Washington State
Department of Transportation

Guidance Documents

Information about WSDOT's Practical Design Procedures

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Foreword

These guidance documents have been created to support implementation of the *Design Manual* practical design procedures found in Division 11. Information provided in these guidance documents do not constitute WSDOT policy, nor is the application of the information required. The intent is to provide interpretations of design policy, options and tools to utilize, and to further define terms and intent of procedures contained in the *Design Manual* regarding practical design.

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Alternative Strategies and Solutions

Guidance Document

Introduction

Practical Solutions calls for the exploration and implementation of operational and demand management strategies prior to making a strictly capital Investment. It involves developing strategies at both a corridor-level and for specific locations within that corridor.

This guidance document presents some operational and demand management strategies and solutions to consider prior to making a major investment in a capital improvement project.

Coordinate with WSDOT region program management, planning and traffic offices for an understanding of overall corridor strategies, operational assessments and the priority programming array. Also, consult any planning documents.

Adoption of any of the strategies or solutions presented here will require close coordination with the region Traffic office.

Operational Strategies

Tools to achieve operational improvement include channelization changes, installing ramp meters, speed management, alterations to signal timing, changes to an existing intersection control type, or alternations to signing, to name a few.

Generally, operational strategies use a near-term design year. The intent is to make alterations that will resolve an already existing operational need, not necessarily resolving a possible future need found in a traffic forecast.

Traffic Management

Traffic management solutions include actions undertaken to manage or regulate traffic conflicts, movements, and use of the roadway. Potential projects in this category include revisions to speed limits through use of speed management treatments; parking restrictions or alterations; turn restrictions; truck restrictions; signal operations; intersection control changes; intersection lane-use control; ramp meters; no-passing zones; crosswalks and midblock crossings; special traffic control schemes; and lane use restrictions.

Driver Guidance

Driver guidance solutions are actions to improve driver guidance, clarify options, or reduce risks in the roadway setting. Potential improvements include informational signs; warning signs; lighting and supplemental illumination; supplemental delineation; glare screen; signals; roadside guidance; and Intelligent Transportation Systems (ITS).

Rechannelization or Enhancement

Solutions that rechannelize existing pavement alter the use of the roadway without additional widening. These projects may add, delete, or modify channelization features, and may include reduction of existing shoulder or lane widths. Potential enhancements include, but are not limited to:

1. **Road Diets, Pavement Markings, and Non-motorized Modal Solutions**

   This work may modify tapers or radii, modify lane or shoulder width, install two-way left turn lanes, install painted islands or channelize bicycle lanes or preferential-use lanes.

   Road diets generally include narrowing or removing vehicle lanes to improve facilities for other modes. Generally, a road diet will reconfigure an existing four-lane roadway to two lanes with a two-way left-turn lane, or two lanes with medians and left-turn channelization. The remainder of the width is used to reconfigure transit, bicycle or pedestrian facilities.

2. **Raised Channelization**

   This work includes adding new or altering existing curbing (including channelization islands) in order to enhance guidance, curtail violations or misuse, or enforce access control.

3. **Rumble Strips**

   Installing new, or altering existing rumble strips can reduce the risk of run-off-the-road crashes.

4. **Left-Turn Channelization (two-lane highways)**

   Restripe two-lane highways to provide left-turn channelization at existing intersections can improve motor vehicle mobility. Ensure that the pavement is structurally adequate for the anticipated traffic loads on sections of pavement previously not exposed to traffic. Evaluate impacts to modes other than motor vehicles .

5. **Minor Roadside Enhancements**

   Minor roadside enhancements include altering the roadway cross sections to address clear zone or sight distance concerns. Alternatives include slope flattening, recontouring a ditch, replacing a ditch with culvert, removing a roadside object or shielding the object with barrier.

Demand Management

Demand management tools such as managed lanes, toll lanes, commute trip reduction, telework, vanpool programs, and ridesharing, can ease the burden on existing systems and allow busy corridors to perform as well as they were designed to perform. Hard-running shoulders for transit use or to manage peak hour traffic volumes, and solutions related to intermodal connectivity or off-system solutions, are also considered demand management solutions.

If a solution involving demand management strategies wasn't considered during prior planning phase studies, but is identified during the design phase, it may be necessary to revisit the planning phase. Certain types of demand management solutions require significant coordination with external partners that could benefit from an advanced planning study prior to proceeding with design.

Off-System Solutions

Understanding travel patterns across the broader network is important. A relatively large number of local trips may be carried by a state route. Depending on the location and how the local network grid is configured, there may be lower cost opportunities to improve the local network. Off-system solutions remove local trips from the state route, thereby improving the regional mobility performance. Off-system solutions fall under demand management strategies even though they will likely be funded under a capital program.

Active Travel Demand Management (ATDM)

Active Travel Demand Management is the dynamic management, control, and influence of travel demand, traffic demand, and traffic flow. Traffic flow is managed and traveler behavior is influenced in real-time to achieve operational objectives, such as preventing or delaying breakdown conditions, improving safety, promoting sustainable travel modes, reducing emissions, or maximizing system efficiency.

Under an ATDM approach, the transportation system is continuously monitored. Using archived data and/or predictive methods, actions are performed in real-time to achieve or maintain system performance. Some examples of ATDM are shown below:

Active Demand Management	Active Traffic Management	Active Parking Management
Dynamic ridesharing	Dynamic lane use control	Dynamically priced parking
On-demand transit	Dynamic speed limits	Dynamic parking reservation
Dynamic pricing	Queue warning	Dynamic wayfinding
Predictive traveler information	Adaptive ramp metering	Dynamic parking capacity

Managed Lanes

Managed lanes are a mobility enhancement tool, and come in a wide variety of types. Generally, managed lanes are oriented to a specific user group. The following table is a listing of different managed lane applications. Managed lanes can be accompanied by ATDM solutions. If managed lanes are used as a time-of-day alternative solutions, then ATDM components will likely be necessary.

Type of Managed Lane	Configurations	Modal Priority Consideration	Context Considerations
High Occupancy Vehicle (HOV) Lanes	See chapters 1230, 1410 and 1420		Limited access facility application in high commute corridors, typical.
High Occupancy Toll (HOT) Lanes	Future *Design Manual* update needed, discuss with Toll Division and use chapters 1230, 1410 and 1420, as applicable.		Limited access facility application in high commute corridors, typical. Also used to support major capital strategies.
Business Access and Transit (BAT) Lane	See chapters 1231 and 1410.		Ideal for suburban commercial contexts on managed access facilities. With transit and land use accessibility needs.
Exclusive Transitways	See Chapter 1231 for limited road type configurations, including hard-running shoulder. Discuss with transit agency provider. See also Chapter 1430.		Can apply to a wide variety of transportation contexts. Configurations on managed access facilities with depend on transit service stop frequency and location.
Exclusive Truck Lanes	Not discussed within the *Design Manual*, if considered discuss with HQ Freight Office.		Limited access facility application. Consider for FGTS T-1 routes with identified freight modal priority performance needs.
Service Lanes	See Chapter 1231 for limited road type configurations.		Type and benefit dependent on modal performance needs and road type, respectively
Bypass Lanes	Not discussed within the *Design Manual*, outside of queue related applications.		Used to resolve a high regional mobility throughput need. Considered in rural town center applications, typical.
Lane Restrictions	Not discussed within the *Design Manual*. Discuss with Region Traffic.		Used on a variety of contexts. Used in layered networks, typical.

Writing Effective Need Statements

Guidance Document

"You will have a problem half solved by defining it correctly on the first day"

-Kaoru Ishikawa

Introduction

Practical design is an approach that focuses project decisions on the real need(s). A clear, specific statement of the need(s) is essential to implementing the practical design approach. Focused need statements make subsequent alternative formulation activities more effective and are essential for finding the most practical/strategic solution. Writing clear concise need statements is effective in aligning the team of decision makers and public by making it simple to understand the need. This document provides guidance for writing effective need statements.

The Basis of Design (see *Design Manual* Chapter 1100) uses need statements to communicate "Baseline need(s)" and "Contextual need(s)". See *Design Manual* Chapter 1101 for a complete discussion of baseline and contextual needs.

What is a Need Statement?

A need statement is simply a clear, accurate, plain talk description of a problem that requires solving. The statement must include a concise explanation of the root reason the problem exists today and provide a metric (unit of measure) and a target (a desired outcome) that can be used to compare alternatives by how well they will address the need. Here are two examples of metrics and targets:

- 5 (target) crashes per year (metric)
- 1 (target) minutes per vehicle (metric)

While an effective need statement will facilitate the development of efficient and focused project alternatives, a need statement cannot include a suggested solution. If you find a need statement with a solution, remove it. A need statement that includes a solution will be misleading and hinder the formulation of real alternatives that will actually solve the need.

What makes an Effective Need Statement?

An effective need statement will provide very concise answers to at least these 5 questions and have a metric and target:

1. What is the problem / What is wrong? Like: More crashes than similar intersections.
2. Where is it happening? Like: The intersection of SR 2 and Elm Way
3. When is it happening? Like: during the PM Peak (5:00pm to 7:00pm)
4. To what extent? How bad is it? What is the magnitude of the problem? Like: In the last 5 years, there have been 5 more injury crashes per year than similar intersections.
5. Why is it important to solve it now? Like: Five more injury crashes per year than similar intersections is no longer acceptable to the community.

Metric and Target: Reduction of at least 5 injury crashes per year.

An effective need statement has these attributes:

- **Factual.** It only mentions facts that are known with certainty. It does not list assumptions, hearsay, or vague statements. It uses clear, accurate, and observed data that conveys the size and severity of the problem.
- **Focused and precise**. It stays focused on one specific need. Other needs will have their own need statements.
- **Specific.** It describes the root underlying contributing factor from the completed contributing factors analysis (see *Design Manual* Chapter 1101. Contributing factors are the known factors/causes attributed to the problem.
- **Relevant**. It explains why the need is important to be fixed.
- **Does not suggest a solution.** A need statement cannot include a solution . A need statement that includes a solution will be misleading and hinder the formulation of real alternatives that will actually solve the need.

Contributing Factors and Need Statements

In many cases, a project need cannot be completed without first performing a diagnosis of contributing factors. Here is an example:

> **Example:** A corridor segment has operating speeds below 70% of posted speed during the PM peak hour. In evaluating location data, it was found that the inefficacy of the right-turn operation at the east leg of the intersection is the contributing factor for these lower operating speeds. Vehicles turning right cut off traffic and cannot accelerate quick enough to not impede traffic causing slowing and sometimes causing rear-end crashes.

The need statement for this problem could be:

> *SR A between MP B and MP C is experiencing operating speeds of as little as 30 mph or 60% of the posted speed of 50mph during the work week PM peak hour (5:00 to 6:00) that causes 5 minutes of delay for each vehicle.* ***This is caused by the inefficacy of the right-turn operation at the east leg of the SR A/SR D intersection.*** **Vehicles turning right cut off traffic and cannot accelerate quick enough to not impede traffic causing slowing and sometimes causing rear-end crashes.**

Does this statement answer the five questions mentioned above?

Examples of Need Statements with Metrics and Targets

Below are several examples of need statements. Remember, a good need statement will at least answer the following 5 questions and have a metric and target:

> **1. What is wrong? What is the performance gap?**
> **2. Where is it happening?**
> **3. When is it occurring?**
> **4. To what extent? How bad is it? What is the magnitude of the performance gap (in terms of metrics and targets)?**
> **5. Why is it important to solve it now?**

<u>Need Statement #1</u>:

The Intersection of US 12 and Elm Way has had an average of 20 injury crashes in the last 5 years (4 injury crashes per year). An analysis using the HSM urban/suburban arterial model shows that similar intersections only have on average 2 injury crashes/year.
Metric and Target: Reduction of at least 2 (target) injury crashes per year (metric)

1. *What is wrong? What is the performance gap?* This intersection is having too many (twice as many) crashes than is typical for this type of intersection.
2. *Where is it happening?* Intersection of US 12 and Elm Way.
3. *When is it happening?* In the last 5 years.
4. *To what extent? How bad is it? What is the magnitude of the performance gap?* This intersection has had 2 more injury crashes/year for the last 5 years or twice as many than is typical for this type of intersection.
5. *Why is it important to solve it now?* Twice the number of injury crashes is unacceptable if we can easily reduce the crashes by half.

<u>Need Statement #2</u>:

I-205 currently terminates 10 miles before the connection with southbound I-5 forcing southbound freight traffic to use Main Street. The city of Vancouver expends $200,000 per year for city street damage by freight traffic using city streets to access I-5.
Metric and Target: *0* (target) *dollars spent to repair damage on the city street caused by freeway related freight traffic* (metric) *per year.*

1. *What is wrong? What is the performance gap?* The city of Vancouver pays $200,000 for damage to Main Street by freight traffic.
2. *Where is it happening?* Main Street in Vancouver.
3. *When is it happening?* Every year.
4. *To what extent? How bad is it? What is the magnitude of the performance gap?* The city of Vancouver expends $200,000 per year for city street damage
5. *Why is it important to solve it now?* The city of Vancouver cannot continue expending maintenance dollars to fix damage caused by freight traffic needing to access I-5 from SR 205.

Is this a well-written need statement?

Consider the following need statement:

Pizza delivery times at the Westside location have been averaging 38 minutes on Friday and Saturday nights (high volume periods). As a result, 20% of the pizzas are being delivered late (past 30 minutes). Delivering pizzas in less than 30 minutes is crucial to revenue as pizzas delivered later than that are free.

Does the need statement answer the 5 questions? Is the need statement factual, focused, specific and relevant? Is a solution included? Evaluating the statement by considering the questions and attributes listed above, the argument can be made that this is indeed a well-written need statement.

In contrast, the following is an example of an ineffective need statement:

The intersection is failing and a new signal is needed.

It is apparent that this statement does not answer all the questions that an effective need statement should. In addition, a solution has been suggested as part of the need statement which can be misleading for real alternative formulation. And, there is no metric and target.

In Summary

Thoroughly understanding each project need and understanding the factors that contribute to the performance issue can be challenging. Effective need statements are critical to the understanging of the real need that facilitates discussion and communication with all affected parties ensuring that all parties have a thorough understanding of the problem and why the problem exists.

Performance Based Decisions

Guidance Document[1]

Introduction

WSDOT's Practical Solutions approach requires that decisions are based on performance. This is a shift from the fully standards-based approach used in the past. While the standards-based approach relied on the design matrices, design levels and associated design criteria to determine a project's scope of work, a performance-based approach asks the questions:

- How should we measure performance?
- What level of performance should we target?

Once these questions are answered, solutions for reaching the performance targets can be discussed, and the scope of work for a project can begin to take shape.

WSDOT is not alone in making the shift from a standards–based approach to a performance-based approach. The shift is occurring in many states, and is fully supported by FHWA:

> *"Performance-Based Practical Design is an approach to decision-making that encourages engineered solutions rather than reliance on maximum values or limits found in design specifications. By establishing a clear understanding of the project purpose & need and how decisions can be supported by objective analysis of data that consider performance, agencies can focus on elements that provide stronger return on investment, develop project scopes that support cost reduction but not reduce performance, and apply aggregate project cost savings to other projects"*

This new approach has been described as an engineering "culture shift." It introduces terminology, processes and procedures that will be new to many WSDOT staff-members. This guidance document is intended to:

- Introduce terms you will need to be familiar with to understand performance based decision-making. This includes performance categories, performance metrics, performance targets, performance gaps and project needs (baseline needs and contextual needs)
- Describe of how these performance elements are used, from the beginning in network screening process through design
- Provide a "shortlist" of baseline performance metrics that you can use today (keeping in mind that this list will continue to evolve).
- Discuss establishing targets within certain performance categories.

[1] The *Design Manual* references and links to this guidance document by the title shown above as well as by the title *Performance Based Design*. Both titles mentioned in the *Design Manual* are intended to reference this document.

Performance Categories

A **performance category** is any broad area of performance important to the state, partnering agency, or local community. WSDOT's performance categories are established around legislative policy goals by RCW 47.04.280:

- Economic Vitality
- Preservation
- Safety
- Mobility
- Environment
- Stewardship

Additional Performance Categories

Additional performance categories exist that may warrant consideration. While WSDOT limits investments to the six categories above, it is important to understand and assess other performance categories that may be important to a partnering agency or local community. Two such performance categories are livability and accessibility.

Livability emphasizes creating more viable transportation choices, reducing transportation costs and improving accessibility to affordable housing and job markets while also protecting the environment. For additional information see USDOT livability website (http://www.transportation.gov/livability).

Accessibility is the ease of reaching destinations.[2] Accessibility isn't the same as access, though the type of access provided is a component of accessibility. Accessibility acknowledges the purpose and value of travel, land use access, the type of access provided (by mode) and the overall transportation network performance.

> **Example**: To improve accessibility for bicyclists, bike parking is provided along the designated bike route. This enables users to park their bike securely and complete their trip to the destination by walking.

Performance Metrics

Performance metrics are the "measurables." They provide a means to assess an outcome in a way that is quantifiable. Travel time, for example, is a performance metric that can be used to evaluate mobility performance. The discussion below will explain the difference between the different types of performance metrics (threshold, baseline and contextual).

Not all state routes are the same. Not all modes are the same either. The performance metrics used for motor vehicle traffic are not necessarily applicable to pedestrian, bike, or transit modes.

Ideally, the selection of metrics would occur during planning phase, to be potentially refined later during the design phase. Planning documents (such as corridor sketch plans), when

[2] *Levinson and Owen "Access to Destinations," Technical Report, Minnesota Department of Transportation, 2012*

available, may provide input from partners and stakeholders related to which performance metrics may be useful in understanding the project need. However, since not all projects will have identified performance metrics identified during the planning phase, the region planning office can be helpful in determining appropriate performance metric(s).

WSDOT has an extensive listing of performance metrics that the agency tracks. It is important to have an awareness of these metrics. Coordinate with your region Program Management office, region Planning office and region Traffic office to help choose metrics that are appropriate for your project.

Performance Metrics used by WSDOT in Reporting

Specific performance metrics are used to articulate corridor or system performance. These performance metrics are identified by WSDOT's Office of Strategic Assessment and Performance Analysis, and used in various agency reports such as the Gray Notebook and Corridor Capacity Report. To view these reports: http://www.wsdot.wa.gov/accountability/default.htm

The metrics used for reporting are well developed and researched. For these reasons, it is worthwhile to consider the use of these metrics when designing. Much of the *Baseline Metrics Shortlis*t (discussed later) is derived from performance metrics used in reporting.

Threshold Performance Metrics – Used in Network Screening

A *threshold performance metric* refers to a metric used in the WSDOT network screening processes, primarily within the priority programming phase of development. They are used to identify that a potential problem exists under a particular performance category. Threshold performance metrics are not necessarily those that will ultimately be used for design, since they tend to be broad indicators used to screen locations for further analysis.

If a threshold performance metric indicates a performance issue at a location, then a planning phase or scoping phase activity is triggered to evaluate the location. This information is provided to project development staff in the form of a planning document or scoping instructions. The next step in the process is to use this information to develop a more detailed understanding of the performance gap indicted by the screening process.

Baseline Performance Metrics - Used in Planning, Scoping and Design

The practical design approach requires understanding the most basic need to be resolved by a project. Baseline performance metric(s) is the term used to distinguish the basic need(s) at a location. By definition, baseline performance metric(s) must be addressed by the preferred alternative, and must correspond to one of the identified performance categories.

Until an agency wide procedure is developed for the selection of baseline metrics, the Baseline Metrics Shortlist at the end of this document has been developed as an interim measure for selecting baseline performance metrics on mobility and economic vitality projects. Other performance category type projects will use the threshold performance metrics as the baseline metric.

Contextual Performance Metrics – Used in Planning, Scoping and Design

Performance metrics not identified as baseline needs are called “contextual needs.” They can be system, corridor, or locally based. Contextual needs can be important in evaluating performance tradeoffs. While a project must address the baseline performance need, contextual needs help to understand the benefit or impact a solution may have on other performance areas important to a facility or location.

There is flexibility in selecting metrics associated with contextual needs. Many contextual performance metrics will be qualitative rather than quantitative.

Performance Targets and Gaps

A **Performance Target** is a desired outcome or performance level for a given metric. Establishing performance targets relies on a thorough understanding of what is important to the WSDOT, the traveling public, regional partners, local partners, stakeholders, and the community.

Performance targets may be identified during planning, scoping or during the design phase. Performance targets that have been identified during the planning phase will need validation during the scoping or design phases, as the level of detail increases. For example, it is important to verify whether or not the planning level targets identified in the Corridor Sketch or Study are still appropriate, and to develop additional or more detailed baseline and contextual targets if needed.

A **Performance Gap** is the difference between a performance target and the measured level of performance. Performance gaps for the baseline need ultimately identify what the design should accomplish. The intent is to best resolve the baseline performance gap(s), while balancing impacts/benefits associated with contextual performance gap(s).

Not all project solutions will completely resolve all performance gaps. It is likely that performance trade-off decisions will be necessary.

Performance Metrics, Targets and Gaps, and the Evolution of a Project Need

The evolution of performance metrics, performance targets and performance gaps into a project need (or needs) for a mobility or economic vitality project is shown in Figure 1. As shown in Figure 1, the evolution of a project need begins within a specific performance category during the network screening and priority programming process.

Figure 1 The Evolution of a Project Need

Priority Programming

- Threshold Performance Metrics are identified within specific Performance Categories
- Threshold Performance Targets are established
- NETWORK SCREENING identifies Threshold Performance Gaps
- Statewide PRIORITIZATION – using the priority array system- will result in some locations within some categories getting prioritized and others not

Prioritized threshold performance gaps are sent to regions for scoping

Non-prioritized threshold performance gaps – while not sent for scoping - may become contextual needs

Scoping

Establish Baseline Needs

- The baseline need will be described in terms of the associated performance metric and target
- Establish a metric and target within the governing performance category
- The selected metric doesn't have to be the same as the threshold metric, but will be associated with the performance category. The selected metric should be appropriate for the context. For example, congested corridors may want to use travel time reliability instead of the threshold metric of Level of Service (LOS)
- Consider the context to verify that the threshold performance gap identified in priority programming IS a valid problem needing addressing

Establish Contextual Needs

- Consider all non-prioritized performance gaps at the location
- Community engagement may reveal contextual needs
- Enhanced project knowledge may reveal contextual needs
- Contextual needs will be associated with metrics that can be used to compare alternatives. The metrics may be quantitative or qualitative.
- Some types of contexts may have inherent contextual needs . For example, a rural town center will likely have an economic vitality need and a livability need inherent with that context.

Formulate alternatives for the baseline metrics and the outcome of the Contributing Factors Analysis. Use contextual metrics to evaluate the trade-offs and choose a preferred alternative.

Scope the Preferred Alternative

Design

Verify & Refine Project Needs

- As project knowledge increases and design details become defined, additional effects to performance trade-offs may be become known. Further evaluation of the trade-offs between baseline and contextual needs may become necessary.

Establishing Performance Metrics

Now that the basics regarding performance have been covered, it's time to discuss exactly how a project team determines which performance metrics are appropriate for use on a project.

Performance Metrics for Mobility and Economic Vitality Projects

Not all state routes are the same. Not all communities are the same. Not all modes are the same either. For these reasons, it is important to consider the communities, partnering agencies and internal views regarding which performance metrics are appropriate. An interdisciplinary advisory team is often utilized to facilitate determination of appropriate metrics on projects like this.

WSDOT is currently considering a standard approach to determining baseline performance. A **Baseline Metrics Shortlist** has been provided at the end of this document to assist in selecting baseline metrics for mobility and economic vitality projects. Other metrics (not shown on the shortlist) may also be used when appropriate.

Performance Metrics for other Projects

Projects outside of the mobility and economic vitality performance categories will generally use the threshold performance metric for evaluating design alternatives, rather than choosing a metric. This is a programmatic approach determined by Capital Program Development and Management (CPDM) office and subject matter experts for preservation and asset management programs.

Environmental specific projects select baseline performance metrics in consultation with partners.

Setting Performance Targets

Before you can set a performance target for a specific metric, it is important to know the following:

- How the selected metric is measured (i.e. what is the unit of measure and what mode is the metric pertinent to?)
- What is the current state; or what is the current measured level of performance for the metric under consideration?
- What context and design year are you designing for, existing or future?
- What is a reasonable and realistic outcome?

The four questions above are all essential to setting a performance target, but none is more important than the last question; what is a reasonable and realistic outcome? This is the governing question that has the potential to significantly influence the solution.

> **Example:** SR777 between mile post 3.5 and 6.5 "tripped" the threshold performance metric of operating below 70% of posted speed during a peak hour. The project is in a rural to urban transition segment with adjacent commercial retail and residential accesses. There are 15 intersections (5 signalized) within the location. The selected design year is a 10 year period, meaning the design should accommodate a future context that may be different

than today. However, the 20 year land use plan from the county shows only one zoning change that will eventually permit a park and ride lot on an adjacent parcel currently zoned for residential use.

The interdisciplinary advisory team recommended a mobility metric of travel time for motor vehicles. The current measured off-peak travel time is 6-9 minutes, or another way to say this is that the average free flow travel time is 3.5 minutes/mile. The current measured travel time during the PM peak in one direction is 18-21 minutes, or 9.5 minutes/mile.

Given the congestion issues faced across the system and knowing the type of context; what is a reasonable and realistic target to achieve? Designing to achieve free flow is likely not appropriate and would lead to more expense and impacts at this location, as well as using essential mobility funding here rather than spreading it across the system needs. After discussion with the interdisciplinary advisory team, they recommended a target for peak hour travel at 7 minutes/mile for the future state.

Setting Contextual Performance Targets

Contextual performance targets do not need to be as refined or specific as baseline targets. Establishing a contextual performance target does not necessarily require identifying a specific value. Qualitative statements, particularly in planning, scoping, and early in design, can also be used, such as “improve,” “reduce,” or “maintain.” Establishing targets using these terms can keep a design from encountering scope creep, but it may also create a more challenging task in evaluating performance tradeoffs. However, teams are encouraged to be as specific about the desired contextual performance target as possible.

Additional Examples

The following examples are intended to help clarify the concepts discussed above.

Example 1

In addressing a clearly defined mobility need on a rural two-lane highway, an agency initially considered a four-lane divided highway cross-section over the entire length of the corridor. As part of the evaluation of alternatives in the National Environmental Policy Act (NEPA) process, the agency conducted both mobility (operational) and safety performance analyses. The operational analysis revealed that improving the two-lane highway to a three-lane section with alternating passing lane sections could meet the desired mobility performance target for the desired service life of the project. Results of the safety analysis indicated that the three-lane alternative could reduce fatal and serious injury crashes by approximately 20 percent per mile as compared to the existing condition. This three-lane alternative significantly reduced the project footprint and associated impacts while improving safety and operational performance. This alternative also can be programmed for construction several years sooner than originally anticipated because it greatly reduces the impacts to environmentally sensitive resources and the time needed to complete the NEPA process. In this scenario, through the NEPA process, the agency identified the three-lane alternative as the preferred alternative for most cost effectively achieving the purpose and need.

By evaluating the performance value of alternatives and applying performance-based decision making early, the agency has created an opportunity for savings that can be used to serve other system needs and priorities. This could include using the anticipated savings to add bike lanes and sidewalks to the entire length of the project, or alternatively, to increase the project length by several miles to address safety and operational needs of the corridor, or do neither and apply the savings to another project that has more critical needs.

Note: this example is from the FHWA website, with the wording modified slightly to reflect WSDOT terminology (link below):
https://www.fhwa.dot.gov/design/pbpd/general_information/faqs.cfm#q1

Example 2

A project team is asked to scope a project with the assigned PIN Title: *SR777/I-5 junction to 8th Street Vicinity - Widening*, under the I-1 mobility program. The assigned pin title, which occurs prior to the scoping effort, leads the project team to understand that there is a mobility need to be solved by widening. The project location was assigned for scoping based on the fact that it tripped a threshold performance metric used for network screening “operating below 70% of posted speed during a peak hour period.” So, all that is known is that somewhere at this location, a threshold metric was triggered. The exact location that this occurred is not known, and the exact reasoning or cause for the condition is not known. There is actually very little that is known specifically when a threshold performance metric used in the priority programming process is triggered.

It is not known what might be contributing to the issue. It is not known whether or not the current operating speed is a result of changes to interactions between the land use and transportation context. It is not known how the local system is interacting with the highway system. It is important to recognize what is and isn’t known prior to evaluating solutions that might resolve the issue.

This example shows that – for an existing project that is already in the project delivery process- it is important to carefully evaluate whether or not the stated project need is performance based. It may be that –when evaluated from this point of view- the performance category is really the only thing that is known about the potential need.

Possible Baseline Metrics Shortlist

This List is currently under development, and will change.

Performance Category: Mobility

Mode	Performance Metric	Unit of Measure	Comments/ Applicability
All	Person delay	Minutes of delay per person	This metric most closely evaluates the overall efficiency of an alternative for all modes. Very useful when comparing TDM strategies type alternative solutions, but should not be limited to this application.
Auto, Frieght, Transit	Level of Service	A,B,C,D,E,F	Consider when only evaluating the motor-vehicle modes, and when a corridor is not identified as a routinely congested corridor
	Travel Time	Integer value (minutes or minutes/mile)	Consider this metric for locations without congestion
	Travel Time Reliability	Integer value (minutes or minutes/mile)	Consider when evaluating a routinely congested corridor
	Volume to Capacity Ratio	Ratio or percentage	Consider when only evaluating motor vehicle modes.
Transit	transit seats occupied	Ratio or percentage	Consider when Transit is identified as a modal priority and/or the baseline need is directly associated with transit.
	Average Operating Speed	MPH by route	Consider for all routes were transit is a design users. This metric is directly related to the cost efficiency and travel time reliability for transit service.
	P&R spaces occupied	Ratio or percentage	Consider when Transit is identified as a modal priority and/or the baseline need is directly associated with transit.
Bike	Miles of continuous roadway bike facilities and shared facilities	Integer value (miles)	Consider when the bicycle mode is identified as a modal priority and/or the baseline need is directly associated with the bike mode.
	Number/size of gaps bike facility network	Integer value (feet, miles, block length)	Consider when the bicycle mode is identified as a modal priority and/or the baseline need is directly associated with the bike mode.
Ped	Miles of continuous pedestrian facilities and shared use facilities	Integer value (miles)	Consider when the pedestrian mode is identified as a modal priority and/or the baseline need is directly associated with the pedestrian mode.
	Number/size of gaps in pedestrian facility network	Integer value (feet, miles, block length)	Consider when the pedestrian mode is identified as a modal priority and/or the baseline need is directly associated with the pedestrian mode.
Ped, Bike, Transit	Number/size of gaps in intermodal network	Integer value (feet, miles, block length)	Consider this metric when the baseline need, or contributing factors analysis shows a need to support alternative modes.

Continued on next page

Possible Baseline Metrics Shortlist (Continued)

This List is currently under development, and will change.

Performance Category: Safety (non-I-2 Program)

Mode	Performance Metric	Unit of Measure	Comments/ Applicability
All	Number of Fatal and Serious Injury crashes	Integer value	Always apply
	Number of [mode] crashes	Integer value	“Mode” means pedestrian, bike, or transit, and excludes motorized vehicle only crashes. Consider with modally integrated designs

Performance Category: Economic Vitality

Mode	Performance Metric	Unit of Measure	Comments/ Applicability
Ped and Bike	Width of streetside zone	Integer value per block length	Context dependent (site design and retail functions associated)- typically Urban core, traditional main streets
	Number of [type] streetside amenities	Integer value per block length	Context dependent (site design and retail functions associated)- typically Urban core, traditional main streets
Auto and Bike	Number (or spacing) of parking amenities	Integer value per block length	Context dependent (site design and retail functions associated)- typically Urban core, traditional main streets
Auto	Density of land use access connections	Integer value per block length	Context dependent - typically suburban strip mall
Freight	Number of truck-related slow downs	Integer value	Non-congestion related

Contributing Factors Analysis

Guidance Document

Introduction

Contributing Factors Analysis (CFA) or Root cause analysis (RCA) is a proven investigative method that categorizes the fundamental events and components that constitute the underlying root reason a problem occurs. The RCA method is designed to explain why something occurs, which leads to sound recommendations to prevent reoccurrence. The RCA method has existed formally since the 1950s, and is still in use by various industries today. The method involves the analysis of data, causal charting tools, diagnosis of contributing circumstances across a variety of elements, root cause identification, and recommendation development and implementation.

Contributing Factors Analysis (CFA), identified in the *Design Manual*, is effectively the same as root cause analysis. A terminology change was made for a variety of reasons, but primarily due to the notion that not all applications of the RCA method lead to definitive root cause. In some cases, multiple contributing factors can be diagnosed without having a common underlying root cause. CFA is required for analyzing baseline needs (per *Design Manual* Chapter 1101), and is recommended for analyzing contextual needs as well.

Contributing Factors Analysis Method

Multiple steps are involved in the CFA method. Each step is intended to further isolate the detailed contributing factors associated with the performance need(s). The CFA method is only applied to the current condition; in other words, there is an identified performance issue today. The steps involved in the CFA method are:

First: Before any contributing factors analysis, an initial draft need statement must be available. (For more information, see *Design Manual* Chapter 1101 and the guidance document *Writing Effective Need Statements.*)

Second: Potential contributing factors are brainstormed by team members with knowledge of transportation, the community, and from partners with direct experience and knowledge of the current condition. It may help to organize ideas using categories such as Geometric, Operational, Maintenance, Context-based, and Human Factors. At this point, the team is looking for potential contributing factors.

Third: Each potential contributing factor is then evaluated by data analysis and direct observation as to whether it is a root reason to be brought forward into the next step, or it is determined to be not happening or deemed insignificant, and is dropped from the list. The team documents the contributing factors that remain and explains why other ideas were dropped.

Fourth: Findings of the CFA are communicated with partners, stakeholders and the community to verify that nothing has been missed.

Fifth: Underlying root reasons are determined. Knowing the root reasons facilitates determination of countermeasures and alternatives.

CFA Tools

There are a number of diagraming tools that can be used to accomplish contributing factors analysis and the selection of countermeasure treatments that will become components of your overall alternative. Two such tools are discussed below:

- Why-Technique
- Cause-and-effect diagraming

Why Technique

Most CFA tools rely on data analysis. However, one of the most powerful tools is simply asking the question "why?" By asking "why," you can peel back the layers to discover the root reason for a problem.

This method requires asking "why" more than once, sometimes as many as five or more times to get to the root issue. For this reason, LEAN practitioners have adapted this method and called it the "5 whys."

Here is an example:

> **Example:** A segment of interstate is congested. Why? There are many property damage only (PDO) rear-end crashes and injury crashes that clog traffic movement. Why? Vehicles stop on the freeway and are rear-ended. Why? The next interchange off-ramp backs up onto the freeway. Why? The ramp terminal intersection is often blocked. Why? The cross street is backed up into the ramp terminal. Why? The train crossing the roadway five blocks ahead of the ramp terminal stops traffic and the backup blocks the ramp terminal.

Cause-and-Effect Diagraming

The cause-and-effect diagram offers a systematic way to pinpoint the various factors that may be causing a problem. It prompts people to ask: "Why is this occurring?" As the diagram is developed, more and more potential causes come to light until you get to the root causes.

Figure 2 and Figure 3 show examples of two different methods for cause-and-effect diagraming. In Figure 3, it is useful to group areas of the diagram around major categories (such as geometric, operations, human factors, context related, equipment, materials, etc). These categories are helpful for brainstorming and later communicating findings. Cause and effect diagraming, like other methods, can be an iterative process.

Figure 2 – Cause-Effect Diagram Example – Network Diagram

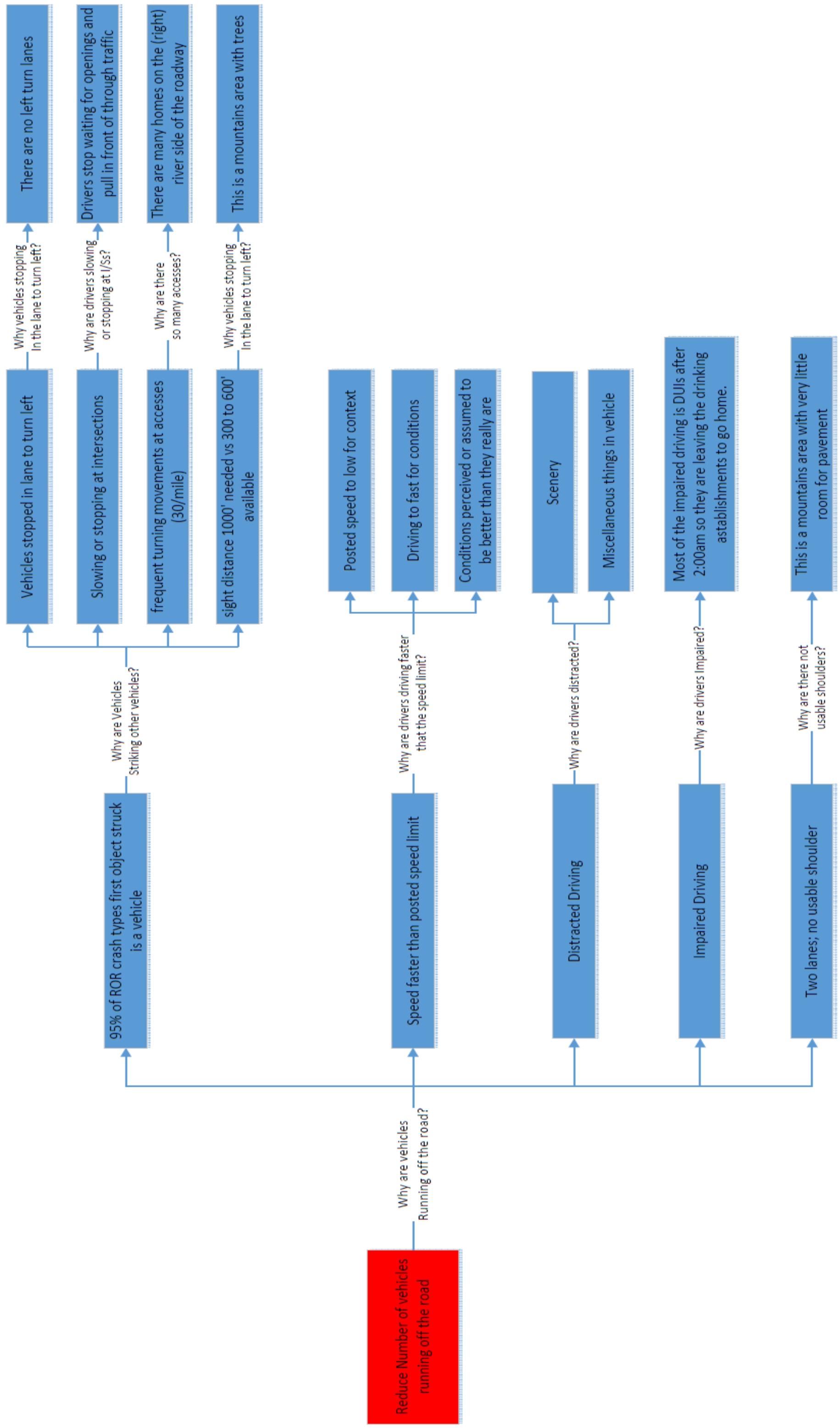
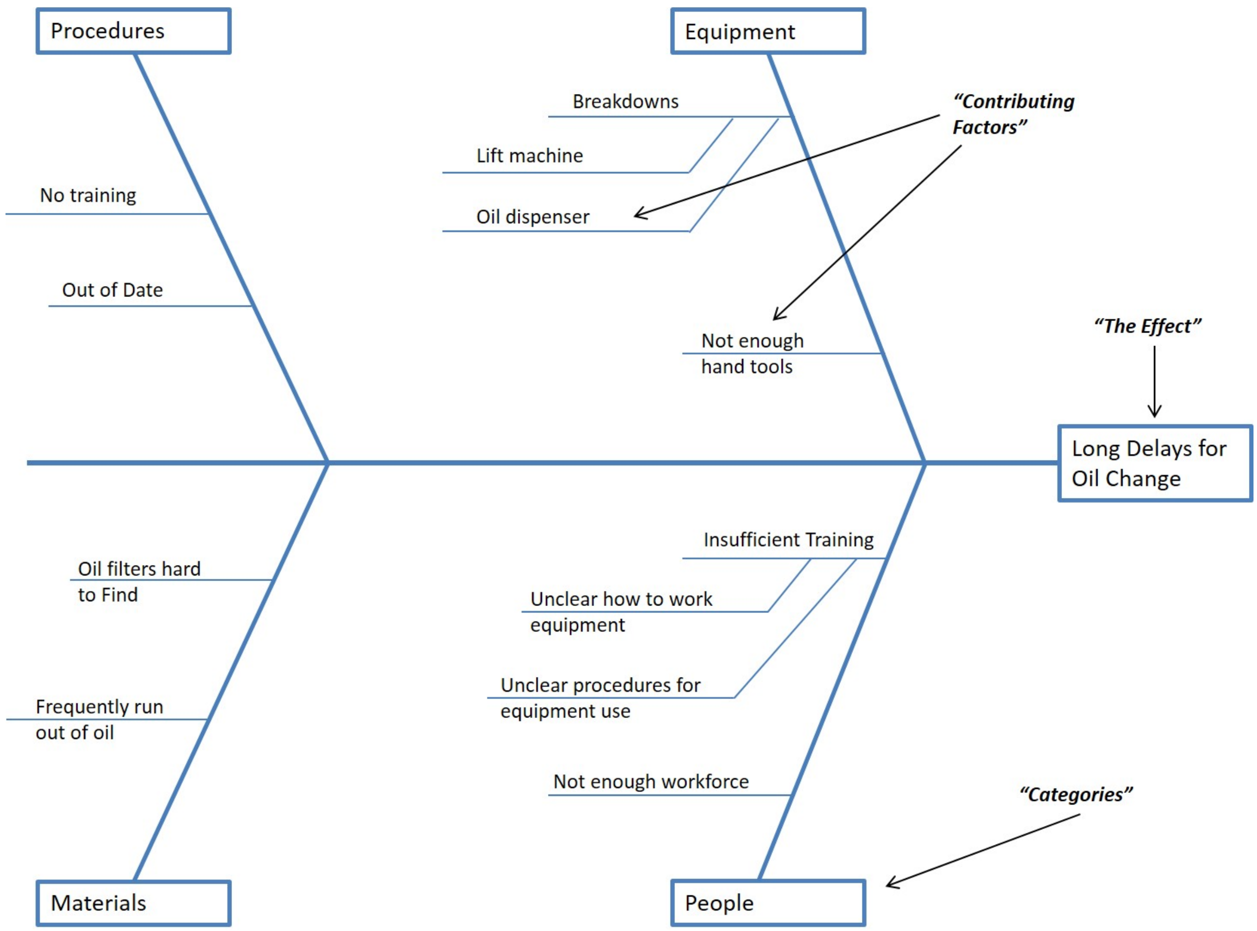


Figure 3 – Cause-Effect Diagram Example – Fishbone Diagram



In Summary

When attempting to determine a need under the practical design approach, it may first be appropriate to quickly apply the "5 Whys" to determine the fundamental need. Once that is determined, utilize a more formal CFA method to determine the fundamental underlying root reasons a problem exists. The findings help to strengthen the need statement, and they focus alternative formulation on the problem with improved chances of preventing its reoccurrence.

Research Summary of Different Design Elements on Performance

Guidance Document

Introduction

When diagnosing a need or considering which design elements to include in an alternative, it is important to understand that different design elements have different effects on performance. Some design elements will have a very significant effect on safety, while others will have a minor or negligible effect. The effect that a particular design element will have on a particular performance category isn't always intuitive and can vary depending on context. A contributing factors analysis (CFA) is critical to providing an understanding regarding which design elements, or other factors can be attributed to the performance need (see *Design Manual* Chapter 1101). With this in mind, this document discusses the known affects key design elements have on different performance categories synthesized from current research.

Disclaimer

Each location and situation is unique, and the relationships identified from this guidance document may not always apply. This guidance document has been created specifically to assist with diagnosis of contributing factors, and for early iterations of alternative formulation prior to engineering analysis. The contents of this guidance document are not a substitution for sound engineering practice or judgment.

Design Element Relationships and Performance

Figure 4 shows many different design elements, along with their relative effect on the performance categories of safety and mobility. Figure 4 includes design elements associated with roadway design, but not all elements that may be required by a particular alternative are listed. Design elements are presented in groupings if they are commonly associated with each other or commonly found within certain contextual applications. Design elements with known performance-related effects are also identified by performance category and mode. If a design element does not identify a related performance effect, it does not necessarily mean that an association to a particular performance category doesn't exist. The relative importance of a design element on a particular performance category may also be indirectly affected by the design controls selected, specifically design speed.

The relative effect that any individual design element has on performance depends on the context, human factors, features within the built or natural environments, as well as the presence and proximity/combination of other design elements.

> **Example:** stopping sight distance (SSD) related to crest vertical curves or horizontal curves has significantly more importance when compounded with another successive curve, intersection, ramp junction, or driveway. When these features are not present, the criteria

for stopping sight distance will likely have less of an effect on mobility or safety performance for nearly every context.

Understanding the relative importance of these elements to a particular design solution helps achieve a practical design outcome by targeting those elements that will have the largest impact.

Example: When considering SSD criteria in the past project development processes, a designed solution would be required to adjust the vertical alignment to meet the SSD criteria. However, knowing the contributing factors, underlying root reason(s), and design element relationships, the alternative solution under the practical design approach may not change or employ the design element SSD or apply it's criteria.

Urban and Suburban Arterials and Collectors

In urban and suburban contexts designed with a low target speed, the conventional criteria for geometric design elements do not hold the same relative importance to mobility and safety performance as they do in other contexts. Within these contexts, design controls, intersection design elements, intersection control types, and multimodal configurations are more relevant in addressing mobility and safety performance than any individual design element.

In general, urban and suburban contexts have a higher likelihood of more diversity in modal needs. An increase in the likelihood of vulnerable users in a more complex environment creates a situation where intermediate and high-speed targets are discouraged, unless significant consideration is given to establishing more restrictive design controls for access and protective and/or segregated treatments are put in place for vulnerable users. Intermodal connections should also be identified. Urban and suburban arterials and collectors designed at intermediate and high target speeds also change the relative effect of conventional geometric design elements on performance.

Rural Two-Lane and Multilane Highways

Figure 5 identifies the key design elements to focus on when considering safety or mobility performance on rural two-lane and multilane highways. These design elements are potential starting points for consideration when formulating alternatives or during contributing factors analysis (see *Design Manual* Chapter 1101). Figure 5 does not reflect site-specific conditions or vehicle types that may further influence the importance of a particular design element related to resolving a particular need. So the figure does not imply that other design elements are not important considerations that may need to be addressed within a particular alternative.

Example A bridge width on two-lane rural highways without access points or horizontal curves in proximity of the bridge location is of significantly less importance to motor vehicle mobility and safety performance than previously thought. This has implications for decisions related to bridge replacements on two-lane rural highways. However, depending on the bridge length and annual average daily traffic (AADT), bridge width on rural two-lane highways can affect the mobility and safety performance of bicycle and pedestrian modes.

Figure 4 The Effect of Various Design Elements on Different Performance Categories

Context	Urban/Suburban Arterials/Collectors										Rural Two-Lane highways										Rural Multilane Highways										Rural and Urban Freeways								Quantitative Analysis Methods		Mode/Function/ Performance Method[4]
Performance Category	Ops – Mobility					Safety					Ops – Mobility					Safety					Ops – Mobility					Safety					Ops – Mobility				Safety						
Design Element[1] / Mode[5]	P	B	T	A	F	P	B	T	A	F	P	B	T	A	F	P	B	T	A	F	P	B	T	A	F	P	B	T	A	F	B	T	A	F	B	T	A	F	HSM[2]	HCM[3]	
Traveled Way																																									
Horizontal Alignment – Curves			○	○	○	○	○						●	●	●			●	●	●			●	●	●			●	●	●		●	●	●		●	●	●	b	a	Chapter 1210
Superelevation																		●	●	●								●	●	●						●	●	●	b		Chapter 1250
Superelevation – Transitions																		●		●			●		●			●		●						●		●			Chapter 1250
Vertical Alignment – Crest																																								b	Chapter 1220
Vertical Alignment – Sag																																									Chapter 1220
Stopping Sight Distance																		○	○	○								○	○	○						○	○	○			Chapter 1260
Lane Width	○	○									○	○	○	○	○			●	●	●	○	○	○	○	○			●	●	●	○	○	○	○		●	●	●	b	b	Chapter 1231, 1232
Bike Lane Width		●																																							Chapters 1231, 1232 & 1520
Pedestrian Crossings	●					●					●					●					●					●					Generally Not applicable								c		Chapter 1510
Lane Transitions																																							c		Chapter 1210
Median Width	○					●												○	○	○								○	○	○						○	○	○	b		Chapters 1239 & 1370
Cross Slope: Lane																																									Chapter 1250
Delineation		●	●	●	●		●	●	●	●		●	●	●	●		●	●	●	●		●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●			Chapter 1030
Grade	●																																						b		Chapter 1220
Roadside																																									
Shoulder Width (including Horizontal Clearance)											●	●	○	○	○	●	●	●	●	●	●	●	○	○	○	●	●	●	●	●	○	○	○	○	●	●	●	●	b	b	Chapter 1231, 1232, 1239
Terminals																		●	●	●								●	●	●						●	●	●			Chapters 1610 & 1620
Transitions																		●	●	●								●	●	●						●	●	●			Chapters 1610 & 1620
Standard Run	Generally Not Applicable					Generally Not Applicable												●	●	●								●	●	●						●	●	●	b		Chapter 1610
Illumination																																							b		Chapter 1040
Cross Slope: Shoulder																																									Chapter 1250
Fill/Ditch Slopes																		●	●	●								●	●	●						●	●	●			Chapter 1239
Clear Zone																		○	○	○								○	○	○						○	○	○	a		Chapters 1239 & 1600
Signing			○	○	○			○	○	○			○	○	○		○	○	○	○			○	○	○		○	○	○	○		○	○	○	○	○	○	○	b		Chapter 1020
ITS			○	○	○			○	○	○			○	○	○			○	○	○			○	○	○			○	○	○		○	○	○		○	○	○			Chapter 1050
Bridges and Tunnels																																									
Vertical Clearance										○			●		●					○			●		●					○		●		●				○			Chapter 720
Bridge – Width	●	●				○	○				●	●				○	○				●	●				○	○				●				○				b	b	Chapter 720, 1231, 1232, & 1239
Bridge Rail																		●	●	●								●	●	●						●	●	●	b		Chapters 720 & 1610
Structural Capacity													●	●	●								●	●	●							●	●	●							Chapter 720
Intersections/Interchanges																																									
Turn Radii	●					●							●	●	●	●																								b	Div 13, various Chapters
Angle																		○	○	○								○	○	○						○	○	○	b	b	Div 13, various Chapters
Sight Distance						●	●	●	●	●						●	●	●	●	●						●	●	●	●	●										b	Div 13, various Chapters
On/Off Connections						NA							●	●	●								●	●	●							●	●	●						b	Chapter 1360
Streetside																																									
Pedestrian Zone Width	●					●																																			Chapter 1231, 1238
Frontage Zone Width																																									Chapter 1231, 1238
Furnishing Zone Width (Horizontal Clearance)						○		○	○	○	Generally Not Applicable										Generally Not Applicable										Generally Not Applicable										Chapter 1231, 1238
Illumination																																									Chapter 1240
Parking Lane Width			●	●	●		○																																		Chapter 1231,1238

See next page for Notes

Notes:

- ● Known to have direct effects on potential performance outcomes.
- ○ Known to have indirect effects on potential performance outcomes, when analyzed with other design elements or design controls.
- a All available or pertinent quantitative models can evaluate performance.
- b Most available or pertinent quantitative models can evaluate performance.
- c One quantitative model can evaluate performance.
- 1 Not all design elements pertinent to a particular site-specific design are listed.
- 2 CMFs may exist for elements not listed herein. Models are specific to a number of transportation contextual factors, such as number of lanes or intersection control type.
- 3 Operational effect analyzed by HCM model pertains to free-flow speed or LOS. Quantitative methods may not be pertinent to your selected mobility performance metric.
- 4 Use quantitative methods for determining design element dimensions whenever available. Application of Design Manual criteria-based method generally pertains to these design elements in isolation, and must take into account site-specific conditions and engineering judgment.
- 5 P: Pedestrian, B: Bicycle, T: Transit, A: Auto, F: Freight

Figure 5 Key Design Elements that Affect Motor Vehicle Mobility and Safety Performance – Rural Two-Lane and Multilane Highways (Adapted from NCHRP Report 783)

Mobility – Operational Performance	Safety Performance
At-Grade Intersection Type and Associated Design Elements	At-Grade Intersection Type and Associated Design Elements
Shoulder Width	Shoulder Width
Lane Width	Lane Width
Horizontal Alignment – Curve Radius	Grade
Grade	Horizontal Alignment – Curve Radius
Superelevation	Superelevation
Stopping Sight Distance (only with successive curves or access points)	Stopping Sight Distance (only with successive curves or access points)
Cross Slope	Cross Slope

Urban and Rural Freeways

Figure 6 identifies the key design elements to focus on, in order of importance, when considering safety or mobility performance on urban and rural freeways. These design elements are potential starting points for consideration within an alternative or during contributing factors analysis (see *Design Manual* Chapter 1101). This exhibit does not imply that other design elements are not important considerations that may need to be addressed within a particular alternative, since it does not reflect site-specific conditions that may further influence the importance of a particular design element related to resolving a particular need.

Figure 6 Key Design Elements that Affect Mobility and Safety Performance – Urban and Rural Freeways (adapted from NCHRP Report 783)

Mobility – Operational Performance	Safety Performance
On/Off Connection Type and Associated Design Elements	**On/Off Connection Type and Associated Design Elements**
Lane Width	Shoulder Width
Shoulder Width	Lane Width
Horizontal Alignment – Curve Radius	Horizontal Alignment – Curve Radius
Grade	Stopping Sight Distance (only with successive curves or access points)
Superelevation	Superelevation
Stopping Sight Distance (only with successive curves or access points)	Grade
Cross Slope	Cross Slope

Transition Areas

Transition areas are typically difficult to categorize in terms of context. These areas can extend for miles between more distinctive context types. In general, a highway transition area should be utilized to alter the route continuity and prepare motorists' expectations for the approaching context. Transition areas may need to deliberately include design elements that have the greatest influence on mobility and safety, or those necessary for speed management if departing an intermediate- to high-speed context and approaching a lower-speed context (see *Design Manual* Chapter 1103 for speed management treatments). Figure 7 shows design elements that may be appropriate for consideration in areas transitioning from higher- to lower-speed targets. The transition from lower to higher speed can be more abrupt and is not covered by Figure 7. However, careful consideration of particular controlling elements like density of access points and intersections may provide distinctive locations on the alignment where an abrupt alteration in continuity is appropriate.

Figure 7 Key Design Elements that Affect Mobility and Safety Performance – Transition Areas

Transition Area Design Elements	Impacts to Mobility and Safety Performance
Intersection Control Type and Associated Design Elements	Intersection types have the ability to alter the continuity of a segment. Generally, roundabouts best serve this purpose due to their ability to alter operating speeds and provide a distinctive break in the sightline. Other control types, such as signals, may need specific modal treatments to achieve operational performance needs of various modes.
Lane Width	While lane widths by themselves only provide a nominal impact on operating speeds, lane width transitions provide an important role in transitioning the environment. They do so from both a human factors perspective and the practical perspective of altering the available right of way for more effective use of the public right of way for other modal performance needs.
Shoulder Width	Shoulder width transitions can significantly impact operating speeds and alter a driver's perception. Reduction in shoulder widths or repurposing the available width for a separated bicycle facility (such as a separated buffered bike lane) can affect driver behavior as they transition to a new environment.
Horizontal Alignment – Curve Radius	Horizontal curves have the largest operational effect of any geometric element with respect to speed. Utilizing the horizontal alignment to assist with speed management or altering context is appropriate in transition areas.
Bicycle Lane Width and Type	The presence of multimodal facilities, particularly those located physically on the roadway, has a direct effect on driver behavior. Repurposing the shoulder width with a separated buffered bike lane that transitions to a less protected bike lane plays an important role in transitioning a section, particularly from a rural to suburban/ urban environment.
Roadside and Streetside Design Elements	Transition areas are a challenge for speed management since the typical land use site design precludes vertical features adjacent to the traveled way. Utilizing roadside and streetside design features to help create vertical features is appropriate in transition areas. This may begin with guide posts and then tree plantings on the roadside that transition to streetside design elements once intermediate speeds are reached. Mitigation for roadside features such as shoulder rumble strips may be appropriate to offset the clear zone guidance criteria.
Speed Management Treatments	Various speed management treatments may involve either geometric, operational, or roadside treatments. Note that certain treatments discussed in *Design Manual* Chapter 1103 are not considered appropriate for use in a transition segment, and are noted as such.

Additional Performance Considerations

The majority of information presented has focused on design elements and their relationship to motor vehicle mobility and safety performance. However, economic vitality and environmental performance relationships may also be impacted by particular design elements depending on the context and performance metric identified.

Design Elements Associated with Economic Vitality Performance

A design element's effect on economic vitality performance may vary, depending on whether the performance metric under consideration is oriented around the freight mode or local land use. Different land use environments also call for different design elements depending on their modal compatibility and site design.

1. **Freight Economic Vitality**

The effects to the economic vitality for long haul freight can be directly equated to mobility performance of the freight mode. As such, WSDOT's Freight Services Division has identified threshold performance metrics centered around speed differentials to identify potential economic vitality performance improvement locations. To view locations that may have either a mobility or economic vitality concern, see Freight Services Division's interactive map: http://wwwi.wsdot.wa.gov/onedot/news/2012/06/29_interactivefreightmap.htm

Specific design elements that have significant effects on long haul freight's economic vitality and mobility performance categories are shown in Figure 8. It is important to note that system continuity and interconnectivity between major freight destinations are likely to directly impact economic vitality more than specific design elements.

Figure 8 Key Design Elements Associated with Economic Vitality and Mobility Performance for Freight

Design Element	Effect on Economic Vitality and Mobility Performance
Interconnectivity and Accessibility	While not necessarily a geometric design element, the ability of freight to access key locations easily and without impediment will have the largest direct effect on economic vitality performance.
Vertical Clearance/Structural Capacity	Vertical clearance and structural capacity directly affect freight economic vitality performance from a system perspective. The more freight vehicles need to reroute due to limited vertical clearance or structural capacity, the less economically viable the route becomes. Criteria for these design elements are more relevant on primary and secondary freight routes.
Grade	Upgrades sustained over a distance have the largest direct operational effect and indirect effects on freight economic vitality performance.
Intersection Radii	Small intersection turn radii has the potential to impact not only freight mobility and economic vitality performance, but also the mobility performance of other motorized users, particularly when large vehicle accommodations create a condition where large trucks need to occupy multiple traveled lanes to make a turning maneuver.

2. Local Economic Vitality Performance

Land use context and modal compatibility provide necessary information about how transportation facilities can affect land uses' economic vitality performance. In general, the design elements and design controls associated with modal accessibility and use of available public space for social activities are key mechanisms to consider. Land use site design (the built environment) provides an indication of which modes may need accessibility priority for the specific context.

- Suburban corridors may focus on automotive and transit accessibility, where the site design of the built environment involves large setbacks from the highway, strip malls, sprawled business developments, office parks, and parking facilities provided at the business locations.
- Rural town centers, traditional main streets, and urban areas may need the focus on pedestrian, bicycle, and transit accessibility, where site design has minimal building setbacks, a lack of private parking facilities, and retail and restaurant business types present.

Loading zones for freight delivery vehicles are also critical to support the local economic vitality performance. Understanding the types of freight delivery vehicles and how they off-load is important and is indirectly associated with modal and land use economic vitality performance.

Figure 9 Design Elements and Considerations Associated with Local Economic Vitality Performance

Design Element or Consideration	Transitions Areas, Suburban Commercial Corridors, Rural Commercial	Rural Town Centers, Traditional Main Streets, Urban Centers, Mixed-Use Areas, some Suburban Commercial Corridors
Modal Accessibility	Motor vehicle access density and type; transit stop frequency and active mode interconnections effect.	Pedestrian connectivity and access; bicycle connectivity and access; transit stop frequency.
Furnishing Zone	Minimal effect; use for bike parking facilities, vegetative landscaping/LID stormwater treatments, and street furniture. Depends on site design and intermodal connectivity opportunities.	Moderate effect; use for bike parking facilities, vegetative landscaping/LID stormwater treatments, and street furniture.
Frontage Zone	No effect or minimal effect for specific businesses inconsistent with the predominant site design.	Moderate effect; use for local business temporary product placement and signing, street furniture, and restaurant outdoor seating.
Pedestrian Zone	Moderate effect; minimal pedestrian thoroughfare design for intermodal connectivity. Direct access from the pedestrian zone to business locations can increase accessibility.	High effect; width should consider both the mobility needs and the social needs of leisure walking and shopping activities.
Parking Zone	Not likely to produce an effect depending on the site design.	High effect; use for loading zones and on-street parking, and consider parklets for creating social activity space, especially in areas with limited right of way and business types that such as cafes and restaurants that find additional benefits from this social use treatment.

Design Elements Associated with Environmental Performance

Environmental performance is impacted in several ways, including the footprint size, mode split, traffic operational efficiency, and ratio of pollution-generating to non-pollution-generating impervious surfaces, among others. For this reason, all design elements associated with the geometric cross section have the potential to affect environmental performance due their association with footprint impacts. Note that site-specific environmental performance metrics may be identified for specific habitat or other concerns that may emphasize more specific design elements. For example, if a protected bird species is known to nest in trees throughout the project area, a performance metric may be specifically developed to preserve that habitat. Work closely with region environmental staff to consider identifying environmental performance metrics from the Environmental Review Summary, and which design elements may affect these metrics. Identifying performance metrics for specific environmental features allows designs to potentially avoid or minimize mitigation early in project development.

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