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An Agency Guide on How to Establish Localized Congestion Mitigation Programs

FHWA's Bottleneck Reduction Initiative Program

Office of Operations

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NOTICE

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16. Abstract

This document provides guidance to state and local transportation personnel who wish to develop a formal program for mitigating congestion using localized and low-cost bottleneck treatments. It presents several templates for developing a localized congestion mitigation program, including documenting alternative templates in use by state Departments of Transportation and Metropolitan Planning Organizations.

FHWA's Localized Bottleneck Reduction Initiative (LBR) program has researched over the last five years the causes, impacts, and mitigations available to combat localized recurring congestion; that is, congestion that is primarily "point specific" as to cause, location, duration, and repetitiveness. This guidance document is intended to aid agencies in establishing either ad-hoc or annualized programs that address localized congestion, much in the same way that an annualized safety-spot program would address localized safety issues.

The main questions that this guidance helps an agency frame are:

1. Do we have a satisfactory agency methodology to specifically address localized congestion problems?
2. Within that program, do we have satisfactory justifications for project candidacy, selection, and solutions for said problems?
3. Are we executing these projects in a timely fashion and within budgets that are representative of the context of a "Localized Bottleneck Reduction" program?

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Executive Summary

FHWA's Localized Bottleneck Reduction Initiative (LBR) program has researched over the last five years the causes, impacts, and mitigations available to combat localized recurring congestion; that is, congestion that is primarily "point-specific" as to cause, location, duration, and repetitiveness. This guidance document is intended to aid agencies in establishing either ad hoc or annualized programs that address localized congestion, much in the same way that an annualized safety-spot program would address localized safety issues.

"Localized" recurring congestion differs from regional or corridor-sized congestion, in that the former is characterized by a relatively low-cost, usually correctable operational deficiency (e.g., lane drop, weave, merge, etc.), whereas the latter is often systemic, and may be sufficiently complex in cause and relief that funding and/or project duration are typically very high and very long, respectively.

An agency that does not have a stand-alone "localized" congestion program is missing an opportunity to address a specific subset of overall congestion.

The main questions that this guidance helps an agency frame are:

1. **Do we have a satisfactory agency methodology to specifically address localized congestion problems?**
2. **Within that program, do we have satisfactory justifications for project candidacy, selection, and solutions for said problems?**
3. **Are we executing these projects in a timely fashion and within budgets that are representative of the context of a "Localized Bottleneck Reduction" program?**

1.0 Introduction

1.1 Purpose of the Guidance Document

This guidance document provides guidelines that can be used by state DOTs and local transportation agencies in developing a Localized Bottleneck Reduction (LBR) Program. It covers all aspects of designing and implementing an LBR program, from establishing the institutional structure required to support an LBR program to bottleneck identification, improvement, evaluation, and public outreach. The guidance document was developed based on best practices used by state and local agencies.

1.2 How to Use this Document

Target Audiences

This document is designed for state, regional, and local transportation agencies that are focused on mitigating operational causes of bottlenecks. These causes include a wide variety of issues from poorly functioning merges to poor signal progression throughout a corridor. This document targets planners as well as traffic, safety, and design engineers. Operations and Maintenance staff will also find this document as a useful way to begin addressing bottleneck issues in a comprehensive and coordinated way. The document includes a discussion on how best to start a LBR program in your agency. It includes case studies and a series of templates, which the reader can use in starting their own program.

Document Structure and Content

This guidance document includes the following sections:

- **Section 1.0 – Introduction.** This section provides background information on traffic bottlenecks and describes how FHWA is addressing bottlenecks through their LBR Program.
- **Section 2.0 – How to Structure a Localized Bottleneck Reduction Improvement Program.** This section provides guidance to state and local agencies in structuring a program to address localized bottleneck problems. It describes agency roles and responsibilities, options for structuring the program, and factors for success. A self-assessment tool is also provided to assist agencies in establishing where they currently stand with regard to implementing a bottleneck program.
- **Section 3.0 – Resources.** This section provides case study examples of successful bottleneck programs across the United States, including best

practice examples in the areas of performance measurement, bottleneck analysis, and project prioritization.

1.3 Background

Bottlenecks: A Definition

The FHWA estimates that 40 percent of all congestion nationwide can be attributed to recurring congestion; some of it "mega" – wherein, entire regions or large facilities (e.g., interchanges or corridors) are overwhelmed by seemingly unceasing traffic demand – and some of it "subordinate" – locations on the highway system where periodic volume surges temporarily overwhelm the physical capacity of the roadway. During off-peak hours, the subordinate locations operate sufficiently and safely for the conditions. These recurring "localized" bottlenecks are those encountered in our everyday commutes, and are characterized as being relatively predictable in cause, location, time of day, and approximate duration. Nonrecurring bottlenecks, on the other hand, are caused by random events such as crashes, inclement weather, and even "planned" events such as work zones and special events.

This guidance document focuses on "localized" recurring bottlenecks (i.e., point-specific or short corridors of congestion due to decision points such as on- and off-ramps, merge areas, weave areas, lane drops, tollbooth areas, and traffic areas); or design constraints such as curves, climbs, underpasses, and narrow or nonexistent shoulders. **Mega-bottlenecks or those occurring due to systemic congestion are not meant to be covered by the scope of this guidance.**

For a bottleneck to be "localized," the factors causing the bottleneck *ideally* should not influence upon, or be influenced by, any other part of the transportation system. As a practical measure, the LBR program recommends considering the closest upstream and downstream decision points as either impacting "to" or impacting "from" the subject location, respectively. Anything much beyond that reach might be considered more than "localized." One exception might be collector-distributor lanes that would almost certainly run through two or more on- or off-ramps. Such a "system" can be considered as a larger, localized condition. Otherwise, recurring, localized bottlenecks generally occur at the following locations:

- A **lane drop**, particularly mid-segment where one or more traffic lanes ends. These typically occur at bridge crossings and in work zones. In large urban areas, a lane drop might occur at jurisdictional boundaries just outside the metropolitan area. Ideally, lane drops should be located at exit ramps where there is a large volume of exiting traffic.
- A **weaving area**, where traffic must merge across one or more lanes to access entry or exit ramps. Bottleneck conditions are worsened by complex or insufficient weaving design.

- **Freeway on-ramps**, where traffic from local streets merge onto a freeway. Bottleneck conditions are worsened on freeway on-ramps without auxiliary lanes, short acceleration ramps, or where there are multiple on-ramps in close proximity.
- **Freeway exit ramps**, which are diverging areas where traffic leaves a freeway. Bottleneck conditions are worsened on freeway exit ramps that have a short ramp length, traffic signal deficiencies at the ramp terminal intersection, or other conditions that may cause ramp queues to back up onto freeway main lanes. Bottlenecks could also occur when a freeway exit ramp shares an auxiliary lane with an upstream on-ramp, particularly when there are large volumes of entering and exiting traffic.
- **Freeway-to-freeway interchanges**, which are special cases on on-ramps where flow from one freeway is directed to another. These are typically the most severe form of physical bottlenecks because of the high traffic volumes involved.
- **Abrupt changes in highway alignment**, which occur at sharp curves and hills and cause drivers to slow down either because of safety concerns or because their vehicles cannot maintain speed on upgrades. Another example of this type of bottleneck is in work zones where lanes may be redirected or even slightly shifted during construction.
- **Low clearance structures, such as tunnels and underpasses.** Drivers slow to use extra caution, or overload bypass routes. Even sufficiently tall clearances could cause bottlenecks if optical illusion causes a structure to appear lower than it really is, causing drivers to slow down.
- **Lane narrowing**, caused by either narrow travel lanes or narrow or nonexistent shoulders.
- **Intended interruptions to traffic flow** that are necessary to manage overall system operations. Traffic signals, freeway ramp meters, and tollbooths can all contribute to disruptions in traffic flow.

A detailed discussion on bottleneck characteristics is provided in FHWA Publication FHWA-HOP-09-037, *Recurring Traffic Bottlenecks: A Primer – Focus on Low-Cost Operational Improvements*, available on FHWA's web site at http://www.ops.fhwa.dot.gov/bn/index.htm.

Bottlenecks: A History

Timeline of National Bottleneck Activities

Over the past several years, transportation professionals have come to realize that highway bottlenecks demand special attention. Several national studies have highlighted bottlenecks as a major congestion problem in urban areas. These studies have raised the level of awareness about bottlenecks as a problem, warranting that they be treated as a significant part of the congestion problem.

One of the LBR tenets is "a bottleneck is congestion, but congestion is not always just a bottleneck." This means that a bottleneck (or chokepoint) is merely a subset of the larger congestion pie. However, that "subset" is now realized to be a uniquely impacting (and increasingly growing) genre of congestion; namely, that it is *subordinate* locations along a highway that need to be fixed, and not necessarily the knee-jerk expectation to rebuild the entire facility. Granted, in some cases, an aging or clearly capacity-deficient facility may need to be replaced. But in this age of budget constraints and economizing, one or two corrections to inefficient subordinate locations on a facility may be all that is needed to improve the condition.

The American Highway Users Alliance (AHUA) conducted studies of the nation's urban bottlenecks in 1999 and 2004. The studies produced rankings of the worst bottlenecks in terms of total delay to travelers and discussed what was being done to fix the problems at locations where specific improvements had been scheduled. The studies found that nearly all of the *worst* bottlenecks are major freeway-to-freeway interchanges in large urban areas, but many smaller bottlenecks were surprisingly impacting as well. The 2004 study updated the 1999 rankings and discussed three bottleneck improvement success stories – bottlenecks identified in 1999 that were subsequently improved or well under construction; the clear message being that mitigations can be realized.

States and regions are beginning to recognize the significance of bottlenecks as well. The Ohio Department of Transportation completed a study of freight (trucking) bottlenecks, and the Interstate 95 Corridor Coalition is undertaking a study of all potential bottlenecks in Coalition states. The Atlanta Regional Commission has defined bottlenecks as a specific portion of their Congestion Management Process and is identifying regional and local bottlenecks in their network.

In 2002, the Texas Transportation Institute compiled a database of before/after measurements of selected Texas DOT initiatives to remove bottlenecks and improve operations on urban freeways. The benefit/cost ratios and reductions in crash rates observed at these locations provided valuable insight regarding the effectiveness of various bottleneck reduction strategies over time.

More recently, an effort by a private data provider, Inrix, also identified the nation's worst bottlenecks (Table 1.1). Whereas previous bottleneck identification efforts were based on analytic procedures using traffic volumes and capacity data, Inrix's approach uses data assembled by them from a variety of sources. As direct travel time measurements become more common and better refined, the science of bottleneck identification and performance will improve.

Table 1.1 Inrix 2009 Annual Report Worst Traffic Bottlenecks

Rank 2009	Rank 2008	CBSA (Pop Rank)	Road/Direction	Segment/Interchange	County	State	Length (Miles)	Hours of Congestion	Average Speed While Congested
1	1	New York (1)	Cross Bronx Expy WB/ I-95 SB	Bronx River Pkwy/ Exit 4B	Bronx	NY	0.35	94	11.4
2	7	Chicago (3)	Dan Ryan Expy/ I-90/I-94 WB	Canalport Avenue/ Cermak Road/Exit 53	Cook	IL	0.4	83	11.1
3	5	New York (1)	Cross Bronx Expy WB/ I-95 SB	I-895/Sheridan Expy/ Exit 4A	Bronx	NY	0.51	95	12
4	2	New York (1)	Cross Bronx Expy WB/ I-95 SB	White Plains Road/ Exit 5	Bronx	NY	0.28	86	11.9
5	3	New York (1)	Harlem River Drive SB	3rd Avenue	New York	NY	0.16	77	9.6
6	62	New Haven (58)	I-91 SB	Hamilton Street/ Exit 2	New Haven	CT	0.22	76	12.8
7	13	Los Angeles (2)	Hollywood Fwy/ U.S. 101 NB	Los Angeles Street	Los Angeles	CA	0.1	85	14
8	24	Chicago (3)	Dan Ryan Expy/ I-90/I-94 WB	18th Street/ Exit 52C	Cook	IL	0.41	83	13.7
9	11	New York (1)	Cross Bronx Expy WB/ I-95 SB	Westchester Avenue/ Exit 5	Bronx	NY	1.15	76	12.8
10	26	Chicago (3)	Dan Ryan Expy/ I-90/I-94 WB	Ruble Street/ Exit 52B	Cook	IL	0.12	86	14.7
11	10	Los Angeles (2)	Hollywood Fwy/ U.S. 101 SB	Vermont Avenue	Los Angeles	CA	0.62	82	15.4
12	16	Los Angeles (2)	Hollywood Fwy/ U.S. 101 NB	Alameda Street	Los Angeles	CA	0.27	82	14
13	29	Chicago (3)	Dan Ryan Expy/ I-90/I-94 WB	Roosevelt Road	Cook	IL	0.22	86	16.2
14	9	New York (1)	Harlem River Drive SB	2nd Avenue/125th Street/ Exit 19	New York	NY	0.22	75	11.1
15	6	New York (1)	Van Wyck Expy/I-678 NB	Liberty Avenue/Exit 4	Queens	NY	0.52	61	11.7
16	36	Los Angeles (2)	Pasadena Fwy/ CA 110 NB	Sunset Boulevard/ Exit 24A	Los Angeles	CA	0.21	45	10.4
17	12	New York (1)	Van Wyck Expy/I-678 NB	Hillside Avenue/Exit 6	Queens	NY	0.12	71	14
18	8	Chicago (3)	Eisenhower Expy/ I-290 EB	U.S. 20/U.S. 45/ U.S. 12/Exit 17	Cook	IL	0.99	62	14.3
19	19	Los Angeles (2)	Hollywood Fwy/ U.S. 101 NB	Spring Street	Los Angeles	CA	0.14	82	16.1
20	17	New York (1)	I-95 NB	U.S. 9/U.S. 1/ U.S. 46/Exit 72	Bergen	NJ	0.42	66	11.3

FHWA Involvement

FHWA's first effort related to bottlenecks was in the freight (trucking) arena. In 2005, using the AHUA studies as a starting point, FHWA conducted an assessment of the impacts that highway bottlenecks have on truck freight shipments. Bottlenecks outside of urban areas were also considered (e.g., steep grades). **A major finding of this study was that in terms of total delay, the urban bottlenecks – typically thought of as a commuter-related problem – are also major sources of truck delay.** In 2009, in partnership with the American Transportation Research Institute (ATRI), FHWA conducted an in-depth analysis to produce a congestion severity ranking for 100 freight significant highway interchanges. The rankings can be used by both public and private sector stakeholders to better identify transportation system deficiencies and to assist in logistics and routing decisions. ATRI and FHWA will continue to monitor these locations on an annual basis.

In preparing the FY 2006 Strategic Implementation Plan (SIP), the FHWA Operations Leadership Council discussed the need for a national strategy to address bottlenecks and requested each Division office to identify bottleneck locations in their state. The responses ranged from mega bottlenecks encompassing multi-interchange corridors to point-specific localized chokepoints. FHWA initiated the Localized Bottleneck Reduction (LBR) Program in 2007 to raise awareness of point-specific localized bottlenecks at the state level and promote low-cost, quick-to-implement geometric and operational improvements to address recurring chokepoints. One of the first activities of the LBR Program was a survey of FHWA Division office personnel to obtain state best practices in bottleneck identification, assessment, countermeasures, and evaluation, including examples of overcoming unique challenges such as strategies requiring a design exception, cooperation among several departments, creative funding, and public perceptions. A compendium of state best practices was developed from these responses. More details on the LBR Program are provided in Section 1.4.

Previous Similar Bottleneck Efforts

TOPICS

The Federal-Aid Highway Act of 1968 established the Traffic Operations Program to Improve Capacity and Safety (TOPICS). The program authorized $200M in Federal matching to fund projects designed to reduce traffic congestion and facilitate the flow of traffic in urban areas. Although candidate projects were not planned to the same scale as regional planning processes,[1] TOPICS was a landmark program in demonstrating the concepts and effectiveness of traffic management practices.

[1] Weiner, Edward, *Urban Transportation Planning in the United States: An Historical Overview. Revised and Expanded Edition.* Praeger Publishers, Westport, Connecticut, 1999.

1.4 The Localized Bottleneck Reduction Program

FHWA's Localized Bottleneck Reduction (LBR) Program promotes operational and low-cost bottleneck mitigation strategies to improve mobility. Managed by the Office of Operations, the program serves to bring attention to the root causes, impacts, and potential solutions to traffic chokepoints that are recurring events; ones that are wholly the result of operational influences. This is "good and bad" news in the sense that design influences can always be corrected, but some corrections may be cost-prohibitive in terms of direct construction costs or indirect right-of-way impacts. Regardless, a significant amount of locations can be corrected for relatively low-cost and/or low physical impact. In any case, the goal of the program is to raise awareness of bottlenecks at the state level and promote low-cost, quick-to-implement geometric and operational improvements to address recurring chokepoints. The LBR Program has several activities either completed or underway, including:

- This guidance document, which provides guiding principles and concepts common to low-cost operational improvement programs to assist states in adopting a programmatic approach to addressing traffic congestion at bottlenecks.
- *Traffic Analysis Toolbox Volume X: Localized Bottleneck Congestion Analysis – Focusing on What Analysis Tools are Available, Necessary, and Productive for Localized Congestion Remediation.* This document provides guidance on analysis tools and data inputs required to analyze the specific genre of localized congestion problems.
- *Recurring Traffic Bottlenecks: A Primer – Focus on Low-Cost Operational Improvements.* This Primer is the "face" of the program. It provides an overview of the wide range of operational and low-cost strategies available to reduce congestion at bottlenecks.
- A compendium of state best practices in bottleneck identification, assessment, countermeasures, and evaluation, including how bottlenecks are treated in the annual planning and programming processes.
- Localized Bottleneck Reduction Regional Workshops. Regional workshops for state and local agencies to learn and share information on localized bottleneck reduction strategies and how they can be incorporated into state and local planning processes.
- Many of the items listed above can be found at the FHWA bottleneck web site, which can be found at the FHWA Office of Operations web site.

Additional guidance documents are forthcoming that are aimed at agencies and personnel who have first responsibility to address bottleneck congestion locations.

2.0 How to Structure a Localized Bottleneck Reduction Improvement Program

2.1 Roles and Responsibilities

There really are no set guidelines for roles and responsibilities of an LBR program. State DOTs, MPOs, or local transportation agencies could all lead an effective LBR effort. State DOTs and MPOs are traditionally the organizations who lead LBR efforts simply because they usually have larger missions, which include bottleneck issues; as well as access to a variety of funding mechanisms. Many successful LBR programs actually depend on a high level of coordination between state DOTs and MPO. Many times, the state may identify bottlenecks and work closely with MPOs to integrate these projects into their TIP and other targeted funding sources such as CMAQ and safety. However the split or leadership role, any transportation agency can lead an effective program.

2.2 Options for Structuring the LBR Program

Those agencies that have been effective at dealing with bottlenecks have developed either special or ongoing programs specifically targeted at dealing with current bottleneck projects. The options for structuring an LBR program vary widely, as described in this section.

Barriers to Establishing the LBR Program

States have cited a number of barriers to establishing bottleneck-specific or similar programs that target chokepoint congestion:

- **A predisposition for large scale, long-term congestion mitigation projects**. Traditional transportation planning and programming efforts are often predisposed toward major capital improvement projects to relieve congestion such as corridor-widening or massive reconstruction of an interchange. There is also no shortage of demand management strategies designed to fight the congestion battle, such as HOVs, tolling and pricing, transit alternatives, and ridesharing programs. But the onerous processes involved in many of these initiatives can squeeze out smaller programs.
- **Lack of program identity**. Unless there is a formal program identity, bottleneck remediation is usually relegated to a few projects completed as

part of an annualized safety program, or as a subordinate part of larger, other purposed projects.

- **Lack of a champion**. Many successful state or metropolitan planning organization programs are the result of one or more persons taking charge to either mandate or adopt a program. High-level administrators often set the policy direction and strategic initiatives for their agencies, while mid-level managers' production reflects their priorities and skills in executing those initiatives.

- **Lack of resources**. Many state agencies are finding themselves overworked and understaffed. Although the return on investment for LBR projects are high, agencies often do not have the in-house resources necessary to conduct detailed analyses required to evaluate and prioritize the large number of potentially competing projects. With limited resources, agencies are relegated to hiring consultants and/or universities to conduct detailed project analysis.

- **Lack of funding**. With many state agencies experiencing major budget shortfalls, lack of funding continues to be an often cited barrier to implementing new programs.

- **Responsibility has not been assigned.** Not part of ongoing planning and programming processes. Localized bottleneck mitigation projects are not often included in the ongoing planning and programming processes for most agencies. Others struggle with how best to identify problem locations, assess existing conditions, and quantify the impacts of proposed remedies, as there is no structured process in place. For example, in developing their structured LBR program, Michigan DOT cited challenges regarding how best to justify and evaluate project impacts while creating a level playing field for application of LBR funding across each of their seven regions.

- **A culture of historical practices**. Many agencies face institutional challenges in changing their current business practices. For example, one agency dutifully executed an annualized "safety" program and looked only at crash rates in determining their annual top 10 list of projects. After instituting a congestion mapping process, they identified several significant stand-alone chokepoints that did not correlate with their high-crash mapping. Thereafter, high congestion hot spots competed with high accident hot spots on their unified top 10 list of projects.

The options for structuring an LBR program vary widely. One approach is to undertake a one-time special program or periodic special initiatives that focus on bottlenecks. Other approaches incorporate annualized reviews or ongoing programs – similar to annualized safety-spot lists – that organized candidate locations and identify them for relatively short-term (e.g., two years or less) attention.

Periodic Special Program or Initiative

For example, in 2007, **the Minnesota DOT** was asked by the Legislature to develop a rapid turnaround plan to identify low-cost, quickly implementable **projects that were *not already identified* by the traditional planning and programming processes.** In a matter of months, this unique approach led by the Traffic Management Center engineers basically "brainstormed" low-cost, candidate projects that were nagging problems, but for whatever reasons, had never landed on traditional Capital Improvement Programs. In 2008, the **Central Arkansas MPO** undertook "Operation Bottleneck," a campaign to openly solicit public input of candidate locations, but one that has a finite life span.

Due to resource limitations, some agencies are using research funds to sponsor special projects involving in-depth analysis of the causes and temporal variations at key bottleneck locations. For example, in the Phoenix metropolitan region, **Arizona DOT** commissioned a special research study to identify freeway bottlenecks and provide a detailed assessment and recommendations of countermeasures. **Wisconsin DOT** partnered with a research agency to identify bottleneck reduction strategies and to develop a *Paramics* model to perform in-depth simulation of the proposed strategies. They plan to expand the project to include other bottleneck locations statewide.

Incorporating Bottlenecks into Other Programs

State DOT Level

At the state DOT level, low-cost bottlenecks can be addressed programmatically even without a special program or initiative. One approach is to conduct a review of existing plans and look for opportunities to include LBR improvements in them. For example, **Caltrans**, as part of their Corridor Management Process, includes the identification of bottlenecks and potential short-term fixes as part of an overall and long-term strategy for making corridor improvements. This often takes the form of an "LBR audit," which is a review of traditional large-scale corridor studies to identify opportunities for using LBR improvements as part of the package of improvements. The concept here is similar to that of Road Safety Audits.

Another approach is to integrate bottleneck strategies as part of ongoing planning and processes, thereby incorporating them into an agency's congestion mitigation toolbox. For example, the **Ohio DOT** added a congestion-based index ranking to their annual identification of spot safety problems for the Federal Hazard Elimination Program (HEP). As a result, congestion hot spots now have a "voice" regardless of crash indices, and congestion-related projects compete for attention in the project selection and scheduling process.

Washington State DOT recognizes bottlenecks and chokepoints as an integral part of their project planning and development process. The recent *Moving Washington* initiative incorporates LBR concepts into a coordinated program to address congestion. In the *Moving Washington* program, WSDOT applies three balanced strategies to fight congestion – operate efficiently, manage demand, and add capacity strategically. By strategically adding capacity, WSDOT targets bottlenecks and chokepoints in the transportation system, and does so cost-efficiently. Recent funding shortfalls have made low-cost, strategic investments a high priority with WSDOT and LBR projects fill this role nicely. Performance results show that *Moving Washington* strategies and projects are making a difference around the State to relieve congestion.

At the planning stage in their Highway System Plan, WSDOT considers bottlenecks together with traditional corridor improvements under the "Congestion Relief" category. Congestion relief projects are ranked using the benefit/cost ratio, contribution to performance goals, and other qualitative factors, and compete on these bases with projects in other categories in the Highway System Plan: Preservation, Safety, Environmental Retrofit, Economic Vitality, and Stewardship.

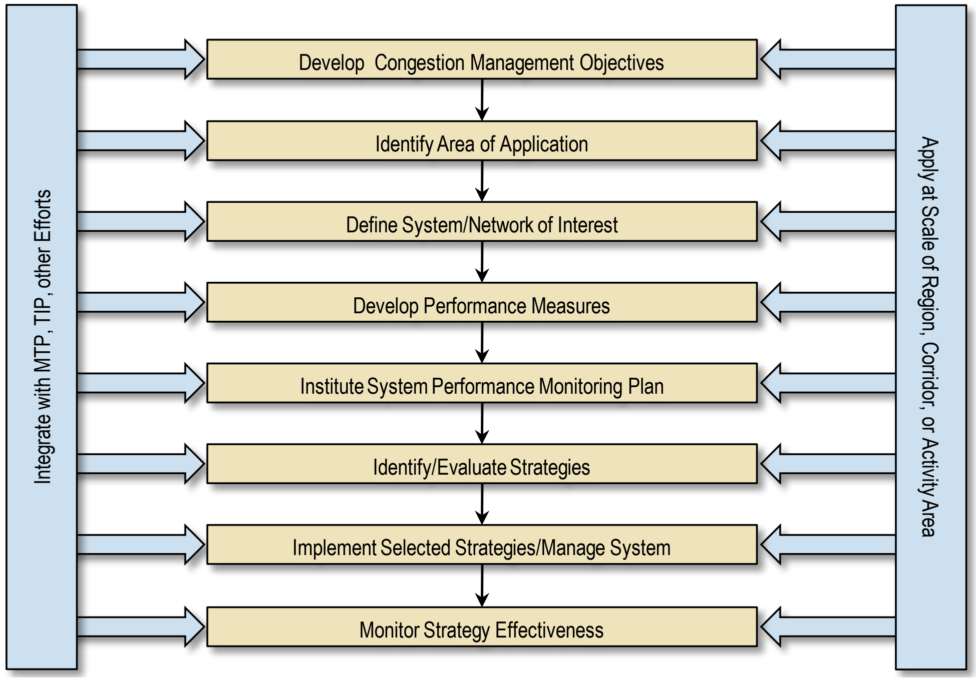
MPO Level

At the metropolitan planning organization level, the short-term nature of LBR projects meshes well with the Congestion Management Process (CMP) and "planning for operations," which are new initiative areas for planners. As planners' perspectives broaden to include these short-term views of the system (in addition to the traditional long-range view), an LBR program makes perfect sense. In fact, one idea may be to include consideration of an LBR program within one the CMP and/or "planning for operations" guidance being developed by FHWA. The idea is not to make an LBR program subordinate to these initiatives but rather to integrate it into the initiatives, noting that LBR is an effective way to address current congestion problems.

From a planner's viewpoint, LBR improvements would be another aspect of the CMP process. Because an LBR program should be data- and performance-driven, it is a logical complement to a CMP; the same data should be used for both purposes. In fact, the steps required to implement an LBR program directly mimic the eight-step CMP process: problems are identified, countermeasures are developed to address the problems, funding is identified, and projects are implemented, and evaluation occurs. Figure 2.1 shows the eight-step CMP process, which bears remarkable similarity to the steps that need to occur within an LBR program. An LBR program is a natural extension of what planners are already doing. In fact, within the context of the CMP, it may useful to make the two processes seamless, at least at the MPO level.

Therefore, there is a strong case for encouraging planners to be engaged in the development and operation of an LBR program.

Figure 2.1 Steps in the Congestion Management Process



Identified LBR Program

Another option is to establish a defined bottleneck program within the agency. For example, **Virginia DOT** has implemented the Strategically Targeted Affordable Roadway Solutions (STARS) Program, which is a safety and congestion program that partners state, planning district and local transportation planners, traffic engineers, safety engineers and operations staff to identify "hot spots" along roadways where safety and congestion problems overlap and are suitable for short-term operational improvements. In summary, the STARS program "road audits" are shelf-ready when budget and/or opportunity (e.g., proximity development plans) are available.

Some agencies were originally driven to explore low-cost congestion relief projects because of budgetary restrictions, but soon realized that these projects could be implemented very quickly and, as a bonus, were highly visible and popular with the public. Several DOTs have been able to create a defined bottleneck program area as a result of their success with special initiatives such as these. For example, as a result of their initial success, **Minnesota DOT** was able to develop a highly accelerated process for bottleneck identification and prioritization, which led to many effective projects in the following two years. Mn/DOT also found that because of lower costs, it could identify multiple locations throughout the region and "spread around" bottleneck reduction projects in a fair and equitable manner. **Utah DOT** initiated a Choke Point Program in 2006 to address safety, congestion, and bottleneck areas. It was so successful that the Utah Legislature put forth funding for additional chokepoint projects.

Other agencies are developing dedicated LBR Programs in response to FHWA Localized Bottleneck Reduction Workshops held around the United States in 2009 and 2010. These include **Indiana DOT** and **New York DOT**.

2.3 Factors for Success: What Does an LBR Program Have to Consider?

The institutional or policy component of localized bottlenecks is extremely important because of the way that agencies and processes have been structured. This is similar to the situation that systems operations and management (O&M) faced 10 to 15 years ago: there was no organizational unit set up to deal with operations and management. As a result, O&M struggled to find an identity in most agencies, and development of O&M programs were hindered. Likewise, LBR programs face institutional and policy barriers. Therefore, one key aspect is to understand the challenges facing agencies in defining a programmatic structure for dealing with bottlenecks. Some of these issues include:

- Competition for funding with other traditional programs;
- Implementation issues such as meeting design standards and conformity requirements;
- Choosing between a temporary, permanent, or periodic (recurring every few years) program for an LBR program;
- Creating a new organization versus imbedding an LBR program within a current program area (e.g., planning or maintenance); and
- Developing management support for an LBR.

This section presents success factors for overcoming these challenges in order to implement a LBR program.

Setting Goals and Objectives for an LBR Program

Setting goals and objectives is an important part of framing the establishment of an LBR Program within an agency. The following success factors were identified from case study examples:

- Relate the goals of the LBR program to the operating objectives of the agency as a whole;
- Gain the public's support in targeting and fixing smaller bottleneck issues in a timely manner;
- Utilize rapid methods to identify and evaluate bottlenecks; and

- Create separate funding mechanism for bottleneck mitigation or ensure bottleneck projects can compete equitably through traditional methods.

New York DOT's Region 11 Planning Office (New York City) established their LBR Program with a mission to mitigate recurring congestion at selected chokepoints along the region's highways, local streets, and intersections, and the operational influences that cause them. Their goal was to investigate the opportunities as well as develop measures for the application of operational and low-cost infrastructure improvements to address chokepoints and to identify cost-effective improvements either as stand-alone initiatives or as part of existing Capital Projects, with an overall objective of moving project recommendations into the capital program.

Championing an LBR Program

The need and urgency for establishing a LBR Program is not always shared across all levels of an agency. Nevertheless, a clear case must be established with upper management and elected officials to secure resources and commitment to proceed with LBR activities.

One way to accomplish this is to **demonstrate the return on investment** to the organization regarding the implementation of an LBR Program, as well as developing a sustainable approach for assessing the impacts of LBR improvements.

For example, in developing their structured Bottleneck Reduction Program, Michigan DOT's Systems Operations and Management (SOM) Section sought to obtain leadership support by requesting a dedicated funding template specifically for bottleneck reduction projects. MDOT does not have any dedicated funding at this time, but it is being discussed. They have developed a systematic approach for demonstrating excellent benefit-to-cost ratios among Bottleneck Reduction projects, which helped to justify the creation of the statewide Bottleneck Reduction Program. MDOT is performing analysis on existing road improvement projects so recommendations can be implemented within the existing projects until dedicated funding is approved.

Other ways to raise visibility include:

- Appointing one element (person or office) within an organization that is the **single point of contact** and champion for the LBR program. Having a sustained champion can greatly enhance the effectiveness of the program within an organization.
- **Involving the public** in identifying bottlenecks is another way to raise the visibility of the program while at the same time building momentum within the organization.

Personnel/Unit Responsible for the LBR Program

The roles and responsibilities for planning and operations usually fall within separate and distinct departments within a typical state DOT. Coordination between departments can improve how an agency tackles bottleneck congestion. A review of state DOTs that have successfully implemented LBR programs within their organizations revealed that having an interdisciplinary team or committee responsible for administering the LBR program is a useful consensus building tool. These teams would facilitate activities of mutual interest such as:

- Identifying strategies to address bottlenecks;
- Developing bottleneck performance measures that are consistent across the agency;
- Coordinating data collection and developing tools for data analysis;
- Developing models to quantify the impacts of bottleneck strategies; and
- Overseeing implementation of bottleneck mitigation strategies and objectives through the TIP or LRTP.

For example, **New York DOT's Region 11** LBR Program is administered through an interdisciplinary project scoping team headed by the Planning Director, but whose members are comprised of staff from other functional groups within the agency. Such an approach is a useful tool for building consensus on the nature of transportation problems, the key issues, and best strategies to address bottlenecks. It also creates a forum for early buy-in of preferred alternatives and courses of action across each of the various functional groups.

Indiana DOT is establishing their LBR Program as part of an overall organizational change as they transition to a new funding system that is asset management based with multiple funding teams. As part of the new structure, they are establishing a Mobility Asset Team.

LBR Program Funding

This section presents success factors and examples of how states/MPOs have funded LBR projects. Options include:

- Developing a funding decision matrix where bottleneck countermeasures compete for funds alongside other mobility and congestion management projects based on benefit-to-cost ratio;
- Funding low-cost improvement projects as part of a dedicated signal timing program; and
- Implementing a dedicated program to provides funding for districts/regions to implement low-cost improvement projects.

For example, the Mobility Asset Team (described shortly above) at **Indiana DOT** will fall under the LBR funding category. INDOT expects that bottleneck countermeasures will have a very good benefit-to-cost ratio and projects will be competitive in the funding decision matrix that is part of the new funding system.

In 2008, **Ohio DOT** initiated a new Systematic Signal Timing Program that provides district offices and local governments with technical assistance (task order consultants) to analyze, coordinate, and upgrade the timing and phasing of signal systems in high-crash areas. Funding can also be used to upgrade signal equipment as needed. Funding is targeted to those areas listed as a top crash priority by ODOT, MPOs, or local governments. Project sponsors must verify that the crash patterns are relevant to signal timing concerns. Funding requests are funneled through the appropriate ODOT district office, which typically must concur with the request for assistance.

Funded by the Utah Legislature, the **Utah Department of Transportation** (UDOT) initiated a Choke Point Program in 2006 to address safety, congestion, and bottleneck areas. It was successful, so the Legislature put forth more funding for additional chokepoint projects. The UDOT has used the Choke Point Program to identify potential projects that could improve operations and safety with relatively low cost and in a short time period.

Pennsylvania has in place a Congestion Corridor Improvement Plan (CCIP) which provides funding for districts/regions to study low-cost improvements. However, this program has not been funded since 2008. It is hoped that the program will be resumed whenever funding is available.

The LBR Planning Process

Planning for localized bottleneck improvements includes a number of steps that could happen in a number of ways. But regardless of the approach, they can be loosely organized into the following five broad steps:

1. Bottleneck Identification;
2. Identify Bottleneck Improvement Strategies;
3. Prioritize Projects;
4. Programming and Implementation; and
5. Evaluate Bottleneck Improvement Projects.

The remainder of this section expands on each of these steps. Later in Section 2.0 of this document, the unique approaches an agency could take in starting their own LRB program are presented but they are all variations on these steps.

Bottleneck Identification

There is a variety of methods for bottleneck identification. One of the primary methods is a data-driven approach, where roadway characteristics data are used to identify chokepoint locations. Potential data sources include ITS data from traffic management centers, or roadway characteristics and traffic data from statewide traffic and HPMS monitoring locations. Traffic analysis tools can be used to systematically identify bottleneck locations by analyzing road segments for congestion or poor levels of service. For example, at **Caltrans**, system monitoring and evaluation using the Performance Monitoring System (PeMS) is seen as the foundation for the entire Corridor System Management Plan process because it cannot only identify congestion problems, but can also be used to evaluate and prioritize competing investments.

Bottleneck locations can also be identified anecdotally by tapping into local agency knowledge and personal experience (e.g., district-level), direct observation of local agency personnel, aerial photographs, or video surveillance data. For example, when **Michigan DOT** solicited potential bottleneck locations, they were sure to include problem descriptions from each of their seven region offices and not merely their headquarters' analysis. More than 200 locations were identified, with about one-third being freeway interchanges.

There is a hybrid approach where anecdotal information and judgment is used to identify candidate locations but data are used to assess priorities objectively. For instance, the following conditions typically exist or help to identify a recurring bottleneck condition:

- A traffic queue upstream of the bottleneck, wherein speeds are below free-flow conditions elsewhere on the facility.
- A beginning point for a queue. There should be a definable point that separates upstream and downstream conditions. The geometry of that point is often coincidently the root cause of the operational deficiency.
- Free flow traffic conditions downstream of the bottleneck that have returned to nominal or design conditions.
- As it pertains to an operational deficiency, a predictable recurring cause.
- Traffic volumes that exceed the capacity of the confluence to process traffic. (Note: This applies to recurring events even more so than nonrecurring.)

Some metropolitan areas have even conducted public outreach efforts to solicit input from motorists on bottleneck locations. For example, **Metroplan, the MPO for the Little Rock, Arkansas region**, conducted Operation Bottleneck during the fall of 2008, a public outreach effort designed to identify traffic bottlenecks, as well as automobile, bicycle, and pedestrian safety issues throughout the region. The program received 3,000 responses within two months, with on-line submissions constituting the highest return. Several minor roadway improvements have already been completed or are planned as a result of the program.

Bottleneck Improvement Strategies

This section describes the types of LBR treatments, as well as a matrix on matching bottleneck treatments to needs. It also describes various barriers to implementing LBR treatments such as design standards/exceptions, air quality conformity, and consistency with long-range design concepts.

Types of LBR Treatments

The following is a sampling of short-term, low-cost operational and geometric improvements. All of these remedies address operational deficiencies, as opposed to other congestion mitigation efforts that address driver choice, travel demand, corridor-wide upgrades, or simply (but expensively) building our way out of congestion.

1. **Shoulder conversions.** This involves using a short section of traffic bearing shoulder as an additional travel lane. Shoulder conversions are appropriate between interchanges or to provide lane congruency with adjacent sections. The shoulder condition should be rated for use as a travel lane.
2. **Restriping merge or diverge areas** to provide additional lanes, provide an acceleration/deceleration lane, extend the merge/diverge area, or improve geometrics to better serve demand.
3. **Lane width reductions.** This involves reducing lane widths and restriping to add an additional travel and/or auxiliary lane.
4. **Modify weaving areas** by adding collector/distributor or through lanes.
5. **Ramp modifications.** These could include ramp metering; widening, extending, closing, or consolidating ramps; or reversing entrance and exit ramps to improve operations.
6. **Speed harmonization (variable speed limits)**. This is the practice of adjusting speed limits when congestion thresholds have been exceeded and congestion and queue forming is imminent. Speed harmonization can also be used to promote safer driving during inclement weather conditions. This mostly European practice reduces the traffic "shock wave" that results through congested corridors, thereby delaying the onset of a breakdown in traffic conditions. The result is decreased headways and more uniform driver behavior, which indirectly benefit bottlenecks and chokepoints.
7. **"Zippering" or self-metering that promotes fair and smooth merges.** A motorist who is 10th in line knows that he will be 20th to merge into the single lane ahead. This helps to eliminate line jumpers that bull ahead, disrupt the queues, and often block adjacent lanes until they force their way in line. Usually this method of merging requires on-site enforcement, but often is exhibited by regulars who know the process and are willing to abide.
8. **Improve traffic signal timing on arterials.** Also, traffic signal timing improvements at ramp terminal intersections will prevent ramp queues from backing up onto freeway main lanes.
9. **Access management principles** to reduce vehicular conflicts (hence, delays) on arterial corridors

10. **Continuous flow intersections.** These are unconventional at-grade intersections, which eliminate one or more left-turn conflicts at a main intersection. This is achieved through dedicated left-turn bays located several hundred feet prior to the main intersection, which allow left-turning vehicles to move at the same time as through traffic. The left-turn traffic signal phase is eliminated, allowing more vehicles to move through the main intersection and thus reducing traffic congestion and delays. These at-grade intersections achieve traffic flow similar to grade-separated interchanges, but at a considerably lower cost.
11. **High-Occupancy Vehicle (HOV) or reversible lanes.**
12. Provide **traveler information** on traffic diversions.
13. **Implement congestion pricing.** Congestion pricing entails charging fees or tolls for road use that vary by level of vehicle demand on the facility. The objective is to bring supply and demand into alignment.

Matching Bottleneck Treatments to Needs

In 2006, as part of the research conducted for National Cooperative Highway Research Program Project 3-83 ("Low-Cost Improvements for Recurring Freeway Bottlenecks"), a series of interviews was conducted with state and local transportation agencies to assess the effectiveness of low-cost improvements used at bottleneck locations within their jurisdictions. The results showed that agencies are using a wide range of strategies to improve bottlenecks, many of them low-cost improvements that can be implemented quickly. The most frequently used operational improvements were ramp metering, auxiliary lanes, and HOV lanes.

Some of the key questions and considerations when selecting improvement alternatives for bottleneck removal include:

- Is there an inside shoulder that would create a usable traffic lane for a short section of freeway?
- If a shoulder is considered for conversion, is there right-of-way (ROW) to allow adding one back for part of the length of the project?
- If there are bridges, are they wide enough to accommodate the extra lane while allowing adequate clearance to barriers (2 feet) and an outside shoulder? If not, are they short enough that a loss of shoulder as a breakdown lane would not be critical (500 feet or less)?
- If changes to an entrance or exit ramp or weaving area are considered, will adjusting the position of ramp gores cause geometric problems which must be resolved?
- Are vertical clearance issues, grade-matching, and sight distance problems created?

- If the bottleneck movement itself cannot be fixed reasonably, can the other traffic which is affected by it be better accommodated?
- Finally, will the improvement invite enough new traffic to cause immediate breakdown again or is this truly the clearing up of a "kink" in the system, without being a capacity addition that will overload some other part of the facility?

Barriers to Implementing LBR Treatments

Because some bottleneck treatments involve innovative solutions that maximize effectiveness with a minimum of new construction, they are occasionally at odds with **highway design standards**. A design exception may be required. For example, the addition of slip ramp to a collector/distributor road or the use of a shoulder as a through lane at selected locations may not strictly follow allowable design standards. Such deviations have the potential to degrade safety if not properly implemented; the elimination of a shoulder may lead to more collisions with roadside features or may impede incident management activities. As it is FHWA's intent to foster creative approaches for low-cost bottleneck improvements, agencies should not see the design standard issue as insurmountable. Rather, they should fully assess the potential safety impacts of strategies and devise ways of addressing them, if necessary. For example, in the case of a shoulder-to-lane conversion, review of crash data, and the specific roadway location (perhaps through a Roadway Safety Audit), it may be determined that a barrier is required to keep vehicles off of the roadside. It may also require a change in incident management policy that would allow emergency vehicles to access incidents from the opposite direction. Finally, agencies should be in contact with the FHWA Division offices throughout the process as design review may be required, depending on circumstances.

The second potential issue relates to **air quality conformity**. Because they are short term in nature, localized bottleneck improvements may emerge as formal projects that have not been previously identified in Statewide Transportation Improvement Programs or MPO-generated Transportation Improvement Programs. Thus, they may not be part of those projects that have been approved to deal with air quality issues in the region or state. Such occurrences must be dealt with on a case-by-case basis by agencies wishing to undertake bottleneck improvements. One point worth noting: if air quality conformity in a location precludes or discourages major capital expansion (e.g., additional lane-miles), the type of improvements in a localized bottleneck program clearly do not fall in this category.

Finally, another potential barrier is that **bottlenecks may not be seen as consistent with Long-Range Design Concepts**. As discussed previously, most bottleneck mitigation strategies such as roadway widening, left-turn lengthening, auxiliary lanes on freeway, or improvement of weave/merge areas may all be seen as distracting resources from larger design solutions, which will be made anyway in a larger longer-term project already in a 20-year plan. Agencies must decide and weigh the benefits themselves whether the cost of doing a smaller bottleneck solutions in the short terms against the cost of waiting for a more complete solution.

Bottleneck Assessment/Analysis Methods

Once bottleneck locations have been identified, the root cause and severity must be determined. Special travel time runs, aerial photography, or video of suspected bottleneck areas can be used to pinpoint sources of operational deficiencies. On freeways equipped with detection technology, dynamic surveillance can be used to identify where and how often bottlenecks occur, and how severe they are. Archived traffic data can be used to measure whether the problem is growing or receding.

Sometimes, the operational cause of a bottleneck is evident, intuitive, or anecdotal. However, when multi-mile corridor congestion is prevalent, microsimulation modeling can assist in identifying, separating, and analyzing bottleneck dynamics within the corridor.

Bottleneck analysis is necessary to study not only the subject location, but also the impacts of potential bottleneck remediation on upstream and downstream conditions. The analysis will justify action to correct bottlenecks, confirm the benefits of bottleneck remediation, or check for hidden bottlenecks along a corridor. When conducting bottleneck analysis, care should be taken to ensure that:

- Improving traffic flow at the bottleneck location does not just transfer the problem downstream. The existing bottleneck may be "metering" flow so that a downstream section currently functions acceptably, but the increased flow will cause it to become a new bottleneck.
- Future traffic projections and planned system improvements are inclusive in the analysis. Safety merits also should be strongly considered.
- "Hidden bottlenecks" are considered. Sometimes, the queue formed by a dominant bottleneck masks other problems upstream of it. Improving the dominant bottleneck may reveal these hidden locations. It is important to take into account the possibility of "hidden bottlenecks" during the analysis stage.
- Conditions not traditionally considered by models are accounted for. There are several bottleneck conditions, such as certain types of geometrics and abrupt changes in grade or curvature, that cannot be analyzed by current analysis tools. Engineering judgment will need to be exercised to identify those problems and possible solutions.

For example, **New York DOT's Region 11 LBR Program** is comprised of an interdisciplinary team headed by the Planning Director. The LBR Team compiles various completed studies and will bring other agencies on board as needed in order to develop a current inventory of bottleneck locations citywide; develop screening criteria; select and recommend priority locations for improvements; develop strategies for the selected locations and prepare the implementation plan. Projects are selected based on the following screening criteria: 1) project cost less than $10M; 2) annual vehicle-hours-delay > 25,000 hours; 3) speeds < 30 mph; 4) requires little or no environmental documentation; and 5) projects NOT already programmed in the TIP. The LBR Team works with Program Management to address project programming, funding, and schedule issues, and they coordinate with local MPO staff regarding any TIP and/or conformity issues. As the work of the LBR program becomes better defined and develops greater focus, the team will expand to include other external agencies as well.

In **Utah DOT's Choke Point Program**, potential projects are identified through public observations in the regions and input from users and local governments. Potential projects are then selected and prioritized based upon several factors, including average annual daily traffic (AADT), volume to capacity ratio (V/C), constructability, region priority, and accident rates. Qualifying criteria for potential projects include: 1) small safety, capacity or bottleneck projects that cost less than $10M; 2) can qualify for a categorical exclusion; 3) can be designed and constructed within one year; and 4) require minimum right-of-way needs. Examples of chokepoint projects include roadway widening, left-turn lengthening, dual left-turns, auxiliary lane on freeway, intersection or signal improvement, passing lanes on rural routes, and improvement of weave/merge areas.

Evaluating Bottleneck Improvement Projects

After implementation, it is often beneficial to conduct an "after" evaluation to gauge the effectiveness of the bottleneck removal project. A conservative approach to evaluating treatment effectiveness is to evaluate operational and safety benefits achieved. Common evaluation methods include microsimulation modeling, benefit/cost analysis, and crash data analysis using data collected before and after project implementation. In addition, the following performance measures are often used to assess the effectiveness of bottleneck improvement strategies: average speed (travel time), lane density, queue lengths, queue discharge rates, vehicle miles of travel (VMT), and vehicle hours of travel (delay). Additional insight could be obtained from before and after opinion surveys of area drivers. These types of evaluations are often not done, yet are important to quantify the benefits achieved through bottleneck mitigation.

Bottleneck Performance Measures in Bottleneck Assessment and Evaluation

This section describes bottleneck performance measures, data and methods needed to develop the metrics, presentation of performance measure results, and matching bottleneck treatments to needs.

Metrics

There are a number of metrics, which could be used to identify and track the results of bottleneck mitigation strategies. Below is a list developed by the Mn/DOT.

- Percentage of miles congested (i.e., number of directional miles with speeds < 45 mph during peak periods);
- Total daily delay (volume x time difference between actual and posted speed);
- Reliability (TTI – Congestion Index/Travel Time Buffer Index);
- Miles of FIRST/incident response coverage;
- Number of hours where volume > capacity;
- Frequency of signal retiming;
- Percent of arterials with coordinated signals;
- "Before/After" benefit/cost ratio of corridor improvements;
- "Before/After" benefit/cost ratio of signal retiming;
- Customer satisfaction survey of peak-hour travel (omnibus transportation survey);
- Percent of MUFS instrumented;
- Planned lane closures System;
- Unplanned lane closures System;
- Average clearance time for snow and ice removal;
- Average clearance time for freeway incidents; and
- Throughput (i.e., number of vehicles through a specific corridor or across a screenline over a specified time period).

Data and Methods Needed to Develop Metrics

Data collection to support bottleneck analysis should be sufficient to capture the duration and extent of congestion. Typically, 15-minute traffic volume counts for all ramps and main lanes for a four-hour peak period are adequate. Other data can be collected through travel time runs, video, or origin-destination studies. Many regional TMCs are archiving the data from their systems and can be a very helpful resource.

Presentation of Performance Measures

Performance measures can be presented in a number of formats. The one recommended for this effort include routine reports on an annual or semiannual basis. If more frequent reporting is required, many emerging on-line reporting tools are becoming available that provide robust dashboard style results to easily convey to leadership and the public the status of a bottleneck program.

2.4 Bottleneck Self-Assessment

Table 2.1 describes procedures for agencies to conduct an LBR Self-Assessment to establish where they currently stand with regard to implementing a bottleneck program, perhaps to the level of identifying at which "stage" it is.

Table 2.1 Bottleneck Programming Maturity Model Matrix

Level	0 – Ad Hoc	1 – Aware	2 – Planning	3 – Defined	4 – Managed	5 – Integrated	6 – Continuous Improvement
Institutional	No structured LBR Program in place.	Some level of bottleneck recognition.	Agency is discussing needs/ plans for a structured LBR program.	Development of a formal LBR program is underway.		A formal LBR program is named and established, either as a separate program or part of another program.	
Organizational	No LBR Program Champion or Team in place.	Agency is aware of the need for a LBR Program champion and Team to support LBR activities.	Some level of LBR program assessment and formulation of roles for LBR Team is underway in one or more offices of agency.			Specific staff have the responsibility for oversee a formal LBR program.	
Planning/ Programming	LBR strategies are not included in agency planning/ programming processes.	Agency has developed procedures for considering LBR strategies in the planning and programming processes.		LBR strategies becomes a component of the CMP.	LBR strategies integrated with short- and long-term planning and programming.	LBR strategies appear in planning and programming documents: MPO TIP, LRTP, annual programmed projects list.	
Performance Measures	No defined practices and techniques for bottlenecks.	Agency has produced a set of procedures for measuring performance of bottlenecks (evaluation procedures).		Selected LBR projects are evaluated.	LBR projects are routinely evaluated.	LBR projects are highlighted in agencywide reports of congestion and safety.	
Assessment/ Analysis Tools	No defined tools to support bottleneck assessment/ analysis process.	Agency has defined procedures for identifying and assessing LBR strategies.				A combination of analytical methods are used at different stages of LBR assessment and evaluations.	

2.5 TEMPLATES FOR GETTING STARTED

This section introduces three templates that transportation agencies can consider in developing their own LBR Program. Each template includes an overall description of the approach, a bullet list of the key elements of the approach, followed by a step-by-step guide to implementing the template. Finally, each template concludes with a real-world example of the approach discussed.

The following templates are included in Appendix A.

- Template #1: Public Outreach Identification Process;
- Template #2: Leverage Existing Non-Bottleneck-Related Processes; and
- Template #3: Internal Identification Processes.

2.6 SUSTAINING A SUCCESSFUL PROGRAM

Once a LBR program has been established, its ongoing success will be based largely on two factors, funding and institutional integration. If funding for LBR programs is either dedicated or at least available through traditional sources, the chances that LBR issues will be considered in the future is very high. If, however, an agency goes through the initial effort of setting up a LBR program and is at the end of the process unable to secure dedicated funding, or at least access to traditional sources, the program will not remain viable. It is, therefore, critical that agencies consider funding options early on in the process. That is not to say LBR effort should not be initiated without funding secured; just the opposite. Many times the effort of setting up the LBR program can build enough momentum within an organization to secure funding or at least ensure access to compete with for funding.

Likewise, sustaining an LBR program will be much easier if the program is integrated into an organization. If identifying and evaluating LBR projects can become part of the core mission of the agency, the LBR program will continue even after the initial champions have left the organization or been reassigned.

2.7 SIGNS OF A LATENT PROGRAM

It may be prudent here to take a moment and discuss “when is a program *not* a program,” that is to say, when a program has de-evolved to not-producing effective mitigation projects.

Certainly, there are some administrative actions that would annul any active program. Foremost among these would be budget cuts, new administration initiatives, and emergencies. But in context of recognizing a dormant localized congestion mitigation effort, here are some vital signs to check.

- **Projects are not being produced under "low-cost, short timeframe" measures.** The LBR program specifically does not define these terms in the context of the program; however, if projects are not being completed within "annualized" budgets, or are not being delivered in relatively short timeframes (e.g., a "construction season" as opposed to multiple out-years) then chances are these projects are outside the de facto definition of a "localized" congestion mitigation project.
- **Candidate project lists are drying up.** If a pre-standing list of candidate mitigation locations either does not exist or has not been updated for some time, then it may be a sign that program momentum has lapsed.
- **Is the work effort generally equitable to the project size?** Generally speaking, low-cost, short-term projects should have a much smaller planning and execution effort than large projects. By their very nature, these projects should be quick turn-around, low-cost, and high-yield benefits. However, if the project is bogged down with overly lengthy studies ("paralysis by analysis"), add-ons, or cost escalations, then it may be a sign that said project is beyond the scope of "localized."

All of the above signs of a latent program are further discussed in FHWA's "Traffic Analysis Toolbox X: Localized Bottleneck Congestion Analysis" (FHWA-HOP-09-042) which focuses on what level of analysis is appropriate and representative for the subject projects and programs. In summary, that document concludes that the level of analysis (of any problem) should roughly correlate to the size of the problem. **The main questions that this guidance helps an agency frame are: 1) do we have a satisfactory agency methodology to *specifically* address localized congestion problems; 2) within that program, do we have satisfactory justifications for project candidacy, selection, and solutions for said problems; and 3) are we executing these projects in a timely fashion and within budgets that are representative of the context of a "Localized Bottleneck Reduction" program?**

3.0 Additional Resources

3.1 Case Studies of Agency Programs

The following provide comparisons of how different state agencies have incorporated low-cost bottleneck projects into their planning and programming processes.

Caltrans

The California Department of Transportation (Caltrans) does not have a formal bottleneck planning process; rather, bottleneck issues are addressed at the district level as part of their Corridor System Management Plans (CSMP), which are developed for some of California's most congested transportation corridors. System monitoring and evaluation is seen as the foundation for the entire process because it cannot only identify congestion problems, but also be used to evaluate and prioritize competing investments. The CSMP includes the identification of bottlenecks and potential short-term fixes as part of an overall and long-term strategy for making corridor improvements. This may take the form of an "LBR audit," which is a review of traditional large-scale corridor studies to identify opportunities for using LBR improvements as part of the package of improvements. The LBR audit concept is similar to that of Road Safety Audits. Caltrans does not have a direct funding for bottlenecks, although bottleneck projects are routinely programmed through the CSMP process.

Florida DOT

In Florida, there is not a "bottleneck" planning process, per se; rather, bottleneck-related issues are addressed as part of the Florida Department of Transportation's (FDOT) standard planning process. The planning process, which is managed by the FDOT Systems Planning Office, begins with needs identification conducted at the district level, then projects are developed and proposed for the Cost Feasible Plan. The Cost Feasible Plan is adopted and projects are ranked for inclusion into the 5- or 10-year programs. Traffic data and the statewide model are used to identify deficiencies, but it is the responsibility of the districts to identify and resolve hot spots.

Indiana DOT

Indiana DOT is in the beginning stages of developing a bottleneck program, as they are transitioning to a new asset management-based funding system with multiple funding teams. A program champion has been identified. Funding for bottlenecks will fall under the newly formed Mobility Asset Funding Team. The program will initially focus on Interstates, although INDOT is still considering how to best identify the spot location bottlenecks. It is expected that bottleneck countermeasures will have a very good benefit/cost ratio and compete well in the funding decision matrix that is a part of the new funding system.

Maryland State Highway Administration

The Maryland State Highway Administration (SHA) has a dedicated program of about $5M per year for the identification and implementation of low-cost traffic congestion improvements at intersections. The program's genesis tracks to when SHA asked, "What can be done if and when a megaproject's 'no-build' alternative is chosen?" The program has been well received by the public and local governments. Projects typically include low-cost projects that can be implemented quickly, such as signal timing upgrades and adding turn lanes and through lanes at intersections. The Maryland SHA also has had considerable success with projects to improve freeway ramps and merge areas that have reduced congestion bottlenecks at a low cost.

Michigan DOT

Michigan DOT currently is in the process of developing a structured Localized Bottleneck Reduction Program. The effort began several years ago with structured changes at MDOT, during which MDOT officially reorganized their Maintenance and Traffic and Safety Divisions to create a Division of Operations. The next step was the formation of a new section titled Systems Operations and Management (SOM). One of their early charges was to develop an approach to identify and eliminate bottlenecks throughout the State. Several years previous to this reorganization, MDOT developed and utilized a "Choke Point" Program, and their current efforts are patterned after that effort.

One of the first official action steps that the SOM Section pursued was to solicit potential bottleneck locations and problem descriptions from each of their seven region offices. More than 200 locations were identified, with about one-third being freeway interchanges. Based on further review by the SOM Section, the total number of potential locations was reduced to approximately 125 locations, which they believed: 1) met their definition of a "bottleneck" location; and 2) had a potential cost-effective solution that could address the problem. One of the primary goals of this highly focused initial effort is to develop a documented and sustainable approach that can demonstrate excellent benefit-to-cost ratios, as well as justification for allocation and expenditure of funds on the statewide LBR Program. The underlying goal was to obtain leadership support and a dedicated funding template specifically for bottleneck reduction projects, which has now been achieved.

Many challenges exist as the Program and structure move forward. One primary challenge is the need to complete a detailed analysis necessary for a large number of potentially competing projects, as well as a freeway analysis of these projects. MDOT staff resources are limited and MDOT is reviewing the potential use of consultants and/or universities for project analysis. Another issue is how to justify and evaluate the impacts of the suggested changes as well as the existing problem. The intent is to create a level playing field for application of LBR funding by each of the seven regions. The third major challenge is the availability of funding. Michigan is going through an extremely dynamic period with the overhaul of the automobile industry, and their funding has been reduced. These issues are all being discussed and debated as MDOT moves forward to establish and document a formal, fully funded LBR Program.

Minnesota DOT

Minnesota DOT was originally driven to explore low-cost congestion relief projects because of budgetary restrictions, but soon realized that these projects could be implemented very quickly and, as a bonus, were highly visible and popular with the public. In much less than one year, Mn/DOT developed a highly accelerated process for bottleneck identification and prioritization, which led to many effective projects in the following two years. Mn/DOT also found that because of lower costs, it could identify multiple locations throughout the region and "spread around" bottleneck reduction projects in a fair and equitable manner. This process consisted of completing a study, which included a five-step process to narrow potential projects into a recommendation list to the state legislature. Evaluation of completed projects produced high benefit/cost ratios, usually greater than 8:1. *Note: Circa 2009, this one-time activity was replaced by an ongoing CMS process known as the Congestion Management Planning Process, which has been formally adopted as part of the 3C planning process.*

Minnesota's Process to Identify and Prioritize Bottleneck Improvements

Step 1: Project Identification
Potential congestion management projects were identified from existing sources:
- Low-cost capacity improvements (e.g., auxiliary lanes);
- Restriping lane configuration; and
- Traffic control device improvements (e.g., ramp meters and signal timing).

Step 2: Quantitative Screening
- Project cost < $15 million
- Not in three-year TIP
- Annual hours of delay > 25,000
- Minimum of two hours of congestion

Step 3: Qualitative Screening
- Design readiness
- Cost range
- Congestion benefit
- Construction traffic management
- Future demand changes
- No adverse downstream effects

Step 4: Expert Workshop
Projects were prioritized by an expert group during a half-day workshop.

Step 5: Project Planning
The following were prepared for each project:
- Geometric sketches;
- Project scope;
- Congestion impacts;
- Safety impacts; and
- Benefit-to-cost ratio.

New York DOT

New York DOT's Regional 11 Planning Office (New York City) established their Localized Bottleneck Reduction (LBR) program with a mission to mitigate recurring congestion at selected chokepoints and the operational influences that cause them on the region's highway corridor mainlines, service roads, ramps, and immediate adjacent local streets and intersections. The operational influences include highway junctions and decision points, lane drops, weaves, merges, ramps, signals, intersections, width-restricted underpasses, and other factors that can adversely impact traffic flow at moderate to high volumes. The LBR program will investigate the opportunities as well as develop measures for the application of operational and low-cost infrastructure improvements to address chokepoints and to identify cost-effective improvements either as stand-alone initiatives or as part of existing Capital Projects. The goal of the LBR will be to move recommendations into the capital program.

Project Team. The LBR Program is administered through an interdisciplinary team headed by the Planning Director, with members designated by the functional unit managers. The approach is modeled after the Preliminary

Feasibility Investigation (PFI) concept currently used by the Planning Office, which utilizes a multifunctional project scoping team as the “vehicle” for building consensus on the nature of a transportation problem, the key issues, and best solutions. This approach has been used by the Planning and Development unit to focus on and analyze the feasibility of specific projects, and it creates a forum for early consensus and buy-in of preferred alternatives and course of actions by the different functional groups.

The LBR Team will evaluate various completed inventories/studies and will bring other agencies on board as needed in order to develop a current inventory of bottleneck locations citywide; develop screening criteria; select and recommend priority locations for improvements; develop strategies for the selected locations; and prepare the implementation plan. The team will work through Program Management to address programming, funding, and schedule issues, and they will coordinate with the local MPO regarding any TIP and/or conformity issues. At the present time, the Localized Bottleneck Reduction program will be confined only to Region 11 functional groups plus FHWA. As the work of the LBR program becomes better defined and develops greater focus, the LBR PFI Team will be expanded to include external agencies, such as the NYCDOT, NYCT, MTA, PANYNJ, etc.

Program Benefits. The benefits of the LBR program include:

- Proactively engaging in reducing recurring delays and improving quality of life for affected communities;
- Reduce the rate of RCNs by elected officials and citizens to the department;
- Low-cost, effective solutions which will not require significant environmental actions and are relatively low-cost capital projects or maintenance work orders;
- Short implementation schedule; and
- Provide opportunity for incorporating recommended mitigations into ongoing projects, etc.

Screening Criteria and Schedule. The screening criteria for project selection is as follows: 1) project cost < $10M; 2) annual vehicle-hours-delay > 25,000 hours; 3) speeds < 30 mph; 4) requires little or no environmental documentation; and 5) projects NOT already programmed in the TIP. Once the LBR PFI Team is constituted and established, it is expected that within the next 9 to 12 months, the identification and assessment, including corresponding mitigation strategies, of up to four bottleneck locations, will be available for further LBR team review and comment.

Ohio DOT

In 2008, Ohio DOT initiated a new Systematic Signal Timing Program that provides district offices and local governments with technical assistance (task order consultants) to analyze, coordinate, and upgrade the timing and phasing of signal systems in high-crash areas. Funding can also be used to upgrade signal equipment as needed. Funding is targeted to those areas listed as a top crash priority by ODOT, MPOs, or local governments. Project sponsors must verify that the crash patterns are relevant to signal timing concerns. Requests are funneled through the appropriate ODOT district office, which typically must concur with the request for assistance.

In Ohio, bottlenecks are part and parcel of the overarching Ohio Department of Transportation (ODOT) Highway Safety Program (HSP), which ranks all candidate projects and drives the statewide highway project selection and scheduling process. Beginning in 2002, ODOT developed a "congestion mapping" division that uses V/C ratios developed from traffic data recorders and roadway inventory. About the same time, ODOT administration pushed for an annual process of overlaying congestion-index and safety-index "hot spots." As a result, congestion hot spots now have a "voice" in the process regardless of crash indices, and congestion-related problems now compete for attention in the HSP listing. Specifically, highway sections with V/C ratios greater than 1.0 are considered "congested" and are added to the listing. Sections with V/C between 0.9 and 1.0, but outside the cities of Columbus, Cincinnati, and Cleveland, are also added. After ODOT headquarters completes their statewide effort of congestion mapping and safety indexing, the respective District engineers are responsible for developing countermeasures for their top-listed candidate projects. District Safety Review teams sort projects into three scales – low (less than $100K and quickly implementable), medium ($100K to $5M and one to two years), and high (greater than $5M and necessitating more than years to implement) – and then compete with other projects having the same scale but in other districts.

Utah DOT

Funded by the Utah Legislature, Utah DOT initiated a Choke Point Program in 2006 to address safety, congestion, and bottleneck areas. It was successful, so the Legislature put forth more funding for additional chokepoint projects. The UDOT has used the choke point program to identify potential projects that could improve operations and safety with relatively low cost and in a short time period. Potential projects are identified through public observations in the regions and input from users and local governments. Qualifying criteria for potential projects include small safety, capacity, or bottleneck projects that: 1) cost less than $10M; 2) qualify for a categorical exclusion; 3) can be designed and constructed within one year; and 4) require minimum right-of-way needs. Examples of choke point projects include roadway widening, left-turn lengthening, dual left turns, auxiliary lane on freeway, intersection or signal improvement, passing lanes on rural routes, and improvement of weave/merge areas. Projects are selected and prioritized in each region based upon several factors, including Average Annual Daily Traffic (AADT), volume-to-capacity ratio (V/C), constructability, region priority, and accident rates.

Virginia DOT

Virginia DOT implemented the Strategically Targeted Affordable Roadway Solutions (STARS) Program. This program is a safety and congestion program that partners state, planning district and local transportation planners, traffic engineers, safety engineers, and operations staff to identify "hot spots" along roadways where safety and congestion problems overlap and are suitable for short-term operational improvements. The major goals of the STARS Program are to identify roadway improvements that:

- Are relatively low in cost with no more than $2M for a primary project and $5M for an Interstate project;
- Address existing mobility and safety problem areas;
- Require minimal preliminary engineering and right-of-way; and
- Can be implemented quickly, with a goal of 24 months or less.

Current funding for the program is through the Highway Safety Improvement Program (HSIP), although VDOT is looking for other funding mechanisms.

STARS Process

Step 1. Study Area Selection
Identify critical safety hot spots, and overlay congestion hot spots

Step 2. Conduct Detailed Study Process
Conduct objective and quantifiable study process

Step 3. Prioritize Recommendations
Prioritize recommendations based on benefit/cost analysis results

Step 4. Programming and Implementation

Washington State DOT

Washington State DOT (WSDOT) has no direct funding or a separate program just for bottlenecks, but formally recognizes "bottlenecks and chokepoints" in their project planning and development process and devotes a portion of the Washington Transportation Plan (WTP) to them. Financing large congestion relief projects has become a serious problem due to reduced tax revenues, so WSDOT has organized the *Moving Washington* initiative. As stated in their most recent Congestion Report:[2]

[2] Washington State Department of Transportation, *The 2010 Congestion Report*, November 2010, http://www.wsdot.wa.gov/Accountability/Congestion/2010.htm.

> … WSDOT applies three balanced strategies to fight congestion – operate efficiently, manage demand, and add capacity strategically. By strategically adding capacity, WSDOT targets bottlenecks and chokepoints in the transportation system. However, because of limited resources, WSDOT understands that adding capacity cannot be the only solution for solving the congestion problem. That is why WSDOT uses operational strategies to maximize the efficiency of the existing transportation system (operate efficiently). WSDOT manages demand by providing alternatives to drive-alone commutes between and within modes of travel and encouraging the traveling public to use them. Performance results show that Moving Washington strategies and projects are making a difference around the State to relieve congestion.

Strategic, low-cost capacity improvements currently are a major emphasis for WSDOT. In the safety area, WSDOT learned that by targeting "black spots" rather than corridor- or systemwide safety improvements, much greater impact for investments could be achieved. This same philosophy is being carried over to bottlenecks.

The *Moving Washington* initiative is part of the larger planning and programming activity of WSDOT. The Highway System Plan[3] is the result of this process, which is performance-driven, as described below.

The process starts with definitions. Bottlenecks and chokepoints are defined differently from a functional viewpoint, but they both relate to the physical characteristics of the facility that impede traffic. Bottlenecks are places where the physical attributes of a roadway change in a manner that impacts the flow of traffic. Typical bottlenecks are locations where the number of lanes decreases; the roadway physically narrows either in shoulder width or lane width and narrow bridges. WSDOT defines chokepoints as places where congestion occurs because of traffic interference and/or the roadway configuration. Both bottleneck and chokepoint locations can be identified by WSDOT or other agency staff just by observation.

The next step is that the observed congestion must be supported with traffic data and analysis models. If congestion is a problem today or anticipated within the next 20 years, it also must satisfy one of the following applicable criteria:

- The congestion problem impacts the flow of mainline through-traffic. Mainline traffic flow is considered to be impacted when through-vehicle peak-hour speeds are equal to or less than 70 percent of the posted speed.
- Traffic flow criteria for ramps will also be considered to determine if the congestion is caused by on/off-ramp traffic.

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[3] http://www.wsdot.wa.gov/planning/HSP.

Once problem locations are identified, potential improvements are identified by central WSDOT staff, regional WSDOT staff, and MPO staff. The potential improvements follow a tiered process:

- First, low-cost improvements are considered, including LBR-type projects and operations.
- Second, larger-scale projects with a longer duration of benefits, short of major reconstruction, are considered.
- Finally, the "ultimate" long-term fix is identified, which usually involves major reconstruction.

Problem locations can have one, two, or three of these tiers identified for it. Solutions are then tested using analytic models developed by WSDOT for benefit/cost ratios and performance analysis. From this, the best combination of improvements is identified statewide.

The entire planning and project development process is performance-based. This fits into WSDOT's longstanding emphasis on using performance measures to guide investment as well as the Governor's Government Management, Accountability and Performance (GMAP) program, which spans all state agencies. Every month, the Governor and her staff meet with the heads of state agencies and departments to evaluate the performance results that these organizations currently are delivering. These open, candid meetings provide insight into what is and what is not working in state agencies, and what is needed to improve performance and achieve on deliverables. These meetings (held in Olympia twice a month in the Legislative Building) are open public forums.[4]

Metroplan, Little Rock, Arkansas

Metroplan, the MPO for the Little Rock region, has implemented a program dubbed "Operation Bottleneck" aimed at identifying current congested locations that are amenable to relatively quick and inexpensive treatments. Major congestion problems – arterial corridors and freeway sections/interchanges with major capacity deficiencies – are well known throughout the area. Further, future (major) problems have been identified with the modeling done for the long-range transportation plan. However, funding for the major improvements necessary at these locations must come from either:

- State DOT, Arkansas State Highway and Transportation Department (they would be managed as state projects; and
- Local governments saving up several years of state and Federal allocations for a single project.

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[4] http://www.wsdot.wa.gov/Accountability/PerformanceReporting/GMAP.htm.

Metroplan wanted a way to serve their constituents better than constructing a scarce few megaprojects. Further, the region is almost in nonattainment for the eight-hour ozone standard. The text from their press release on the program sums up their intent very well:

> "We're aware of the major congestion issues in our area and have identified those in our long-range plans, but we know there are dozens, maybe hundreds of neighborhood problems throughout the region that could be fixed with something as simple as a roundabout or coordinating traffic signals to improve flow," McKenzie says. "Localized problems like these can be harder to identify and are sometimes overlooked, even though they can be just as frustrating to drivers. Often they can be addressed much more quickly than larger projects. Those are the types of areas we are hoping to identify through Operation Bottleneck."

Operation Bottleneck is largely based on the establishment of a Regional Mobility Authority (RMA). In Arkansas, an RMA is a coordinating body with no taxing powers – member counties would have to raise the taxes necessary to fund projects; multiple counties would be involved. Most likely, the RMA will be based on a temporary increase in local sales taxes county-by-county; they feel it is important to sunset the tax so it is more palatable to the public and elected officials. Metroplan hopes to leverage state and Federal funds against their self-generated revenue to fund the projects. Also key to the strategy is a specific list of projects to be funded by the tax increase, and most of the Operation Bottleneck effort has gone into project identification, as discussed below.

Project identification is being driven almost exclusively by public input via local meetings and an Internet survey. Metroplan also hired a marketing firm to promote the program through local media. Both congestion safety problem areas are being solicited, along with other modal deficiencies (transit, special transportation). A huge range of responses has been received, from megaprojects to minor problems on local roads. For congestion problems, signals and interchanges are dominating the responses. Safety problems identified by the public tend to be more general than site-specific. (This is understandable since congestion is experienced routinely but crashes are rare events for individuals.)

Metroplan staff will assemble the projects and will develop a list of projects to iterate with the public. Staff will also make revenue projections under different sales tax rates. No formal benefits assessment is planned – as with project identification Metroplan emphasized that public input is the driver for Operation Bottleneck, not technical processes (which they use for all other transportation planning activities). The staff will compare public-identified projects with those in the TIP and LRTP as well as against congested sections identified in their Congestion Management System in developing a prioritized list. Metroplan staff offered two types of improvements that are likely to dominate the project list:

- Low-cost arterial improvements – improved timing, intersection approach geometric improvements, and access management; and
- Roundabouts at uncontrolled, stop sign-controlled, or low volume signal locations.

Initial results are planned to be presented to public officials in October 2008.

Metroplan would like to make this an ongoing process, especially since the public support for the program has been very high. How to structure the funding for an ongoing program will be tricky, however.

A. Templates for Implementation

A.1 Template #1. Public Outreach Identification Process

Overview

This approach to starting a LBR program utilizes a public outreach campaign to identify bottleneck locations. After all, who knows more about traveling local roads than the people who use them every day? Major congestion issues are usually thoroughly identified through the traditional regional long-range planning approach, but there are hundreds of more targeted neighborhood-based problems throughout any region that are sometimes overlooked, even though they can be just as frustrating to drivers. Often these bottlenecks can be addressed much more quickly than larger projects.

Key Elements

- Good method to quickly identify bottlenecks at a modest cost.
- Requires coordination between different organizational elements within an agency.
- Builds public support which could be leveraged for targeted revenue initiatives to fix the worst bottlenecks.
- Response rates from the public can be significant and feedback of results is critical to success.

Timeframe	Cost	Institutional Hurdles	Analytical Complexity
Quick Turnaround	Moderate	Moderate	Low

Approach

Step 1. Establish the types of bottlenecks to solicit.

Agencies should first decide how broadly or narrowly they want to explore bottlenecks in their region. For example, a region could choose to only look for suggestions for pedestrian-related issues. Likewise, the focus could be on signalization issues on corridors or even centered on modal concerns.

Step 2. Determine outreach mechanisms.

Once the scope of the outreach is clarified, an approach to solicit the public's input should be developed next. Leveraging the public input is an appealing approach to identifying bottlenecks since almost all transportation agencies have experience in communicating with the public. Outreach mechanism to consider include public meetings, telephone surveys, mail-in questionnaires, web-based surveys, and even newer social media surveys.

Whichever approach is selected, a targeted questionnaire should then be developed. The length, detail, and composition will be driven by the delivery mechanism. Care should be taken if multiple channels are utilized such as public meetings and telephone surveys. In these cases, one survey approach or questionnaire will probably not be appropriate and multiple methods to solicit responses to the public will be warranted.

Agency Public Information Offices (PIO) should be engaged in this process early; since they can provide a wealth of experience and expertise in reaching the public. The PIO can also help secure local press coverage of the agency's bottleneck efforts. This exposure can increase participation in public meetings as well as any survey mechanisms utilized.

Step 3. Develop prioritization and sorting methodology.

Once bottleneck locations are collected, a mechanism must be developed to rank and prioritize the responses. Transportation agencies routinely prioritize and rank projects. However, for this effort, it is not recommended that any traditional extensive modeling or benefit analyses be conducted. These traditional planning processes, although well established, are too cumbersome for this effort since in this case input from the public is the driver not a technical processes.

Instead, priorities should be established by agencies using sketch level and simplified ranking mechanisms. Examples in include comparing the public identified projects with those in the TIP and LRTP as well as against congested sections identified in their Congestion Management System. Priorities could also be assigned by simply assessing the frequency of the number of occurrence of either specific bottlenecks or bottleneck subregions thereby generating regional hot spots.

Step 4. Create feedback mechanism.

Sharing the results of the bottleneck outreach and prioritization is vital to the success of this approach. Working with the PIO, agencies should ensure the results are released. Examples include holding another round of public meetings, additional press conference or releases, or a coordinated public relations campaign to promote the findings.

Example: Operation Bottleneck, Metroplan, Little Rock, Arkansas

Metroplan, the MPO for the Little Rock region, implemented a program dubbed "Operation Bottleneck" aimed at identifying current congested locations that are amenable to relatively quick and inexpensive treatments. Major congestion problems – arterial corridors and freeway sections/interchanges with major capacity deficiencies – are well known throughout the area. Further, future (major) problems have been identified with the modeling done for the long-range transportation plan. However, funding for the major improvements necessary at these locations must come from either:

- State DOT, Arkansas State Highway and Transportation Department (they would be managed as state projects); and
- Local governments saving up several years of state and Federal allocations for a single project.

Metroplan wanted a way to serve their constituents better than constructing a scarce few megaprojects. Further, the region is almost in nonattainment for the eight-hour ozone standard. Operation Bottleneck is largely based on the establishment of a Regional Mobility Authority (RMA). In Arkansas, an RMA is a coordinating body with no taxing powers – member counties would have to raise the taxes necessary to fund projects; multiple counties would be involved. Most likely, the RMA will be based on a temporary increase in local sales taxes county-by-county; they feel it is important to sunset the tax so it is more palatable to the public and elected officials. Metroplan leverages state and Federal funds against their self-generated revenue to fund the projects. Also key to the strategy is a specific list of projects to be funded by the tax increase, and most of the Operation Bottleneck effort went into project identification, as discussed below.

Project identification is being driven almost exclusively by public input via local meetings and an Internet survey. Metroplan also hired a marketing firm to promote the program through local media. Both congestion safety problem areas are being solicited, along with other modal deficiencies (transit, special transportation). A huge range of responses have been received, from megaprojects to minor problems on local roads. For congestion problems, signals and interchanges are dominating the responses. Safety problems identified by the public tend to be more general than site-specific.

Metroplan staff assembled the projects and developed a list of projects to iterate with the public. Staff also made revenue projections under different sales tax rates. No formal benefits assessment was conducted – as with project identification Metroplan emphasized that public input is the driver for Operation Bottleneck, not technical processes (which they use for all other transportation planning activities). The staff compared public-identified projects with those in the TIP and LRTP as well as against congested sections identified in their Congestion Management System in developing a prioritized list. Metroplan staff said two types of improvements that dominated the project list:

1. Low-cost arterial improvements. Improved timing, intersection approach geometric improvements, and access management.
2. Roundabouts at uncontrolled, stop sign-controlled, or low-volume signal locations.

A.2 Template #2: Leverage Existing Non-Bottleneck-Related Processes

Overview

This approach to starting a LBR program promotes integrating a bottleneck program with congestion or safety programs already active in a transportation agency. Since starting a LBR program can sometimes face institutional, bureaucratic, as well as funding challenges, one successful method of addressing bottlenecks is to ensure LBR issues are integrated into already existing agency project identification and funding procedures. Established congestion or safety programs routinely survey for issues and hot spots and provide a great opportunity to be integrated with LBR issues. The advantage of this approach is that LBR-related projects will have access to an established funding mechanism.

Key Elements

- Provides LBR-related projects access to established funding mechanism;
- Bottleneck identification is linked to traditional processes which are potentially slower than other LBR approaches discussed in this report;
- Requires internal institutional reconfiguration of traditional processes which could take time as well as political momentum; and
- Care must be taken in ensuring LBR projects are given opportunity to compete fairly against other more traditional projects.

Timeframe	Cost	Institutional Hurdles	Analytical Complexity
Quick Turnaround	Low	Low	Low

Approach

Step 1. Identify existing program.

Transportation agencies looking to integrate LBR projects into existing procedures should first do an assessment of which of their current programs are applicable. Options could include integrating LBR concepts into an agency's traditional corridor improvement process. For example, the identification of bottlenecks and potential short-term fixes could be included as part of an overall and long-term strategy for making corridor improvements. Or a review of existing traditional large-scale corridor studies could identify opportunities for using LBR improvements as part of the package of improvements similar to that of a road safety audit. Agencies could also work to integrate LBR activities and initiatives into their existing Congestion Management Programs. Finally, LBR projects could be linked with safety programs and bottleneck issues and criteria could be added to the process of identifying safety projects.

Step 2. Integrate bottleneck-related metrics into project evaluation procedures.

Ensuring bottleneck-related metrics are included into the project evaluation process is a critical step in this approach. The metrics to include vary greatly depending on the type of traditional program. However, there are some core metrics which should be considered. Examples include simple V/C ratios, hours of delay, total daily delay, reliability, or something as simple as frequency of signal retiming. Since this approach is promoting the integration of LBR issues into existing processes, it should be noted that only a few bottleneck-related metrics will be eventually included in the final process.

Example

When the Ohio Department of Transportation (ODOT) revamped their Highway Safety Plan (HSP) efforts a number of years ago, one of the controlling elements identified was the level of congestion. A number of analyses showed that the highway safety and levels of congestion were intertwined, so an element was included in the HSP to specifically address congested locations regardless of the crash levels. ODOT's HSP for the past six years has addressed congested locations in addition to freeway and nonfreeway high-crash locations. The HSP is administered by the Office of Systems Planning and Program management in the Division of Planning and the Districts through the District Safety Coordinators. Each year about $65M in funding is awarded for projects in the various categories that make up the program. Additionally, the districts utilize a portion of their budgets for low-cost improvements. The program has four elements in addition to the identification and study of high-crash locations that are described below.

1. **Hot Spot Locations.** Defined as any two-mile segment of freeway with more than 250 crashes or a nonfreeway location with more than 250 crashes over three years.
2. **Rear-End Hot Spot Locations Map.** Crash threshold set at 150 rear-end crashes for the section (both freeways and nonfreeways).
3. **Congestion.** Identified by calculating a roadway's volume to capacity ratio (V/C). Sections with V/C ratios greater than 1.0 are considered congested and added to the annual work plan. Sections with V/C ratios between 0.9

and 1.0 are added if they are outside of Columbus, Cincinnati, and Cleveland.

4. **Corridor Safety Program.** Corridors with the highest density of fatal crashes are studied and addressed using a crossjurisdictional approach that combines engineering, enforcement, and educational resources.

The District Safety Review teams are required to study the locations identified in these components, as well as high-crash locations. The congested locations often show up on multiple lists, including the Hot Spot or High-Crash Location lists. When this is the case, the higher order study takes place and the location is listed as the higher order need. In general, this order is High-Crash Location, Hot Spot Location, then Congestion Location. This makes it difficult to identify all congestion relief efforts since a significant number of locations are listed on the higher order lists. The statistics presented here are based on locations flagged in ODOT's Safety and Congestion Work Plan as congested locations, so they should not be considered as all inclusive of ODOT's efforts in congestion relief.

The list of congested locations is determined using ODOT's Road Inventory databases and applying highway capacity calculations to determine V/C ratios. The methodology includes analysis of signalized intersections and the development of artificial signalized intersections in urban areas that do not have accurate traffic signal inventories. Attachment 1 is the current ODOT list of congested locations that was generated in July of 2007. Study outcomes and fixes are tracked in a database. This database includes all locations since the effort started approximately six years ago.

Each location is studied using an abbreviated format that includes verification of the actual congestion issue by the District Safety Review Team. This is necessary since the data used to determine that statewide list is system level and may not always reflect actual conditions within a given section of roadway. ODOT has been collecting cost data and hopes to eventually be able to evaluate the cost-effectiveness of the various countermeasures being utilized at congestion locations.

Solutions are grouped according to length of effectiveness and cost. Each Congestion Fix receives a Cost/Time code that is determined by rating Cost as Low, Medium, or High and Time as Short Term, Mid Term, or Long Term. The solutions range from simple maintenance activities to the programming of major projects. A number of Short-Term/Low-Cost recommendations have included meeting with the local law enforcement agencies, review of signs and pavement markings for upgrade, and use of time lapse video to analyze actual travel patterns.

Additional low-cost improvements have included signal timing revisions; minor striping and signing changes (e.g., changing lane assignments on intersection approaches); and other measures that can be accomplished by state or local staff. Medium-cost improvements have included signing, striping, and RPM upgrades/revisions; minor widening (e.g., turning lanes; and traffic signal system upgrades). High-cost improvements are either new projects with the primary purpose of addressing the congestion or are major components of larger projects that are often major system rehabilitation efforts.

In summary, Ohio has been studying congestion sections and locations as part of their Highway Safety Program for the past six years and has been applying solutions to these that range from increased law enforcement and roadside assistance patrols to major reconstruction projects. They are collecting data and intend to use it to develop benefit/cost factors for future use and to evaluate the effectiveness of the solutions implemented. The location studies are prepared and reviewed by the District Safety Review teams that are multidiscipline teams well acquainted with using a wide variety of methods to implement solutions. They also can quickly determine if a specific location is listed on the various other components of the HSP. A variety of methods are used to implement improvements ranging from state or local forces performing the work to Federal-aid construction contracts.

A.3 Template #3: Internal Identification Processes

Overview

This approach to starting a LBR program leverages internal expertise within a transportation agency in identifying bottlenecks. Major congestion issues are usually thoroughly identified by transportation agency personnel through the traditional regional and state long-range planning approach. However, there are perhaps hundreds of smaller scale targeted bottleneck problems which are overlooked simply because their scale does not compare to the larger congestion issues. In this approach to setting up a LBR program, the districts and regions are called upon to identify these other smaller projects. District and regional employees have the closest interaction with public; engage with them on a regular basis on a variety of traffic, congestion, or safety issues; and are in many times the best experts in identifying real bottlenecks that affect drivers every day.

Key Elements

- Low cost since agency staff are being polled and no public outreach is required; and
- Short timeline since many times, district and region engineers and planners already know where many local bottlenecks exist.

Timeframe	Cost	Institutional Hurdles	Analytical Complexity
Moderate/Long Term	Low	High	Moderate

Approach

Step 1. Establish the types of bottlenecks to solicit.

Agencies should first decide how broadly or narrowly they want to explore bottlenecks in their region. For example, a region could choose to only look for suggestions for pedestrian-related issues. Likewise, the focus could be on signalization issues and corridors or even centered on modal concerns.

Step 2. Determine bottleneck solicitation mechanisms.

Once the scope of the outreach is clarified, an approach to solicit the districts or regions should be developed. It is recommended that an internal "call for projects" be developed and disseminated to the districts and regions. This call should have explicit directions on the information required for each bottleneck to target. This information should include standard performance measures such as traffic and safety, but the submission criteria should be flexible enough to include nontraditional metrics. It is recommended that a relatively short timeframe be assigned for the projects to be submitted. A shorter timeframe will promote a "tiger team" approach and districts and regions will be more motivated to ensure projects in their region are included to compete with other statewide projects.

Automated survey mechanism (i.e., web-based) could be utilized as well but care should be taken to ensure they are robust enough to allow districts and regions flexibility in submitting a wide variety of projects.

Step 3. Develop prioritization and sorting methodology.

Once bottleneck locations are collected, a mechanism must be developed to rank and prioritize the responses. Transportation agencies routinely prioritize and rank projects. However, for this effort, it is not recommended that any traditional extensive modeling or benefit analyses be conducted. These traditional planning processes, although well established, are too cumbersome for this effort.

Instead, priorities should be established by agencies using more strategic and simplified ranking mechanisms. Examples include comparing the potential LBR projects with those in the TIP and LRTP or ranking projects higher if they have lesser environmental documentation.

The ranking could be conducted by engineers and planners from Central Office or Headquarters or an expert panel could be formed with representation from each district and region to determine the priorities of the bottlenecks.

Step 4. Develop Bottleneck Project Plans.

Once projects are identified, project plans need to be developed and the projects programmed. It is recommended that a quick turn project plans be developed for these projects. Elements include geometric sketches, traffic and safety impacts, costs, and even rough benefit/cost analyses. The projects need to be developed so that they can either compete for set aside LBR dollars or compete with other projects in the traditional programming process.

Example

Mn/DOT was originally driven to explore low-cost congestion relief projects because of budgetary restrictions but quickly realized that these projects could be implemented very quickly (and thus were highly visible to the public). They also found that because of low costs, they could identify multiple locations all over the region – the projects could be "spread around."

The cornerstone of this process is the Congestion Management Planning Study (CMPS). This was developed as quick turnaround study so that projects could be recommended to the Legislature before it adjourned for the session. (The process was started in February and results achieved in May.) It was envisioned as a "tuning study" – how can the system be "tuned" in specific areas to get congestion relief rather than rebuilt. Although cast as a single study, it is hoped that it can be integrated as an ongoing process within the Department. The process works as follows:

- **Step 1: Project Identification.** Projects were identified from a number of different sources, including Mn/DOT project lists, Mn/DOT Area Managers, SRF Consulting Group, Inc., Mn/DOT Metro District's Safety Capacity, Mn/DOT's freeway congestion maps and the Governor's 2007 bonding list. By combining the information gathered from the sources, 184 projects were identified and included in this study as congestion management projects.
- **Step 2: Screening #1.** A series of binary tests (pass/fail) were applied to the projects, resulting in downsizing the list to 100 projects:
  - Project cost < $15M;
  - Project not in three-year TIP;
  - Could require project memorandum or lesser environmental documentation;
  - Annual hours of delay > 25,000 hours of congestion;
  - Freeway or Arterial > two hours of congestion; and
  - Arterial relieves parallel congested freeway or directly responsible for freeway congestion.
- **Step 3: Screening #2.** Qualitative criteria were applied, resulting in 60 projects still under consideration:
  - Project implementation/design readiness;
  - Cost range;

  - Congestion benefit (weighted delay);
  - Traffic management for construction;
  - Future demand changes; and
  - Relieves congestion without adverse downstream affects.

- **Step 4: Expert Workshop.** Short-range congestion projects were prioritized by expert group during half-day workshop, resulting in 19 projects totaling $60.8M. The projects fell into three broad categories:
  - Low-cost capacity improvements (e.g., auxiliary lanes);
  - Restriping to change lane configuration (which the maintenance department could handle); and
  - Traffic control device improvements (add ramp meters and "tune" signal timing).

- **Step 5: Project Planning.** For each of the 19 projects, the following project estimates were prepared:
  - Geometric sketches;
  - Type and scope of project;
  - Congestion impacts;
  - Safety impacts; and
  - Estimated benefit-to-cost ratio.

Bottleneck Performance Measures

The State of Minnesota (not just the DOT) has been a leader in developing and using performance measures to assess how it is meeting customer expectations. In accordance with these principles, evaluation of completed projects is being done to track the effectiveness of current and future investments:

- Measurement of "before" and "after" project conditions to assess the project's effectiveness and build experience for the type of benefits those different projects can deliver;
- Annual system measures that can capture overall congestion trends for different systems over time (e.g., Texas Transportation Institute (TTI) congestion index, percentage of Metro Urban Freeway System (MUFS) congested); and
- Measurement of strategies to shifts peak demands to off-peak periods (e.g., number of persons moved at the per lane capacity with speeds greater than 45 mph).

A preliminary list of performance measures being considered are as follows. Additional ones may be developed in the future and not all may apply to the bottleneck relief projects:

1. Percentage of miles congested (i.e., number of directional miles with speeds < 45 mph during peak periods);
2. Total daily delay (volume x time difference between actual and posted speed);
3. Reliability (TTI – Congestion Index/Travel Time Buffer Index);
4. Miles of FIRST/incident response coverage;
5. Number of hours where volume > capacity;
6. Frequency of signal retiming;
7. Percent of arterials with coordinated signals;
8. "Before/After" benefit/cost ratio of corridor improvements;
9. "Before/After" benefit/cost ratio of signal retiming;
10. Customer satisfaction survey of peak-hour travel (omnibus transportation survey);
11. Percent of MUFS instrumented;
12. Planned lane closures System;
13. Unplanned lane closures System;
14. Average clearance time for snow and ice removal;
15. Average clearance time for freeway incidents; and
16. Throughput (i.e., number of vehicles through a specific corridor or across a screenline over a specified time period).

Overall, the CMSP process follows a procedure to develop candidate projects. (Freeway Performance data are used in the screening but in a very high-level way). Mn/DOT's freeway data system provides lane by lane data for all controlled access road as well as all ramps – this allows them to easily created accurate and timely analysis on an as needed basis. This existing archive data system allowed Mn/DOT order to keep to the aggressive schedule. At the end of the process (Step 5) more quantification comes into play. This process worked extremely well in the eyes of Mn/DOT – they feel that a more labor intensive, and drawn-out procedure would have essentially yielded the same project list. The reason appears to be that current bottleneck problems are easily identified through visual inspection and via the freeway surveillance data, so a detailed analysis is not required.

Another aspect of the streamlining (in addition to the qualitative project identification and screening process) is that some larger environmental aspects could not be addressed (e.g., area drainage). In order to keep the costs low and the projects quickly implementable, these environmental concerns were thought to be within the scope of the longer-term "megaprojects" being planned for.

Bottleneck Funding

No separate funding program was established for the CMPS projects – they have to compete for funding with other projects. If projects are seeking Federal funding, then they have to go through the evaluation process established by the MPO, which has its own set of evaluation criteria.

Example Bottleneck Projects

Three low-cost bottleneck projects were highlighted by Mn/DOT. (These are being submitted as examples by the Division.) The positive impacts of these projects on congestion are dramatic. (See Table A.1 and A.2 for details.)

- **I-394 at Louisiana Street.** Mn/DOT added an auxiliary lane one mile long at a cost of $2.6M. Previously, queues could back up for six miles on this section; after completion, queues were reduced to zero! (for recurring conditions).
- **I-94 in St. Paul.** A four-lane section of freeway connected to two six-lane sections (a lane-drop bottleneck). Queues were 2.0 miles in the eastbound direction. Mn/DOT increased the number of lanes to six throughout this extended segment at a cost of $10.5M. Although the desired result was achieved, the existence of other major bottlenecks at the end of the segment (freeway-to-freeway interchanges) limited the effectiveness of this improvement.
- **TH-100 in St. Louis Park.** This is another example of a 6-4-6 lane drop with a highly restricted cloverleaf interchange in the four-lane section. The shoulder was used to provide an additional through lane; two close-spaced interchanges were connected with CD roads and the 1950s cloverleaf interchange was redesigned to a diamond interchange at a cost of $7.5M. Northbound queues were reduced from 5.25 miles to 0.25 miles and southbound queues were reduced from 6.0 miles to 0.25 miles.

Table A.1 Cost and Travel Time Benefit of Completed Congestion Management Projects[a]

	Project Cost (In Millions)	Reduction in Annual Hours of Delay	Estimated Annual Travel Time Benefit (In Millions)	Project Service Life (In Years)	Estimated Travel Time Benefit Over Project Service Life (In Millions)	Estimated Travel Time Benefit to Cost Ratio
I-394	$2.6	87,000	$1.1	20	$21.6	8
I-94	$10.5	139,000	$1.7	20	$34.6	3
TH 100	$7.1	1,063,000	$13.2	7	$92.3	13
Total	**$20.2**	**1,289,000**	**$16.0**	**–**	**$148.5**	**–**

a Congestion data for Tables A.1 and A.2 were provided by Mn/DOT Metro Traffic and based on freeway loop detector data from 2004 to 2007.

Table A.2 Other Benefits of Completed Congestion Management Projects

	Peak Period Vehicle Flow Increase	Decrease in Miles of Congestion	Increase in Peak Period Speeds	Preliminary Safety Impacts
I-394	4,650	6.0	30 mph in p.m.	Sixty percent reduction of property damage crashes, no change in injury crash rate.
I-94	3,200	2.5	40 mph in a.m. 25 mph in p.m.	Modest reduction in number of mainline crashes.
TH 100	14,450	10.75	45 mph in a.m. 30 mph in p.m.	Thirty percent reduction of property damage crashes, 70 percent reduction of injury crashes.

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