Bus-Only Shoulders in the Twin Cities
June 2007

FTA-MN-26-7004

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	6/30/2007	Final, August 2006 – June 2007

4. TITLE AND SUBTITLE
Bus-Only Shoulders in the Twin Cities

5. FUNDING NUMBERS

6. AUTHOR(S) State and Local Policy Program, Hubert H. Humphrey Institute of Public Affairs, University of Minnesota

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Hennepin County
Minnesota

8. PERFORMING ORGANIZATION REPORT NUMBER
FTA-MN-26-7004

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

Federal Transit Administration

U.S. Department of Transportation
Washington, DC 20590 Website URL [http://www.fta.dot.gov]

10. SPONSORING/MONITORING AGENCY REPORT NUMBER
FTA-MN-26-7004

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12a. DISTRIBUTION/AVAILABILITY STATEMENT
Available From: National Technical Information Service/NTIS,
Springfield, Virginia, 22161. Phone 703.605.6000, Fax 703.605.6900,
Email [orders@ntis.fedworld.gov]

12b. DISTRIBUTION CODE

12. ABSTRACT (Maximum 200 words)

The Minneapolis/St. Paul metropolitan area (Twin Cities) is home to 271 bus-only shoulder miles. This amounts to more than 10 times the number of bus-only shoulder (BOS) miles in the rest of the nation combined. As the BOS network took root in the Twin Cities and expanded, it became a fundamental piece of the region's transportation system facing little opposition. Partnerships among transportation agencies and officials contributed greatly to the success of the idea, ensuring that support and resources were made available. The result has been the proliferation of a "transit advantage" to transit passengers, who bypass congestion and may even save time by taking the bus.

To understand how and why bus-only shoulders in the Twin Cities have been so successful, this report used five elements of transportation projects identified by the Hubert H. Humphrey's State and Local Policy Program (SLPP) to examine the origin and evolution of bus-only shoulders. Governance, stakeholder participation, finance, design, and economics each played a role in developing the BOS system. Collectively, the details of each provide a picture of how bus-only shoulders came to be in the Twin Cities and also provide insight for cities interested in pursing BOS networks of their own.

14. SUBJECT TERMS None

15. NUMBER OF PAGES
47

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	

NOTICE

Bus-Only Shoulders in the Twin Cities

Final Report

Prepared by:

Frank Douma

State and Local Policy Program
Hubert H. Humphrey Institute of Public Affairs
University of Minnesota
301 19th Avenue South
Minneapolis, Minnesota 55455

June 2007

Acknowledgements

We would like to extend a special thanks to Jennifer Conover for sharing her research on the history of Team Transit. Because bus-only shoulders were one of the first major undertakings of Team Transit, the history of the two is often difficult to differentiate. Jennifer was generous to share with the State and Local Policy Program (SLPP) the insights of interviews she conducted with a number of individuals involved at the inception of Team Transit and bus-only shoulders. In addition, as the current Team Transit project manager, Jennifer has served as a valuable resource on the current state of the bus-only shoulder network and its future.

In addition, this project would not have been possible without the interviewees who generously contributed their time and expertise. We would like to thank Aaron Isaacs, Scott McBride, Mike Abegg, Samantha Porter, Jim McCarthy, Georgia Stinson, Steve Fraser, and Joe Gladke.

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Executive Summary

As of December 2006, the Minneapolis/St. Paul metropolitan area (Twin Cities) is home to 271 bus-only shoulder miles. This amounts to more than 10 times the number of bus-only shoulder (BOS) miles in the rest of the nation combined. As the BOS network took root in the Twin Cities and expanded, it became a fundamental piece of the region's transportation system facing little opposition. Partnerships among transportation agencies and officials contributed greatly to the success of the idea, ensuring that support and resources were made available. The result has been the proliferation of a "transit advantage" to transit passengers, who bypass congestion and may even save time by taking the bus.

To understand how and why bus-only shoulders in the Twin Cities have been so successful, this report used five elements of transportation projects identified by the Hubert H. Humphrey's State and Local Policy Program (SLPP) to examine the origin and evolution of bus-only shoulders. Governance, stakeholder participation, finance, design, and economics each played a role in developing the BOS system. Collectively, the details of each provide a picture of how bus-only shoulders came to be in the Twin Cities and also provide insight for cities interested in pursing BOS networks of their own. A timeline summarizing the development of the BOS network in the Twin Cities can be found in Appendix A.

Introduction

In spring 1993, rising floodwaters caused the closure of nearly all bridges over the Minnesota River west of the Cedar Avenue Bridge on Minnesota Highway 77 (MN 77), a six-lane divided controlled access highway in Bloomington, a suburb south of Minneapolis. Congestion was severe and certain to increase during the bridge closures the coming week. On Thursday, June 24, Governor Arne Carlson called an emergency meeting of transportation professionals to find a way to remedy the problem. Beverly Miller, executive director of the Minnesota Valley Transit Authority (MVTA), suggested that buses be allowed to use the shoulders on the Cedar Avenue Bridge to increase traffic capacity and alleviate some of the congestion, a practice already in use on some major arterial highways elsewhere in the metropolitan area. Miller also recommended that park and ride facilities be set up and located on either side of the bridge to encourage bus use and minimize the number of vehicles needing to cross the bridge. Over the weekend, the Minnesota Department of Transportation (Mn/DOT) workers posted signs to alert drivers that buses would be operating on the shoulder along MN 77. By the following Monday, the bridge was prepared to accommodate buses on the shoulder in addition to general traffic in the main lanes.

Since the early 1990s, bus-only shoulders have become common in the Twin Cities. Bus-only shoulders on arterial roads had been in use since 1991; use of bus-only shoulders on MN 77 was the first occurrence of shoulder use on a freeway. A BOS is a street or highway shoulder constructed, modified, or enhanced to support bus traffic. Buses operate on shoulders to increase existing corridor capacity. BOS networks have been developed in Minneapolis/St. Paul, Minnesota; Miami, Florida; San Diego, California; and Falls Church, Virginia [TCRP]. Other countries, including Canada and Ireland, have implemented bus-only shoulders as well. The Minneapolis/St. Paul metro area, however, has the most extensive BOS network to date, with 271 BOS miles as of December 2006 [Mn/DOT]. The network has increased by 10 to 30 miles per year since its inception in 1991, such that the total number of BOS miles in the Twin Cities is 10 times that of the rest of the country combined.

Previous work at the SLPP identified five elements pervasive in transportation-related projects: governance, stakeholder participation, finance, design, and economic benefit. To illustrate the emphasis placed on each element, this paper is organized under the respective subheadings. In the case of bus-only shoulders, however, the governance and stakeholder participation elements are combined to stress the interrelated nature of these two areas.

Background

In the early 1990s, the Twin Cities, like many metropolitan areas, faced growing congestion as a result of limited highway capacity on major corridors. Local transportation agencies were under pressure to decrease congestion within constrained budgets. The Metropolitan Transit Commission, hereafter referred to as Metro Transit as it was renamed in 1994, was experiencing decreasing ridership and travel time reliability due to congestion. To maintain ridership, it needed to make transit a more reliable and

attractive option. At the same time, Mn/DOT was faced with the challenge of relieving congestion and providing better service opportunities with little investment. These problems, along with pressure from the Metropolitan Council (Met Council) to promote transit, motivated the Center for Transportation Studies (CTS) at the University of Minnesota to host a brainstorming workshop to develop innovative solutions to congestion in the Twin Cities. The workshop included representatives from Mn/DOT, Metro Transit, other local transit providers, and transit advocacy groups. The focus of the workshop was to examine the strengths, weaknesses, and stresses on the existing transportation network and to discuss possible approaches and solutions.

One outcome of the workshop was the concept of Team Transit, which officially came into being in 1991. The purpose of Team Transit was to connect the multiple agencies involved in highway and transit efforts to improve the effectiveness and efficiency of these efforts. The agencies involved in creating Team Transit included CTS, the Minnesota State Patrol, representatives from the Twin Cities and other municipalities served by transit, Mn/DOT, and Metro Transit. While the concept of Team Transit was born from many stakeholders, the primary players were Metro Transit and Mn/DOT. The focus of Team Transit was to find innovative ways to address transportation issues, both generally and specific to each agency, with consideration for the needs and demands of highways and transit. A primary goal of Team Transit was to focus on maximizing the number of people moving throughout the Twin Cities not the number of vehicles. BOS was one of the first transit-advantage ideas suggested and put into action.

The first BOS was tested in 1991 on trunk highway (TH) 252 north of Minneapolis. TH 252 needed congestion relief since it opened, and the time was ripe for a solution. After reviewing the roadway design and engineering, including an assessment of traffic movement at each intersection, the corridor was approved for a BOS pilot project. Under the name “Team Transit,” Metro Transit and Mn/DOT worked together to make sure that operating buses on shoulders did not negatively affect travel behavior in the general-purpose lanes. Both agencies knew that a successful BOS trial period would open the door for a BOS network and also set the stage for other innovative approaches to addressing congestion. An unsuccessful BOS trial period had the potential to hamper future BOS efforts and further support of Team Transit.

Early bus-only shoulders, such as those on TH 252, were limited to arterial roads with stoplights. Stoplights control intersections and aid in maintaining speed limits; both aspects facilitate the ability to safety operate buses on the shoulder. Other locations of early BOSs include TH 47 (University Avenue NE) as well as the Third and Fourth Street ramps off of Interstate 94 (I-94). The success of bus-only shoulders on arterial roads prompted Metro Transit to request that buses be allowed to use shoulders on I-35W; however, that request was denied. Safety concerns and uncertainty over the effect of BOSs continuing through auxiliary lanes were raised by the Mn/DOT traffic office and the Federal Highway Administration (FHWA) and prevented the use of shoulders on freeways until the 1993 Minnesota River flood.

The success of BOS use on MN 77 in 1993 served as the catalyst for allowing the use on other metro area freeways. Today, approximately half of all bus routes operated by Metro Transit and MVTA, the region's two largest transit providers, operate on corridors that have the option to use BOS at some point along the route. Bus drivers and riders alike welcomed the extension of BOS use to freeways as it enhanced the transit advantage. Over time, additional enhancements and improvements to the BOS system aided its success.

Governance and Stakeholder Participation

Team Transit

The need to address congestion throughout the Twin Cities metro area brought together several stakeholders that each sought to find solutions. The outcome was the creation of Team Transit. To be successful, the new entity and its efforts required support at multiple levels. Initial support for Team Transit came from a number of high-level individuals and organizations including the Commissioner of Transportation Jim Denn and former Commissioner of Transportation Dick Braun, who had become the founding director of CTS. The Deputy Commissioner of Transportation at the time, Darryl Durgin, was particularly active and vocal in his support of Team Transit. These upper-level individuals were not involved in the details of bringing Team Transit's "transit advantages" to fruition, but they sent a clear message that discussion around BOS use should focus on the question of how bus-only shoulders can become a reality and rather than ask if buses can be driven on shoulders. The goal behind such careful framing of the question was to move the focus from identifying obstacles to BOS use to finding ways to overcome them. The potential for success was never a question; rather, it was a matter of working out the details.

The emergence of bus-only shoulders as a viable option to increase the number of people who could effectively use the transportation system during peak periods occurred at the organizational level in the early 1990s. Mn/DOT began to recognize that it would be impossible to build the Twin Cities out of congestion, and Metro Transit was looking for a way to meet increasing transit demands with a diminishing budget. Consequently, the two organizations began to work together to plan and implement transit advantages that could increase the number of people effectively using the transportation system during peak periods. The support and cooperation of these two organizations helped enable BOS use by overcoming legal, institutional, operational, and technical obstacles at every level. As Team Transit became a permanent entity and as other transit advantages achieved success, involvement and responsibilities shifted to a Team Transit project manager from Mn/DOT who worked with Metro Transit, primarily Metro Transit Facilities Manager Aaron Isaacs, to identify potential locations and secure funding for bus-only shoulders.

Dick Braun, Mn/DOT transportation commissioner from 1979 to 1986, chose to tackle the institutional impediment of Mn/DOT culture. Prior to the CTS workshop and creation of Team Transit, Mn/DOT had had little to do with transit issues. The fact that federal money received by Mn/DOT could not be allocated to transit may have contributed to the lack of consideration it was given within the organization. Despite the general disconnect from transit, there was support for increased cooperation between highway and transit agencies prior to Team Transit. As commissioner, Braun chose improving the connections between highways and transit as one of his areas of focus. Nonetheless, the idea persisted at Mn/DOT that highway construction and funding had little connection to transit.

The development and implementation of transit advantages through the cooperation of Metro Transit and Mn/DOT prompted a shift in Mn/DOT philosophy. The creation of

Team Transit required Mn/DOT to increase its relationship to transit, which eventually affected its outlook on highway projects. One of Mn/DOT's first moves to include transit came about when implementing use of bus-only shoulders was coupled with the construction or reconstruction of roads. This approach not only provides a transit advantage, but also allows Mn/DOT to use funds more efficiently. In addition to recognizing that Mn/DOT had a role in improving transit, there were technical and operational obstacles that needed to be overcome. For example, snow plowing during winter months limited buses' ability to operate on shoulders. Support and cooperation were necessary to manage this, and other issues, that arose.

As one of Team Transit's first major achievements, bus-only shoulders helped to institutionalize the new relationship between Mn/DOT and Metro Transit. Initially, these two agencies worked separately in appointing and funding individuals to handle BOS tasks and responsibilities. Mn/DOT assigned Scott McBride, a non-highways project planner, to work with Metro Transit on BOS-related projects; Aaron Isaacs, then the facilities planning manager with Metro Transit, was responsible for Metro Transit's involvement. McBride, appointed in 1991, is considered the first Team Transit project manager; although, he worked closely with Isaacs. At that time, neither position was full-time; Team Transit duties were in addition to McBride's responsibilities as a Mn/DOT engineer and Isaacs' other facilities management tasks. In 1996, Joe Gladke became the first full-time Team Transit project manager as the position's duties had increased. By 1997, the project manager role had proven vital enough for Mn/DOT to establish it as a permanent position. Salary for the full-time position was drawn from Mn/DOT's budget beginning that same year.

The role of the Mn/DOT Team Transit project manager has grown over time as Team Transit has become a more successful program. The project manager's primary role is to coordinate activities among agencies and maintain relationships among all stakeholders involved. The project manager also is responsible for acting as an advisor to Mn/DOT department heads on proposed transit advantages, their feasibility, and predicted effect. In addition, the project manager is responsible for understanding transit issues and must look for ways to build transit advantages into ongoing Mn/DOT projects. Prior to 1996, the project manager also secured funding within Mn/DOT for various projects including bus-only shoulder efforts. Since 1996, Team Transit has received funds each year to provide transit advantages. Metro Transit and suburban transit providers contact the Team Transit project manager directly for BOS operating or maintenance concerns.

Isaacs was a major contributor of ideas and impetus for many transit advantages. Having been involved with Team Transit from the beginning, Isaacs was the first to suggest that buses should operate on shoulders. Over the course of nearly 10 years, BOS use went from a pilot project to a full-blown network. During this time, Isaacs and the various Team Transit project managers, along with others, worked to create operating rules and standards, developing the BOS concept into part of the larger transportation system. As previously mentioned, support from leaders in the transportation community was necessary to get Team Transit and BOS projects rolling. The partnership between Mn/DOT and Metro Transit and the change in Mn/DOT's philosophy toward transit provided the long-term support BOS efforts needed to become embedded in the

transportation system. The creation of a full-time Team Transit project manager did not decrease the role of Isaacs or Team Transit, but rather it made available a single contact person to address BOS questions and concerns.

Approval for Team Transit to test the BOS concept came from Commissioner Denn. While initial BOS pilot projects did not require a formal process for establishing their legality, the increasing number of successful sections of bus-only shoulders created pressure for codifying operating regulations and standards. Bus-only shoulders had proven to be a safe and efficient means of improving the Twin Cities transportation system, and legislation describing the conditions under which BOS routes could be operated and who was authorized to use them was passed into state law in 2001. The passage of the BOS law also enabled the state patrol to issue tickets for misuse of the shoulder by bus and automobile/truck drivers.

The Minnesota BOS law permits transit providers in the Twin Cities metro area to use designated shoulders to bypass traffic congestion and provide transit passengers an advantage over other vehicles traveling on the same road. The most recent legislation pertaining to bus-only shoulders states that, "…the commissioner of transportation may permit the use by transit buses and Metro Mobility buses on a shoulder of a freeway or expressway… in the seven-county metropolitan area" (See Appendix B). With the passage of this legislation, the legitimacy of BOS use in Minnesota increased dramatically. This is important because allowing any vehicle to drive on the shoulder conflicts with the Uniform Vehicle Code (UVC), which details the common protocol for highway operation standards and guidelines. The UVC is designed to promote consistency in transportation infrastructure and regulation among states. Currently, there are few, if any other, states that permit buses to drive on shoulders without a statute. These states face a higher level of liability if crashes occur or problems arise that can be attributed to the BOS system.

Other Parties

In addition to Metro Transit and Mn/DOT, other stakeholders have influenced the evolution of BOS use. Those stakeholders consulted about the implementation of bus-only shoulders in the Twin Cities included bus drivers and supervisors, members of the Minnesota State Patrol, suburban transit providers, the FHWA, and the Federal Transit Administration (FTA).

Bus Drivers and Supervisors

Bus drivers have played a vital role in the success use of bus-only shoulders in Minnesota. During initial rollouts of bus-only shoulders throughout the transportation network, bus drivers and their supervisors provided key feedback about the operation of buses on shoulders in general and specifically related to various areas and circumstances. During the trial period along TH 252, it was not clear how fast the buses should be allowed to travel on the shoulder. As the trial period continued and drivers became more comfortable with driving on the shoulders, speeds began to increase. Safety concerns over the appropriate speed led the state patrol and Metro Transit to meet with those drivers who had been operating buses along TH 252 to determine how fast buses should

be allowed to travel in the shoulder. Findings from the meeting (See the Design section of this report) determined that bus speeds on the shoulder would not exceed 35 miles per hour (mph). In addition to their contribution in determining the BOS speed limit, input from bus drivers also aided in determining width standards for shoulders. For example, when bus-only shoulders were approved for the Cedar Avenue Bridge, bus drivers' concerns over the safety of driving next to a barrier prompted establishment of an 11.5-foot minimum shoulder width when a barrier is present on one side. This led Mn/DOT to re-stripe the lanes on the bridge one week after the BOS operation began on the bridge.

Although the BOS network allows drivers to provide improved service to their passengers, it also may increase bus driver stress as passengers have pressured drivers to drive on unauthorized shoulders. Such pressure from passengers, while commonly reported, has not been identified as a serious problem. Taking note of the locations in which drivers report pressure to use unauthorized shoulders is another example of how drivers have helped Team Transit to identify potential locations for BOS operations. Bus drivers have been considered a primary resource for identifying areas of highway that would benefit from implementation of bus-only shoulders and for calling attention to locations requiring maintenance.

While bus drivers are trained to use bus-only shoulders based on operation standards developed by Mn/DOT, the responsibility of driver training falls to transit providers. Charter bus drivers are trained to use bus-only shoulders by charter service providers who register with the Team Transit project manager to use shoulders. If a charter bus company provides transit service, however, it is not necessary that they to register, as the law allows the use of shoulders for any transit-related activity.

Trained drivers have played a vital role in establishing and maintaining the safety of the BOS system. No transit provider requires drivers to drive on authorized shoulders at any time. However, due to the likelihood that drivers, at some point, will be assigned to routes that have the option to use bus-only shoulders, all drivers from transit services that use bus-only shoulders are trained to operate buses on shoulders. Bus drivers use their own discretion on when to use shoulders based on their impressions of congestion, weather, and safety. Buses are allowed to operate on designated shoulders when roadways are congested both when passengers are on board and when "deadheading," that is when the bus is leaving or returning to a transit garage without passengers. Some drivers feel more comfortable driving on the shoulder than others. New drivers in particular admit to initial nervousness, but time and experience seem to eliminate concerns. As can be expected, inclement weather or other unfavorable conditions decrease the level of comfort drivers have using the shoulders. Overall, bus-only shoulders have been well received by bus drivers.

Minnesota State Patrol

The Minnesota State Patrol has played a small but critical role in implementing bus-only shoulders. The state patrol was contacted in the early stages of BOS development and is continuously informed about who the authorized users are. This is to make certain that proper use of shoulders on state highways is enforced; this task falls under the state patrol's jurisdiction. The Team Transit project manager is responsible for keeping the list

of authorized users updated. Should a bus driver be pulled over by a law enforcement officer, the individual driver is responsible for any ticket issued for the offence(s) committed. The state patrol informs the appropriate transit provider of any driver offences, and that provider administers the appropriate disciplinary action.

When BOS use was introduced, there was some concern about the illegal use of shoulders by cars and other unauthorized users. The expectation was that some vehicles would copy buses by following them onto the shoulder, mistaking it for a high-occupancy vehicle (HOV) lane or additional traffic lane. While some cases of unauthorized use were reported by the state patrol, overall this predicted problem never materialized.

Suburban Transit Providers

Although Metro Transit has been the lead transit agency and the acting partner in Team Transit efforts, suburban transit providers have contributed to the development of and have benefited from the implementation of BOS use as well. Originally, bus-only shoulders were open to all buses except school and charter buses. The rules have since changed, and now only authorized users are allowed to operate on the shoulders. Currently-authorized include Metro Transit, six suburban transit providers (Maple Grove Transit, Minnesota Valley Transit Authority, Plymouth Metro Link, Southwest Transit, University of Minnesota, and Metro Mobility), and charter bus service providers that have registered with Team Transit.

Suburban transit providers have been major beneficiaries of BOS use. These agencies rely heavily on freeways and interstate highways to meet the needs of passengers moving between major destinations either in the central city or other suburbs. Since suburban transit agencies began using bus-only shoulders, transit travel times from the suburbs has become faster than many personal vehicle trips, which provides an increased incentive for transit riders to use the long haul service offered by suburban transit providers, and thus facilitates the growth of these suburban agencies and their sphere of influence. For example, when Team Transit was first formed and bus-only shoulder use was first introduced, MVTA had two full-time employees. This agency has since grown substantially to become the largest suburban transit provider in the Twin Cities metro area. While MVTA recognizes that Metro Transit historically has represented all transit providers in transit planning and policy-making and that it has benefited from Metro Transit's lead in working with Mn/DOT and Team Transit, MVTA is now working toward playing a larger role in transit decisions.

MVTA claims that, in addition to other factors, BOSs have led to the expansion of suburban transit providers and therefore their role in BOS-related administrative processes. While MVTA admits it is difficult to pinpoint the exact contribution bus-only shoulders have made in attracting new riders, it is certain that the use of shoulders has helped to retain riders. MVTA and Metro Transit both report receiving calls from riders concerned that drivers are not using shoulders, which these agencies have interpreted as indication that riders perceive shoulder use as an advantage they desire.

The biggest challenge MVTA faces with regard to bus-only shoulders is using them during evening rush hours in the winter when weather conditions are less than ideal for

traveling along such a narrow passage. These shoulders do not have heavy enough traffic volumes to adequately compact snow and thus aid in identifying the shoulder boundaries during heavy snowfall. If snow on shoulders accumulates on the shoulders faster than buses are able to safely and comfortably navigate them, bus drivers are less inclined to drive on the shoulder. The challenge of using shoulders during times of inclement weather detracts from the service providers' ability to maintain the transit advantage. One potential solution to this problem is the use of intelligent transportation systems (ITS) technologies to guide buses on a "virtual" guideway along the shoulder. Metro Transit sponsored some initial experimentation by CTS with ITS technologies and guidance systems for use on bus-only shoulders, but it did not implement the technology due to the high cost of installing it throughout its large bus fleet. MVTA has fewer buses and has chosen to continue work with ITS technologies as a likely solution to operating in BOS lanes during inclement weather.

Maple Grove Transit is another example of a suburban transit provider that has benefited from BOS use. This agency says that it was able eliminate 90 percent of its marketing budget once bus-only shoulders were opened on I-694. The image of buses passing cars on the freeway seemed to provide enough advertising to fill the buses they had in service at the time and to add additional service to meet increasing rider demand.

Federal Government

The FHWA aided in developing the operating and structural standards for bus-only shoulders. From the beginning, the FHWA's primary concern regarding bus-only shoulders was safety. Unsuccessful experimentation with allowing vehicles to operate on shoulders in Seattle caused the FHWA to be particularly wary at the prospect of shoulder use in the Twin Cities. In Seattle, shoulders were used as HOV lanes allowing carpools and transit providers to use the shoulder. This pilot project was not deemed to be successful, however, due to safety issues that arose from allowing so many vehicles to use shoulders. While the proposed use in the Twin Cities did not include carpools, concerns about operating buses on shoulders remained. Fortunately, these concerns were alleviated over time as BOS use on non-federal highways such as Highway 77 (Cedar Avenue), proved to be safe. The FHWA also brought attention to the conflict between BOS operation and the UVC. The UVC states that driving on shoulders should not be permitted and that passing on the right is not allowed. Thus, in 1992, Mn/DOT adopted an alternative standard that permitted buses to drive on the shoulder. This alternative standard to the UVC was one of many standards created as a result of establishing bus-only shoulders and eventually became part of Minnesota's bus shoulder law.

Project Champion/Opposition

A number of individuals interviewed for this report emphasized that there was no single champion of Team Transit and instead stressed that it was really a partnership supported by numerous agencies and individuals. Key individuals include: Aaron Isaacs, who introduced the idea of bus-only shoulders and is to a great degree credited with their success; Deputy Commissioners Darryl Durgin and Ed Cohoon, who contributed greatly to the success of BOS use by creating an atmosphere at Mn/DOT that was open to involvement in innovative transit opportunities. Their support for bus-only shoulders,

along with that of the Mn/DOT transportation commissioner, was vital to overcoming obstacles and some slight opposition based mainly on safety concerns, which were expressed by Mn/DOT engineers and the FHWA during the early stages of BOS implementation. Safety never became a prohibitive issue due to the careful selection of corridors and establishment of operating rules.

Finance

Finding funding for bus-only shoulders was piecemeal at first, but with time and success, funds became easier to justify and obtain. Metro Transit and Mn/DOT were the main contributors to early projects, but financial support also was provided through the legislature and other sources over time.

Capital Funding

Mn/DOT and Metro Transit split capital costs when transit advantage strategies, such as BOS use, began to be implemented. Mn/DOT paid for the construction of early bus-only shoulders. Metro Transit contributed to the BOS system by paying for park and ride facilities, which are an integral part of the BOS system (See the Park and Ride Facilities section of this report). The overall cost of adding bus-only shoulders to the transportation system was born almost equally between Metro Transit and Mn/DOT with the exception of bus-only shoulders along county roads, which were paid for with county funds.

The costs associated with early BOS projects were minimal compared to other highway projects. Capital costs for the first stretches of BOS were limited to creating and installing signs and lane striping; shoulders that would have required any sort of construction to increase the width were avoided. Costs increased with the need to reinforce and construct shoulder facilities as the network expanded. Even then, BOS projects were worked in to other highway construction projects, when possible, to defray expenses. The coordination of BOS implementation with highway maintenance and construction was a timely and financially efficient way of accomplishing multiple goals at one time.

The bonding package passed in 2003 contributed $46 million to the capital costs of bus-only shoulders and allocated “at least $36 million of the appropriation for accelerating transit capital improvements on trunk highways such as shoulder bus lanes, park and ride facilities, and ramp meter by-pass facilities” (See Appendix C). The money allocated to BOS projects in the bonding package could be used only for capital projects and was in addition to the $2 million Mn/DOT budget.

Mn/DOT

As mentioned, Mn/DOT and Metro Transit split capital costs in the beginning. In 1996, Mn/DOT began to contribute dedicated funds to transit projects, and in 1997, Mn/DOT, Metro District created a Team Transit set-aside of $2 million per year from their total construction budget. In 2006, this set-aside amount was reduced to $1 million a year.

Operational Funding

Individual transit providers cover their operating costs for BOS service the same way they would if bus-only shoulders did not exist. The cost of operating buses using bus-only shoulders versus in congested mainline traffic reduces operation costs in terms of both time and resources. With the decreased trip times BOS use provides, transit providers can maintain the same service levels with fewer buses and bus drivers.

FTA

The FTA's contribution to transit providers and to the development of a BOS system in the Twin Cities was unique. With the passage of the Transportation Equity Act for the 21st Century (TEA-21) in 1998, federal funding for "fixed guideways" became available to communities with any "transit service that uses exclusive or controlled rights-of-way or rails, entirely or in part" [FTA].[1] The Twin Cities' BOS network fit the criteria for this type of funding and as such, received $14.7 million in 2002. Although this additional revenue source can be applied to either capital or operational costs, it has been used almost exclusively for operational costs such as those relating to providing additional service. Currently, Twin Cities transit providers receive $20 million per year. Funding from the FTA for fixed guideways is distributed to the Met Council, which then distributes the funds further among Metro Transit and suburban transit providers. The amount earned by having a fixed guideway is determined by a complex set of formulas as shown below:

- Urbanized Area Formula Program (Section 5307)
  - ✓ Extra 20 cents for every vehicle mile operated on a fixed guideway
  - ✓ $32,973 for every mile of fixed guideway
- Capital Program for Fixed Guideway Modernization (Section 5309)
  - ✓ Additional $1 for every vehicle mile operated on fixed guideways greater than seven years old
  - ✓ Additional $34,098 for every mile operated on fixed guideways greater than seven years old
  - ✓ As existing shoulders continue in use for more than seven years, revenue increases

Metro Transit also received federal money from the Congestion Mitigation Air Quality Improvement Program (CMAQ), which is jointly administered by the FHWA and the FTA. Money from CMAQ was used for regional transportation improvements that provided transit advantages, including ramp-meter bypasses and park and ride facilities. This money, along with congressional appropriations attributable to Martin Sabo, all went to Metro Transit. Team Transit funding comes from Mn/DOT, Metro District's state construction funds.

[1] Currently, the FTA is reconsidering the classification of bus-only shoulders as fixed guideways.

Design

Standards and Regulations

It took a number of years and experience to refine standards and regulations to suit all stakeholders involved in BOS use. Bus drivers, other Metro Transit/suburban transit staff, Mn/DOT, state patrol, and FHWA staff all aided in the evolution of initial standards. Most standards required mere modification of what already existed. The operating rules, however, were developed from scratch and exclusively for BOS use.

Operating Rules

The legislative statute language that codified BOS use into state law is basically the same as the operating guidelines and design standards that had been in place prior to passage of the law. The 2002 law neglected to specifically include Metro Mobility buses, which always had been allowed to use bus-only shoulders. The error was corrected in 2005.

A 35-mph speed limit is included in the operating rules. According to Aaron Isaacs, the speed limit was determined through a simple survey of bus drivers. Drivers who had been using shoulders were asked at what speeds, by a show of hands at five mph increments, they felt it was or was not safe to operate on bus-only shoulders. At 40 mph, some drivers stopped raising their hands, so it was decided that 35 mph would be the limit.

The results of the bus driver survey along with insight from the Mn/DOT traffic office helped to inform the FHWA in their support for the shoulder speed limit. The Mn/DOT traffic office had considered the potential damage that could be caused by sideswipes and other collisions. To prevent and limit such damage in case of an accident between a bus on the shoulder and vehicles in the general-purpose lanes, Mn/DOT recommended, and the FHWA mandated, that buses not be allowed to drive more than 15 mph more than the general traffic. Referring to the safety record of bus-only shoulders as evidence, the FHWA agreed that the 35 mph speed limit was an appropriate speed limit if buses did not drive more than 15 mph faster than the general traffic. Since the FHWA defines traffic moving at 20 mph as “congested,” the 35 mph limit fit the FHWA requirements perfectly.

BOS Width, Thickness, Signage, Catch Basins

Design criteria for shoulders address shoulder width, structural capacity, signage, and drainage structures.

Initially, buses were allowed to drive on shoulders “as is” without any modification. This posed no threat to the integrity of the shoulders because at the time, very few buses were using them. As the use of shoulders increased, wear and tear became a greater concern, and Mn/DOT’s focus turned from installing signs and lane striping to the repaving, reinforcing, and widening the shoulders. To date, only one shoulder has been replaced due to wear caused by buses.

The standard width of shoulders on bridges was set almost immediately. When the Cedar Avenue Bridge shoulder was opened to buses, bus drivers complained within the first week that they did not feel comfortable driving with only 10 feet between the edge of the

bridge and the vehicles in the general-purpose lanes. Over the next weekend, Mn/DOT sent out crews to re-stripe the bridge to provide an 11.5-foot shoulder. After addressing the drivers' concern with the shoulder width, service continued smoothly.

Because the BOS standards and preferences have evolved, the width of bus-only shoulders throughout the Twin Cities is not uniform. More than 90 percent of bus-only shoulders are 10 feet wide (See Appendix D). These 10-foot-wide shoulders leave nine inches of "extra" space on each side of the bus and does not account for side mirrors, which add an additional six inches on each side of the bus. Bus-only shoulders are required to be a minimum of 10 feet wide on stretches of highway and freeway without barriers or bridges; however, Mn/DOT's preference is 12 feet, which has become the standard width for shoulders in new construction for added safety. A 12-foot standard allows a more comfortable space for buses to operate. Additionally, should the road be widened in the future, this width makes modifying the shoulder to a general traffic lane economical, fast, and easy. A 12-foot width also is beneficial should traffic need to be rerouted for construction or emergency purposes. The minimum width standard for bus-only shoulders on bridges and other segments with a barrier is 11.5 feet because the presence of barriers seems to decrease drivers' perception of the actual space available, even though the width of the shoulder is at least 10 feet. BOS width standards and preferences are based on feedback from bus drivers and the desire to reduce potential sideswipe accidents.

The standard thickness of shoulder material changed during the 1980s from about 2 inches to 7 inches, which is consistent with that of the general-purpose lanes. As mentioned previously, buses were initially allowed to operate on shoulders despite the sometimes shallow thickness of material. Shoulders constructed before the change to a 7-inch minimum thickness were modified to prevent premature deterioration. A 7-inch thickness for shoulders is preferred because it reduces the amount of maintenance required and increases the shoulder's longevity. Many states routinely construct shoulders that are 7-inches thick for construction diversion and emergency purposes.

Soon after buses began operating on shoulders, it became apparent that driving over catch basins, in place to help remove storm water from the road, made a rough ride for passengers and caused potential damage to the catch basin as well. As a result, Mn/DOT developed new catch basin standards designed specifically for bus-only shoulders that include placing a concrete pad around each catch basin and bringing the structure level with the shoulder. The new catch basin design is ideal for buses that drive on the shoulder. And while it doesn't appear that driving on the shoulder damages catch basins themselves, it does damage the pavement around catch basins. Such damage is prevented with the use of the new catch basin design. However, the effectiveness of these new catch basins in removing storm water has been reduced slightly.

The rumble strips installed along shoulders as a safety measure to alert drivers that they are close to the pavement edge necessitated a minor, but unexpected, alteration as the BOS network expanded. Although it is not Mn/DOT's policy to install rumble strips in the metro area, there were a few instances in which shoulders with rumble strips were opened for bus use. In these areas, the rumble strips were simply moved to a position where buses could straddle them, removing the noise and rough ride that they caused previously.

The pavement markings and signage along bus-only shoulders changed a number of times before final designs were determined. Initially, bus-only shoulders were marked in the center of the shoulder with "special use" diamonds. This symbol was reserved for any use other than that of a general-purpose lane, according to the UVC. However, the diamond symbol was already in use to indicate HOV lanes in the Twin Cities, and use of the same diamond symbol in bus-only shoulders caused confusion over which vehicles were allowed to use the shoulder. The resulting illegal use of some shoulders by HOVs led to the removal of the diamond symbol from the bus-only shoulders. Signs were installed to indicate bus-only shoulders and were modified a number of times before the final design reading "Shoulder – Authorized Buses Only" was employed (See Appendix E).

Selecting Shoulders for Bus-Only Use

Implementation of bus-only shoulders is limited by statute to expressways and freeways in the seven-county metro area. However, bus-only shoulders exist on a few arterial roads where they have been deemed necessary by Mn/DOT, under the authority of the transportation commissioner and in consultation with the transit operators. Once a congested corridor is identified, Mn/DOT engineers determine whether existing shoulders are wide enough as is or if they require modification before buses can safely operate on them. As this process developed, Mn/DOT established roadway eligibility criteria that needed to be met in order for a roadway to be considered for BOS use. These criteria include the following:

- There must be predictable congestion delays, meaning the running speed of roadway must be less than 35 mph during the peak period and/or approaches to intersections have continuous backups.
- Congestion delays must occur one or more days per week.
- A minimum of six transit buses per day must use the proposed bus shoulder.
- The expected time savings of using the shoulder must be greater than eight minutes per mile per week.
- The proposed shoulder must have a continuous shoulder width of at least 10 feet [Mn/DOT].

Often, bus drivers, or other staff members from the participating agencies, suggest an area that they feel would benefit from BOS use; their request is sent to Mn/DOT. In addition to the listed criteria, Mn/DOT selects shoulders for conversion to bus-only shoulders based on cost (can the shoulder accommodate buses by installing signs only or is reconstruction necessary), safety, and how well conversion can be coordinated with

other construction or maintenance projects. The list of shoulders to be constructed/converted is maintained by the Team Transit project manager and is subject to change based on demand, other ongoing projects, and available budget.

Maintenance, Snow Removal, and Plowing

In Minnesota, one major roadway maintenance issue is snow removal. Mn/DOT maintenance personnel are evaluated based on the number of lane miles they plow and how quickly it is done. Originally, bus-only shoulders were not included in lane mile equations. As a result, the shoulders were not being cleared as quickly as the general-purpose lanes. In fact, the shoulders had been used for temporary snow storage in some places. This resulted in having to close bus-only shoulders during snowstorms when congestion is at its worst. As BOS use increased, it was recognized that the transit advantage bus-only shoulders provide should be maintained at a level at least equal to that of general traffic lanes. In winter 2004, Mn/DOT plow drivers began receiving credit for clearing shoulders. Now, shoulders used by buses are cleared of snow and obstructions as part of normal maintenance activities, with routine maintenance occurring during off-peak hours.

Safety Concerns

Safety was a concern of all parties involved in creating and implementing bus-only shoulders. A slow implementation process that considered the comments and concerns of bus drivers helped to prevent unsafe situations. Formal training of bus drivers by bus driver supervisors on the rules and regulations of operating a bus on the shoulder has been standard procedure for authorized transit providers and is crucial to maintaining safe operation on shoulders. The low number of incidents over the 15-year existence of the BOS network in the Twin Cities indicates that operating buses on the shoulder while observing the required policies, procedures, and regulations is safe. Despite every effort to ensure the safest of driving conditions for buses on shoulders and the traffic in general purpose lanes, accidents do occur. While no safety baseline was recorded, due to the incremental growth of the BOS network, Mn/DOT did a general accident study that found that between 1991 and 2001, there were only 20 accidents on the shoulder involving a bus, and all of these crashes caused property damage only. Most accidents consist of minor scrapes or mirror clips. Metro Transit reserves only $7,000 per year for damages resulting from BOS-related accidents. Since 2001, there has been one injury crash—a fatality involving a bus operating on the shoulder. In this case, the bus driver was found not to be at fault. There have been no other injury crashes; however, another incident occurred when an automobile broadsided a bus on the shoulder. Fortunately, there were no injuries to anyone involved.

Some general guidelines for BOS operations have emerged with time and experience. The general rule of thumb observed by drivers for dealing with obstacles or activity in the shoulder is to re-enter the general traffic lanes two light poles (approximately 1,000 feet) before the obstacle. Such obstacles may include stalled vehicles, debris, or emergency vehicles. This rule came forth after one bus waited too long to merge into the general traffic lane and, boxed in by a car, took the door off a Highway Helper (now known as FIRST Trucks) truck that was aiding a stalled vehicle on the shoulder.

The tendency of motorists to straddle the right-hand line can result in minor slow downs in bus speed. Drivers usually do so unconsciously or out of necessity. There are some drivers, referred to as "jealous motorists," who intentionally block buses from passing on the shoulder. Such instances pose more of an annoyance than a threat to buses on the shoulder. Buses have no choice in these cases but to stay behind the vehicle until it moves out of the way. Although it is a common occurrence, it does not pose a serious problem either for safety or operational efficiency. Bus drivers can usually just honk their horn to get these drivers to move to the center of their lane.

Finally, buses are required to yield to other automobiles exiting or entering traffic. The responsibility to yield is easier to control when it is put on bus drivers, promoting a safer driving environment from the transit providers' perspective. It has been suggested that the success of bus-only shoulders on freeways in the Twin Cities has been aided by the use of metered ramps, which regulate traffic entry to freeways more uniformly, preventing BOS users from being stuck behind entry ramp queues and increasing the ease of buses operating on the shoulder to merge with traffic entering the freeway.

Economic Benefits

Ridership, Travel Time, and Reliability

Prior to BOS use, Metro Transit was unable to establish an accurate bus schedule for many of its express routes because of the unpredictable nature of rush hour traffic and congestion. Bus-only shoulders "…allowed us to make the schedules we were advertising," stated Aaron Isaacs. An evaluation of shoulder use by buses prepared by MathCraft Inc. and JHK and Associates in 1996 showed shoulder use resulted in increased transit ridership and decreased operational costs. Shorter, more predictable travel times and fewer missed transfer connections have increased ridership. Operational costs have decreased because more reliable travel times result in less driver overtime. Decreasing route travel and deadhead time has, for some routes, allowed the same number of trips to be made by fewer buses and drivers decreasing the cost to the transit provider.

Bus-only shoulders have not necessarily enabled drivers to complete routes more quickly than they did prior to BOS use. If general traffic moves at a speed greater than 35 mph, bus drivers operate in a general-purpose lane and reach transit stops on time or possibly before the scheduled time. It is also important to recall that if traffic in the general-purpose lanes is stopped, buses on the shoulder are allowed to drive only 15 mph. It is when corridors are congested that buses are able to bypass congestion by using the shoulder, which allows them to stay on schedule and provide a benefit to transit passengers. BOS use provides transit riders with a predictable arrival time, which is less predictable for those in other vehicles or for a bus that is restrained to general-purpose lanes during peak congestion.

Although the traffic speed as well as that of buses may be minimal when corridors are heavily congested, passengers' perception of time saved is considerable. Respondents to an on-board survey conducted in 1998 reported that they reached their destination faster than they had prior to BOS use. These reports overestimated the actual amount of time saved by two to three times. A 1997 study of bus-only shoulders in the Twin Cities analyzed more than nine BOS routes for a period of two years and found that overall there was a 9.2 percent increase in ridership along these routes. At the same time, total ridership had decreased by 6.5 percent [Metro Transit]. That BOS routes were able to increase their ridership at a time when overall ridership had decreased indicates that passengers highly value BOS use.

Park and Ride Facilities

Park and ride facilities have been recognized as an important part of the comprehensive BOS system and have benefited the trunk highway system by providing additional accommodation to transit riders and reducing the number of vehicles on the highway. In the past, Metro Transit funded park and ride projects with no more than 200 parking stalls because they wanted to focus on service to the immediate community. However, Metro Transit has found that people are willing to drive farther for the extra service a large park and ride facility can support. As a part of the BOS system, park and ride facilities work best if parking lots are large enough to accommodate a maximum number of vehicles

during peak driving hours. Today, since such facilities have proven to be a vital component to providing transit advantages, particularly for BOS use, Metro Transit does not fund park and ride projects with fewer than 200 parking stalls.

Capital Costs Comparison

The costs associated with constructing, operating, and maintaining transit systems vary tremendously among modes, and bus-only shoulders serve a different niche of the transit network than light rail transit (LRT) and bus rapid transit (BRT) as each of these modes are appropriate in distinct situations. In comparing the costs of BOS construction with those of LRT or BRT, however, the investment for BOS is significantly lower, and merits consideration when funding is tight, as was the case in Minnesota in the early 1990s. According to Light Rail Now, a Texas-based LRT advocacy group [2003], LRT projects vary in capital cost from $15 to $100 million per mile, with the average cost per mile approximately $46 million. The Hiawatha LRT Line serves as a more applicable comparison as it is in the Twin Cities and reflects construction and land prices typical of the metro area. The Hiawatha Line, which runs from downtown Minneapolis to the Mall of America in Bloomington, cost approximately $65 million per mile to construct [Metro Transit].

While the capital costs associated with BRT appear significantly less than those of LRT, the degree of separation from traffic is a major variable. According to the FTA, the least costly BRT option is to include buses in a mixed-flow lane possibly with queue jumps. This runs between $2.5 and $2.9 million per mile, excluding any cost associated with acquiring right of way. Costs associated with this approach are most comparable to those associated with the construction of bus-only shoulders.

However, according to the TCRP, capital costs for bus-only shoulders in the Twin Cities ranges from as little as $1,500 per mile to $100,000 per mile depending on the current state of the shoulder (See Appendix F). The cost per mile of even the most costly BOS is far less than the suggested average cost of BRT. It is interesting to note that BRT as part of a mixed-flow lane provides less advantage to transit riders than does allowing buses to operate on the shoulder because it does not provide buses exclusive right of way. The most expensive approach to BRT involves the provision of lanes for exclusive use by buses. The cost of providing exclusive right of way can be anywhere from 3 to 20 times that of including buses in a mixed-flow lane. Bus-only shoulders can, in some cases, provide a better cost-to-benefit ratio when considering the travel time savings compared to time savings from BRT and LRT services.

Operating Cost Comparisons

Operating costs for bus-only shoulders in the Twin Cities are closely bound to those of regular bus service making it difficult to extract operating costs for BOS routes from those of regular service routes or to compare the two. However, routes using BOSs are more expensive to operate per rider, in part because of lower passenger turnover compared to in-town routes. To make a local comparison, the Hiawatha LRT ridership turns over several times between downtown Minneapolis and the Mall of America, and vice versa, greatly reducing the per rider cost. Although the per-rider subsidy is higher on

BOS routes, the on-average higher per rider subsidy would be the same for an equivalent service to and from the same suburban location. Making an accurate operating cost comparison between transit modes would require comparing routes of the same length and number of stops, that run at the same time of day, and are operated by the same transit provider, a level of detail that was beyond the scope of this study.

The Future of BOS Use in Minneapolis/St. Paul

The bulk of BOS conversion and construction in the Twin Cities has been completed. Current plans for developing new BOS routes extend to 2010 (See Appendix D). Mn/DOT and the Team Transit project manager have begun to change their focus from identifying new areas for BOS routes to maintenance and repair of existing BOS facilities. Up to this point, structural maintenance of bus-only shoulders has been minimal. Much of the proposed future work is maintenance-oriented as the quality of existing shoulders has begun to degrade over time—over fifteen years in some sections. Some shoulders now open for BOS use were not built to same standards as the general-purpose lanes. For example, the shoulder of TH 47 was not the preferred thickness to begin with; however, this will be fixed when Mn/DOT improves the general-purpose lanes on this highway. The recent cut in Team Transit funding coincides with the decreased demand for new BOS projects. Because the bulk of the BOS network is largely built, it seems logical that the focus should shift to other transit advantages. Should funding to Team Transit increase in the future when there also is potential to expand the BOS network, further investment would be pursued since BOS has proven its worth.

Further Research

Bus-only shoulders have been part of the Twin Cities transportation network for more than 15 years. Despite their success, studies of bus-only shoulders have dwindled in recent years, leaving a wealth of opportunity to further explore the benefits and challenges BOS use presents in the Twin Cities and elsewhere. For example, there has yet to be a thorough analysis of the BOS operating costs and how that compares to other transit modes such as LRT and BRT. Even more interesting would be a total costs analysis that then incorporates the differences in capital investment with this operational costs analysis. Information on the monetary and temporal benefits of BOS use would benefit transit providers and passengers in the Twin Cities and elsewhere. Further research should be done into the type of transit routes that would benefit the most from BOS use so the routes can be designed to maximize the benefit. As the Twin Cities highways have grown more congested, many people are beginning to wonder what type of effect congestion is this having on BOS operation, thus providing another avenue for future study.

As other cities to consider the benefits of BOS use, they can learn a great deal from the history of bus-only shoulders in the Twin Cities; however, implementation in other cities will be different. Changes to the FTA's definition of what constitutes a fixed guideway will affect the feasibility of implementing bus-only shoulders; the differences in operating costs between a BOS network and implementing LRT or BRT networks now also must be considered. BOS use offers a means of increasing the efficiency of existing road networks with little or no investment. As cities continue to look for ways to mitigate congestion, BOS use will surely receive increasing attention based on the success in the Twin Cities. To increase the rate at which other communities can plan for and implement BOS systems, it is necessary to answer the questions mentioned here and many others as well.

See Appendix G for information on the methodology and interviews used to complete this report.

Appendix A: BOS Development Timeline

1979–1986	Dick Braun, Mn/DOT Commissioner of Transportation
1987–1990	Leonard Levine, Mn/DOT Commissioner of Transportation
1990	Consensus reached that it is not possible to build out of congestion.
1990–1991	Metro Transit faces budget cuts and increased ridership [Caroon].
1991–1999	James Denn, Mn/DOT Commissioner of Transportation
1991–1993	Scott McBride, First Team Transit Project Manager
1991	John H. Riley, Mn/DOT Commissioner of Transportation
1991	First BOS opens for operation along TH 252.
1992–1997	Capital costs are split 50/50 by Metro Transit and Mn/DOT.
1993-1995	Mark Dierling, Second Team Transit Project Manager
1993	MN River floods, closes several bridges, and causes severe congestion; bus service over Cedar Avenue Bridge begins; buses are allowed on the freeway shoulder for the first time. On-board survey done of passengers on BOS routes.
1994	Diamond symbols removed from BOS lanes due to driving public's confusion.
1996	First full-time Team Transit project manager is hired; 50% salary paid by Mn/DOT, 50% paid by Metro Transit.
1996–1998	Joe Gladke, Third Team Transit Project Manager
1997	BOS guidelines adopted by Mn/DOT [SM/jc]. Mn/DOT Metro funds full-time Team Transit project manager. Mn/DOT Metro District sets aside $2 million from construction budget for Team Transit. Four years after buses began driving on interstate shoulders, FHWA gives approval [JC/sf].
1999–2000	Lynn Clarkowski, Fourth Team Transit Project Manager
1999–2002	Elwyn Tinklenberg, Mn/DOT Commissioner of Transportation
2000	Signs changed to read "Shoulder – Authorized Buses Only"
2001	Study conducted by Mn/DOT shows that from 1991 to 2001, there were only 200 accidents involving a bus operating on the shoulder. Speed limit implemented [JC/sf].
2002–2004	Heather Lott, Firth Team Transit Project Manager
2002	Legislation for BOS use codified; overlooks Metro Mobility vehicles.
2002	Funding comes from FTA for "fixed guideway system."
2003–Present	Carol Molnau, Mn/DOT Commissioner of Transportation
2005–Present	Jennifer Conover, Sixth Team Transit Project Manager
2005	BOS legislation updated to include Metro Mobility vehicles.
2008	Extent of existing BOS projects.

APPENDIX B: MN Statute—Use of Shoulders by Buses

Section 1. Minnesota Statutes 2005, section 169.306:

Effective May 11, 2005

169.306 [USE OF SHOULDERS BY BUSES.]

(a) The commissioner of transportation may permit the use by transit buses and metro mobility buses of a shoulder of a freeway or expressway, as defined in section 160.02, in the seven-county metropolitan area.

(b) If the commissioner permits the use of a freeway or expressway shoulder by transit buses, the commissioner shall also permit the use on that shoulder of a bus with a seating capacity of 40 passengers or more operated by a motor carrier of passengers, as defined in section 221.011, subdivision 48, while operating in intrastate commerce.

(c) Buses authorized to use the shoulder under this section may be operated on the shoulder only when main line traffic speeds are less than 35 miles per hour. Drivers of buses being operated on the shoulder may not exceed the speed of main line traffic by more than 15 miles per hour and may never exceed 35 miles per hour. Drivers of buses being operated on the shoulder must yield to merging, entering, and exiting traffic and must yield to other vehicles on the shoulder. Buses operated on the shoulder must be registered with the Department of Transportation.

(d) For the purposes of this section, the term "metro mobility bus" means a motor vehicle of not less than 20 ft. in length engaged in providing special transportation services under section 473.386 that is:

(1) operated by the Metropolitan Council or operated by a public or private entity receiving financial assistance from the Metropolitan Council; and

(2) authorized by the council to use freeway or expressway shoulders.

APPENDIX C: Shoulder Use by Buses—Geometric Design Standards

(Form updated September 15, 2004)

Highway Type

Multi-Lane Divided Highway, Urban (High Speed)

Design Standard

Design of this project will follow the "MnDOT Standard for Shoulder Use by Buses" listed on the following page in Table 1 Critical Design Elements.

Design Parameters

- **Functional Class** ( ) Principal Arterial ( ) Minor Arterial ( ) Collector
- **Terrain** ( ) Level ( ) Rolling ( ) Rough
- **Traffic Volume** Current ADT_____ vehicles/day
  based on: ( ) actual counts; ( ) traffic flow map
  dated __/__/__
- **Posted Speed** _____ mph

( ) Existing and Proposed Typical Sections are in the appendix.
( ) Reduced layout is included in appendix.

Critical Design Element	Existing Condition, Minimum	Proposed Condition, Minimum	MnDOT Standard for Shoulder Use by Buses	Reference MnDOT Road Design Manual
Design Speed	Design Speed selected for this project is 35 mph. 35 mph is the maximum speed for buses traveling on the shoulder, as per Minnesota Statutes, Chapter 169, 169.306.			Table 4-4.03A Minnesota Statutes, Chapter 169, 169.306
Shoulder Width (Right Only)	___ ft	___ ft	10 ft min 12 ft desirable	Table 4-4.03A
Bridge Shoulder Width (Right Only)	___ ft	___ ft	11.5 ft min 12 ft desirable	Table 4-4.03A
Horizontal Clearance to Obstructions	___ ft	___ ft	0 ft	Table 4-4.03A, Section 4-6.05
Bridge Structural Capacity	HS __ design load	No change (1)	All new bridges to have HS-25 Minimum design load	Chapter 9, Section 9-2.0, Table 4-4.03A
Stopping Sight Distance	___ ft	No change	250 ft min.	Table 2-5.09A Table 4-4.03A
Horizontal Alignment, Radius	___ ft	No change	Match existing roadway	Table 3-2.03A or Table 3-2.03B
Grades, Percent	___% maximum		Match existing roadway	Table 3-4.02A
Inslopes	X:X	No change (2)	1:6	Table 4-4.03A
Vertical Alignment, K value Crest Sag	 __ ft/% min. __ ft/% min.	 No change No change	 Match existing roadway Match existing roadway	 Figure 3-4.04A Figure 3-4.04D
Normal Cross Slope		No change	0.02–0.05	Table 4-3.01A
Superelevation		No change	0.06 maximum	Chapter 3, Section 3-3.0
Vertical Clearance Highway under bridge	___ ft	No change	14 ft	Table 4-4.03A Table 9-2.01B

Table 1 Critical Design Elements Table

Table Notes

An asterisk preceding proposed condition indicates a Geometric Design Exception. See Geometric Design Exception Justification below for additional information.

(1) Bridge Structural Capacity—The standards call for an HS 25 design load for new bridges. For existing bridges to allow shoulder use, the shoulder must be structurally adequate (capable of carrying legal loads and does not appear on the inventory of inadequate bridges).

(2) Inslopes—Existing inslopes are as steep as 1:4, where not protected by guardrail. The bus-only shoulder standard for inslopes is 1:6 (rise:run). If the inslopes are steeper than 1:6, Mn/DOT's Road Design Manual calls for the following actions:

If inslopes are flatter than 1:6, inslopes may be steepened to 1:6. If inslopes are steeper than 1:6, match existing, except in the following cases: If fill slope is steeper than 1:3 and higher than 2 ft, provide guardrail. If fill slope is steeper than 1:3.5 and

higher than 5 ft, provide guardrail, unless there is 18 ft between the edge of shoulder and the point where the fill slope becomes steeper than 1:3.5.

The existing inslopes are 1:4 or flatter, or protected by guardrail. The design of this project will meet the conditions stated above. Therefore, the design meets Mn/DOT standards.

Interstate/STRAHNET System

( ) This project does not involve work on the Interstate/STRAHNET system.

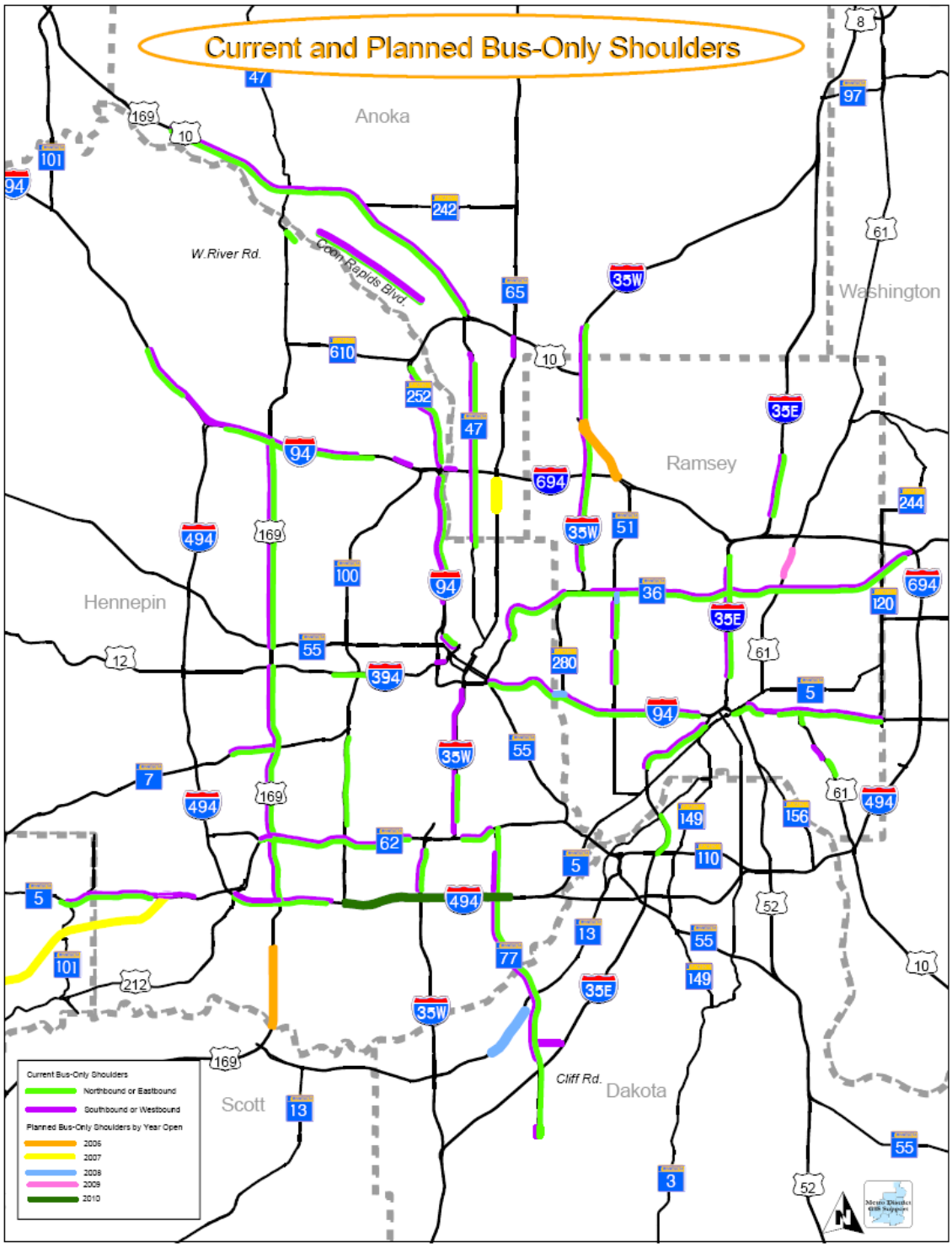
( ) This project involves work on the Interstate/STRAHNET system.

- ( ) At the completion of this project, all bridges will meet the 16-foot standard for vertical clearance over Interstate highways.
- ( ) At the completion of this project the vertical clearance of the bridge will remain unchanged. The scope of work involves limited repair of the bridge or roadway pavement. The project scope does not provide the opportunity to alter the vertical clearance situation. FHWA will be requested to coordinate with the Department of Defense—Military Traffic Management Command Transportation Engineering Agency (MTMCTEA) at least three months before letting.

Geometric Design Exception Justification

Within this section please justify the design exceptions (if any) noted in Table 1 Critical Design Elements table on the previous page. Refer to Section 2-6.01.01 of the Mn/DOT Road Design Manual for additional guidance on Geometric Design Exceptions.

APPENDIX D: Current and Planned Bus-Only Shoulders



APPENDIX E: Illustrations, Including Signage

APPENDIX F: COSTS ASSOCIATED WITH IMPLEMENTING BUS-ONLY SHOULDERS

Condition	Costs plus signing and striping
Shoulder width and bituminous depth are adequate. Catch basins do not need adjustment. Signing and striping are only requirements.	$ 1,500 per mile – Freeway $ 2,500 per mile - Expressway
Shoulder width and bituminous depth are adequate. Minor shoulder repairs and catch basin adjustments are needed.	$ 5,000 per mile – Freeway $ 5,000 per mile – Expressway
Shoulder width is adequate but bituminous depth requires a 2" overlay. This assumes shoulder and roadway can be overlayed at the same time.	$ 12,000 per mile – Freeway $ 12,000 per mile - Expressway
Same as above but adjacent roadway is not being overlayed. Shoulder must be removed, granular base adjusted and increased bituminous depth replaced.	$ 80,000 - $ 100,000 per mile
Shoulder width and depth replacement are required.	$ 42,000 - $ 66,000 per mile for both freeway and expressway
Installing a 12 ft shoulder rather than a 10 ft shoulder in a new construction project.	$ 30,000 per mile for both freeway and expressway

Table 2 Costs Associated with Implementing Bus-Only Shoulders

Source: Mn/DOT. 1998. Study of Bus-Only Shoulders.

APPENDIX G: METHODOLOGY AND INTERVIEWS

Methodology

This report was written in late 2006/early 2007 by researchers at the State and Local Policy Program. The information presented in this report was collected from a series of primary interviews with current and former staff members of Metro Transit, Mn/DOT, the State Patrol, suburban transit providers, and the FHWA. In addition, secondary data from interviews conducted by Jennifer Conover was used as supporting evidence. Through her work on detailing the history of Team Transit, Conover found that implementing BOSs was a major accomplishment of the team. As a result, the climate that led to creating the BOS program is an important element of the Team Transit history. We are grateful for her willingness to share her work with us as it greatly enriched our own efforts.

Primary Interviews

October 10, 2006—Mn/DOT
Jennifer Conover, Team Transit Project Manager, 2005–Present

October 11, 2006—Metro Transit
Aaron Isaacs, Manager of Facilities Planning (retired in 2006)

October 19, 2006—Metro Transit
Georgia Stinson, Bus Driver Manager

October 20, 2006—Mn/DOT and current Hennepin County Transit Planner
Joe Gladke, Team Transit Project Manager 1996–98

November 6, 2006—MVTA
Mike Abegg, Planner
Samantha Porter, Operations Manager

November 8, 2006—Minnesota State Patrol
Tom Fraser, Metro West Captain

November 9, 2006—Mn/DOT
Scott McBride, Team Transit Project Manager, 1991–93

November 27, 2006—FHWA
Jim McCarthy, Project Manager

Jennifer Conover's Interviews

Dick Braun	Mn/DOT Commissioner, 1979–86
Bob Johns	Center for Transportation Studies Director
Mike Christenson	Metro Transit, Director
Tom Johnson	Metro Transit, Transit Development
Aaron Isaacs	Metro Transit, Engineer and Facilities
Dick Stehr	Mn/DOT Traffic Engineer
Larry McKenzie	Mn/DOT Traffic Supervisor
Jim McCarthy	FHWA Project Manager
Scott McBride	Mn/DOT, First Team Transit Project Manager, 1991–93
Mark Dierling	Mn/DOT, Second Team Transit Project Manager, 1993–95
George Serumguard	Metro Transit Operations
Tim Henkel	Mn/DOT Metro Planning Director
"Jack" John Caroon	Mn/DOT Metro Planning
Joe Gladke	Mn/DOT, Third Team Transit Project Manager, 1996–98
Lynn Clarkowski	Mn/DOT, Fourth Team Transit Project Manger, 1999–2000
Heather Lott	Mn/DOT, Fifth Team Transit Project Manager, 2002–04
Jennifer Conover	Mn/DOT, Sixth Team Transit Project Manager, 2005–Present
Jim Kranig	Mn/DOT Regional Traffic Management Center (RTMC)
Randy Halvorson	Mn/DOT Office of Transit

Glossary of Agencies and Programs

Below is a list and brief description of acronyms and agencies mentioned in this report. The purpose of this glossary is to provide additional information and context for those individuals not familiar with the Twin Cities.

Congestion Mitigation Air Pollution (CMAQ) Improvement Program
This program is jointly administered by the FHWA and the FTA. It provides more than $8.1 billion dollars in funds to state departments of transportation (DOTs), metropolitan planning organizations (MPOs), and transit agencies to invest in projects that reduce criteria air pollutants regulated from transportation-related sources over a period of six years (1998–2003) [FHWA].

Federal Highway Administration (FHWA)
The FHWA is one of 10 modal administrations within the U.S. Department of Transportation. Each state has an FHWA office that works closely with the state DOT to prioritize and fund transportation projects. In Minnesota, the state DOT and the local FHWA office work together closely to fund projects, develop and maintain standards, and ensure compliance with statutes and regulations. Depending on the state, the role of the FHWA varies from an overseer to a partner in transportation projects.

Federal Transit Administration (FTA)
The FTA is one of 10 modal administrations within the U.S. Department of Transportation. The FTA administers federal funding to support a variety of locally planned, constructed, and operated public transportation systems throughout the U.S. The FTA administers federal funding to transit agencies such as Metro Transit.

Minnesota Department of Transportation (Mn/DOT)
Mn/DOT is responsible for identifying and addressing transportation needs in Minnesota. Mn/DOT spends the bulk of its money constructing and maintaining state highways and local roads. Mn/DOT is funded primarily by the state but is also eligible to receive federal funding and grants.

Minnesota State Patrol
The mission of the Minnesota State Patrol is to: protect and serve all people in the state through assistance, education, and enforcement; provide support to allied agencies; and provide for the safe, efficient movement of traffic on Minnesota's roadways. Bus-only shoulders on any Minnesota road are under the jurisdiction of the Minnesota State Patrol [State Patrol Web site].

Metropolitan Council
The Metropolitan Council is the regional planning agency serving the Twin Cities seven-county metropolitan area and providing essential services to the region, including a regional transportation system.

Metro Transit
Metro Transit is the transit division of the Metropolitan Council. Metro Transit is funded by and operates under the authority of the Metropolitan Council. Money comes from the state motor vehicle sales tax, the state general fund, fares, and federal revenues.

Metro Mobility
Metro Mobility is one of four paratransit services for people who are unable or have extreme difficulty using regular-route transit service because of a disability or health condition. The service is provided through the Metropolitan Council. Metro Mobility serves Minneapolis, St. Paul, and a number of surrounding suburbs.

Metropolitan Transit Commission (MTC)
The MTC was the name of Metro Transit before it became a part of the Metropolitan Council in 1994.

Suburban Transit Providers
Maple Grove Transit—Based in the city of Maple Grove, Maple Grove Transit provides express bus service to downtown Minneapolis in the morning and return service in the evening.

Minnesota Valley Transit Authority—MVTA provides public transportation alternatives for the suburbs of Apple Valley, Burnsville, Eagan, Rosemount, and Savage. Major destinations include downtown Minneapolis, downtown St. Paul, the University of Minnesota, and a number of suburban locations.

Plymouth Metro Link—Based in the city of Plymouth, this transit service provides express bus service to downtown Minneapolis in the morning and return service in the evening.

Southwest Transit—Southwest Transit provides local transit service to Chanhassen, Chaska, and Eden Prairie as well as service to downtown St. Paul, downtown Minneapolis, and a number of other destinations within the Twin Cities.

University of Minnesota Campus Connector
The University of Minnesota Campus Connector provides free transit service to University students. Stops are located on the East and West Banks of the Minneapolis campus and on the St. Paul campus.

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