear Creek Community, and Partners for Access to the Woods. As most of the project went through forest lands, CDOT established a partnering relationship with the U.S. Forest Service on the project team. To deal with the public, CDOT employed an in-house public relations officer and public relations consulting firm. An iterative design process allowed all stakeholders to have input on the project design.

Prairie Pkwy Phase 1, Kane, Kendall, Will LaSalle and DeKalk Counties, IL

The Prairie Parkway study covered a massive area that incorporated 7 counties in Central Illinois. Many stakeholder groups were involved including resource agencies (U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers, Illinois Environmental Protection Agency, Illinois Department of Natural Resources, Illinois Department of Agriculture, FAA, FEMA and FHWA). Additionally, local governments from 7 counties and 32 municipalities as was the Chicago Metropolitan Agency for Planning were consulted. Several Illinois Department of Transportation (IDOT) agencies (aeronautics and rail) and regional planning and soil conservation districts were involved as well. A variety of civic, business, and other interest groups were involved in the project through meetings and membership in the project advisory groups/task forces.

3. Seek Broad-Based Public Involvement

Seek broad-based public involvement from the earliest stages of the project development process.

Definition

Involvement is fostered from all interested and affected persons throughout the project development process utilizing a variety of means to solicit participation beyond any required public hearings.

Criteria for Application

- The project team identifies all interested and affected persons early in the project development process.
- The project team proactively identifies what information they need from the public and the methods needed to solicit that input.
- Opportunities for public involvement are provided throughout the entire project development process.
- A transparent and rational decision making process is in place to incorporate public input.

Principle Concepts and Project Phases

One of the unique things about CSS is its concern for the entire project development process. So it is with the CSS principles to "involve stakeholders" and "seek broad-based public involvement." These are meant to apply at differing, but appropriate levels *throughout the process.* Also,

the CSS principle to "use a full range of communication methods" is important in achieving success especially with regard to broad-based public involvement. There are many potential benefits to carrying out these principles in project development, but they certainly can result in increased public/stakeholder ownership and trust and community satisfaction.

The general public may not have the same legal standing as some stakeholders, but they are an important source of information about critical community interests and concerns of a social and cultural nature. They have a legal right to be heard. Gaining access to a broad base of the potentially affected and interested public may require using a multi-media approach from door hangers to a local talk radio spot to announce an informational meeting. Traditional newspaper announcements and articles are becoming less effective for broad outreach.

As with all events, there are four major concerns with carrying out stakeholder/public involvement: (1) **when,** (2) **where,** (3) **how,** and (4) **why.**

Some transportation agencies require the early development of a public involvement plan or program for CSS projects. This should involve professionals who are familiar with the tools, techniques and methods of successful public engagement. Those trained in communication, mass media, and facilitation of public meetings working closely with or as part of the project team are particularly important. That is not to say that these tasks can be turned over to someone else to be carried out and documented to meet the "obligation." It is extremely important that the entire team be involved in the engagement of the stakeholders/public and that the communication tools and methods used be tuned to producing useful guidance for the project team. Such guidance should, as an example, provide not just laundry lists of possible issues, but prioritized concerns that are important to achieving community satisfaction and assist the project team in achieving a design with features appropriate to the context. The Florida DOT has developed a useful public involvement manual and the FHWA has prepared a catalogue of public involvement tools and methods. Resources such as these should be consulted.

Examples of Public Involvement Techniques Relating to Project Phases

The following are illustrative of the public involvement techniques that can be used during the project development process:

- Programming
  - Opinion poll or survey.
- Planning
  - Neighborhood meeting,
  - Focus group meetings, and
  - Structured public involvement session.
- Construction
  - Door hangers,
  - Open house, and
  - Select individual interviews.
- Throughout the Process
  - Citizen/Project advisory committee,
  - Web site/bulletin boards,
  - Hotline, and
  - Newsletters.
- Design
  - Design charrette,
  - Field tours,
  - Structured public involvement session, and
  - Public area display.

The selection, preparation for, and execution of these and other possible techniques will need the expertise of public involvement specialists or others trained and experienced in their use.

Proper Use

To have a successful public involvement process, the professional must answer the following three strategic questions:

- What do I need and want to learn from the public?
- What does the public want and need from me?
- What will I do with the results?

Having a clear answer to these questions then enables the professional to design a process that will clearly inform the project. The answers to these questions are best developed with input from the entire project team, so that they all give conscious thought to the information they need from the public. Once these guidelines are established, a wide range of facilitation tools and public outreach techniques are available to actually accomplish the goals laid out by the following three questions:

What Do I Need and Want to Learn from the Public?

The answer to this question breaks down into the following basic categories:

1. Inventory: First, the professional needs an inventory from the public's point of view. How do they describe the situation? This step is important—if the public does not perceive that there is much congestion, or believes that the situation is more dangerous than the professional's training tells her, they will never agree on suitable solutions.
2. Values: What is important to them? A roadway may appear to have plenty of capacity, and thus seem to be satisfactory to the professional, but the public may be concerned about the safety and livability aspects associated with speeding traffic on a street where drivers encounter few obstacles.
3. Analysis: What kinds of solutions does the public see as suitable? The professional wants to know this to ask the follow-up question: why? Every solution presumes a particular analysis of the problem, and the why question gives the professional access to that analysis and desired outcome. It may also suggest that some education is needed as to pros and cons of various solutions.

What Does the Public Want and Need from Me?

Fundamentally, the public expects the same information from the professional: inventory, values, and analysis. Professionals are usually very good at making their case to the public, but may unwisely assume the public shares their worldview. This is the opportunity for the professional to present what their tools and indicators are telling them about the situation, why they are concerned about that, and the kinds of solutions that would typically follow from that kind of analysis. It is a useful exercise for the professional to break their presentation into these three parts so as to make it easy for the public to understand why they are being asked to come to a public meeting in the first place. It is also useful to help the professional clearly understand their own position vis-à-vis the project.

What Will I Do with The Information?

The answer to this question is fundamental to the process. If there is no answer to this question, then there is no point in having a meeting other than to amuse people. And it is the one question most crucial to the legitimacy of the public involvement process. It will pay large benefits to the project team to the extent they can explicitly develop the linkages between the public involvement information they gather and the problem they are solving. An inability to develop

these linkages suggests the wrong questions are being asked of the public, since the information gained can't be used to improve the project.

The three questions necessarily fit together in a logical triad. Knowing what one intends to do with the information from the public involvement process guides what questions one needs answered, and what information needs to be provided to allow the public to give informed input. The following should be kept in mind when developing the public involvement strategy or plan:

- The project team should respect the lives of the public client. Make meetings efficient, materials clear, speeches short, and the public's job easy.
- The project team should view themselves as advocates and consultants to the public. After all, it's public money paying for the project.
- The project team should be willing to use public involvement professionals of the highest standards.

Benefits

Table 3 provides an overall summary of benefits, the rationale for selection, and their indicators. Additional discussion on each metric can be found in the benefit guidelines.

Case Studies

The following case studies utilized the application of this principle and demonstrated the presence of the benefits associated with this principle.

SR 179 Reconstruction, Sedona, AZ

In addition to the Arizona DOT and FHWA, the stakeholder groups included the Big Park Regional Coordinating Council, Yavapai County, Coconino National Forest, City of Sedona and Coconino County. Those stakeholders worked cooperatively with the Arizona DOT on Executive, Public Outreach and Project Management Teams and on the Segment Concept Design panels. As a consequence, there was close cooperation and involvement with Arizona DOT in the

Table 3. Summary of benefits of seeking broad-based public involvement.

Benefits	Rationale	Indicators
Improved community satisfaction	The consideration of comments received during the public involvement process will increase community satisfaction regarding the process and the solution developed and enhance the agency's image for future projects.	• Semi-quantitative assessment of opinion and satisfaction level
Improved long-term decisions and investments	The consideration of comments received during the public involvement process will assure that the solution developed fits with the long-term goals of the community.	• Increased transportation/ community long-term benefit relative to cost • Semi-quantitative assessment of expert opinion
Improved predictability of project delivery	The use of a broad-based public involvement will allow for the identification of all possible areas of concern and their proper resolution, which in turn has the potential to reduce future delays and thus improve predictability of project delivery.	• Project duration in months to complete • Semi-quantitative assessment of expert opinion

early phases of project development. Stakeholder initiatives including grants were an outgrowth of this interaction/cooperation.

I-4 Reconstruction, Tampa, FL

This project is part of a study that began in 1987. FDOT held many public meetings to obtain input and feedback from the public, especially in the historic Ybor City District. Due to the large scope of the project, hundreds of locals were impacted. FDOT engaged them both in open forums and through numerous personal contacts by FDOT staff. These contacts continued throughout the project.

Connecticut Oyster River Roundabout, West Haven, CT

The location of this 3-leg roundabout is uniquely sited along Long Island Sound adjacent to a small parking lot serving a public beach and surrounded with single family homes and a small shopping plaza. The planning, design, and construction phases involved the affected home owners and business interests along with the local town officials. The final intersection design (the roundabout option) and incorporation of specific features (e.g., sidewalks) as well as construction phasing (to avoid the busiest summer months) were the direct result of community involvement. Visualization techniques were useful from the vary outset in consideration of the roundabout option. Much of the success of this project is attributed to the early involvement of all interested parties.

Mon-Fayette Expressway, PA

The project is currently in the design phase, but in the preliminary design, an extensive public involvement process was followed. Design Advisory Teams (DAT) were formed that comprised of various stakeholders, and their meetings were open to the public for input solicitation. In addition to these meetings, public events were hosted periodically at municipal meetings, festivals, and local venues in order to showcase the DAT decision and progress. DAT members participated in speaking engagements with various groups, such as special interest groups, government officials, and local business groups.

4. Use a Full Range of Communication Strategies

Use of a full range of appropriate communication strategies throughout the project development process.

Definition

A variety of approaches to appropriately engage and solicit input from the stakeholders/public is used in the project development process.

Criteria for Application

- The project team employs a full range of communication techniques appropriate to the purpose of the communication and the nature of the participants.
- Communication methods must be used to both disseminate and collect needed information.
- Communication is continued throughout the project and beyond.

Principle Concepts and Project Phases

Over the past few decades there has been a significant change on the level of interest and involvement of the public in transportation projects. Several key legislative actions including the National Environmental Protection Act (NEPA) and the 1995 National Highway Act have strengthened this requirement for involvement and have encouraged public input in the project development process. These legislative actions along with several official publications, have documented and emphasized that the development and selection of solutions to transportation projects is not the sole responsibility of the agency—and it never was. What is needed is two-way communication, a dialogue first between the experts of the team and then between the team and the stakeholders/public. The needed communication is purposeful—you need information from "them," and they need information from you. And for it to be really productive you need to think of it at some point as a collaboration to find the best fit solution—a project specific strategy.

Different tools and techniques are useful to the project team as it engages the stakeholders/public during the project development process. These have differing requirements to apply successfully and the team (or at least the responsible member) should have the necessary knowledge and experience. The basic skill of "facilitation" is needed for even the smallest of public meetings. Advanced facilitation skills are needed for dealing with larger groups that require applying techniques for establishing a gradient of agreement and crafting a consensus. At the high end, structured public involvement used to solicit design preferences requires the designer to make a major investment in the process and relies on visualization, electronic poling, and computer analysis. Such activity requires a tailored approach and sophisticated processing in the background.

Possible Techniques for Project Development

Table 4 lists some of the techniques and tools that can be used to solicit involvement at different stages in the project development process.

One of the most useful techniques or tools is the Project Advisory Committee. Forming such a committee that is representative of the community allows for higher quality collaboration and the efficient exchange of information. Members of the committee can help spread the informed word and reduce rumor and speculation in the larger community. Many of the possible involvement/communication techniques are thoroughly described, with examples of proper use, in the FHWA Handbook "Public Involvement Techniques for Transportation Decision-making."

Table 4. Techniques and tools for project development.

Involvement Need	Possible Involvement Technique/Tool
Refine purpose and need statement	Project Advisory Committee Neighborhood Meetings
Identify environmental issues and community concerns	Project Advisory Committee Neighborhood Meetings
Determine alternative preferences	Project Advisory Committee Structured Public Involvement Sessions
Determine design option preferences	Project Advisory Committee Design Charrette Structured Public Involvement Sessions
Develop consensus option and possible enhancements	Project Advisory Committee Structured Public Involvement Sessions Neighborhood Meetings
Determine best construction phasing schedule	Project Advisory Committee Neighborhood Meetings
Determine best methods to maintain access	Neighborhood Meetings Individual Property Owner Meetings
Measure project delivery performance	Project Advisory Committee Stakeholder Opinion Survey

Proper Use

Special attention needs to be paid to communication both within the project team and with the stakeholders/public. Team members must make time and take the effort to understand each other and their use of professional jargon. Those who work regularly with each other certainly learn over time, but a new discipline to the project team may be challenging. When dealing with the public, special effort should be made to eliminate all professional jargon. For example, the public has no clue as to the meaning of some highway geometric terms (e.g., vertical curve) that may be used daily in engineer-to-engineer discussions. When dealing with the public graphic representations (graphs, charts, photographs, artist's renderings) may be particularly useful. Be aware that the public consists of people with differing skill sets and knowledge levels—and may have various cultural-based perspectives.

In the end, then, project managers must design the public into the process, instead of treating public involvement as a required set of meetings. It is helpful to think of the public as a resource to help define and solve the planning or design problem at hand. The public cannot become the design professional, but the professional can cultivate a relationship with the public similar to that between an architect and a client, so that the public's goals and outcomes, first captured in the purpose and need statement, can be further developed throughout the project. Both public and professionals can learn from such a process, and a better product will result. Only a broad base of appropriate communication methods can facilitate this goal during the project development process. Such a communication strategy can work if based upon an understanding of the following:

- The public must be involved instead of marketed to;
- Dynamic two-way communication must be established;
- The process must be inclusive of all stakeholders and create mutual understanding;
- Respectful communication becomes the norm;
- Early and continuous engagement occurs;
- The decision process is defined, structured, and transparent;
- Agency leadership helps make process happen and provides resources to enable it; and
- Feedback is sought from participants in evaluating the process and input solicitation mechanisms.

Benefits

Table 5 provides an overall summary of benefits, the rationale for selection, and their indicators. Additional discussion on each metric can be found in the benefit guidelines (Part II of the Guidelines).

Table 5. Summary of benefits when using a full range of communication strategies.

Benefits	Rationale	Indicators
Increased stakeholder/public participation, ownership and trust	The use of full range communication means will allow stakeholders to better participate in the process and therefore provide them with a more informed process for providing meaningful input.	• Stakeholder involvement measures • Semi-quantitative assessment of opinion and satisfaction level
Improved stakeholder/public feedback	The use of full range communication means will allow stakeholders to fully understand the issues and elements of the project and thus enhance their ability to provide the appropriate feedback when required.	• Number of stakeholder responses • Semi-quantitative assessment of expert opinion

Case Studies

The following case studies utilized the application of this principle and demonstrated the presence of the benefits associated with this principle.

US 14/16/20 Reconstruction, Yellowstone N.P., WY

Wyoming Department of Transportation (WYDOT) incorporated video imaging early in the design phase of the project to help non-highway personnel and residents visualize the completed project. Several public meetings were held as well as weekly work review sessions during project construction. Daily announcements were made during rock blasting and other road closure operations. The community was kept informed by radio and brochures. The Advisory Committee planned and determined times for road closures during the heavy tourist season. An environmental training video and grizzly bear video were used to inform and educate state, federal, and contractor employees prior to working on the project.

SR 179 Reconstruction, Sedona, AZ

A wide variety of communication methods were used in all phases of the project to interface with the general public through construction. Those included: community interviews, charrettes, focus group meetings, information booths, educational forums, informal meetings, newsletters, news releases to public media, a website, a safety inspection vehicle (during construction), a telephone hotline and a project office staffed by ADOT personnel that was available to the public.

I-4 Reconstruction, Tampa, FL

Public involvement was used to provide guidance in an iterative design process. Throughout the project, many tools were used including charrettes, focus groups, public meetings, face-to-face meetings, web sites, visualization, surveys (conducted in Spanish), variable message boards and newsletters. All worked well.

M St. & Wisconsin Ave. Sidewalk Reconstruction, Georgetown, DC

Media outreach through local news programs and newspapers kept the community abreast of the project successes. The project communication committee developed a project logo that was used in all forms of outreach including press releases, letters to the community, business cards, and other office-related communications. An area parking rules poster that could be placed in the windows of the businesses located in the work zone corridor was provided. Table cards were also provided for restaurants. The contractor provided permanent "no parking" signs along the construction zone. One of the more informative resources was the project web site that provided information about the project and reminded people that Georgetown was still accessible and that people should continue to patronize the Georgetown restaurants and retail shops. Subsequently, the project team had stickers made with the project logo and had those adhered to construction signs. The District Department of Transportation (DDOT) liaison was also a key communication tool for this project. This person attended the monthly resident and business meetings. The liaison was available to answer any questions and to immediately address any concerns or complaints. The expediency to responses was crucial in a high-visibility community such as Georgetown.

5. Achieve Consensus on Purpose and Need

Achieve consensus on the purpose and need of the intended transportation project.

Definition

The purpose and need of the project has been established by a full range of the stakeholders/public, the agency and the project team.

Criteria for Application

- The purpose and need statement is developed early in the project development process and is revised as warranted during planning and preliminary design.
- The purpose and need statement is based on consensus of the project team and interested and affected stakeholders/public.
- The purpose and need statement establishes measures of effectiveness to guide the decision-making process.

Principle Concepts and Project Phases

Establishing the need and purpose for a proposed transportation project is at the core of everything about an intended project. A purpose and need statement does the following:

1. Identifies the most critical problem(s) and other concerns that are important to keep in balance;
2. Provides focus for project design work;
3. Communicates to those to be involved and potentially impacted;
4. Makes the consensus-based business case (that the intended project is worthwhile); and
5. Establishes the measures of effectiveness for measuring the project performance; and
6. Is required, at least for some projects.

Substantiating the transportation need in specific terms and establishing the transportation purpose is the primary purpose of the statement. Stating any other significant criteria or expectations (goals and objectives) relevant to the situation is appropriate for the statement. It should be easy for a design engineer or team to establish the design criteria or principles to be met from the statement. The content and accuracy of the purpose and need statement is the responsibility of the state highway agency as the agency of primary substantive expertise. And it is this statement of what and why that then becomes the litmus test for the consideration of project alternatives and options and for what might then become the project that gets constructed and the facility that is put into service.

Background definitions and general guidance from federal sources is summarized as follows:

The purpose and need statement is to "identify and describe the proposed action and the transportation problem(s) or other needs which it is intended to address" and "briefly specify the underlying purpose and need to which the agency is responding" (FHWA and NEPA). Additionally, preparers are admonished to do the following:

- Clearly demonstrate that a need exists and define the need in terms understandable to the general public, and
- Clearly describe the problems which the project is to correct—graphic communication is encouraged.

Issues and concerns that may be appropriately included, depending on the situation are the following:

- Project history (or background);
- Transportation system linkage;

- Identification of capacity (and safety) issues;
- Transportation demand (trends and projections);
- Legislative mandates;
- Social demands or economic development; and
- Modal interrelationships.

Project Phases

This principle comes into play at the earliest point in the project development process. Its focus is the unique statement of purpose and need for the project that gets drafted in the initial planning phase and that may have been outlined in the programming phase. It may be revisited and finalized in the early design phase. It is then the "litmus test" for any further project development activities.

Proper Use

While the purpose and need statement may be "required" for a project, it is to be used to guide the development of a solution to the transportation problem. It is not to be written by someone, filed neatly away, and simply checked off the requirement list (obtaining federal approval of course). Rather it should be used as a tool to clearly and concisely state purpose and need and capture the intended project's goals and objectives for the unique situation. It should communicate to all the professionals involved what the intent of the project is, as well as, to the community's citizens, adjacent property owners, affected businesses, and other stakeholders (including resource agencies) that may be affected or have some legal standing in the project development process. The statement in its final form should garner the consensus support of those involved, and be the test against which each alternative, option, or final design must stand. CSS practice calls for a re-emphasis of the purpose and need statement's role in the project development process.

- While the statement may be written by one person it should have an interdisciplinary content that is the product of the transportation professionals (planning, design, environmental, etc.) of the agency. It is important that the project professionals buy into the content of the statement.
- The statement should become the basis for understanding the project intent as the project development process progresses and relevant portions stated/reviewed at public meetings and work sessions.
- It should be made clear that the agency's professionals are responsible for working with the affected community and other stakeholders to achieve a reasonable and balanced solution to the purpose and need statement within the professional judgment of the design engineers.

The very first paragraph of a purpose and need statement should clearly and briefly state the intended project's purpose and need as well as any key criteria, expectations or concerns relevant to the situation. This lead paragraph should be written without the technical terms that may be considered necessary in subsequent paragraphs that detail need and purpose. The statement should be clear and specific so that the average citizen can understand the transportation problem and need as well as the expected project goals. While the average citizen may not care to read more than this first paragraph the remaining portions of the statement should be as clear and concise as possible. Jargon should be limited and technical terms explained throughout. The use of maps and photographs along with simple and clear tables and charts is encouraged.

Substantiating text/graphic examples might be found further into a purpose and need statement. Precise simplicity that the general public may understand is to be sought over an abundance of undefined jargon.

Benefits

Table 6 provides an overall summary of benefits, the rationale for selection, and their indicators. Additional discussion on each metric can be found in the benefit guidelines.

Case Studies

The following case studies utilized the application of this principle and demonstrated the presence of the benefits associated with this principle.

Arkansas Route 215, Ozark National Forest, AR

Providing for travel improvement and access to camping and other recreation opportunities while keeping the roadway foot print to a minimum was agreed upon. The consensus was achieved through a series of one-on-one conversations and group meetings involving the state DOT's divisional staffs, the US Forest Service, and the Water Quality and Scenic Preservation agencies beginning in the planning stage and continuing into the design stage. This desired minimalist approach took a bit of design trial and error to achieve an acceptable solution which included a cross-section and geometrics that was sensitive to view sheds from the roadway and from the adjacent Mulberry River.

Table 6. Summary of benefits of achieving consensus on the purpose and need.

Benefits	Rationale	Indicators
Increased stakeholder/public participation, ownership and trust	Achieving consensus on purpose and need by the stakeholders will allow for increased participation and engagement in the process as well as a feeling of ownership of the project, since its purpose and need will reflect their input and values.	• Stakeholder involvement measures • Semi-quantitative assessment of opinion and satisfaction level
Improved predictability of project delivery	Achieving consensus on purpose and need by all parties will allow for addressing all concerns in a timely manner and avoid unanticipated delays.	• Project duration in months to complete • Semi-quantitative assessment of expert opinion
Improved long-term decisions and investments	Achieving consensus on purpose and need will assure that the solution developed fits with the long-term goals of the community.	• Increased transportation/ community long-term benefit relative to cost • Semi-quantitative assessment of expert opinion
Improved mobility for users	The consideration of all modes will allow for the identification and inclusion of all modes appropriate for the community and thus enhance mobility options and choices for the users of the facility.	• Index of quality of travel for all modes • Semi-quantitative assessment of opinion and satisfaction level
Improved community satisfaction	Achieving consensus on purpose and need will allow for developing a project that is in sync with the community vision, since its purpose and need will reflect such input and vision thus resulting in a project that will satisfy the community.	• Semi-quantitative assessment of opinion and satisfaction level

KY 234, Bowling Green, KY

The city and KYTC initiated this project to provide another link between I-65 and the downtown. When concerns arose about possible sprawl growth near the interstate, city planners worked with KYTC to limit growth by combined use of zoning and limited roadway access. This cooperation overcame opposition and allowed the project to proceed.

M St. & Wisconsin Ave. Sidewalk Reconstruction, Georgetown, DC

The Georgetown DC area had been subject to years of deterioration and neglect prior to the onset of this project. Not only was the sidewalk deteriorated, but the area had many utility problems as well. Local residents and businesses welcomed the opportunity for local renewal of the sidewalks and utility infrastructure. The minimal disturbance approach and simultaneous bundled maintenance helped win support for the proposed project.

6. Address Alternatives and All Modes

The project to be developed should consider and address transportation alternatives and all modes.

Definition

All appropriate modes are considered in the evaluation of alternatives and addressed given the project's purpose and need.

Criteria for Application

- Alternatives encouraging mode choice capable of addressing the issues in the purpose and need statement are identified and developed.
- Each alternative is developed to its fullest potential appropriate to the stage of the project.
- The "No Build" alternative is considered and is provided as a genuine alternative.
- Alternative evaluation criteria are objective.

Principle Concepts and Project Phases

Based upon technical studies conducted for existing and future condition analysis and the resulting Purpose and need statement, a fuller understanding of the mobility problem in a project area can be achieved. Often a given problem or need manifested in the transportation system is related to community/socio-economic and other issues that reach far beyond the number of lanes on the roadway. These can include the following:

- Distribution of population and major employers;
- Growth trends and development;
- Seasonal variations in traffic/tourism;
- Topography, roadway design factors;
- Physical condition of the transportation infrastructure;

- Safety/crash problems; and
- Pedestrian/bicycle activities.

In order to find a true "solution" to mobility problems in a project area, it is necessary to examine a wide range of alternatives that go beyond the pavement to the source of the problem. Therefore, after the development of a Purpose and need statement, several alternatives should be developed that span the entire spectrum of possible solutions.

During project planning phases alternatives should be developed on a conceptual scale and include all reasonable capital, policy, program, management and modal alternative solutions to the mobility problem(s). Identification of conceptual solutions or alternatives should begin with specifying the needs to be addressed in the Purpose and need statement. Depending on the complexity of the problem, it may be necessary to present a number of alternatives. The number and range of alternatives selected should be appropriate to the identified needs. Typically, along with one or more build alternative studies, include the identification and evaluation of modal alternatives, transportation management or operational alternatives, and a no-build alternative(s). A brief description of each of these types of alternatives is provided in the following paragraphs.

No-build alternative(s). "No build" does not mean "no improvement." The no-build alternative may include extensive maintenance or in-kind replacement of an existing facility. As such, it is possible that there may be more than one no-build alternative. The no-build alternative establishes the base condition for the project. In this role, all measures of effectiveness used in the selection criteria should be applied to the no build alternative.

Policy/Programming alternatives. Implementing new policy and programming strategies can have a significant impact on the operation and use of the transportation system. It is only at the programming and policy level that land use can be directly linked to the improvements transportation system in order to directly affect demand on the transportation system. Policy and programming can also be used to effectively maintain capacity on a new or existing roadway well into the future through permitting regulations.

Transportation demand/system management. Transportation Demand Management (TDM) and Transportation System Management (TSM) alternatives attempt to improve the efficiency of the existing transportation system by influencing the system utilization. System utilization may be improved both temporally and spatially, by increasing the utilization off peak periods and parallel routes.

Modal alternatives. Whenever possible modal alternatives should be identified and developed to identify their potential to improve mobility needs in a project area. Modal alternatives are not limited to bus transit but may include any other mode of transportation besides general use highway facilities. Modal alternatives typically offer more environmentally friendly alternatives than single occupancy vehicles and have a higher passenger carrying capacity than general use highway facilities. Modal alternatives are typically very effective in extremely dense areas with high levels of congestion.

Operational alternatives. Operational improvement strategies are those alternatives that have the ability to increase the capacity of the roadway while maintaining the existing basic infrastructure and right of way. These alternatives are typically lower cost than major capital improvements projects and typically have fewer right of way and environmental impacts than major roadway projects. Operational improvement strategies include improvements in traffic control, optimization of existing traffic control, and comprehensive access management strategies. These strategies can also be implemented with other alternative strategies.

Build alternatives. Build alternatives consider the expansion of the existing highway infrastructure. This may include widening of an existing facility or the construction of a new facility. In the conceptual alternative stage, the build alternative is only developed to the same level of detail as the other alternatives considered. Therefore, the build alternative should only be developed to the point of identifying existing facilities to be expanded, or identifying new connections to be made within the existing roadway network.

Other alternatives. Due to the unique nature of transportation problems and the differing environment in which transportation problems exist, a unique solution may always be present to address these special issues. Any Innovative conceptual solutions that have the ability to meet these demands should be explored within the project planning in order to identify more effective and economical alternatives.

The final alternative chosen or carried forward for further consideration and preliminary design can be a single conceptual alternative or a combination of alternatives. A combination of alternatives is often preferred as each strategy employed will offer different benefits. By combining alternatives, it is possible to maximize benefits that better serve the community.

Proper Use

While identifying alternatives, it is imperative to identify all alternatives and develop a fair and consistent method of evaluating them so that all are equally considered and not just given lip service. It is important to continue working with stakeholders to seek and address their ideas and concerns about how to best address the identified problem. Ample consideration should also be given to all ideas proposed, developing them to their best potential. Ideas from stakeholders that are not initially feasible may be modified to make them more viable rather than rejected out of hand. This will help to ensure that all potential solutions will be identified early in the process and not be proposed near the end of the process, causing possible delays, or worse, ignoring a potentially better alternative.

Furthermore, no alternative should be developed further than others so that they remain on equal footing with one another. Limiting the level of development of the alternative will reduce the time and cost of preliminary design and planning for the alternative, allowing for the development of more strategic alternatives and keep the build alternative on the same footing as other alternatives, so that it is not perceived as more "tangible" than other alternatives.

Equally important to identifying all alternatives is the development of a unique set of criteria to evaluate ALL alternatives, allowing a direct comparison. Evaluation criteria should generally apply to all and not inherently favor one alternative over another. For example measuring average travel time per person through a corridor could be an even better method to capture all benefits of alternatives, since it is a truer representative of mobility than LOS or V/C ratios.

Often times, modal alternatives are not carried forward to implementation as they are not shown to significantly reduce congestion in an area. However, with increasing congestion in our urban areas and constrained rights of way, modal alternatives can often offer an alternative to congested general use facilities. While congestion is not mitigated, the public would then have a choice which reduces travel time.

Evaluation criteria should be directly tied to study transportation goals and objectives, including but not limited to the measures of success identified in the Purpose and need statement. Where an adopted regional, state, or local transportation plan exists, evaluation criteria should be consistent with the goals or objectives of that plan. Stakeholders should also be involved in developing the evaluation framework and criteria to ensure "buy-in" of the stakeholders and public for the evaluation approach that will lead to buy-in of the results.

Benefits

Table 7 provides an overall summary of benefits, the rationale for selection, and their indicators. Additional discussion on each metric can be found in the benefit guidelines in the next chapter.

Case Studies

The following case studies utilized the application of this principle and a brief description of the principle application is provided here.

New Pueblo Freeway (I 25), Pueblo, CO

This is a project that had as purpose to develop a solution that improves the mobility of all users and provide for alternate modes. Light rail train was chosen over additional highway expansion or High Occupancy Vehicle (HOV) lanes because it provides very high capacity for very little space. The project is in a very constrained corridor and a multi-lane highway expansion would have had numerous residential and business relocations. A variety of options were explored in the planning phase, using a multi-level screening process to develop and evaluate modes such as Bus/HOV lanes, light rail transit, highway expansion, commuter rail transit, and alternative alignments. A number of possible locations for transit stations were also developed and evaluated. The design solution

Table 7. Summary of benefits of addressing alternatives and all modes.

Benefits	Rationale	Indicators
Improved mobility for users	Consideration of all alternatives and modes will identify all potential options for the users to be considered.	• Index of quality of travel for all modes • Semi-quantitative assessment of opinion and satisfaction level
Improved multi-modal options	Consideration of all alternatives and modes will improve the connectivity of modes and identify potential new modes that could be part of the project and therefore improve the modal choices for the facility users.	• Each modal facility element inclusion and extent • Modal connectivity (count/volume) and safety (crashes/severity) • Semi-quantitative assessment of opinion and satisfaction level
Increased stakeholder/public participation, ownership and trust	Consideration of all alternatives and modes will improve stakeholder participation, since their input will be sought to identify potential alternatives and modes to be considered; ownership of the project, since their input will be solicited and considered in the final project design; and trust in the process, since their comments will be considered and addressed during the project development process.	• Stakeholder involvement measures • Semi-quantitative assessment of opinion and satisfaction level
Improved long-term decisions and investments	Consideration of all alternatives and modes will assure that the solution developed fits with the long-term goals of the community.	• Increased transportation/ community long-term benefit relative to cost • Semi-quantitative assessment of expert opinion
Improved walkability and bikeability	Consideration of all alternatives and modes will improve the options for pedestrians and bicyclists.	• New and expanded options for pedestrians and bicyclists • Index of quality of travel for bicyclists and pedestrians • Semi-quantitative assessment of opinion and satisfaction level

that best met purpose and need and minimized environmental impacts was a combination of highway widening and establishment of an LRT corridor.

SR 99 Pacific Hwy South Reconstruction, Des Moines, WA

This project considered the accommodation of transit along the corridor and established bike lanes on the roadway. In addition, sidewalks were provided along the entire corridor, since they were not available before and midblock crossings were constructed with refuge islands to improve safety of pedestrian crossings. The inclusion of these elements to accommodate all modes and users was due to the stakeholder input in the public involvement phase and the commitment of the project team to address the multimodal needs of the corridor.

Eastern Corridor, Southwestern, OH

In addition to considering all alternatives and modes, it is imperative that those modes be chosen and implemented when they are shown to be the best option for the community. In addition, it is likely that projects should incorporate numerous modes to provide a well-rounded solution that is capable of meeting the needs of all users. The Eastern Corridor project undertaken by the Ohio DOT exemplifies this approach. The eastern corridor project includes portions of downtown Cincinnati as well as suburban and rural areas east of the city in Clermont County. As a result of these diverse needs, the project includes recommendations for Rail Transit, Bus Transit, Transportation System Management, New Roadway Capacity, and Bikeway improvements. It is through this varied use of improvements that it is able to serve the diverse needs of the community.

T-REX, Denver, CO

During the MIS phase, a multi-level screening process was used to develop and evaluate modes such as Bus/HOV lanes, light rail transit, highway expansion, commuter rail transit, and alternative alignments. A number of possible locations for transit stations were also developed and evaluated. The design solution that best met purpose and need and minimized environmental impacts was a combination of highway widening and Light Rail Transit (LRT) corridors. LRT was chosen over additional highway expansion or HOV lanes because it provides very high capacity for very little space. The project is in a very constrained corridor and a multi-lane highway expansion would have had numerous residential and business relocations.

7. Consider a Safe Facility for Users and Community

The resulting project should consider and develop a safe facility for users and community.

Definition

The resulting project creates a safe facility for the project users and the community by addressing safety issues.

Criteria for Application

- A safety review is conducted at each phase of the project with consideration of the needs for all users.
- Input from all modal user groups is sought to better understand their safety needs.
- The project team develops a solution addressing safety concerns.

Principle Concepts and Project Phases

CSS projects may address many more issues than involved in a "traditional" highway project, which may increase the complexity of the project and introduce new elements. Often times, the designer must juggle and balance many more needs than typically encountered on a project. Due to the potential complexity involved in these projects, it is recommended that a comprehensive safety review of the proposed plan be conducted within the design stage to ensure safety for all road users. The objective of this safety review should be to (1) Consider the safety of all road users; (2) Consider interactions at the borders or limits of the project; and (3) Examine the interaction of project elements.

The safety review is not an opportunity for the reviewer to redesign the project, or impact commitments made during previous work. The process outlined by the FHWA Road Safety Audit (RSA) program may be used as a good starting point for developing this review.

Consider the Safety of All Road Users

In order to consider the safety of all road users, it is imperative to use a multi-disciplinary team that is skilled in design and operations as well as the intricacies involved in different modes of transportation. The particular needs of all road users must be considered within projects. Pedestrians have a wide variety of capabilities ranging from toddlers to active teenagers to elderly pedestrians who may have limited mobility and vision. Cyclists may also behave as vehicles in the traffic stream or as pedestrians in a crosswalk. The use of transit vehicles will also introduce vehicles with very different acceleration and deceleration characteristics, as well as frequent stops and attracting pedestrian activity. As CSS projects may often encourage increased modal options on a project, a special consideration of the special safety needs is essential to assure safety for all users.

Project Border/Limits

While design consistency principles should be applied within a CSS project, the safety review should ensure that such consistency is maintained throughout the project. This is especially true at the project termini as the flexible design features applied on many CSS projects may present different characteristics than those in the adjacent roadway network. Often crashes will be concentrated at these transition points, as such sudden changes may not meet driver expectations and create surprises. In order to address issues such as these, the safety review should extend beyond the project limits and identify any issues on the approaches before and after the project. If such issues are identified, then properly designed transitions can be incorporated into the project to safely convey the driver from one roadway cross-section to the other.

Interaction of Project Elements

The holistic approach advocated by CSS principles may result in a multi-faceted design that incorporates elements not typically seen on traditional projects. For instance, in order to preserve historically and environmentally significant trees in an area, a designer may minimize clear zone requirements and incorporate the trees into the design. At the same time, horizontal curvature elements may be introduced in the design to provide speed control. While this does not in and of itself present a safety problem, it should be identified and sufficiently investigated to ensure that no unreasonable level of risk exists. This would include ensuring that the trees are not located at the outside of a tight curve. While many design elements are sufficiently understood to be "safe," special attention may be required to examine interaction between the various elements.

The safety review of the project can be conducted at any phase, and the level of detail will vary accordingly. A review during the planning stages will identify the major areas of concern and potential safety issues to be examined. The review during the preliminary design will locate the general safety issues relative to the corridors proposed as well as the values for the design elements to be examined. In the final design and after the selection of the preferred alternative, the safety

review examines the specific elements and values used and determines potential safety concerns with the selected values. A safety review during preconstruction identifies the areas of concern regarding the constructability of the project as well as issues related to the work zones to be established for construction. Similarly, the safety review in the construction phase examines potential considerations regarding any change orders and design changes made after the final design. Finally, a safety review after the opening of the project focuses on identifying issues as they relate to the operation of the project and reviews all safety aspects of the project.

Proper Use

A preliminary safety review should be initiated from the early stages of the project in order to identify and document any potential safety issues and concerns. As the project moves through the various phases, safety concerns from general (planning) to specific (design and construction) could be identified and properly addressed. In order to achieve this, it is important that the safety reviews be conducted by a multi-disciplinary team familiar with the needs of all users. A well-documented process should be followed, where any potential issues identified should be listed along with an explanation describing why these were considered by the project team to be (or not be) a safety issue. The list should also include the corresponding potential solutions as well as a description of how these issues were addressed within the project constraints.

Safety reviews of projects should be conducted as a separate and independent element of the project. This will assure that the evaluation has been conducted properly and all potential issues have been adequately addressed and resolved. It is desirable that the safety review is conducted by an independent team that is not involved in the project design, but is familiar with CSS practices. Providing an independent review team provides a different perspective than the lead designer of a CSS project team.

An additional aspect to be considered is the inclusion of the stakeholders and the public in the identification of potential safety issues and problems. It is possible that site visits may not identify and document all existing problems and concerns. Often those who see or drive the area for the proposed project every day will have a much deeper understanding of the idiosyncrasies of a project area than members of the project team. The presentation of the safety issues and means to address them should be presented to the public in order for the public to understand the issues, the choices, and the effect of the treatments on safety and final design.

Benefits

Table 8 provides an overall summary of benefits, the rationale for selection, and their indicators. Additional discussion on each metric can be found in the benefit guidelines.

Case Studies

The following case studies utilized the application of this principle and a brief description of the principle application is provided here.

KY 234, Bowling Green, KY

The existing road was inadequate for handling peak daily traffic. The road lacked signalized intersections that were necessary for traffic accessing local subdivisions. The new facility provided a divided four lane roadway that helped prevent crashes. Additionally, the road incorporated a multi-use path that safeguarded pedestrians and bikers along the busy road. Limited access along the road minimized the number of conflict points. The new facility has experienced less crashes and injuries than the preceding route.

Table 8. Summary of benefits of considering a safe facility for users and community.

Benefits	Rationale	Indicators
Improved safety (vehicles, pedestrians and bikes)	Considering a safe facility will result in an improved safety level, since the needs of all users will be considered and addressed.	• Number of crashes, crash frequency and severity • Improved design features by type • Semi-quantitative assessment of opinion and satisfaction level
Improved quality of life for community	Considering a safe facility will result in an improved quality of life for the community, since a safer facility will allow for lower crash rates.	• Semi-quantitative assessment of opinion and satisfaction level • Alignment with community plans (land use and activity pattern)
Improved speed management	Considering a safer facility will result in improved speed management, since the design elements provided in the project design will consider speed issues as part of their selection and aim in addressing speed management.	• Operating speed (expected/ actual) • Semi-quantitative assessment of opinion and satisfaction level
Improved walkability and bikeability	Considering a safe facility will result in an improved safety level for pedestrians and bicyclists, since their needs will be considered and addressed.	• Modal safety (crash/severity) • Semi-quantitative assessment of opinion and satisfaction level
Increased risk management and liability protection	Considering a safe facility will result in increased risk management protection, since all decisions will be documented and properly supported.	• Number of legal actions taken against the agency • Semi-quantitative assessment of expert opinion

SR 73/US 321 Gateway Project, Gatlinburg, TN

Flexibility in the design process resulted in transportation needs (increased capacity, etc.) being addressed with the recommended modifications without any design exceptions. Safety was not compromised with the new design, and was expected to be enhanced with the adoption of the median boulevard concept with turn lanes and major intersections. Some limited number of right-of-way tracts have only right in, right out access, but the impacts to these parcels was not significant. The addition of a landscaped median coupled with reduced lane widths and a reduced speed limit helped create a parkway experience.

US 1 Planning Study, College Park, MD

As a guiding principle of CSS, safety must be involved in every aspect of the project development process. The US 1 College Park Planning Study exemplifies this as a primary goal of the project as stated in the purpose and need statement to improve safety for motorists, pedestrians and cyclists. As such, safety considerations were a driving force behind alternative development, selection and drove many of the refinements to the ultimate design. The only alternative not retained for further study was considered to address many operational concerns but was dropped as it did not adequately address pedestrian safety on the corridor. Final alternatives were also revised during latter stages of the project to incorporate a full width bike lane as opposed to a wide outside shared lane due to concerns for driver and cyclist confusion from the presence of an unmarked shared lane. Ultimately the selected alternative incorporated designated bicycle facilities, pedestrian refuge islands, improved sidewalks and pedestrian islands and comprehensive access management practices, to address the entire spectrum of safety issues on the corridor. By placing safety

at the forefront of the decision-making process the Maryland DOT was able to deliver a great project to the residents and users of the US 1 corridor.

8. Maintain Environmental Harmony

The resulting project should maintain environmental harmony.

Definition

The resulting project is in agreement with its physical and social setting and minimizes disruption during construction and operations.

Criteria for Application

- All natural, human and cultural resources within the study area must be identified and considered in the project development process as early as possible.
- Environmental harmony is determined both by the stakeholders/public and appropriate studies.
- The project strives to enhance resources, not merely maintain them.

Principle Concepts and Project Phases

The goal of maintaining environmental harmony should be sought from the earliest planning stages of the project when conceptual alternatives are developed and considered for inclusion. Environmental harmony should not be included as an afterthought of how do we avoid/mitigate impacts with XY alignment, but rather what alternative, mode or alignment offers the greatest benefit or least impact to the environment should be considered. Therefore, environmental considerations should be used as primary criteria when evaluating different alternatives.

In order to understand the context of the project it is imperative to perform studies of the natural and human environment in the project area, which must be fully integrated and considered in the design process. Extensive environmental studies can be cost prohibitive to examining a full range of potential solutions and alternatives. Therefore, a stepwise approach to environmental studies is recommended whereby environmental studies are refined and developed as alternatives are eliminated or carried forward to limit the scope of the initial environmental studies and streamline the process.

After alternatives are developed and carried forward for further evaluation, it is necessary to move to a more detailed examination of both the context of the study area and the ultimate project design. This is achieved by implementing a high level of interaction between the design elements and the environmental constraints in the project area. Environmental investigations and analysis should NOT be directed by the final design or used to justify a particular design.

NEPA requires and FHWA is committed to the examination and avoidance of potential impacts to the social and natural environment when considering approval of proposed transportation projects. In addition to evaluating the potential environmental effects, we must also take into account the transportation needs of the public in reaching a decision that is in the best

overall public interest. The FHWA NEPA process is an approach to balanced transportation decision making that takes into account the potential impacts on the human and natural environment and the public's need for safe and efficient transportation.

While only Federal Funded projects are required to formally prepare studies and fulfill the NEPA requirements, it is recommended that projects not requiring federal funding or federal action be developed in a process closely following the NEPA process. This will ensure an integrated CSS that addresses pertinent environmental issues. In addition, such projects may be eligible for future federal funding at subsequent stages of the project development, maximizing funding sources and minimizing project delay.

Proper Use

All natural, human, and cultural resources within the project area must be identified and considered in the project development process. Care should be taken, however, to ensure that environmental studies are consistent with the level of development of the project. There is no need to conduct extensive field investigations for a regional study in the preliminary planning stages. Instead major issues or "Red Flags" should be identified for initial screening. As alternatives are developed further from concept to corridors and finally individual alignments, more extensive investigations should be undertaken to match the needs of the design stage.

In developing design options, several alternatives must be developed that meet the desired outcome of the project. Each of these alternatives should aim to meet the NEPA requirements to avoid, minimize, and mitigate potential impacts on the resources of an area. However, in order to deliver true environmental harmony, the project should attempt to enhance these resources and not merely maintain them. Other environmental resources that may not be regulated by NEPA or specific resource agencies, but are important to the community, should also be preserved. These may include objects of the built or natural environment that the community values and cultural or environmental resources that are unprotected but contribute to the character of the area, such as a rural view shed. By enhancing these resources it is possible to leave an area in better condition than when the project was started and maintain environmental harmony for years to come.

Finally, solutions should be sought that may perpetuate the environmental resources. This may take the form of incorporating maintenance contracts or agreements with local officials or neighborhoods to maintain any mitigation or enhancement or designing those features in a way that does not require maintenance. This may include plantings and vegetation that do not require maintenance or allowing reclamation of impact areas by the natural environment.

Benefits

Table 9 provides an overall summary of benefits, the rationale for selection, and their indicators. Additional discussion on each metric can be found in the benefit guidelines.

Case Studies

The following case studies utilized the application of this principle and a brief description of the principle application is provided here.

US 14/16/20 Reconstruction, Yellowstone N.P., WY

The project involved geometric upgrades for a heavily traveled tourist and recreational corridor, while preserving environmental and aesthetic features. The conservation easement obtained as mitigation for the project helped preserve many acres from future development. Environmental and

Table 9. Summary of benefits of maintaining environmental harmony.

Benefits	Rationale	Indicators
Minimized overall impact to human and natural environment	Achieving environmental harmony will result in minimized impacts to natural and human environment, since the appropriate issues will be considered and addressed.	• Percentage of human and environmental impacts of the alternative used for project compared to other alternatives • Semi-quantitative assessment of opinion and satisfaction level
Improved environmental stewardship	Aiming to maintain environmental harmony will demonstrate the commitment of the agency to environmental concerns and issues and improve the agency's stewardship.	• Increased or enhanced mitigation beyond mandated ratio/acres • Semi-quantitative assessment of expert opinion
Improved quality of life for community	Achieving environmental harmony will result in improved quality of life for the community, since all social and natural environment issues will be considered and addressed.	• Semi-quantitative assessment of opinion and satisfaction level • Alignment with community plans (land use activity patterns)
Design features appropriate to context	Maintaining environmental harmony will result in developing a project solution that will have design features that are appropriate to the context since the environmental concerns will be considered and addressed in a proper manner.	• Semi-quantitative assessment of opinion and satisfaction level

visual features were enhanced by the project, including rock cuts, re-vegetated slopes, reclaiming old road cut slopes, closing and reclaiming locally pioneered roads, habitat enhancement paid by the WYDOT and implemented by the USFS, river enhancements using rock structures, relocating trailheads away from a grizzly bear habitat, and closing a campground in a grizzly bear habitat and reclaiming it into wetland. Access to a sensitive cultural resource was improved, data from archeological sites were retrieved, wetlands were reconstructed, four new interpretative centers were constructed, and temporary stream crossings were constructed without disturbing existing channel bottoms. A U.S. Forest Service landscape architect was employed, as well as an environmental compliance officer to ensure environmental sensitivity.

Arkansas Route 215, Ozark National Forest, AR

Extraordinary steps were taken in the design of Route 215 to ensure that the project was in harmony with the environment. The footprint was minimized with a curb and gutter design and the road generally follows the centerline of its gravel predecessor with a minimum of new cuts and fills. Attention was given to protecting the viewshed from the Mulberry River for canoeists and rafters while an overlook was provided for the motorists of the river valley. Natural stone from the area was used for retaining walls and for the stone veneer on the overlook walls.

US 27/68 Paris Pike Reconstruction, Lexington—Paris, KY

Roadway alignment was selected to avoid and/or minimize impacts to historical properties and structures. Highway design consultants joined with environmental specialists, landscape architects, and historic preservationists to develop a design that would be safe, efficient, with minimal impacts to the historic and scenic resources unique to the Paris Pike corridor. Extensive landscaping and aesthetic treatments such as grass shoulders, wood timber guardrail, and stone facades matching indigenous outcrops were used to blend the roadway into the surrounding horse farm countryside traversed by the new roadway. Dry-stone walls were prominent

along the corridor and approximately three miles of walls were dismantled and reconstructed or constructed. Historic signature entrances to horse farms were avoided where practical and where impacted, new entrances were built to match the original entrances as part of the contract cost. Roadway alignment and median widths were selected to minimize impact to matriarchal trees. Utility easement modifications were coordinated to lessen impact on trees. An endangered species, Running Buffalo Clover, was transplanted to a fence-protected easement purchased specifically for this purpose. Water channel changes were combined to minimize and control erosion. Archeological site investigations were performed at Monterey and McConnel Station.

North Carolina Parkway, Wilmington, NC

A complete redesign of the intended final two segments of the parkway was carried out to minimize the environmental impact to businesses as well as the wetland, and to avoid hazardous materials fill sites. Several years had passed and the circumstances had changed regarding land use and environmental regulations since the first two segments had been designed and constructed. The planning and design groups worked with nearby critical industries to revise the previously planned alignment in order to minimize construction vibration. Alignment was also altered to avoid chemical production and waste areas and to accommodate an abandoned rail bed so as to preserve it for possible future use. Some parking enhancement was provided to an adjacent historic district. And the roadway cross-section was changed in one segment to an elevated structure to minimize impact to the wetland adjacent to the Cape Fear River.

9. Address Community and Social Issues

The resulting project should consider and address community and social issues.

Definition

The resulting project addresses the issues identified through stakeholder/public involvement and provides a solution that preserves/enhances the community's resources and values.

Criteria for Application

- The project team through public interaction investigates and documents the context of the project in terms of community and social resources and how the project may affect that context.
- Proposed solutions are sensitive to the community values and various cultures within the community.
- The project team is open-minded and considers non-traditional solutions that fit the community.

Principle Concepts and Project Phases

Every area surrounding a transportation project has a distinctive context and character that consists of cultural, environmental, socioeconomic, and physical features. It is therefore imperative to understand the implications stemming for each of these features and properly address

them during the project development process. With such a variety of features, the importance of identifying and involving all appropriate stakeholders is essential. Such stakeholders will then be able to provide the needed information for understanding the "true" transportation needs of the community and identifying potential solutions to address them. In addition, this approach allows for a determination of the community values, social issues, and other relative information that could shape the final solution. Moreover, it is also important to understand that there will be different perspectives and values assigned to each of these features by the members of the community and the challenge is to develop a solution that will balance all these, sometimes conflicting, values. Such a process will contribute to achieving the appropriate balance of transportation needs (safety, mobility), physical and natural resources, scenic, aesthetic, and cultural values.

The essence of CSS is to provide a transportation solution that considers and addresses all factors including: safety, environment, community, capacity, mobility, and budget. The project team is asked to develop an appropriate solution that satisfies all these. A significant part of these factors is defined through a continuous and sincere involvement of the public and stakeholders. The solicitation of comments and input should also be considered as the first part of the process. Addressing concerns and issues as they pertain to each specific project phase in a timely fashion within the project phase allows for developing a solution that considers and addresses all pertinent issues. The need for timely response may require a commitment by the transportation agency of additional personnel that oversees and organizes the public involvement plan and coordinates responses by the technical experts of the project team.

Another important aspect for addressing community and social issues is the commitment of the transportation agency to accept, consider, and evaluate non-traditional solutions. This requires an "open-minded" approach to each project and a departure from some of the solutions used in the past. The need to be flexible is very important during such meetings because the unwillingness to consider alternative solutions creates public mistrust. It is also important to approach initial meetings as project-shaping opportunities where transportation solutions should be sought to address the true community transportation needs and deficiencies. This requires the acceptance and consideration of multi-modal solutions as well as the willingness to revise and incorporate suggestions of the public in follow up designs and alternatives.

Proper Use

There are no specific guidelines for addressing the community and social issues but it should be emphasized that these are present in almost all projects. Each project will affect a community, regardless of how small it is. Therefore, there is a need for identifying the relative community issues and develop a solution that will have the potential to improve the quality of life for the community. Reliance on trained professionals is fundamental for the proper solicitation and identification of these issues as well for developing the required solutions. It is therefore imperative that appropriate team members (i.e., community involvement specialists) are included in this process. It is possible that other specialists may be involved in order to identify social and cultural resources within the boundaries of the project.

Once these are identified and methods for addressing them developed, input should be solicited from the public and stakeholders to evaluate and comment on the proposed choices. The potential solutions and their alternatives should be presented along with the implications for each choice on the final design. It is desirable that these proposed solutions are viewed at this stage as the starting point for discussion rather than the ultimate decision for the project. This approach will open up the dialogue between the project team and the public in order to define the preferences of the public and at the same time explain to the public issues, and consequences of their preferences.

The final choices selected should be documented to clearly provide the rational for the process and approach taken to address the community and social issues in the final designs. This will also allow for the public to clearly see how their concerns were addressed in the final solution.

Benefits

Table 10 provides an overall summary of benefits, the rationale for selection, and their indicators. Additional discussion on each metric can be found in the benefit guidelines.

Case Studies

The following case studies utilized the application of this principle and a brief description of the principle application is provided here.

12300 South Design Build Project, Draper and Riverton, UT

Two Community Coordination Committees were created for Draper City and Riverton City and consisted of residents, community leaders, business owners, and city officials. Each CCC was allocated $400,000 for landscaping and aesthetic improvements that best represented their

Table 10. Summary of benefits of addressing community and social issues.

Benefits	Rationale	Indicators
Improved community satisfaction	Considering community and social issues will improve community satisfaction, since the final design solution will address the community desires as they were formed during the public and stakeholder input meetings.	• Semi-quantitative assessment of opinion and satisfaction level
Increased stakeholder/public participation, ownership and trust	Considering the community and social issues will enhance stakeholder participation, since their input will be sought; ownership, since their comments and suggestions will be considered in the project's solution; and trust, since their input will be seriously considered and included in the final project design.	• Stakeholder involvement measures • Semi-quantitative assessment of opinion and satisfaction level
Minimized overall impact to human and natural environment	Considering the community and social needs will minimize the impact to human environment, since all appropriate issues will be addressed and appropriate solutions will be sought to be included in the final project design.	• Percentage of human and environmental impacts of alternative used for project compared to other alternatives • Semi-quantitative assessment of opinion and satisfaction level
Improved quality of life for community	Consideration of community and social issues will improve the quality of life since comments and input from public involvement that were addressed in the final project design will result in a project that will enhance their quality of life.	• Semi-quantitative assessment of opinion and satisfaction level • Alignment with community plans (land use and activity patterns)
Design features appropriate to context	Consideration of community and social issues will result in a design that fits the context, since comments and input from public involvement will be addressed in the final project design.	• Semi-quantitative assessment of opinion and satisfaction level

community. Six neighborhood groups were created to effectively listen and respond to the unique needs and concerns of the citizens. GRW met with each group throughout the project to discuss access issues, road restrictions, utility interruption, noise, landscaping, and aesthetics. The CCC was empowered to award up to $2M as an incentive to the Contractor based on certain criteria.

Connecticut Oyster River Roundabout, West Haven, CT

City officials and local leaders of the West Haven community wanted the roundabout to serve as a "gateway" to include landscaping and special lighting. The final alignment was chosen to avoid an endangered species of beach grass with the help of the state's Department of Environmental Protection. Many residents were concerned about high speeds and found the roundabout option as a useful way to provide traffic calming. In addition, the roundabout design did not require additional right-of-way; the original roadway's overall footprint that included a stop-controlled intersection was maintained and the design was able to also accommodate the community-requested sidewalk. The new roadway design is seen as maintaining the community's character while providing specific enhancements that create a lasting value.

North Carolina Parkway, Wilmington, NC

Both the alignment and cross-section were changed from the earlier plans to accommodate two major industries that had since developed adjacent to the originally planned alignment. The alignment was further altered to avoid the possibility of disturbing hazardous wastes near a chemical storage facility. The alignment and overpass assured that an abandoned rail line bed would remain unobstructed for possible future urban rail use. The section adjacent to the downtown was designed to include land dedicated to parking near the historic area. An old magnolia in the path of the road near the point where it connects with the existing Cape Fear Bridge was "preserved" in a unique way with the help of community involvement that included using the wood to craft benches for the city's museum and with the help of an arborist over 100 young saplings were reproduced to be placed in parks throughout the city.

Eastern Corridor, Southwestern, OH

The Eastern Corridor Project undertaken by the Ohio DOT is located in the jurisdiction of two counties, Hamilton and Clermont, and includes the jurisdiction of 17 cities, villages or townships, each having their own distinct character and concerns. As a result of the initial planning efforts, 5 different improvement strategies were identified including roadway capacity, transit capacity, bikeways, transportation system management, new rail capacity. Despite the enormous scope of the project, each of the elements were evaluated for appropriateness and suitability to each jurisdiction affected. The large scale of the project required a higher order of evaluation, but these efforts would be used to direct future analysis and designs. Primary resources of each area included in the study were identified, and these resources directed impact evaluations. This allowed for identification of the special issues and concerns within each area. For instance, the communities of Fairfax, Newtown, and Indian Hill border the Little Miami River corridor, a national scenic river, and they seek to preserve this resource. This issue led to the development of plans to control access on a proposed roadway, to limit access points along the Little Miami River, and to create bus circulator/feeder routes to serve rail transit to maximize right-of-way efficiency and support the land use priorities. Conversely, the downtown area along Eastern Avenue is heavily developed and therefore, a predominantly transit-based TSM improvement plan was developed. No new roadway alignments were proposed for this area. This plan was chosen primarily due to the high level of development as well as substantial section 4(f) and 6(f) issues due to the large number of parks on the corridor. By understanding the key issues in 6 areas identified in the project, alternatives were able to be developed to meet the specific needs and concerns of the stakeholders and citizens. In doing so, a large wide-scale project was able to meet the individual needs of the community.

US 1 Planning Study, College Park, MD

In order to provide a project that addresses the needs and issues of the community, the project must engage and involve the community and its leaders throughout the project. Maryland DOT led an extensive public and stakeholder involvement campaign with the US 1 Planning study to do just that. The project was overseen by a focus group that directed many of the studies and decisions made by the team as well as coordinated with local coalitions of businesses, advocacy groups, and general outreach to the public. As it is stated under proper use of this principle, CSS projects "require an 'open-minded' approach to each project and departure from solutions used in the past." This was demonstrated through various aspects of the project, but substantially so in the evaluation of new alternatives developed by the focus group. One such idea was an alternative utilizing a reversible lane to meet capacity demands. While ultimately not chosen, this alternative was fully evaluated by the project team at the direction of the stakeholders demonstrating a commitment to understanding the needs and listening to the public. Were it not for the direction and reliance of the project team on the various groups involved, it is uncertain if the project would have as clearly met the needs of the community. In doing so the project was able to serve the high level of pedestrian traffic and cyclists generated by the residents along the corridor, and maintain access to businesses even with the consolidation and elimination of numerous access points on the route.

10. Address Aesthetic Treatments and Enhancements

The project should consider and address aesthetic treatments and enhancements.

Definition

The project develops aesthetically pleasing solutions that result in improvements compatible with community preferences and project context.

Criteria for Application

- The process for selecting various elements for the aesthetic design involves the appropriate team members and stakeholders/public.
- Design elements are selected in accordance to the context of the project and reflect the character of the area.

Principle Concepts and Project Phases

Roadway aesthetics are defined as those elements that increase the visual appeal of the roadway and provide a unique character for the roadway. These elements are often selected based on the location of the roadway and are typically a result of the cooperation among designers, landscape architects, arborists, and the public. There is a great variety of elements that could be utilized and that could be examined especially during the design phase of the project. It should be also noted that the need for an interdisciplinary team is a strong necessity in this design aspect. The highway aesthetics are of great importance in creating a sense of place which will provide uniqueness to the roadway and balance community and natural environmental concerns as well as budgetary constraints.

There are no specific requirements or guidelines for this aspect of the roadway design but rather an open-ended design of the roadway's surrounding environment in order to develop an acceptable solution and aesthetically appealing result. As noted above, the use of multi-disciplinary teams is essential for developing a successful aesthetic design for the roadway and reliance on the expertise of several non-engineering disciplines is required. Moreover, the plans for the elements to be included should be completed in consultation with the public to develop a reasonable and widely acceptable solution.

The essence of context sensitive design and solutions is to eventually provide a roadway that considers and addresses all issues including safety, environment, community, capacity, mobility, and budget. The designers and planners are therefore asked to develop appropriate solutions and designs that satisfy most all. At the same time, the aesthetic appeal of each solution should be sought and evaluated. It should be pointed out though that the aesthetic appeal and value of each solution could be different among the various members of the design team. This may indeed require the development of an agreement among the team members in resolving such differences and reaching a conclusion. By definition, aesthetics are a branch of philosophy dealing with beauty and especially with judgments of taste concerning it. Therefore, there is significant subjective interpretation of each element and thus there is the potential for diverse opinions and appraisals for each design. However, design specialists (i.e., a bridge aesthetic design specialist) working with the community can result in aesthetic solutions that are accepted by the community and provide it with lasting value.

An issue that has a potential influence on the final designs is the budgetary constraints for any given project. It is possible that components for aesthetic design elements are not part of the initial budget. In such case the designer is called upon to provide a solution that would reasonably address all the concerns and develop a solution that could be unique to the context of the roadway. In addition to the initial budget requirements, maintenance of the various elements is also an important consideration and the responsibilities for this should be considered and identified during the design stages of the roadway.

There are four basic principles of aesthetic road design that a team should be mindful during the design process. These principles are that the design must fit with the roadway setting, pay attention to edge design, minimize roadway intrusion, and project scale. Most of these principles are interrelated and choices for one will often affect the others. Moreover, the order with which the principles are presented here does not indicate their relative importance.

Fit with Roadway Setting

This principle identifies the need to consider the roadway environment, both natural and human, in order to develop a solution that does not disturb but rather complement them. Such examples include the development of an alignment that closely follows the natural terrain or the use of a grassy median for urban arterials. The concept of developing a solution that would fit the roadway setting could also be seen as a design that promotes views from the roadway as well. For example, a roadway design that follows the natural terrain allows for developing viewing areas along the roadway.

Attention to Edge Design

Traditionally, designers are mostly concerned with developing a roadway cross section that addresses mobility and safety concerns and often disregard the elements required to connect this cross section to the existing environment. This principle requires the consideration of specific elements that could be used to connect the proposed cross section to the roadway environment and could include a variety of elements. For example, there are a variety of materials and structures for noise walls that could be used to avoid the stark concrete option of the past. Such solutions include the use of simulated stone, vines and landscaping as well as the use of the walls as murals. All of

these designs can provide for a more aesthetically pleasing roadway environment and at the same time allow for the creation of a special character or uniqueness for each roadway segment.

For urban settings, the use of trees in medians or the use of benches and other street furniture on sidewalks have been extensively utilized to enhance the roadway aesthetic appeal and to create a pleasant environment for all users. At the same time, the use of these elements could be seen as a means to attract and increase pedestrians and improve quality of life. It should be noted though that the introduction of these elements could be viewed as unsafe for the motorists due to their potential proximity to the roadway edge. However, it should be pointed out that the safety of the pedestrians is equally important and each design should be carefully considered and evaluated.

Minimization of Roadway Intrusion

This principle identifies the notion of masking the roadway within its setting by creating the smallest possible disruption to the natural and human environment. This principle requires a careful consideration of the number of lanes used to address mobility and capacity concerns, the use of aesthetic median treatments (such as using grass, trees, and stone walls); the use of different material for shoulders (such as grass reinforced shoulders); and the development of solutions that require a narrower right of way. Development of such solutions and incorporation of elements that achieve this principle could be considered the essence of a context sensitive design and solution, since it will be able to develop a roadway that fits the environment and addresses all concerns. The development of designs that resemble parkways has been promoted in the past decade but has received little attention.

Project Scale

A basic concept placed on roadway design is the consideration of the project scale where the "size" of the users and the surrounding built environment should be considered. This principle requires the identification of the potential users, and especially the presence of pedestrians, in determining the dimensions of the various geometric elements. For example, the need of pedestrian crossings should be examined in relationship to potential pedestrian generators and such crossings should be included beyond those provided at intersections. This consideration will increase the safety of all users by minimizing mid-block crossings at unmarked locations. At the same time, street widths should be evaluated to allow for safe and comfortable pedestrian crossings. In addition, sidewalks should be carefully designed to both allow for adequate connections between points and access to buildings as well as to safely protect pedestrians from vehicles. Such designs will require the evaluation of alternatives for separating pedestrians and vehicles and may demand the use of "physical" barriers between these two streams which may be trees, shrubs, or even parked vehicles. However, each design will have a safety implication for one of the two users as well as a budgetary effect that would require additional attention.

Special treatments and enhancements for community gateway projects, bridges and adjacent parks or overlooks may require experienced design specialists to become part of the project team. They will bring aesthetic design principles appropriate to these features to the design solution. These specialists include: bridge designers, landscape architects, and historic preservation architects.

Proper Use

As noted above, aesthetic treatment does not have set guidelines or need to always be present. However, it has the potential to create a unique environment and a signature project for the community. Reliance on trained professionals is fundamental for the proper identification of the appropriate aesthetic treatment and development of solutions that fit the needs and desires of all

users of the project. It is therefore imperative that the process for selecting the various elements for the aesthetic design must involve the appropriate team members (i.e., landscape architects and arborists) and the stakeholders and public. It is possible that other specialists may be involved in order to identify aesthetic treatments that are in accordance to the context of the roadway and reflect the character of the area.

Input should be solicited from the public and stakeholders regarding elements to be selected and when a preliminary plan has been developed to evaluate and comment on the proposed choices. Possible alternatives should be presented along with the implications for each choice on the final design. These implications can include costs, time for installation, safety effects, maintenance requirements, and any other pertinent information. The proposed elements and designs should be viewed at this stage as the starting point for discussion rather than the ultimate decision for the project. This approach will open up the dialogue between the project team and the public in order to define the preferences of the public and at the same time explain to the public issues stemming from their choices. These efforts will capture the preferences of the public and develop a solution that reflects the context of the area surrounding the project.

The selection process of the final choices should be also documented to clearly provide the rational for the elements considered and included in the final designs. This will also allow for the public to gain ownership of the project and clearly see how their ideas and input were incorporated in the final solution.

Benefits

Table 11 provides an overall summary of benefits, the rationale for selection, and their indicators. Additional discussion on each metric can be found in the benefit guidelines.

Case Studies

The following case studies utilized the application of this principle and a brief description of the principle application is provided here.

Table 11. Summary of benefits of addressing aesthetic treatments and enhancements.

Benefits	Rationale	Indicators
Improved community satisfaction	Providing aesthetic treatments will improve community satisfaction, since the final design solution will address the community desires as they were formed during the public and stakeholder input meetings.	• Semi-quantitative assessment of opinion and satisfaction level
Increased stakeholder/public participation, ownership, and trust	Providing aesthetic treatments will enhance their participation, since their input will be sought; ownership in the project, since their comments and suggestions will be considered in the project's solution; and trust, since their input will be seriously considered and included in the final project design.	• Semi-quantitative assessment of opinion and satisfaction level
Improved quality of life for community	Providing aesthetic treatments will improve quality of life for the community, since the final design solution will provide an aesthetically pleasing environment	• Alignment with community plans (land use and circulation) • Semi-quantitative assessment of opinion and satisfaction level

SR 99 Pacific Hwy South Reconstruction, Des Moines, WA

This project aimed to develop not only a solution that would address safety and mobility issues but deliver a project that would be aesthetically pleasing to the community. The project has landscaped medians and planter strips along the entire corridor, used specially designed lighting fixtures in the median and matching streetlights on the sidewalks, and buried utilities underground to improve aesthetics. Both team members and stakeholders agree on the aesthetic value of the roadway and commented highly on its appeal.

FM 1120 Low Water Crossing, Real County, TX

Through the use of innovative construction and design methods, the low-water crossing had minimal impacts to the natural environment and local economy. The resulting structure met the needs of the traveling public and recreational visitors to the Frio River. The low-water crossing was aesthetically pleasing and provided a river crossing that will withstand floods with minimal maintenance for many years.

KY 234, Bowling Green, KY

The project incorporated considerable use of aesthetic treatments and enhancements. Included were stone facades for an overpass bridge, landscaping, and a $500,000 contract for decorative plantings. In addition, a multi-use path was constructed. Local civic groups assisted with additional tree plantings and annual flower plantings in raised medians along the roadway. The city and a local university created stone gateways along the road. The city also provided decorative lighting and long mast light signals to be incorporated on the project. The KYTC is currently in negotiations with the city to turn over land-locked property to create a city park.

Iowa Des Moines River Bridge, Keosauqua, IA

The word "Keosauqua" means "stream bearing a floating mass of ice" in a Native American language. The community placed a high importance on the historical significance of the bridge and scenic river front area for the City of Keosauqua. While this would be the third bridge to be built crossing the river in this location, enhancing the design and providing aesthetic treatments was agreed to be the best way to provide lasting value to the community. Designers assessed the features of the bridge to be replaced and chose the most pleasing features while eliminating most negative aspects with the help of the local Bridge Committee. Weathering steel was chosen for the superstructure and the Committee chose a red-brown color for the railings which are of a unique design that reflects the truss design of the replaced bridge. The size of the earlier piers with their steel icebreaker plates on the upstream surfaces are dramatized in the new design and small pedestrian overlooks are centered above each pier. Bridge lighting is of the same design as that incorporated into nearby streetscapes. Both sides of the river offer uninterrupted views of the bridge from the shoreline (Lacey Keosauqua State Park and small city park and the nearby historic Hotel Manning).

Four Bears Bridge, Ft. Berthoud Reservation, ND

A wide two-lane segmental concrete bridge was designed/constructed containing a pedestrian walkway. Some bridge elements (piers, pedestrian guardrails and lighting) were based upon input from the Native American Citizen Advisory Committee. Native American art was placed on the side of the bridge (emblems of animals) and on the walkway (medallions) depicting the history and culture of the three affiliated tribes. The overall color of the bridge was selected to blend into the surrounding environment. Special night lighting was employed to highlight the Native American emblems on the side of the bridge.

11. Utilize Full Range of Design Choices

Utilize full range of design choices in the appropriate phases of the project.

Definition

All appropriate design options are considered and evaluated by the project team based on agreed project context criteria and input of the stakeholders/public.

Criteria for Application

- Alternative design choices/options are developed that meet the purpose and need of the project.
- Design options developed must *avoid, minimize, or mitigate* impacts to natural, human, and cultural resources and attempt to *enhance* these resources where possible.
- The project designs are sensitive to the community values and various cultures within the community.
- Stakeholder and public input is collected and integrated into design options.

Principle Concepts and Project Phases

A stepwise approach is appropriate for defining the appropriate design options to be considered while understanding the context of the project. This approach will allow for performing the appropriate studies of the natural and human environment within the project area and avoiding extensive environmental studies that could be cost prohibitive. Therefore, the recommended approach refines and develops environmental studies as alternatives are eliminated or carried forward allowing for a streamlined process. The following steps could be taken to direct this process while utilizing a full range of design choices.

Develop the design concept. The design concept is a detailed definition or description of the conceptual transportation alternative or strategy that best meets the identified need including modes to be used, primary linkages between the various areas, and logical termini of the project.

Identify red flags in the project area. The first step in the design process is the identification of potential constraints (Red Flags) to the project from human and natural environmental issues. Red Flags do not necessarily identify locations that must be avoided, but rather identify locations that may entail additional study, creative management or design approaches, increased right-of-way, construction costs or environmental impacts.

Develop alternative corridors. Based on the Red Flag summary, corridors are developed that meet the design concept definitions and needs while attempting to avoid and minimize impacts to red flag and environmentally sensitive areas. Several corridors should be developed for each design concept. Once the alternative corridors have been developed, those alternatives that are acceptable to the agency and the public, and meet the purpose and need are carried forward for further evaluation.

Conduct necessary environmental field investigations. Once the study area has been sufficiently reduced in size through the selection of corridors, environmental field studies are conducted. The environmental field studies are used to quantify and qualify the characteristics of the natural and man-made resources within the corridor. Environmental field investigations aim to identify resources that are not identifiable through secondary source information.

Identify potential alignments within corridors. After developing a clearer understanding of the constraints within the corridors from the environmental field investigations, alignments are developed that aim to avoid, minimize and mitigate potential impacts.

Evaluate potential solutions. The ultimate purpose of this evaluation is to provide the basis for recommending a preferred alternative that can be presented to stakeholders, agencies and the public. The evaluation should combine the environmental data, design information and operational analysis for the feasible alternatives. Evaluation of each of the feasible alternatives is easily performed and communicated in a matrix format, which has the ability to clearly identify the trade-offs associated with each design.

Selection and design of preferred alternative and identification of final impacts. Based upon the evaluation a preferred alternative is chosen and carried further for final design. Due to the limited information available from the conceptual and preliminary design stages, additional environmental field studies may be required after the final construction limits of the preferred alternative have been identified to refine the potential impacts.

Documentation. A critical component of the entire interdisciplinary process is maintaining documentation of the design considerations and environmental issues. Providing adequate documentation can ensure proper communication between the project team, the public and reviewing agencies. Documentation should identify all alternatives considered, environmental studies conducted and the thought processes behind the evaluation so that the final recommendations of the study are transparent to parties involved from the beginning and those that may provide review or seek to comment at later stages of project development. This will aid in avoiding unnecessary setbacks at later stages in the design process by demonstrating that all viable alternatives have been fully identified, developed and evaluated to lead to the final preferred alternative.

As stated above documentation can be in the form of federally mandated regulations such as the preparation of the Categorical Exclusion and Environmental Assessment Documents or a full Environmental Impact Statement. Additionally, documentation may take the form of local or state requirements or at a minimum policies and procedures established by the project team.

Proper Use

After alternative strategies have been developed and carried forward for further evaluation, it is necessary to move to a more detailed examination of both the context of the study area and the ultimate design of the project. This is achieved by a high level of interaction between the design elements and the environmental constraints, or context, in the study area. As such the ultimate design should be responsive to the environmental issues.

In order to find the most appropriate solution to mobility problems in a project area, it is a necessity to examine a wide range of design choices that consider all relative issues to address the specifics of the project. Therefore, the choices identified should be reflective of the issues and concerns identified in the Purpose and need statement. Design choices should first be developed on a conceptual scale and include all reasonable capital, policy, program, management, and modal alternative solutions to the mobility problem(s).

To properly examine the full range of design choices, the project team must identify and consider all natural, human, and cultural resources within the project area. This will allow for an

understanding of the context and the issues to be addressed and provide for developing a contextual solution. At the same time, several alternative designs must be developed and evaluated while developing the design options. This will allow for addressing and capturing all issues as they may relate to the project. Finally, all design options developed must avoid, minimize and mitigate impacts to resources. In addition to preserving the resources within the project area, the project should also be sensitive to the community values and the cultures of the community and area. While the NEPA requirements aim to avoid, minimize, and mitigate impacts on the resources of an area, the aim of a context sensitive project should be to enhance these resources, if possible.

Stakeholder and citizen advisory committees should be solicited to assist in the development and evaluation of design options in order to produce a solution that satisfies the community needs and desires. The identification of user preference is also ideally suited for applications of structured public involvement and polling procedures. While it is not expected that the stakeholders and pubic will begin to draw lines on paper or provide detailed designs, it is crucial to understand community preferences. This will assist the designer when faced with trade-offs and choices within the design constraints. Understanding these preferences is the key in delivering a solution truly sensitive to its context and community. As the design options are developed, the public needs to know all of the options that are available and what the trade-off is between the multiple alternatives developed. This is where the design professional must be able to explain what the project constraints are and how/why certain wants and needs may require adjustment.

Benefits

Table 12 provides an overall summary of benefits, the rationale for selection, and their indicators. Additional discussion on each metric can be found in the benefit guidelines.

Table 12. Summary of benefits of utilizing a full range of design choices.

Benefits	Rationale	Indicators
Design features appropriate to context	Utilizing a full range of design choices will result in developing a project solution that will have design features that are appropriate to the context since all concerns will be considered and addressed in a proper manner.	• Semi-quantitative assessment of opinion and satisfaction level
Improved multi-modal options	Utilizing a full range of design choices will improve the options for mode connectivity and include any new modes identified in the final design solution.	• New and/or expanded modal choices • Modal connectivity (count/volume) and safety (crashes/severity) • Semi-quantitative assessment of opinion and satisfaction level
Minimized overall impact to human and natural environment	Utilizing a full range of design choices will minimize the impact to natural and human environment, since all appropriate issues will be addressed and appropriate solutions will be sought in the final project design.	• Percentage of human and environmental impacts of alternatives used for project compared to other alternatives • Semi-quantitative assessment of opinion and satisfaction level
Improved speed management	Utilizing a full range of design choices will result in improved speed management, since the design elements provided in the project design will consider speed issues when selected and aim in addressing speed management.	• Operating speed (expected/actual) • Semi-quantitative assessment of opinion and satisfaction level

Case Studies

The following case studies utilized the application of this principle and a brief description of the principle application is provided here.

US 1 Planning Study, College Park, MD

As identified above incorporating a full range of design options in a successful project requires the full evaluation of various options throughout the project development process which are modified as necessary to meet changing project demands. This approach is precisely the approach the Maryland DOT took in developing the final alternative for the US 1 College Park Planning Study. The project involved aimed to improve safety and vehicular capacity on US 1 between College Avenue and Sunnyside Avenue while improving access for pedestrians, bicycles and transit to serve the residents on the corridor. Preliminary alternatives identified and evaluated included the following:

- The No-Build, which functions as a baseline for comparison;
- Transportation Systems Management (TSM)/Travel Demand Management (TDM);
- Four-Lane Divided;
- Five-Lane Undivided; and
- Cherry Hill Road Full Bridge Interchange Option.

Once these alternatives were carried further to more detailed design, the alternatives were refined by using available options to the design. For instance, the 4-lane and 5-lane options were evaluated to serve bicycle traffic using both a wide (14 ft) shared outside lane, and an independent 5 ft bicycle lane. The evaluation showed that the 5 ft bike lane did not require additional ROW or have increased impacts and would better serve bicycle traffic. Therefore this option was incorporated into the design. Likewise, a variable tree-lawn width was used along the corridor to minimize right of way impacts. Retaining walls and lane shifts were also used throughout the project to fit the roadway into the community. As a result of applying different design options and utilizing all of the tools at the disposal of the engineer, the project was able to minimize impacts while maximizing the benefit to the community.

Iowa Des Moines River Bridge, Keosauqua, IA

Extensive consideration was given to restoration of the existing bridge which was listed on the Historic Register. The nature of the piers and the limited vertical and horizontal clearance of the truss structure as well as the need to close the bridge to traffic for an extended period made the restoration option unacceptable to the community. The need to maintain some traffic capability, the desire to keep the new structure as near as possible to the exiting bridge's footprint, the desire to maintain the general appearance of the existing bridge and the desire to maintain the view sheds from the bridge and toward the bridge became part of the design criteria. The final design balanced the historical and cultural factors (employing a bridge aesthetic specialist) with the need to provide a roadway with the traffic calming of the old narrow lane bridge while providing enhanced facilities for pedestrians and a new bikeway. A local Bridge Committee was formed that included 15 community leaders and citizen representatives to work with the project design staff to review concepts and scenarios which included use of visualization techniques. This facilitated the development of options and selection of the design solution in a timely manner. Samples of the textured concrete and painted steel railings, along with a scale model of the near final design, were presented to the community for review.

12. Document Project Decisions

The transportation agency should document all project decisions.

Definition

All project decisions are documented to create a clear and open record, assure continuity through all project phases and provide a framework for measuring results.

Criteria for Application

Input from the project team, stakeholders and public involvement activities documents include the following:

- The purpose and need statement;
- Project constraints and their impact on design choices;
- The full range of alternatives considered in the project;
- All natural, human and cultural resources within the study area;
- Potential safety concerns and their treatment;
- The selection process and design values chosen for each design element; and
- Construction activities and commitments.

Principle Concepts and Project Phases

Transportation agencies move projects through these steps under somewhat different policies and procedures. Traditionally, agencies have established work units (e.g., Divisions) for the major steps. The process is intended to be somewhat linear and segmented so that the project moves from one to the other as it develops. This can become challenging to work continuity and some steps or substeps may also be outsourced to different firms. Also some steps are closely linked to others and can be iterative. CSS attempts to remedy some of these difficulties by thoroughly documenting project decisions and tracking and meeting all commitments.

Project Planning

Documentation is a critical component of the design and environmental procedures. Providing adequate documentation can ensure proper communication between the project team, the public, and reviewing agencies. Documentation should identify all alternatives considered, environmental studies conducted, and the thought processes behind the evaluation so that the final recommendations are transparent to parties involved from the beginning and those that may provide review or seek to comment at later stages of project development. This will aid in avoiding unnecessary setbacks at later stages in the design process by demonstrating that all viable alternatives have been fully identified, developed, and evaluated to lead to the final preferred alternative.

Specific guidelines to implement the NEPA policies are provided through meeting the environmental documentation for federally funded projects. While only federal funded projects are required to prepare these studies and fulfill the NEPA requirements, documentation may take the form of local or state requirements or at a minimum policies and procedures established by the project team. It is recommended that projects not requiring federal funding or federal action be developed following the NEPA process. This approach will assure an integrated context sensitive solution that addresses pertinent environmental issues. In addition, such projects may be eligible for future

federal funding at subsequent stages of the project development, maximizing funding sources and minimizing project delay.

Design and Specifications

Context sensitive design and resulting solutions can be achieved in many cases with the application of flexible design or through the use of other design elements included in the Green Book or other design guidelines. When using this approach, nearly every aspect of the geometric design can be adjusted or modified to meet specific conditions or desired limits specific to a roadway. It is, therefore, important to note that this approach necessitates flexibility in applying the current design guidelines and the use of creative design in addressing site-specific project needs. The designer is encouraged to use creative design and move away from the "typical cross section" concept, where a standard template is used. There are often conflicting elements in a design and a designer is called upon to develop a solution that will consider and address these elements by designing a roadway not conforming to the full design values used up to that point. The designers and planners are therefore asked to develop an appropriately contextual solution and design that may indeed necessitate the consideration of alternatives that could initially not be viewed as appropriate.

The documentation of design exceptions provides the means for the designer to go on record regarding a recommended context sensitive design solution. In addition, the necessary information is recorded in sufficient detail to support the transportation agency's decision and deviate from the typical design. Typically, a formalized process is required to document the deliberations and the justification to deviate from the recommended design. Written justification is a significant part of the process of ensuring that designers limit their liability when using flexible design and varying from adopted guidelines. Design exceptions are a legitimate and acceptable component of the overall design process and designers should not feel reluctant to request a design exception if they have fully investigated the alternatives and are confident in the expected operational and safety characteristics of the proposed design. As is commonly the case for construction of projects with design exceptions, the overall design of the road is improved as compared to the existing condition and documentation of design exceptions provides the justification for such solutions. Therefore, it is critical to communicate to all stakeholders and agency that the resulting project design will nearly always be an improvement over the existing condition, while meeting the objectives of all involved parties. This is the approach sought when attempting to balance the objectives of safety and mobility with reality of practical designs or the desire to accommodate the natural and human environment.

Construction and Maintenance Documentation

One of the most important aspects of CSS as related to construction activities is to clearly document and communicate all project commitments (PCs). The best way to do this may be to have an individual, such as the project manager, responsible for authorizing, compiling and tracking PCs (they may be revised as a project moves forward). The formal PCs listing should be available to agency personnel developing a project. It is also important to note here that these commitments should not be value-engineered out of the project during construction, since they are an important, and often integral, part of the solution that allowed the project to be constructed. Project commitments should not be viewed as add-ons that could be eliminated to reduce project costs.

To provide responsive bids, contractors must know what they are obligated to do prior to submitting a bid. This can be best achieved by a combination of pre-bid meetings and a listing of detailed project commitments in the PS&E documents. If a contractor is made aware of commitments in pre-construction or follow-up meetings, he may request a change order to accommodate those resulting in added costs to a transportation agency.

Proper Use

The CSS approach requires the use of innovative approaches and implementation of thinking "outside the box" for determining the values for the roadway geometrics. Moreover, this approach

necessitates flexibility in applying the current design guidelines and the use of creative design in addressing the site-specific project needs. The CSS approach encourages the designer to use creative designs and move away from the "typical cross section" concept, where a standard template is used. There are often conflicting elements in a design and a designer is called upon to develop a solution that will consider and address these elements by designing a roadway not conforming to the full design values used up to that point. In instances where such deviations are implemented, documentation of the decision process is essential. These documents should be viewed as an integral part of the design process, since there is a greater need today to address various issues to deliver a product that is acceptable by the affected community and does not negatively impact the environment.

The use of documentation in the project development process is a means of achieving an appropriate level of safety, while managing liability exposure. Additional guidelines for the application of flexible design include the following:

- Document non-typical design features.
- Use permissive language rather than mandatory language in policy and design manuals.
- Develop policies authorizing highway designers to consider non-traditional factors and flexible design for all roads.
- Apply flexible design concepts to achieve the appropriate balance between safety and mobility, and impacts on the community and the environment.
- Failure to justify innovative design with comprehensively documented and well-reasoned design exceptions will cause problems.
- Justification for flexible design applications should be based on sound engineering judgment and not just cost considerations.

All commitments made in the various phases of the project development to the public and/or stakeholders need to be documented and tracked to assure that they were met in the final product in order to build trust in the transportation agency and work cooperatively and enthusiastically in the future on other projects.

Benefits

Table 13 provides an overall summary of benefits, the rationale for selection, and their indicators. Additional discussion on each metric can be found in the benefit guidelines.

Table 13. Summary of benefits of documenting project decisions.

Benefits	Rationale	Indicators
Increased stakeholder/public participation, ownership and trust	The documentation of project decisions will increase stakeholder trust in the process, since there will be a record of the decisions made throughout the entire process and it could be used to support all choices made.	• Stakeholder involvement measures • Semi-quantitative assessment of opinion and satisfaction level
Improved community satisfaction	Documentation of project decisions will improve community satisfaction since it will demonstrate that the choices were made based on community and stakeholder input and provide a rational support for each choice made.	• Semi-quantitative assessment of opinion and satisfaction level
Increased risk management and liability protection	Documentation of project decisions will result in increased risk management and liability protection, since all project decisions will be documented and properly supported.	• Number of legal actions taken against the agency • Semi-quantitative assessment of expert opinion

Case Studies

The following case studies utilized the application of this principle and a brief description of the principle application is provided here.

Mon-Fayette Expressway, PA

The project team hired a facilitation consultant who also tracked and documented all efforts. Goals and objectives were set for the various meetings and the results for each meeting were documented and summarized in a detailed report.

13. Track and Meet All Commitments

Track and meet all commitments made to the stakeholders/public during the project development process.

Definition

All commitments made in the various phases of the project to the stakeholders/public are documented and tracked to assure that they were met in the solution.

Criteria for Application

- Identify and document project commitments in all project phases.
- Ensure that all project commitments are satisfactorily addressed prior to project completion.
- Maintain all project commitments throughout the project development process and over the service life of the facility.

Principle Concepts and Project Phases

Project commitments made by a transportation agency to project the stakeholders/public are a very important component of CSS projects. PCs can be made throughout the entire project development process by the transportation agency or its representatives. These commitments can be made in many ways that involve agency contact with stakeholders/public or can arise through legislative actions or internal agency policies. Project commitments may commonly be developed through the following venues:

- Stakeholder/Public meetings;
- Citizen's advisory committees;
- Visits to impacted property owners;
- FHWA and NEPA processes;
- Resource agencies (e.g., DNRs, COE); and
- Internal Agency policies.

Compliance and follow-through with project commitments results in increased stakeholder and public support of current and forthcoming projects and creates an atmosphere of mutual respect and trust that carries over to future projects. Controversy can often arise from interpretation of

PCs, and PC follow-through. Therefore, it is critical that (1) all commitments are carried through to construction and (2) the commitments are constructed fully as intended and as an integral part of the project.

Some PCs will address features that are not directly related to roadway construction. They can relate to specific environmental requirements while others may be new features (enhancements) such as planters, park facilities, or special treatments to roadway items (e.g., wooden guardrails). These features may be of as much (or more) importance to the stakeholders/public as the transportation facility being constructed. They may be the key reason for stakeholder/public support of the project. Therefore, non-transportation features need to be overseen and inspected by construction personnel as thoroughly as roadway components.

In addition to what is to be built project commitments may often prescribe *how* the project is to be built to minimize disruptions during the construction period.

Clearly, meeting the commitments falls in the construction and operations phase of a project. However, these commitments may build up through interactions with various stakeholders (including public officials and property owners) and the general public starting in the earliest programming and planning stages and continuing on through preliminary and final design stages and even into construction/operations. Recording and keeping these commitments visible to all concerned so they can be acted upon appropriately is a major challenge in the project development process.

Proper Use

The following actions are needed to accomplish the full intent of the principle:

- Inform prospective bidders of all contract requirements including project commitments.
- Keep stakeholders and public informed about project progress including actions addressing project commitments.
- Conduct follow-up audits of project commitments after a project has been completed. Incorporate the audit findings as "lessons learned" for continuous project improvement.

The actual construction of the project is the ultimate key to the success of CSS. Therefore, the contractor needs to be knowledgeable of transportation agency requirements/expectations and willing to carry them out in the spirit with which they were established.

Compliance with PCs can add considerable complexity to projects. Many commitments, especially those arising from NEPA and environmental permitting may be extensive and require special awareness from transportation agency personnel/representatives and contractor personnel involved with a project. PCs have significant impacts on contractors including the following:

- How, when, and where work is to be performed;
- Restriction on existing features that are to be taken, moved, avoided or replaced;
- Enhancements that may be added along the ROW;
- Protection of adjacent property owners from construction impacts (e.g., noise, dust, light etc.); and
- Traffic control requirements.

To provide responsive bids, contractors must know what they are obligated to do prior to submitting a bid. This can be best achieved by a combination of pre-bid meetings and a listing of detailed project commitments in the PS&E documents.

An important aspect of CSS as related to construction activities is to clearly document and communicate all project commitments. The best way to do this may be to have an individual

such as the project manager responsible for authorizing, compiling and tracking PCs (they may be revised as a project moves forward). The formal PC listing should be available to agency personnel developing a project. A computer-based system that may track project progress is ideal for this purpose. Key issues that must be addressed related to project commitments are:

- Collection of commitments throughout the entire process;
- Assignment of a gatekeeper to authorize/track commitments;
- A computer-based recording system;
- Specific entry into the PS&E documentation; and
- Callout of the commitments at pre-bid conferences.

Benefits

Table 14 provides an overall summary of benefits, the rationale for selection, and their indicators. Additional discussion on each metric can be found in the benefit guidelines.

Case Studies

The following case studies utilized the application of this principle and demonstrated the presence of the benefits associated with this principle.

US 40 Berthoud Mt Pass Reconstruction, Clear Creek Co., CO

The Environmental Assessment done for Berthoud Pass incorporated extensive public outreach, working with local elected officials, special interest groups, business interests, homeowners, and several federal resource agencies. The communications took the form of small group meetings, public open houses, and working meetings over several years. The culmination of that work was the completion of the EA with a FONSI, plus ongoing working meetings with stakeholders through the design and construction phases. CDOT does not have a formalized system to track commitments in the Berthoud Pass EA into the design and construction (which are now mostly complete). The EA was required reading for the design teams working on projects, as well

Table 14. Summary of benefits of tracking and meeting all commitments.

Benefits	Rationale	Indicators
Increased stakeholder/public participation, ownership and trust	Tracking and meeting project commitments will increase stakeholder ownership, since it will demonstrate that their input and commitments made during the various project phases were met; trust, since the commitments made were followed through; and possibly participation in future projects, since it will indicate that involvement is considered important	• Meetings attended by stakeholders • Semi-quantitative assessment of opinion and satisfaction level
Improved community satisfaction	Tracking and meeting project commitments will improve community satisfaction, since it will demonstrate that their input and commitments solicited during the public involvement process were met and followed through resulting in a project in accordance with community vision and values.	• Semi-quantitative assessment of opinion and satisfaction level
Increased risk management and liability protection	Tracking and meeting project commitments will result in increased risk management and liability protection, since all project decisions will be documented and properly supported.	• Number of legal actions taken against the agency • Semi-quantitative assessment of expert opinion

as the construction engineers administering contractor's work. Regular meetings were held throughout the design and construction phases that included federal resource agencies and CDOT environmental staff. This helped ensure that commitments in the EA were followed through. This approach was successful. With construction virtually complete, all commitments made have also been addressed.

14. Use Agency Resources Effectively

The process followed should result in a project that uses agency resources effectively.

Definition

The project has used time, expertise, and budget in an effective way to deliver the project and conserve resources.

Criteria for Application

- The project is developed in a timely manner.
- Expenditures are appropriate for the project scope/context.
- The project team has the appropriate support and resources to effectively carry out their task.

Principle Concepts and Project Phases

The entire team has the responsibility to achieve a successful outcome. The team and its leader or project manager must seek to use all resources effectively. These scarce resources include: knowledge and experience of team members as well as the project's stakeholders; time available (deadline) for project delivery; and the available funding.

Every project team must understand its responsibilities and every team member their role. The resources needed and available should be clear as well as any boundaries or constraints. Having a written and established charter may be helpful. The charter should make clear the objective, members of the team, how they will operate (process) and communicate, and the boundaries and available resources. The process may include a work breakdown structure, key team decision points and specify interim/final product timeline and budget.

It is imperative that the project team have the necessary and appropriately diverse expertise to move the CSS project successfully through the project development process and its key decision points to use resources effectively. Communication among the project team professionals and the stakeholders/public must be open and two-way to ensure the agency's CSS policy/procedure is clearly known and accepted by all members of the CSS project team. Open communication is imperative so that all questions and concerns can be addressed before the project moves forward. This will save valuable resources by avoiding the need to go back and revisit alternatives or problems that were not fully addressed at earlier stages of the design process.

During planning and design, it is best to only develop the plan or design to a level appropriate to the stage of the project development process. It is often tempting to develop "tangible alter-

natives" such as new roadways or major widening more so than conceptual alternatives such as policy, transit or demand management strategies. Limiting the level of development of the alternative will (1) reduce the time and cost of preliminary design and planning for the alternative, allowing for the development of more strategic alternatives and (2) keep the build alternative on the same footing as other alternatives so that the build alternative is not perceived as more "tangible" than other conceptual alternatives.

Special consideration should be given to CSS projects during maintenance operations to ensure effective use of the resources after project construction. In order to effectively maintain the project maintenance, personnel must first ensure that all elements to be maintained are in proper condition and second, identify all special needs associated with the project. Maintenance should not assume facilities with incomplete work, especially on CSS items. Contractors should be required to have all work related to construction including any commitments or enhancements completed and in good condition prior to project acceptance.

Benefits

Table 15 provides an overall summary of benefits, the rationale for selection, and their indicators. Additional discussion on each metric can be found in the benefit guidelines.

Case Studies

The following case studies utilized the application of this principle and a brief description of the principle application is provided here.

US 40 Berthoud Mt Pass Reconstruction, Clear Creek Co., CO

While the project took some time/cost to develop including focusing on construction disruption requirements (for the tourism/skiing business), the effort was well spent. No new environmental impacts were created and issues related to the existing facility were properly remedied (environmental problems minimized, user safety increased, and maintenance & operations improved). To reduce the road template, CDOT and the U.S. Forestry service agreed upon changes to the maintained safety and maintenance functions while reducing construction costs by $30 million.

Table 15. Summary of benefits of using agency resources effectively.

Benefits	Rationale	Indicators
Decreased costs for overall project delivery	The effective use of all project resources will have as an immediate result the decreased cost for overall project delivery, since it will optimize all resources (interdisciplinary team, stakeholder, and public) to their maximum potential.	• Decreased dollar cost amount for project delivery • Number and cost of change orders/Scope Changes • Semi-quantitative assessment of expert opinion
Decreased time for overall project delivery	The effective use of all project resources will have as an immediate result the decreased time for overall project delivery, since it will optimize all resources (interdisciplinary team, stakeholders, and public) to their maximum potential.	• Number of months by project phases and total project duration • Semi-quantitative assessment of expert opinion
Improved long-term decisions and investments	The effective use of all resources will improve sustainable decision and investments, since it will allow for a better attainment of community vision and goals.	• Increased transportation/ community long-term benefit relative to cost • Semi-quantitative assessment of expert opinion

M St. & Wisconsin Ave. Sidewalk Reconstruction, Georgetown, DC

DDOT coordinated utilities with rights-of-way in the sidewalk area to jointly access the sidewalk areas for each entities repair/upgrade requirements. This minimized disruption, downtime to the facility for sidewalk users, allowed joint use of signage, minimized public/stakeholder contact requirements, and allowed sharing of equipment. All parties agreed to work at night to minimize loss of daytime parking and income to local businesses. This allowed for cost sharing and prevented undesirable damage to the sidewalk by eliminating succeeding follow-on utility work. By working with the utilities, DDOT was able to compress fifteen years of construction work into four years.

FM 1120 Low Water Crossing, Real County, TX

Since timing was important several agencies and entities came together in an extraordinary effort to approve this project quickly. The San Angelo District worked closely with TxDOT's Environmental Affairs Division, Bridge Division, Junction Area Office, the Leakey Maintenance Office, and the contractor, Earth Builders Inc. The Texas Historical Commission approved the cultural resources permits in a timely manner. The United States Corps of Engineers, Fort Worth District, expedited necessary permits. The public, including local residents, community leaders and businessmen were fully in favor of the project because of its importance to the local tourist industry. The San Angelo District shortened the road closure time by expediting the planning and construction. Construction started in October 2002 and was complete by July 2003. Since the majority of the construction was done in the winter months, which is the off season, there was less impact on tourism reducing negative effects on the local economy.

15. Create a Lasting Value for the Community

The constructed project should create a lasting value for the community.

Definition

The resulting solution becomes an asset to the community with involved parties agreeing that it meets or exceeds expectations and is compatible with the long-term vision of the community.

Criteria for Application

- The project meets the purpose and need statement.
- The project is compatible with long-range community plans.
- The project incorporates solutions that move beyond addressing mobility and address quality of life issues and community values.
- The project is sustainable in terms of social, economic and ecological impacts.

Principle Concepts and Project Phases

The creation of lasting value for a community through a transportation project requires that it does no harm to the community fabric, provides a facility the meets transportation needs into the foreseeable future and incorporates features important to the community.

It requires that the project does not conflict with the intent of community development plans, but rather provides support for the community's planned development vision. So while it does not harm the human and natural environment the transportation project creates some form of enhancement to a valued resource (any human or natural resource deemed important), the opportunity to expand a resource and its value (i.e., improved access to an historic district) or even establishes something of new value for the community (i.e., provides a visual "gateway" at the point of entry). Not all projects offer such opportunity, but through cooperative development of projects some will. Communities may also be willing to share installation cost of some features and/or in their maintenance.

Applying CSS principles to a project increases the opportunity to create a lasting value for the community. Employing an interdisciplinary project development team, seeking input from all stakeholders, reaching out to the public with an appropriate communication strategy and gaining consensus on the project's purpose and need set the stage for developing options and providing the appropriate design for the chosen option. There are many potential benefits to carrying out CSS principles in project development, but they certainly can result in increased public/stakeholder ownership and trust and community satisfaction. The CSS approach goes a long way toward ensuring that the project will create a lasting value to the community.

Communication is critical in these initial steps and it must be purposeful—you need information from "them" and they need information from you. And for it to be really productive you need to think of it, at some point, as a collaboration to find the best fit solution. Nowhere in the process will public input be as critical in determining the ultimate utility of the project as at the initial stages, particularly the development of the purpose and need statement. Gaining public input on this process is crucial, because the purpose of the project should be to address the transportation and related needs of the people. Through the public involvement process the project team learns the needs of the community and project stakeholders. At the same time, the public and stakeholders should be informed of the transportation reason the project is being undertaken to provide direction and focus on the associated needs and/or concerns that should be identified. This would include identifying the extent of the study area and whether the intent is to improve mobility, safety and/or economic development, as funding sources may constrain the ultimate purpose of the project.

All of the priority issues and concerns gathered from the public and stakeholders should be incorporated into the purpose and need statement. While this statement may be "required" for a project, it is important that it be used to guide the development of a solution to the transportation problem. It should be used as a tool to clearly and concisely state purpose and need and capture the intended project's goals and objectives for the unique situation. It should communicate to all involved the intent of the project, as well as, the priority concerns of the community's citizens, adjacent property owners, affected businesses and other stakeholders (including resource agencies) that may be affected or have some legal standing in the project development process. The statement in its final form should garner the consensus support of those involved, and be the test against which each alternative option or final design must stand. CSS practice calls for a re-emphasis of the purpose and need statement's role in the project development process.

An important aspect of all stakeholder and public involvement is the commitment of the transportation agency to accept, consider, and evaluate non-traditional solutions. This requires an "open-minded" approach to each project and departure from solutions used in the past. The need to be flexible is very important during such meetings because the unwillingness to consider or even hear through alternative solutions creates mistrust from the public. It is also important to approach initial meetings as project-shaping opportunities where transportation solutions should be sought to address the community transportation needs and deficiencies. This requires the acceptance and consideration of multi-modal solutions as well as the willingness to revise

and incorporate suggestions of the public in follow-up designs and alternatives that account for community values. The project results can provide a lasting value to the community that may include such features as: traffic calming and improved speed management; safe pedestrian walkways and/or bike facilities; accommodation/encouragement of public transit; special lighting and/or landscape aesthetics; minimized roadway footprint to better maintain community scale; the skirting of an existing park or creating a pocket park; bending the alignment to avoid a historic artifact (i.e., the George Washington tree) while still providing access; the provision of a roundabout as a community gateway or focal point or combinations of features such as these.

Proper Use

The transportation needs and related values of the community should be explicitly part of the purpose and need statement from the beginning of the project. The purpose and need statement should then be used to ensure that these needs are met and used to guide the development of a solution to the transportation problem. The statement in its final form should garner the consensus support of those involved, and be the test against which each alternative, option or final design must stand. CSS practice calls for a re-emphasis of the purpose and need statement's role in the project development process. It then becomes a challenge for designers to apply flexibility and find the unique solution that balances the transportation needs with all the other factors. Through this practice, it will be assured that the goals established by the community will be met at the completion of the project. As a result, the project will be developed to meet the needs of the community and provide a lasting value.

Benefits

Table 16 provides an overall summary of benefits, the rationale for selection, and their indicators. Additional discussion on each metric can be found in the benefit guidelines.

Case Studies

The following case studies utilized the application of this principle and a brief description of the principle application is provided here.

12300 South Design Build Project, Draper and Riverton, UT

The 12300 South DB Project minimized disruption to the community by implementing UDOT's first "turn-key" right-of-way program. Approximately 350 property ownerships, 950 individual parcels, and the relocation of 60 business and residences were affected by the construction. UDOT assembled a team of experienced professionals to assist project personnel, local governments and community groups with solving problems of property owners and tenants. The group's focus and innovative solutions increased the public's positive perception of the project and UDOT. The involvement of the community was instrumental in incorporating all landscape and aesthetic treatments that highlighted the natural, historical, and present characteristics of the cities of Draper and Riverton.

US 27/68 Paris Pike Reconstruction, Lexington—Paris, KY

Roadway alignment was selected to avoid and/or minimize impacts to historical properties and structures. The Advisory Task Force was a positive factor in creating a trusting relationship between the public and the project team. Success was achieved from the overall attention given to site and corridor-specific characteristics. Overall, the project was a successful effort involving a wide range of stakeholders in the development and direction of designing and constructing a highway through an aesthetic and historic section of central Kentucky.

Table 16. Summary of benefits of creating a lasting value for the community.

Benefits	Rationale	Indicators
Improved quality of life for community	A project that creates a lasting value to the community will improve quality of life, since it will be a project reflecting the community vision and address the public and stakeholder issues and concerns.	• Semi-quantitative assessment of opinion and satisfaction level • Alignment with community plans (land use and activity/circulation patterns)
Increased stakeholder/public participation, ownership and trust	A project that creates a lasting value to the community will improve stakeholder ownership, since the project reflects their input; trust, since it will demonstrate that the input was considered and addressed; and possibly participation in future projects, since their participation was valued and considered.	• Stakeholder involvement measures • Semi-quantitative assessment of opinion and satisfaction level
Improve long-term decisions and investments	A project that creates a lasting value for the community will improve long-term decision and investments, since it will allow for a better attainment of community vision and goals.	• Increased transportation/ community long-term benefits relative to costs • Semi-quantitative assessment of expert opinion
Improved community satisfaction	A project that creates a lasting value for the community will improve community satisfaction, since it will consider and address public and stakeholder input and result in solutions that will provide a project appropriate to its context.	• Semi-quantitative assessment of opinion and satisfaction level

SR 73/US 321 Gateway Project, Gatlinburg, TN

The community was pleased that the implemented project changes will forever reflect lasting value to the community. They were so pleased that they expressed willingness to properly maintain the landscaping on the project to assure lasting value. Since tourism is a major driver to the local economy, specific hardscape "theme elements" were developed that could easily be added within the corridor after project completion. Hardscape elements were inspired by local use of stone, and by landscape and signage for the Great Smoky Mountains National Park. It was determined that although the CSS process was used to retrofit an unaccepted project into the community, the final product was anticipated to truly enhance the area, not simply be acceptable to the community.

Four Bears Bridge, Ft. Berthoud Reservation, ND

The bridge has become a focal point for the Native American tribes on the Fort Berthold Reservation. The bridge opening was celebrated by a multi-day Native American ceremony. The bridge has received significant recognition and has received several noted bridge design awards.

Benefits

1. Improved Predictability of Project Delivery

This relates to the ability of a transportation agency to reliably program and to deliver projects within reasonable time limits. Projects may have elements of controversy including potential environmental and community impacts. Stakeholder/public concerns can also exist due to the depredations of previous projects. These can result in vocal opposition, political pressure and/or litigation that can stall or stop project development. Short delays can extend project development. Long delays may impact agency project programming. CSS can effectively ameliorate opposition/concerns allowing project development to proceed within predictable time limits.

Improved predictability of project delivery will be promoted by application of the following principles:

Seek broad-based public involvement. The use of broad-based public involvement will permit identification of all possible areas of concern and their proper resolution. That has the potential to eliminate potential delays and improve predictability of project delivery.

Achieve consensus on purpose and need. Achieving consensus on purpose and need will address potential conflicts from the outset of the project by defining their impact and influence on the solution to be sought thus reducing any unexpected delays.

The secondary principles of impact for this benefit are the following:

- Use of interdisciplinary teams,
- Involve stakeholders,
- Address community and social issues,
- Address aesthetic treatments and enhancements,
- Document project decisions,
- Track and meet all commitments, and
- Use all resources effectively (time and budget).

Metric Indicator—Difference in project duration in months to complete. This information and data is typically available in project files. The planned or estimated duration can be compared to the actual duration by project phase and the overall duration. Verification is possible by query to the project manager/team. The following Metric used the data collection form for "Decreased time for overall project delivery."

Project schedule (months)	Programming	Planning	Design	Construction	Total
Estimated					
Actual					
Difference					

Metric Indicator—Semi-quantitative assessment of expert opinion. Measuring opinion requires the development/use of a standard question set with a rating scale. The opinion level can be measured over time (e.g., at the end of project phases). The survey can be administered to stakeholders. The degree of agreement can also be determined by administering the survey to the project manager/team members. This metric will be measured using an opinion scale through a project team and stakeholder surveys from the following statements:

- **The project was developed in a timely manner.**
- **The project was completed when expected.**

2. Improved Project Scoping and Budgeting

CSS projects properly address all transportation, environmental, and community issues in a thorough balanced manner. All vital concerns are effectively identified, appropriate actions incorporated, and project costs estimated prior to lettings. This results in minimal construction change orders and projects that are completed on budget.

Improved project scoping and budgeting will be promoted by application of the following principles:

Use of interdisciplinary teams. The use of interdisciplinary teams will allow for input from all members as the design is developed and will employ the special knowledge and skills of team members to provide optimum solutions and promote a complete, balanced project.

Use agency resources effectively. The effective use of project team members and other resources applied to properly develop CSS projects will provide optimum project solutions. The effective use of all agency resources will promote a complete project that addresses all issues and results in a project that is completed in a timely manner without cost overruns.

The secondary principles of impact for this benefit are the following:

- Involve stakeholders,
- Seek broad-based public involvement,
- Use full range of communication methods,
- Achieve consensus on purpose and need,
- Address alternatives and all modes,
- Consider a safe facility for users and community,
- Maintain environmental harmony,
- Address community and social issues,
- Address aesthetic treatments and enhancements,
- Create a lasting value for the community,

Metric Indicator—Number and cost of change orders/scope changes. The number (and dollar magnitude) of change orders can be determined from project records (construction phase). The following metric is the same as the metric used for evaluating the benefit "Decreased costs of overall project delivery" and will be measured using the same form.

Scope Change/Change Order No.	Cost ($)	Time delay (months)

Metric Indicator—Semi-quantitative assessment of expert opinion. Measuring opinion requires the development/use of a standard question set with a rating scale. The opinion level

can be measured over time (e.g., at the end of project phases). The survey can be administered to stakeholders. The degree of agreement can also be determined by administering the survey to the project manager/team members. This metric will be measured using an opinion scale through a project team survey from the following statements:

- **Project scoping was improved.**
- **Project budgeting was improved.**

3. Improved Long-term Decisions and Investments

This benefit relates to agency actions that promote the environment, the economy, and social equity. Environmental improvements relate to partnering actions with resource agencies that improve the environment on a local or regional basis. On a global basis it can include actions that constitute improvements to the biosphere (e.g., the implementation of mass transit to alleviate air pollution). Economic benefits include stimuli to the local economy (both short- and long-term). Social equity improvements include training and creating jobs for disadvantaged minorities and remedying social problems created by previous transportation projects.

Improved sustainable decisions and investments will be promoted by application of the following principles:

Achieve consensus in purpose and need. Achieving consensus on the purpose and need will allow the agency to identify the long-term goals for the project and lead in sound investments.

Address alternatives and all modes. Consideration of all alternatives with input from the stakeholders/public will promote the development of a project providing decisions that are sustainable and that promote social equity, and the identification of potential investment opportunities resulting from the project.

Use agency resources effectively. Effective use of all resources will improve sustainable decision making and investments, since it will allow for a better attainment of community vision and goals (e.g., design that promotes/addresses community needs such as business growth).

Create a lasting value for the community. A project that will create a lasting value for the community will be the result of improved long-term decisions and sound investments.

The secondary principles of impact for this benefit are the following:

- Use interdisciplinary teams,
- Seek broad-based public involvement,
- Utilize full range of design choices,
- Consider a safe facility for users and community,
- Maintain environmental harmony,
- Address community and social issues,
- Address aesthetic treatments and enhancements, and
- Document project decisions.

Metric Indicator—Semi-quantitative assessment of expert opinion. Measuring opinion requires the development/use of a standard question set with a rating scale. The opinion level can be measured over time or simply at the end of the pertinent activity. The survey material can be administered to the project team members, members of the CAC, and other stakeholder representatives. If all three groups are surveyed the degree of agreement could also be determined. This metric will be measured using an opinion scale through a project team survey from the following statement:

- **Long-term decisions and investments were employed on this project.**

4. Improved Environmental Stewardship

The resulting project balances transportation, the environment, and communities. It promotes ecologically sound outcomes that minimize negative impacts while promoting long-term sustainable environmental benefits including agency actions in maintenance and operations.

Improved environmental stewardship will be promoted by application of the following principles:

Maintain environmental harmony. Seeking to maintain environmental harmony will demonstrate the agency's commitment to environmental concerns and issues and improve the agency's environmental stewardship.

The secondary principles of impact for this benefit are the following:

- Use of interdisciplinary teams,
- Involve stakeholders,
- Seek broad-based public involvement,
- Address community and social issues,
- Address aesthetic treatments and enhancements,
- Track and meet all commitments,
- Create a lasting value for the community, and
- Use all resources effectively (time and budget).

Metric Indicator—Increased or enhanced mitigation beyond regulatory mandates. Obtain required environmental clearance documents (EIS, EA/FONSI) from regulatory agencies for mitigation/enhancements (out-of-kind mitigation, creation of mitigation or conservation banks, and participation in regional ecologic initiatives). This information will be compared to mandated requirements in the project. This metric will be measured with the following data form.

Regulatory Agencies	Mandated	Enhanced/Mitigated

Metric Indicator—Semi-quantitative assessment of expert opinion. Measuring opinion requires the development/use of a standard question set with a rating scale. The satisfaction level can be measured over time or simply at the end of the pertinent activity. Members of the CAC and other stakeholder representatives can be surveyed (particularly resource agencies).

This metric will be measured using an opinion scale through a project team survey from the following statement:

- **Environmental Stewardship improved.**

5. Optimized Maintenance and Operations

This benefit can affect all parties involved with a transportation facility. The agency obtains lower maintenance costs and fewer environmental complications. Communities and businesses can rely on the facility to continually meet their transportation needs. Other stakeholders can be confident of the agency's continued compliance with their interests and regulations. Maintenance and operations activities can impact a community far longer than those derived from the design and construction processes. Proper consideration of maintenance and operational issues during project development can provide significant cumulative benefits once a facility is completed and in service.

Optimized maintenance is a primary benefit of the use of interdisciplinary teams. How this principle impacts maintenance is discussed below.

Use of interdisciplinary teams. The inclusion of agency maintenance personnel as team members will allow for more streamlined operations for the facility and facilitate any future special needs for facility upkeep.

The secondary principles of potential impact for this benefit are the following:

- Utilize full range of design choices,
- Address aesthetic treatments and enhancements,
- Create a lasting value for the community, and
- Use all resources effectively (time and budget).

Metric Indicator—Annual cost, hours, or closures in dollars. Obtain maintenance records including cost data and duration of maintenance activities on the roadway. This metric will be measured with the following data form.

Item	Annual Cost ($/yr)	Duration (days)
Utilities		
Roadway maintenance		
Landscaping/mowing		
Other		

Metric Indicator—Semi-quantitative assessment of expert opinion. Measuring opinion requires the development/use of a standard question set with a rating scale. The opinion level can be measured over time. The survey material can be administered to the project manager and maintenance manager (and facility responsible maintenance staff). The degree of agreement could also be determined. This metric will be measured using an opinion scale through a project team survey from the following statement:

- **Maintenance and operations activities are optimized.**

6. Increased Risk Management and Liability Protection

Context sensitive design and resulting solutions can be achieved in many cases with the application of flexible design or through the introduction of "lower than typical" design values commonly shown in the Green Book or other design guidelines. When using this approach, nearly every aspect of the geometric design can be adjusted or modified to meet specific conditions or desired limits specific to a roadway. Typically, a formalized process is required to document the deliberations and justification to deviate from the recommended design. Written justification is a significant part of the process of ensuring that designers limit their liability when using flexible design and varying from adopted guidelines. The documentation of design exceptions provides the means for the designer to go on record regarding a recommended context-sensitive design solution. In addition, the necessary information is recorded in sufficient detail to support the transportation agency's decision and deviate from the typical design.

Increased risk management protection is a primary benefit of two principles. How these principles impact risk management protection is discussed below.

Consider a safe facility for users and community. Considering a safe facility will result in an improved safety level for all users which in turn will increase risk management protection.

The efforts to provide for a safer facility will reduce unfavorable consequences from crashes and also contribute to decreased risk.

Document project decisions. Documentation of project decisions will result in improved protection against risk, since there will be a record of the decisions made throughout the project development and it could be used to support all choices made and prevent misunderstandings.

Track and meet all commitments. Tracking all commitments made will reduce the risk associated with litigation, since all commitments made and their justified associated solutions will be documented and recorded.

The secondary principles of potential impact for this benefit are the following:

- Use of interdisciplinary teams,
- Involve stakeholders,
- Achieve consensus on purpose and need,
- Address alternatives and all modes,
- Utilize full range of design choices,
- Maintain environmental harmony, and
- Address community and social issues.

Metric Indicator—Number and cost of legal actions taken against project. Obtain legal records demonstrating impacts (time and costs) on project completion. Interviews with project team members may be needed to identify full extent of these actions.

Legal Action	Cost ($)	Time delay (months)

Metric Indicator—Semi-quantitative assessment of expert opinion. Measuring opinion requires the development/use of a standard question set with a rating scale. The opinion level can be measured over time or simply at the end of pertinent activity. Members of the CAC and other stakeholder representatives can be surveyed (including affected residential or commercial property owners). The degree of agreement can also be determined by administering to the project manager/team members.

This metric will be measured using an opinion scale through a project team survey from the following statement:

- **Risk management and liability protection was increased.**

7. Improved Stakeholder/Public Feedback

This benefit relates to a transportation agency obtaining information from stakeholders/public about specific transportation project needs or about the suitability of proposed transportation project details. Those can include the type of project, a proposed project corridor, the project footprint, design details/components, community/environmental impacts, and project commitments. That information will enable a transportation agency to make more informed project decisions that yield facilities that improve transportation networks and fit well in communities and the natural environment.

Improved stakeholder/public feedback will be promoted by application of the following principles:

Involve all stakeholders. Stakeholder/public involvement will provide the opportunity for a more appropriate and organized feedback process through an interactive, highly engaging process with the project team.

Use a full range of communication strategies. The use of full range communication strategies will allow the stakeholders/public to fully understand the issues and elements of the project and thus enhance their ability to provide the appropriate feedback.

The secondary principles of impact for this benefit are the following:

- Seek broad-based public involvement and
- Address community and social issues.

Metric Indicator—Number of stakeholder/public responses. Review of project record including meeting minutes is required to determine the number of responses per meeting, and the agency's documentation of due consideration of the input. Verification is possible by querying the project manager/team.

This metric will be measured with the following data form.

Meeting with…	Number of responses	Was project modified based on responses?

Metric Indicator—Semi-quantitative assessment of expert opinion. Measuring opinion requires the development/use of a standard question set with a rating scale. The opinion level can be measured over time (e.g., at the end of project phases). The degree of agreement can also be determined by administering the survey to the project manager/team members. This metric will be measured using an opinion scale through a project team survey from the following statements:

- **Stakeholder and public input feedback increased compared to traditional (non-CSS) projects.**
- **The quality of stakeholder and public feedback improved compared to traditional (non-CSS) projects.**

8. Increased Stakeholder/Public Participation, Ownership, and Trust

This benefit relates to a high degree of stakeholder/public involvement in the transportation project development process that results in consensus approval of transportation agency decision making. It entails the stakeholders/public having a significant role in project development that results in a feeling of project ownership/identification. The stakeholders/public must not only believe that they have significant project input, but also they must trust the final decisions/resulting actions of the transportation agency. When this occurs, stakeholder/public opinion about the transportation agency improves, creating a reservoir of goodwill and trust for future transportation projects.

Increased stakeholder/public participation, ownership, and trust will be promoted by application of the following principles:

Involve all stakeholders. Stakeholder involvement will provide the opportunity for a more appropriate and organized feedback process through an interactive, highly engaging process with the project team.

Use a full range of communication strategies. The use of a full range of communication strategies will allow stakeholders to completely understand the issues and elements of a project enhancing their ability to provide appropriate feedback.

Achieve consensus on purpose and need. Achieving consensus on purpose and need with stakeholder involvement will foster their ownership of the project, since the purpose and need will reflect their input and values.

Address alternatives and all modes. Consideration of all alternatives and modes will improve stakeholder participation (since their input will be sought to identify potential alternatives and modes to be considered), ownership of the project (since their input will be solicited and considered in project decision making), and trust in the process (since their input will be solicited, considered and dealt with during the project development process).

Address community and social issues. Consideration of community and social issues will generally require stakeholder/public input, ownership (since their comments and suggestions will be considered in the project's solution), and trust (since their input will be seriously considered in project decision making).

Address aesthetic treatments and enhancements. Providing aesthetic treatments will improve stakeholder participation (since their input will be sought to identify potential treatments to be considered), ownership of the project (since their input will be solicited and considered in project decision making), and trust in the process (since their input will be solicited, considered and dealt with during the project development process).

Document project decisions. Documentation of project decisions will increase stakeholder trust in the process, since there will be a record of the decisions made throughout the project development. That record can be used to support all choices made and prevent missteps or misunderstandings.

Track and meet all commitments. Tracking and meeting project commitments will increase stakeholder/public ownership (since it will demonstrate that agency commitments made during the various project phases were met), trust (since the commitments made were followed through), and possibly participation in future projects (since it will indicate that the agency will stand by its word).

Create a lasting value for the community. A project that creates a lasting value to the community will improve stakeholder/public ownership (since the project reflects their input), trust (since it will demonstrate that the input was considered and addressed), and possibly participation in future projects (since their participation was valued and considered).

The secondary principles of impact for this benefit are the following:

- Use of interdisciplinary teams,
- Seek broad-based public involvement,
- Utilize full range of design choices,
- Consider a safe facility for users and community,
- Maintain environmental harmony, and
- Use all resources effectively (time and budget).

Metric Indicator—Stakeholder/public involvement measures (participation). Participation is measured by number of stakeholders/public (by category) attending meetings over the entire project delivery cycle (by phase) to determine representation and repeat attendance. This

information could be available from project files. This metric will be measured with the following data form:

Meeting with…	Date	No. of Attendees	Project Phase

Metric Indicator—Meetings attended by stakeholders/public. This includes the number of meetings with specific major stakeholders including resource agencies, local governments and interest groups. Involving these groups throughout the project promotes partnering, shared decision making and enhances trust.

Metric Indicator—Semi-quantitative assessment of (ownership and trust) opinion and satisfaction level. Measuring opinion and satisfaction requires the development/use of a standard question set with a rating scale. The opinion level can be measured over time (e.g., at the end of project phases). The survey can be administered to stakeholders/public. The degree of agreement can also be determined by administering the survey to the project manager/team members. This metric will be measured using an opinion scale through a project team and stakeholder surveys from the following statements:

- **Stakeholder and public participation increased throughout the project.**
- **A sense of stakeholder and public ownership developed.**
- **Trust in the project team and transportation agency increased.**
- **The participants were treated fairly at public meetings and other venues.**
- **I am satisfied with the procedures and methods that allowed me to have input to project decisions.**
- **I am satisfied with the relationship I had with the project team.**

9. Decreased Costs for Overall Project Delivery

This benefit relates to reduced total agency costs for transportation project development compared to conventional non-CSS projects. This can be direct cost savings (elimination of expensive features such as grade-separated interchanges). It can also be derived by CSS-related right-sizing of facilities (reduction in the number of lanes or in the ROW footprint). Other savings can be achieved by avoidance actions (reducing the environmental clearance from an EIS to an EA/FONSI). Other savings can be estimated from avoidance of opposition (historic project cost information due to litigation/delays). Oftentimes, transportation agency officials believe that CSS projects are expensive when they actually avoid higher agency costs due to opposition/litigation/delays.

Decreased costs for overall project delivery will be promoted by application of the following principles:

Use agency resources effectively. Effective use of all project resources will result in the decreased cost for overall project delivery, since it will optimize all resources (interdisciplinary team, stakeholder, and public) to their maximum potential.

The secondary principles of impact for this benefit are the following:

- Use of interdisciplinary teams,
- Achieve consensus on purpose and need,
- Address alternatives and all modes,
- Utilize full range of design choices,
- Document project decisions, and
- Track and meet all commitments.

Metric Indicator—Decreased dollar cost amount for project delivery. Project delivery costs measured in dollars can be estimated and many agencies know the average cost required to deliver a project. This requires tracking costs by phase (and subsequently total delivery costs). This metric will be measured with the following data form:

Project Cost	Programming	Planning	Design	Construction	Total
Actual					

Metric Indicator—Number and cost of change orders/scope changes. The number (and dollar magnitude) of change orders can be determined from project records (construction phase). This information/data allows for comparison with conventional projects. This metric will be measured with the following data form:

Scope Change/Change Order No.	Cost ($)	Time delay (months)

Metric Indicator—Semi-quantitative assessment of expert opinion. Measuring opinion requires the development/use of a standard question set with a rating scale. The opinion level can be measured over time (e.g., at the end of project phases). The survey can be administered to stakeholders/public. The degree of agreement can also be determined by administering the survey to the project manager/team members.

This metric will be measured using an opinion scale through a project team survey from the following statement:

- **Costs for overall project delivery through construction decreased.**

10. Decreased Time for Overall Project Delivery

This relates to reduced total agency time for transportation project development. It can be time savings achieved by avoidance actions (reducing an environmental clearance from an EIS to an EA/FONSI). Other savings can be estimated from avoidance of delays due to opposition/controversy (historic project programming information due to litigation/delays). Oftentimes, transportation agency officials believe that CSS projects take too long when they actually save overall time by eliminating opposition/litigation/delays.

Decreased time for overall project delivery will be promoted by application of the following principles:

Use of interdisciplinary teams. Interaction between team members will allow resolution of issues that may arise in the subsequent phases of the project development process reducing the time requirements for succeeding phases and the entire project.

Use agency resources effectively. Effective use of all project resources will have as an immediate result the decreased time for overall project delivery, since it will optimize all resources (interdisciplinary team, stakeholders, and public) to their maximum potential.

The secondary principles of impact for this benefit are the following:

- Involve stakeholders,
- Achieve consensus on purpose and need,

- Address community and social issues,
- Document project decisions, and
- Track and meet all commitments.

Metric Indicator—Number of months by project phases and total project duration. Project delivery time is usually measured in months and many agencies know the average time it takes to deliver a project. This requires tracking duration by phase (and subsequently total delivery time). This data allows duration comparisons between CSS and conventional projects by project or program managers. This metric will be measured with the following data form:

Project Schedule (months)	Programming	Planning	Design	Construction	Total
Actual					

Metric Indicator—Number and cost of change orders/scope changes. The number (and dollar magnitude) of change orders can be determined from project records (construction phase). This information/data allows for comparison with conventional projects. This metric will be measured with the following data form:

Scope Change/Change Order No.	Cost ($)	Time delay (months)

Metric Indicator—Semi-quantitative assessment of expert opinion. Measuring opinion requires the development/use of a standard question set with a rating scale. The opinion level can be measured over time (e.g., at the end of project phases). The degree of agreement can also be determined by administering the survey to the project manager/team members. This metric will be measured using an opinion scale through a project team survey from the following statement:

- **Time for overall project delivery decreased.**

11. Increased Partnering Opportunities

Involving stakeholders throughout the entire project development process using many feedback loops will increase the stakeholder engagement, involvement, and participation (since their input will be solicited at certain points of the process), improve trust of stakeholders in the process (since their opinion will be valued and considered), and enhance ownership of the project (since their concerns will be addressed and their input considered). Stakeholder involvement will enhance the opportunities for joint development because the interaction between the project team and the stakeholders could identify possible areas where outside funds could be jointly pursued, opportunities for leveraging mitigation/enhancement funds with other grants, and development loans or other opportunities.

Improved opportunities for partnering will be promoted by application of the following principles:

Involve stakeholders. Stakeholder involvement will enhance the opportunities for partnering because the interaction between the project team and the stakeholders could identify possible areas where such activities could be jointly pursued.

The secondary principles of impact for this benefit are the following:

- Use interdisciplinary teams,
- Seek broad-based public involvement,

- Use full range of communication methods,
- Address alternatives and all modes,
- Address community and social issues,
- Address aesthetic treatments and enhancements, and
- Use all resources effectively (time and budget).

Metric Indicator—Number of Memorandum of Agreements or grants established

This information is typically available in the project files. Verification is possible by querying the project manager, team, CAC, and stakeholders. This metric will be measured with the following data form:

Agreement /Grant with…	Purpose

Metric Indicator—Semi-quantitative assessment of expert opinion. Measuring opinion requires the development/use of a standard question set with a rating scale. The opinion level can be measured over time (e.g., at the end of project phases). The survey can be administered to stakeholders. The degree of agreement can also be determined by administering the survey to the project manager/team members. This metric will be measured using an opinion scale through a project team and stakeholder surveys from the following statement:

- **Opportunities for partnering increased.**

12. Minimized Overall Impact to Human and Natural Environment

This benefit results from a project that has limited intrusion on natural resource and existing communities. Direct effects include takings and constructive use. For example, they may include choosing a corridor and/or design that minimizes the project footprint causing fewer household/business relocations or reducing acreage of land disturbed. These effects can be permanent or occur only during construction. Indirect impacts include avoidance and mitigation actions. They may also include cumulative impacts that occur over time (e.g., sprawl growth). That can be minimized by a combination of access control and zoning. In the past, new roads have seriously impacted communities and their environments. This benefit accrues when an interdisciplinary project team focuses on transportation solutions that include addressing community/social issues and maintaining environmental harmony.

The impact to the human and natural environment will be minimized through the application of the following principles:

Use of interdisciplinary teams. The use of these teams will allow for input from all members while the design is developed. It employs the skills and experience of team members to produce a balanced transportation solution that limits negative impacts and maximizes positive ones.

Utilize full range of design choices. The use of a full range of design choices will allow for identification of all potential impacts to the human and natural environment and develop solutions for addressing these impacts.

Maintain environmental harmony. Maintaining environmental harmony will result in minimum impacts to the natural environment since the project solution will properly address all potential environmental concerns.

Address community and social issues. Considering community and social needs will minimize impacts to the human environment, since all appropriate issues will be addressed and appropriate solutions will be addressed in the final project design.

The secondary principles of impact for this benefit are the following:

- Involve stakeholders,
- Seek broad-based public involvement,
- Use full range of communication methods,
- Achieve consensus on purpose and need,
- Consider a safe facility for users and community,
- Track and meet all commitments, and
- Create a lasting value for the community.

Metric Indicator—Percentage of human and environmental impacts of the project. NEPA documentation will be reviewed to identify alternatives and takings (number, area, type/quality of taking). Obtain NEPA documentation for corresponding conventional project(s).

a. Compare alternative used to others and determine the comparative level of impact (human and environmental) to the alternatives.
b. Compare with similar data from corresponding conventional project(s)

This metric will be measured with the following data form:

Environmental resource	Units	In project area	Impacted	Percent impacted
Personal Properties	EA			
Commercial Properties	EA			
Environmental Justice Properties	EA			
Parks 4(f)	acres			
Endangered Species Habitat	acres			
Wetlands	acres			
Streams	ft			
Other				

Notes: Partial takings should be considered as a portion (e.g., 50%) of relocations. Economic conversion of environmental resources: "System for Valuing Changes to Environmental and Historic Amenities," University of Kentucky, 2004

Metric Indicator—Semi-quantitative assessment of opinion and satisfaction level. Measuring opinion requires the development/use of a standard question set with a rating scale. The opinion level can be measured over time or simply at the end of the pertinent activity. Members of the CAC and other stakeholder representatives can be surveyed (particularly resource agencies). This metric will be measured using an opinion scale through a project team and stakeholder surveys from the following statements:

- **Overall Impact to the human environment was minimized.**
- **Overall impact to the natural environment was minimized.**

13. Improved Mobility for Users

This benefit addresses improving mobility for transportation facility users and providing a balanced mobility for all users according to the purpose and need of the project. This entails addressing the practical range of transportation options that can be practically applied on a project and that can materially enhance mobility for all potential users including the economically disadvantaged. The need to allow for and encourage the various modes can be identified through applying principles of CSS in the early stages of project development. While there may be macro issues involving the accommodation and even substitution of transit there are other concerns that may have a minor impact on the project, but result in a major improvement for the mobil-

ity of individuals in a community. Concern for modal connectivity can also be an important goal in considering achieving improved mobility.

The mobility for all users will be improved through the application of the following principles:

Achieve consensus on purpose and need. Achieving consensus on purpose and need will allow for improving the mobility of the transportation system users since the goals of the project regarding the modes to be addressed will be identified and agreed upon.

Address alternatives and all modes. Consideration of all transportation modes is vital for the identification and inclusion of those in projects where they can materially serve the community.

The secondary principles of impact for this benefit are the following:

- Use of interdisciplinary teams,
- Involve stakeholders,
- Seek broad-based public involvement,
- Utilize full range of design choices,
- Consider a safe facility for users and community,
- Address community and social issues,
- Track and meet all commitments, and
- Create a lasting value for the community.

Metric Indicator—Index of quality of travel for all modes. The quality of travel can be determined using travel time estimates and Level of Service designations for each mode. This would require a project study. This metric will be measured with the following data form:

Mode of Travel	Travel time	LOS
Walk		
Bike		
Mass Transit		
Auto		

Notes:

1. Pedestrian and Bicycle LOS : "Pedestrian and Bicycle Level of Service on Roadway Segments" TRR 2031, 2007
2. Transit LOS: "Transit Capacity and Quality of Service Manual, 2nd Edition", TCRP 100 , 2003
3. Auto LOS: "Highway Capacity Manual," TRB, 2000

Metric Indicator—Semi-quantitative assessment of opinion and satisfaction level. Measuring opinion requires the development/use of a standard question set with a rating scale. The opinion level can be measured over time or simply at the end of the pertinent activity. The survey material can be administered to the project team members, members of the CAC and other stakeholder representatives. If all three groups are surveyed the degree of agreement could also be determined. This metric will be measured using an opinion scale through a project team and stakeholder surveys from the following statements:

- **Overall mobility for users was improved.**
- **Overall mobility for financially disadvantaged users was improved.**

14. Improved Walkability and Bikeability

Improving both walkability and bikeability, as part of transportation project, are generally supplementary concerns. Sometimes those improvements can be very beneficial to overall

transportation goals and community development. Occasionally, this benefit takes on greater significance—improved walkability and bikeability may help achieve a human scale in an urban setting by improving community health and reducing traffic demand. It may also enhance sustainability by helping to reduce fuel usage/air pollution, promoting tourism and serving the economically disadvantaged. Such improvements may also improve the livability of a community and even contribute to improved safety.

The walkability and bikeability will be improved through the application of the following principles:

Address alternatives and all modes. Consideration of all transportation modes is vital for the identification and inclusion of the pedestrian and bicyclist aspects that are required to improve the service for these users.

Consider a safe facility for users and community. Considering a safe facility will result in an improved safety level for pedestrians and bicyclists, since the design will reflect elements aiming at improving safety for these users.

The secondary principles of impact for this benefit are the following:

- Use of interdisciplinary teams,
- Involve stakeholders,
- Seek broad-based public involvement,
- Utilize full range of design choices,
- Address community and social issues,
- Track and meet all commitments, and
- Create a lasting value for the community.

Metric Indicator—New and expanded options for pedestrians and bicyclists. This information is to be obtained from the project record (files and plans). The pedestrian and bicycle facilities and options available in terms of numbers and extent can be compared before/after and with similar conventional projects. Verification is possible by querying the project manager/team and CAC/stakeholders. This metric will be evaluated using the data form provided for the benefit "Improved Modal Options."

Modal Option Metric	Existing	Implemented
Pedestrian Facilities		
Sidewalk (ft)		
Crossing (ea)		
Other _____		
Bicycle Facilities		
Multi-Use Paths (mi)		
Bike Lanes (mi)		
Other _____		

Notes:
Economic conversion of bicycle facility benefits: "Guidelines for the Analysis of Bicycle Facilities" NCHRP 552, 2006

Metric Indicator—Index of quality of travel for bicyclists and pedestrians. The quality of travel can be determined using travel time estimates and Level of Service designations for bicyclists and pedestrians. This would require a project study. This metric will be measured with the following data form:

Mode of Travel	Travel time	LOS
Walk		
Bike		

Notes:
Pedestrian and Bicycle LOS: "Pedestrian and Bicycle Level of Service on Roadway Segments" TRR 2031, 2007

Metric Indicator—Modal safety (crash/severity). This information is to be obtained from the project record (files and plans). The modal safety in terms of crash/injury levels can be compared before/after. Verification is possible by querying the project manager/team and CAC/stakeholders. This metric will be measured with the following data form:

Modal Safety	Crashes (before)	Crashes (after)	Change in crashes
Pedestrian			
Bicycle			

Metric Indicator—Semi-quantitative assessment of opinion and satisfaction level. Measuring opinion requires the development/use of a standard question set with a rating scale. The opinion level can be measured over time or simply at the end of the pertinent activity. The survey material can be administered to the project team members, members of the CAC and other stakeholder representatives. If all three groups are surveyed the degree of agreement could also be determined. This metric will be measured using an opinion scale through a project team and stakeholder surveys from the following statements:

- **Walkability was improved.**
- **Bikeability was improved.**

15. Improved Safety (Vehicles, Pedestrians, and Bikes)

The benefit is improved safety for vehicles, pedestrians and bikes as appropriate to a project. While safety is not pre-eminent among the considerations that must be balanced in a successful transportation project, it is always important. A project's major needs may include improving safety. No solution would be acceptable that reduced safety or had the prospect of creating untenable conflicts among vehicles-pedestrians-bikes. Considering a safe facility for users and the community through planning and design can achieve this benefit. When employed along with other applicable principles, it can result in a successful CSS project.

Improved safety (vehicles, pedestrians and bikes) is achieved through the application of the following principles:

Consider a safe facility for users and community. Considering a safe facility will result in improved safety levels for all users, since the design will reflect elements that aim at improving the safety level, reducing the number and severity of crashes, and minimizing conflicts between the facility users.

The secondary principles of impact for this benefit are the following:

- Use of interdisciplinary teams,
- Involve stakeholders,
- Seek broad-based public involvement,

- Achieve consensus on purpose and need,
- Address alternatives and all modes,
- Utilize full range of design choices,
- Address community and social issues,
- Track and meet all commitments, and
- Create a lasting value for the community.

Metric Indicator—Number of crashes, crash rate and severity. The information/data can be found in project records (files and studies) as well as crash data bases maintained by most states. The number of crashes by type, frequency and severity should be collected. This metric will be measured with the following data form.

Crash Type	Before	Crash Rate (Before)	After	Crash Rate (After)	Change in Crash Rate
Total					
Property Damage Only (PDO)					
Injury					
Fatal					
Pedestrian					
Bicycle					

Note: Economic conversion of crashes: "Crash Cost Estimates by Maximum Police Reported Severity within Selected Crash Geometries," FHWA-HRT-05-51, 2005.

Metric Indicator—Semi-quantitative assessment of opinion and satisfaction level. Measuring opinion requires the development/use of a standard question set with a rating scale. The expert opinion of professionals (project/program managers and subject matter experts) within the responsible operating agency can be determined. Before/after results can be compared. A similar survey can be used with selected stakeholder groups. This metric will be measured using an opinion scale through a project team and stakeholder surveys from the following statement:

- **Overall safety (vehicles, pedestrians and bikes) was improved.**

16. Improved Multi-modal Options (Including Transit)

Improving multi-modal options (including transit where appropriate) is a benefit from properly applying CSS. Accommodating those options and their connectivity can be achieved by thoughtfully considering a range of modal options at the appropriate stage of project development. Identifying workable modal options and accommodating their deployment may be achieved through pursuing the principles associated with addressing alternatives and all modes and utilizing a full range of design options. Where appropriately considered these can benefit a community and achieve a unique transportation solution.

Modal options including transit can be improved through the application of the following principles:

Address alternatives and all modes. Consideration of all alternatives and modes will improve their connectivity and identify potential new modes that could be part of a project. This will improve the modal choices for the facility users.

Utilize a full range of design choices. Utilizing a full range of design choices will help identify all potential modes that could be part of the project and their potential utilization in and benefit to a project. This will improve modal options for the community.

The secondary principles of potential impact for this benefit are the following:

- Use of interdisciplinary teams,
- Involve stakeholders,

- Seek broad-based public involvement,
- Achieve consensus on purpose and need,
- Consider a safe facility for users and community,
- Address community and social issues,
- Track and meet all commitments, and
- Create a lasting value for the community.

Metric Indicator—Modal connectivity (count/volume). This information is to be obtained from the project record (files and plans). The modal connectivity in terms of count/volume can be estimated by identifying possible connections between modes. Verification is possible by querying the project manager/team and CAC/stakeholders. This metric will be measured with the following data form:

Modal Connectivity Options	Existing	Implemented
Pedestrian crossing (ea)		
Bike racks on buses		
Bike racks (parking)		
Park and ride facilities		
Bus stops on route		
Other		

Metric Indicator—Each modal facility element inclusion and extent. This information is to be obtained from the project record (files and plans). The modal options available in terms of numbers and extent can be compared before/after and with similar conventional projects. Verification is possible by querying the project manager/team and CAC/stakeholders. This metric will be evaluated using the data form provided for the benefit "Improved Modal Options."

Modal Option Metric	Existing	Implemented
Automobile Facilities		
Single vehicle (lane-miles)		
High occupancy vehicle (lane-miles)		
Other _____		
Pedestrian Facilities		
Sidewalk (ft)		
Crossing (ea)		
Other _____		
Bicycle Facilities		
Multi-Use Paths (mi)		
Bike Lanes (mi)		
Other _____		
Transit (Bus)		
Routes (ea)		
Frequency (Trips/day)		
Transit (other)		
Routes (ea)		
Frequency (Trips/day)		
Other		

Notes:
Economic conversion of bicycle facility benefits: "Guidelines for the Analysis of Bicycle Facilities" NCHRP 552 2006

Metric Indicator—Modal safety (crash/severity). This information is to be obtained from the project record (files and plans). The modal safety in terms of crash/injury levels can be compared before/after. Verification is possible by querying the project manager/team and CAC/stakeholders. This metric will be measured with the following data form:

Modal Safety	Crashes (before)	Crashes (after)	Change in crashes
Pedestrian			
Bus			
Bicycle			
Auto			
Other			

Metric Indicator—Semi-quantitative assessment of opinion and satisfaction level. Measuring opinion requires the development/use of a standard question set with a rating scale. The opinion level can be measured over time or simply at the end of the pertinent activity. The survey material can be administered to the project team members, members of the CAC and other stakeholder representatives. If all three groups are surveyed the degree of agreement could also be determined. This metric will be measured using an opinion scale through a project team and stakeholder surveys from the following statement:

- **Multi-modal transportation options were improved.**

17. Improved Community Satisfaction

A successful CSS project will provide a community with a high level of satisfaction. A CSS project will be integrated into the community and, over time, it will be perceived as an enhancement. Community satisfaction may be achieved by delivering what the community wants and needs or, at a minimum, what it will accept. In some cases, the level of community satisfaction with a CSS project can be assessed by the level of community dissatisfaction with proposed alternatives.

Community satisfaction will be improved through the application of the following principles:

Seek broad-based public involvement. Consideration of comments received during the public involvement process will increase community satisfaction with the process and the resulting solution as well as enhance an agency's image for future projects.

Achieve consensus on purpose and need. Achieving consensus on purpose and need will facilitate developing a project that is in sync with the community vision as it will reflect their input and vision. This will result in a project that will satisfy the community.

Address community and social issues. Incorporating community and social issues based on public input will result in a project solution that is more acceptable to a community and increases community satisfaction.

Address aesthetic treatments and enhancements. Providing aesthetic treatments will improve community satisfaction, since the final design solution will address the community desires formed during the public and stakeholder input meetings.

Document project decisions. Documentation of project decisions will improve community satisfaction since it will demonstrate that the choices were made based on community and stakeholder input and provide a rational support for each choice made.

Track and meet all commitments. Tracking and meeting project commitments will improve community satisfaction, since it will demonstrate that their input and commitments solicited during the public involvement process were addressed resulting in a project conforming with community vision and values.

Create a lasting value for the community. A project that creates a lasting value for the community will improve community satisfaction, since it will result in solutions that will provide a project appropriate to its context.

The secondary principles of potential impact for this benefit are the following:

- Use of interdisciplinary teams,
- Involve stakeholders,
- Use full range of communication methods,
- Address alternatives and all modes,
- Utilize full range of design choices,
- Consider a safe facility for users and community, and
- Maintain environmental harmony.

Metric Indicator—Semi-quantitative assessment of opinion and satisfaction level. Measuring opinion requires the development/use of a standard question set with a rating scale. The opinion level can be measured over time (e.g., at the end of project phases). The survey can be administered to the CAC and other stakeholders. The degree of agreement can also be determined by administering the survey to the project manager/team members. This metric will be measured using an opinion scale through a project team and stakeholder surveys from the following statement:

- **The community was satisfied with the project.**

18. Improved Quality of Life for Community

A successful CSS project improves the overall quality of life for members of a community. This benefit may be primarily transportation-related: by decreasing delays, providing new mobility options, and/or improving safety for roadway users, pedestrians, residents and others. Special enhancements may be applied to a project contributing to a multitude of other aspects to life including recreation, education, shopping and work.

Quality of Life can be improved through the application of the principles listed in the next section. How the fundamental principles impact community satisfaction is discussed in the following paragraphs.

Consider a safe facility for users and community. Considering a safe facility will result in an improved quality of life for the community, since a safer facility will reduce unfavorable consequences from crashes.

Maintain environmental harmony. Achieving environmental harmony will result in improved quality of life for the community, since the natural environment is a critical component of the community.

Address community and social issues. Consideration of community and social issues will improve the quality of life since comments and input from public involvement, addressed in the final project design, will result in a project that will enhance their quality of life.

Address aesthetic treatments and enhancements. Providing aesthetic treatments will improve quality of life for the community, since the final design solution will provide an aesthetically pleasing environment that represents value to the community.

Create a lasting value for the community. A project that creates lasting value for the community will improve quality of life, since it reflects the community vision and addresses the public and stakeholder issues and concerns.

The secondary principles of potential impact for this benefit are the following:

- Use of interdisciplinary teams,
- Involve stakeholders,
- Achieve consensus on purpose and need,
- Address alternatives and all modes,
- Utilize full range of design choices, and
- Use all resources effectively (time and budget).

Metric Indicator—Semi-quantitative assessment of opinion and satisfaction level. Measuring satisfaction requires the development/use of a standard question set with a satisfaction rating scale. The satisfaction level can be measured over time or simply at the end of the pertinent activity. Members of the CAC and other stakeholder representatives can be surveyed (particularly resource agencies). This metric will be measured using an opinion scale through a project team and stakeholder surveys from the following statement:

- **Quality of life for the community was improved.**

Metric Indicator—Alignment with community plans. Measuring such alignment requires a standardized survey tool that uses a rating scale. The level of alignment can be assessed in categories of land use (i.e., residential, commercial or industrial) and measures of activity patterns (i.e., neighborhood walking). In case of weak or non-existent community plans, the metric could focus in measuring whether the project helped to develop such plans. The survey can be administered to the CAC and selected stakeholders including community planning officials and professionals. This metric will be measured using an opinion scale through a project team and stakeholder surveys from the following statement:

- **The project is compatible with the community plan.**

19. Improved Speed Management

Proper speed management provides a roadway that influences speeds that motorists employ while properly accommodating those speeds by design. Matching operational and design speeds provides a safer roadway for both the motorists and non-users living and working adjacent to the roadway. A key element of speed management is identifying the context of the roadway and determining what an appropriate speed would be as well as understanding that the context may change along a roadway and the design and speed needs to be flexible to meet the changing needs of the community and context.

Speed management is a primary benefit of two principles. How these principles impact speed management is discussed in the following paragraphs.

Utilize full range of design choices. Examination of the full range of design choices will result in a better understanding of the issues pertaining to speeds. A solution can be developed appropriate for the project context considering preferences between local or through traffic and thus enhance speed management.

Consider a safe facility for users and community. Considering a safer facility will result in improved speed management, since the design elements incorporated in the project design will consider speed issues in their selection process to fit the project context.

The secondary principles of potential impact for this benefit are the following:

- Address alternatives and all modes,
- Address community and social issues, and
- Create a lasting value for the community.

Metric Indicator—Operating speed (expected/actual). Obtain before/after speed postings from project files. Evaluate speed data for various project postings with traffic volumes and agency speed records (85th percentile, etc.). Determine design speed (AASHTO Green Book). Compare speed data with those for similar conventional project(s). This metric will be measured with the following data form:

	Operating Speed (85^{th} Percentile)
Expected	
Actual	

Metric Indicator—Semi-quantitative assessment of opinion and satisfaction level. Measuring opinion requires the development/use of a standard question set with a rating scale. The opinion level can be measured over time or simply at the end of the pertinent activity. The survey material can be administered to the project team members, members of the CAC and other stakeholder representatives. If all three groups are surveyed the degree of agreement could also be determined.

This metric will be measured using an opinion scale through a project team and stakeholder surveys from the following statement:

- **Vehicle speeds are appropriate for the context.**

20. Design Features Appropriate to Context

Obtaining a facility that matches the context of the area in which it is placed is a fundamental benefit of CSS. Each project has unique requirements that must be aligned with the setting in which it resides in terms of community, environmental resources, topography, etc. To achieve this, trade-offs are necessary between project/facility requirements and the environs in which it is placed. A key element of designing to the appropriate context is an understanding that the context may change along a project and a design needs to be flexible to meet the changing needs of the community and context. Ultimately this approach may lead to varying cross-sections, design speeds, and differing alignments.

Design features appropriate to context is a primary benefit of two principles. How these principles impact context-appropriate design features is discussed below.

Use of interdisciplinary teams. The use of these teams will allow for input from all members while the design is developed, employ the special knowledge skills of different team members to provide optimum solutions and promote complete balanced project, and allow for addressing the specific elements required by each team member as they may influence design.

Utilize full range of design choices. Utilization of a full range of design choices will aid in developing a customized solution for the project with features that are appropriate to the project context.

Maintain environmental harmony. Maintaining environmental harmony will provide a project solution with design features appropriate to the context since the environmental concerns will be considered and addressed in a proper manner.

Address community and social issues. Consideration of community and social issues will result in a project solution with features appropriate to the project context since these solutions will be based on public input.

Address aesthetic treatments and enhancements. Providing aesthetic treatments will improve the appropriateness of the design features, since the final design solution will address the community desires formed during the public and stakeholder input meetings to develop an acceptable solution.

The secondary principles of potential impact for this benefit are the following:

- Involve stakeholders,
- Seek broad-based public involvement,
- Achieve consensus on purpose and need,
- Address alternatives and all modes,
- Consider a safe facility for users and community, and
- Create a lasting value for the community.

Metric Indicator—Semi-quantitative assessment of opinion and satisfaction level. Measuring opinion requires the development/use of a standard question set with a rating scale. The opinion level can be measured over time or simply at the end of the pertinent activity. The survey questionnaire can be administered to the project team members, members of the CAC and other stakeholder representatives. If all three groups are surveyed, the degree of agreement could also be determined. This metric will be measured using an opinion scale through a project team and stakeholder surveys from the following statement:

- **Project features are appropriate to the surroundings and the community.**

21. Minimized Construction-Related Disruption

While temporary, construction work can severely impact motorists, communities and the environment. Steps necessary to minimize construction disruption should be developed prior to the onset of work and included in the project commitments. Construction disruptions typically include traffic impacts related to delays, detours, closures and environmental impacts related to noise, light, dust, and visual as a result of the construction activities.

Traffic disruptions are a primary concern on most projects involving reconstruction of existing roads or on new roads where they tie into existing ones. It is important to identify acceptable and unacceptable disruptions for the project which may often vary considerably between different communities or even within the same community. Construction disruptions typically involve contractor activities but may also include utility relocation or other activities. Some construction-related environmental impacts may be addressed by resource agency permits or MOUs dealing with storm water runoff/ground water protection plans, disposal of organic waste (burning) and impacts to endangered species habitats.

Minimized disruption is a primary benefit of a principle. How this principle affects minimization of disruption is discussed below.

Involve stakeholders. Stakeholder involvement has the potential to identify approaches for reducing the disruption to the community by identifying desirable closure periods for construction and/or providing suggestions for alternative routes.

The secondary principles of potential impact for this benefit are the following:

- Seek broad-based public involvement,
- Use full range of communication methods,
- Consider a safe facility for users and community,
- Maintain environmental harmony,
- Address community and social issues, and
- Track and meet all commitments.

Metric Indicator—Work zone delays. Information and data can be obtained from the project files. Verification is possible by querying the project manager/team. This metric will be measured with the following data form:

MOT Operations	Total Estimated Delay (hrs)
Actual	

Metric Indicator—Semi-quantitative assessment of opinion and satisfaction level. Measuring opinion requires the development/use of a standard question set with a rating scale. The opinion level can be measured over time or simply at the end of pertinent activity. Members of the CAC and other stakeholder representatives can be surveyed (including affected residential or commercial property owners). The degree of agreement can also be determined by administering to the project manager/team members. This metric will be measured using an opinion scale through a project team and stakeholder surveys from the following statement:

- **Disruption caused by the project was minimized.**

22. Improved Opportunities for Economic Development

Stakeholder involvement will enhance the opportunities for economic development because the interaction between the project team and the stakeholders could identify possible areas where such opportunities (e.g., improved business due to better access to stores or improved opportunities for local employment due to industry brought by new roads) can arise.

Improved opportunities for joint use and economic development will be promoted by application of the following principles:

Involve stakeholders. Stakeholder involvement will enhance the opportunities for joint development because the interaction between the project team and the stakeholders could identify possible areas where funds could be jointly pursued.

The secondary principles of impact for this benefit are the following:

- Use of interdisciplinary teams,
- Seek broad-based public involvement,
- Address alternatives and all modes,
- Utilize full range of design choices,
- Address community and social issues,
- Address aesthetic treatments and enhancements,
- Create a lasting value for the community, and
- Use all resources effectively (time and budget).

Metric Indicator—Economic development indicators. This information can be obtained by performing a market study, expert interviews or may be available in project files in the form of

direct agreements with local businesses or stakeholders. Verification is possible by querying the project manager, team, CAC, and stakeholders. This metric will be measured with the following data form:

Indicator	Economic impact
Business activity level ($/year)	
Jobs	
Total income ($/year)	
Other	

Notes:
Additional information on economic development indicators: "Guidebook for Assessing the Social and Economic Effects of Transportation Projects" NCHRP 456 2001

Metric Indicator—Semi-quantitative assessment of expert opinion. Measuring opinion requires the development/use of a standard question set with a rating scale. The opinion level can be measured over time (e.g., at the end of project phases). The survey can be administered to stakeholders. The degree of agreement can also be determined by administering the survey to the project manager/team members. This metric will be measured using an opinion scale through a project team and stakeholder surveys from the following statement:

- **Opportunities for economic development were identified and exploited.**

Abbreviations and acronyms 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	Air Transport Association
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
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
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
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