CAMBRIDGE SYSTEMATICS

MnPASS System Study

final report

prepared for

Minnesota Department of Transportation

prepared by

Cambridge Systematics, Inc.

with

URS Corporation

April 7, 2005

www.camsys.com

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date

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Executive Summary

What is MnPASS?

MnPASS is the term used by the Minnesota Department of Transportation (Mn/DOT) to describe "express toll lanes."[1] Express toll lanes provide a congestion-free alternative to highways with high congestion by charging a toll for drivers to use one or more specially designated highway lanes. Mn/DOT is considering two types of MnPASS lanes:

1. High-occupancy toll (HOT) lanes, whereby existing (or proposed) high-occupancy vehicle (HOV) lanes are opened up to non-HOV traffic for a toll; or
2. New highway capacity adjacent to existing highways (either freeways or conventional highways), where all traffic except transit vehicles pays a toll.

In both cases, these MnPASS lanes would have the following characteristics:

- Speeds at or near the posted limits would be maintained by pricing that varies with demand and use of the lanes.
- Collection of the tolls would be automated, through the use of electronic toll collection – there would be no toll booths or cash transactions.
- Variable message signs would be used to advise drivers of the toll rate in place at any given time.
- Heavy trucks in excess of 26,000 pounds would be excluded from the MnPASS lanes.
- Transit vehicles would use the MnPASS lanes for free. Although the study team did not explicitly evaluate the implications of MnPASS on future transit system performance, it did perform a simplified analysis to illustrate the potential synergies between MnPASS and transit.
- Access into and out of the MnPASS lanes would be provided by slip "ramps" with the adjacent general purpose lanes, which would likely require periodic

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[1] Formerly known as FAST lanes – Freeing Alternatives for Speedy Transportation. This is the name included in Federal legislation in 2004 for the express toll lane concept that would have had specific statutory requirements associated with it. The current state administration favorably endorsed FAST lanes in a press conference on December 29, 2004, defining them as "… new publicly-owned lanes paid for by private entities which are repaid by users of the lanes." Since that time, Mn/DOT has adopted the MnPASS name to refer to any kind of tolled express lane in Minnesota, and MnPASS is used throughout this report.

breaks in a double-striped lane to allow for merging and weaving between the facilities. Other options are possible, such as "T" ramps from a bridge above. However, the slip-ramp concept is consistent with Mn/DOT's I-394 toll lane demonstration, and was used as the basis for this study.

There are numerous other details regarding how MnPASS lanes might operate that still need to be worked out. However, the above points provide the basic framework.

Mn/DOT is in the process of implementing the first MnPASS project on I-394, generally from I-94 to just west of I-494, with an anticipated opening in May/June 2005. This project involves the conversion of the existing HOV lane to a HOT lane, and has specific design and operational characteristics which may or may not be relevant to other MnPASS lanes that might be implemented later.

Study Goals and Objectives

The primary goal of the MnPASS System Study was to evaluate and report any relevant data concerning the impacts of overlaying a MnPASS toll lane system in the Twin Cities Metropolitan area of Minneapolis and St. Paul. The overall objective of the study was to identify a potential Twin Cities Metropolitan Area MnPASS tolling lane system and to provide Mn/DOT and the Metropolitan Council with information on the cost, operational, revenue and system implications of that system. The intent was not to evaluate the benefits of tolled versus nontolled capacity expansion, but rather to study a potential future system of express toll lanes.

The study evaluated impacts that the MnPASS implementation would have on existing transportation system and policy plans, and addressed operational and financial implications of alternative networks of MnPASS lanes in the Twin Cities Metropolitan area. The study determined the extent to which these lanes could be self-supporting and how they might fit into the larger transportation system.

To support the project's goals and objectives, the study had to consider both those segments with sufficiently high travel demand to provide immediate financial leverage for construction, as well as those segments that were consistent with a long-term regional vision but may have been too costly to implement quickly. The original focus of the study was on the segments that could be built relatively quickly in partnership with the private sector, and as a result, the financial viability of potential MnPASS segments was an important factor in developing system recommendations. As the study progressed and it became clear that toll revenues would not recoup the required capital investment, the focus of the study shifted to developing a long-term MnPASS vision managed by the public sector.

Results from the MnPASS System Study are consistent with Mn/DOT's strategic objectives. The vision articulated in Mn/DOT's 2003 Strategic Plan calls for *"a* *coordinated transportation network that meets the needs of Minnesota's citizens and businesses for safe, timely and predictable travel."* The MnPASS System Study supports this vision by looking beyond individual corridors to a regionally interconnected system of toll lanes. In addition, the managed-lane concept will be dynamically priced so that the MnPASS lanes can consistently achieve higher speeds and more reliable travel times than the untolled lanes.

The MnPASS System Study is also consistent with Mn/DOT's strategic direction to "make the transportation network operate better." MnPASS supports the objectives of this strategic directive by addressing traffic congestion in the Twin Cities metropolitan area, improving mobility within highly traveled corridors (including transit improvements), and exploring potential partnerships with the private sector.

Summary of Findings

The following are key findings from the MnPASS System Study:

- MnPASS lanes are a new transportation "product" that can provide a congestion-free alternative, as long as tolls are charged. MnPASS users enjoy significant time savings, but nonusers and the transit system are also expected to benefit.
- Public investment is required since the MnPASS lanes are not expected to be self-sustaining from tolls. Typical segments will recover about 15-55 percent of their capital cost; on average, only 22 percent of the regional MnPASS system capital costs could be expected to be recovered from tolls. Although not self-sustaining, new revenue from tolls can contribute to closing the transportation program funding gap.
- The most financially viable segments, to be built from scratch, are not in the region's 25-year Transportation Policy Plan (TPP).[2] Advancing these projects would require modifying the TPP and likely delaying other projects. However, leveraging money in the TPP would require waiting many years, since the projects that are in the TPP also require an infusion of public investment.
- The HOT lanes now under construction on I-394 and proposed in this study on I-35W are expected to fill up with HOV traffic by 2030. Since HOVs cannot be priced out of the MnPASS lanes, the lanes are predicted to become congested and leave little room for paying vehicles. The long-term success of

[2] The TPP was still being developed during this study. The analyses in this report are based on the draft plan dated November 16, 2004. The Metropolitan Council's final 2030 Transportation Policy Plan was adopted on December 15, 2004 and is available at: http://www.metrocouncil.org/planning/transportation/TPP/2004/summary.htm

the HOT concept may require flexibility in the HOV definition, such as changing the definition from HOV 2+ to HOV 3+ or vanpools only.

Study Framework

The study began with a blank slate, meaning that any existing or proposed highway in the metropolitan area was a candidate for the addition of MnPASS lanes. The consultant team worked with a study Steering Committee and Technical Group to develop evaluation methods and criteria to narrow the focus of the study as more information became available.

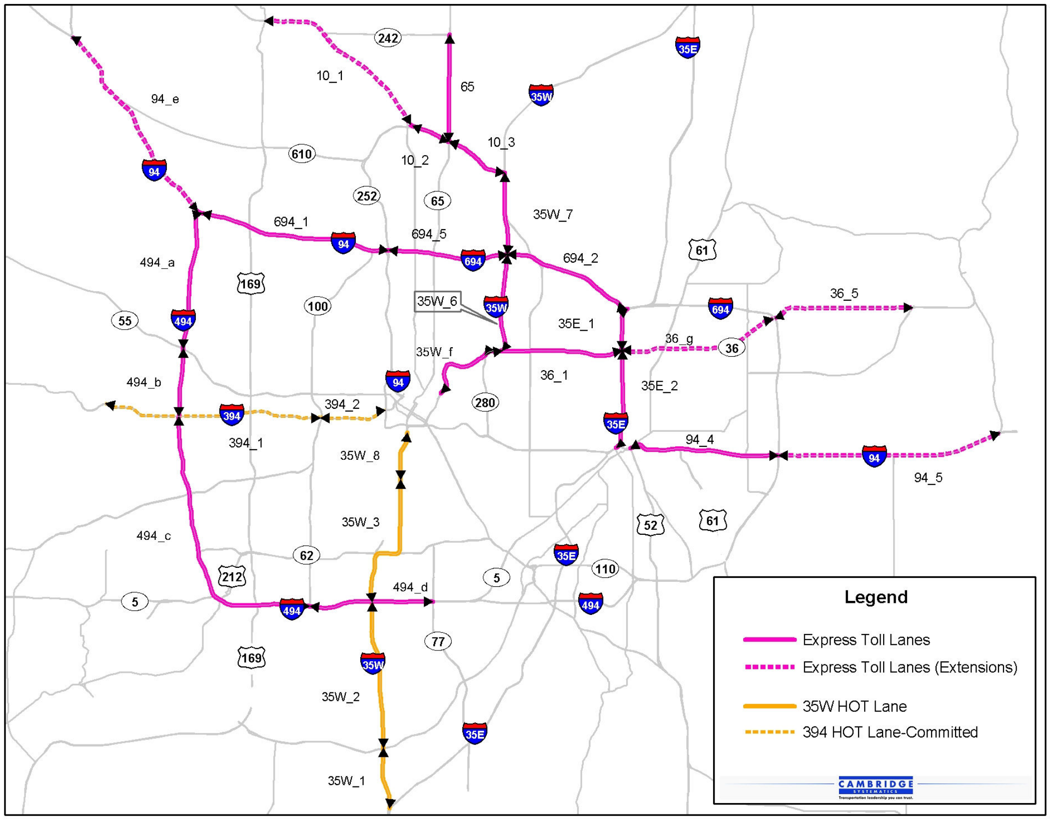
An early screening effort using readily available data led to two rounds of technical analysis aimed at understanding the financial and system implications of different combinations of MnPASS lanes.

At the conclusion of the first round of analysis, the consultants worked with the study committees to define a 144.5-mile system of 28 highway segments called **Concept A** that would form the basis for the more detailed Round 2 work (see Figure ES-1). In this figure, the "express toll lanes" represent the best segments that emerged from the first round of analysis, and the "extensions" represent segments that performed less well, but might be logical to combine with projects on other corridors. The system of potential MnPASS segments in Concept A was then evaluated in terms of cost through two different lenses, referred to as Concept A-1 and Concept A-2.

In **Concept A-1**, the costs of building MnPASS lanes "from scratch" were treated as "MnPASS costs," assuming the highway network committed to be built by 2013 is already in place. No contributions were assumed from projects in the 2030 TPP. In most cases, we assumed that the MnPASS lanes were added without reconstructing existing lanes. [3]

[3] This assumption in Concept A-1 could tend to understate the cost of an actual project that Mn/DOT may want to build, but does reflect the cost of building just an additional lane.

Figure ES.1 Concept A Map



In **Concept A-2,** only those projects already included in the 25-Year TPP were considered for MnPASS treatment. The TPP is the Twin Cities' long-range transportation plan that includes policies and projects to slow the region's growth in congestion and improve mobility. Under Concept A-2, the incremental cost of converting a TPP lane-addition project to a MnPASS lane (gantries, striping, additional buffer zones, etc.) was assumed to be the "MnPASS cost." Concept A-2 was intended to investigate which segments could best leverage Mn/DOT investments already planned in the TPP.

A key "ground rule" of this study was that no existing lanes, lanes presently under construction, or new lanes proposed in Mn/DOT's 10-year Construction Work Program (CWP) could be considered for conversion to MnPASS. The only exception to this ground rule was for the existing and planned HOV lanes on I-35W, which were proposed in this study as HOT lane conversions. While the study committees agreed to these ground rules, not all individuals on the committees endorsed them.

Summary of Technical Findings

MnPASS lanes are an innovative new transportation product that provides a way to build new capacity that will remain uncongested as long as tolls are charged.

Few transportation strategies can accomplish this. The 144.5-mile MnPASS system represented by Concept A could be expected to save almost 32,000 vehicle hours of travel (VHT) per day in 2010 and almost 177,000 VHT in 2030 when measured over the entire Twin Cities metropolitan area highway network (see Table ES-1). On the highways with MnPASS, increased speeds are expected not only for MnPASS users, but also for users of the adjacent untolled lanes.[4] MnPASS users are also expected to travel about 20 mph faster than users of the adjacent untolled lanes, on an average daily basis.

Table ES.1 Network and System Performance Summary: Concept A

	2010	2030
Regional Network Performance[a]		
Daily Vehicle Hours Saved	31,642	176,713
Change in Daily Vehicle Miles	382,801	-284,853[d]
Average Daily Speeds on Concept A MnPASS System[b]		
Future Base Condition	44.4 mph	34.6 mph
With MnPASS: All Lanes	48.0 mph	38.9 mph
With MnPASS: MnPASS Lanes Only[c]	65.5 mph	59.0 mph
With MnPASS: Non-MnPASS Lanes Only[c]	46.6 mph	37.4 mph

Notes: [a] Regional highway network refers to the entire seven-county Twin Cities metropolitan area as represented by the Metropolitan Council's travel demand model.

[b] MnPASS System refers to the system of MnPASS lanes represented in Concept A, and the non-toll highway lanes immediately adjacent to them.

[c] Does not include potential HOT lanes on I-394 and I-35W.

[d] The decrease in daily 2030 vehicle miles, as compared to the No Build condition, is due to travelers shifting from SOVs to HOVs, which reduces the total number of vehicles.

As compared to the no-build traffic forecasts in 2010 and 2030 on the 2013 highway network, the daily vehicle miles of travel (VMT) over the entire regional network is expected to increase by over 380,000 when comparing 2010 traffic forecasts, but decreases by over 280,000 when comparing 2030 traffic forecasts. The No Build and Build scenarios use a fixed trip table, so changes in VMT and

[4] In most scenarios, the MnPASS lanes will result in small regional increases in VMT. Most highway capacity increases will have this impact as some travelers shift modes from transit or change their auto travel patterns to take advantage of the new capacity. However, because of the reduction in congestion, VHT decreases more than VMT increases, resulting in improved average speeds which are calculated by dividing VHT by VMT. Future improvements to the regional transit system might negate this forecast VMT increase.

VHT are due to mode shifts and/or route diversions, not changes in trip distribution. The decrease in 2030 VMT is due to a forecast shift from the SOV to the HOV mode, which reduces the number of vehicles traveling. Under 2030 travel conditions, we found a mode shift from SOV to HOV, meaning that the same number of people would be traveling in fewer vehicles. The fewer vehicles yield the lower level of VMT. This is consistent with the finding that the HOV lanes will fill up with HOV traffic in 2030, and should be viewed with caution. Although 2030 VMT on a *regional* basis decreases, the VMT on the actual *system* of MnPASS lanes and the non-tolled adjacent lanes increases in both 2010 and 2030.

Although MnPASS lanes are predicted to favorably improve system performance, our analysis shows that the cost of building any system of these lanes cannot be recovered through toll revenues alone, as has sometimes been suggested. Building MnPASS lanes also requires significant public investment beyond the 22 percent on average of the capital costs that could be expected to be recovered from tolls if the toll lanes are built "from scratch" without any contribution from the Transportation Policy Plan, as defined in Concept A-1. Nevertheless, these segments represent the best early opportunity targets for Mn/DOT to build without TPP funding because cost recovery would be the largest and the funding gap the smallest. However, these segments, absent some of the connections which only become viable with TPP funding (see Concept A-2), do not in and of themselves constitute a complete system of MnPASS lanes. The consultant-recommended system of MnPASS lanes using Concept A-1 cost criteria, together with system performance measures, is shown in Figure ES-2. The first tier recommendations represent the most attractive segments, the second tier recommendations represent segments that are promising but performed less well, and the HOV conversion on I-35W is recommended assuming potential future changes in high-occupancy eligibility criteria.

If the lanes are built by leveraging the cost contributions from the region's TPP as defined in Concept A-2, the cost recovery ratios are much better – combined, the TPP segments recover 75 percent of capital cost. However, since there are few highway widening projects in the TPP, the projects that do best financially under this scenario do not, by themselves, constitute a complete system of MnPASS lanes. The consultant-recommended system of MnPASS lanes under the Concept A-2 method of cost allocation is shown Figure ES-3.

Figure ES.2 Consultant Recommended MnPASS System Assuming No TPP Contributions (Concept A-1)

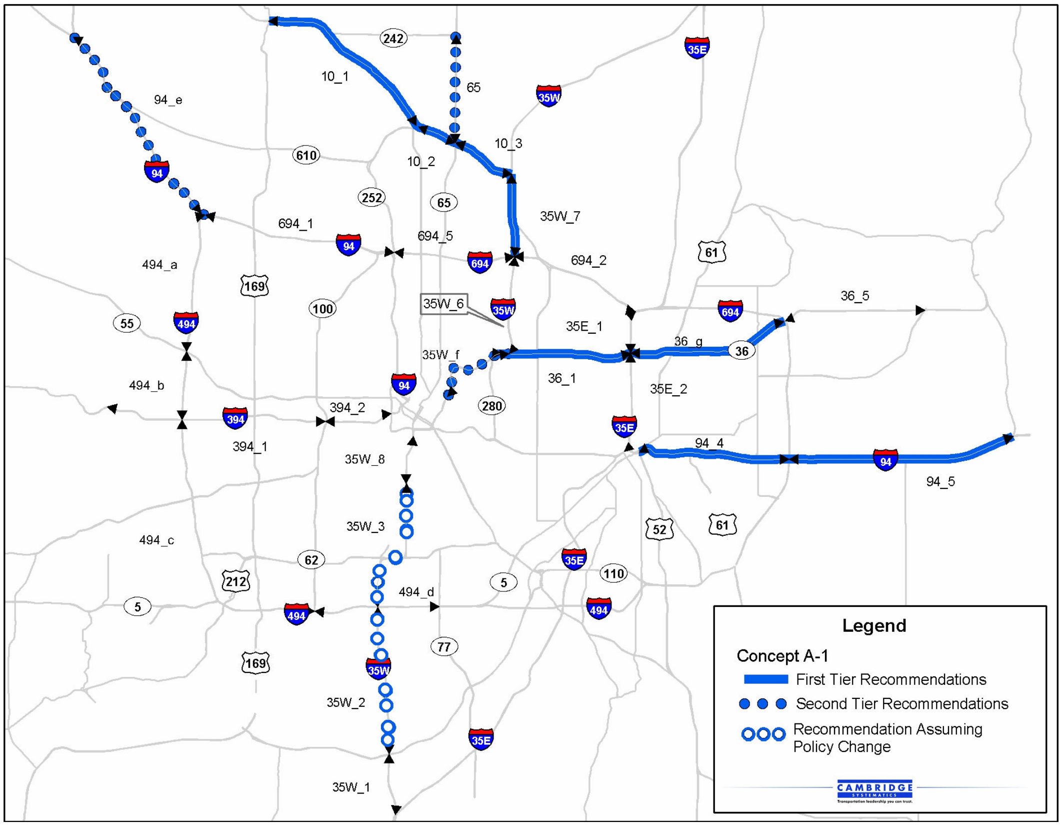
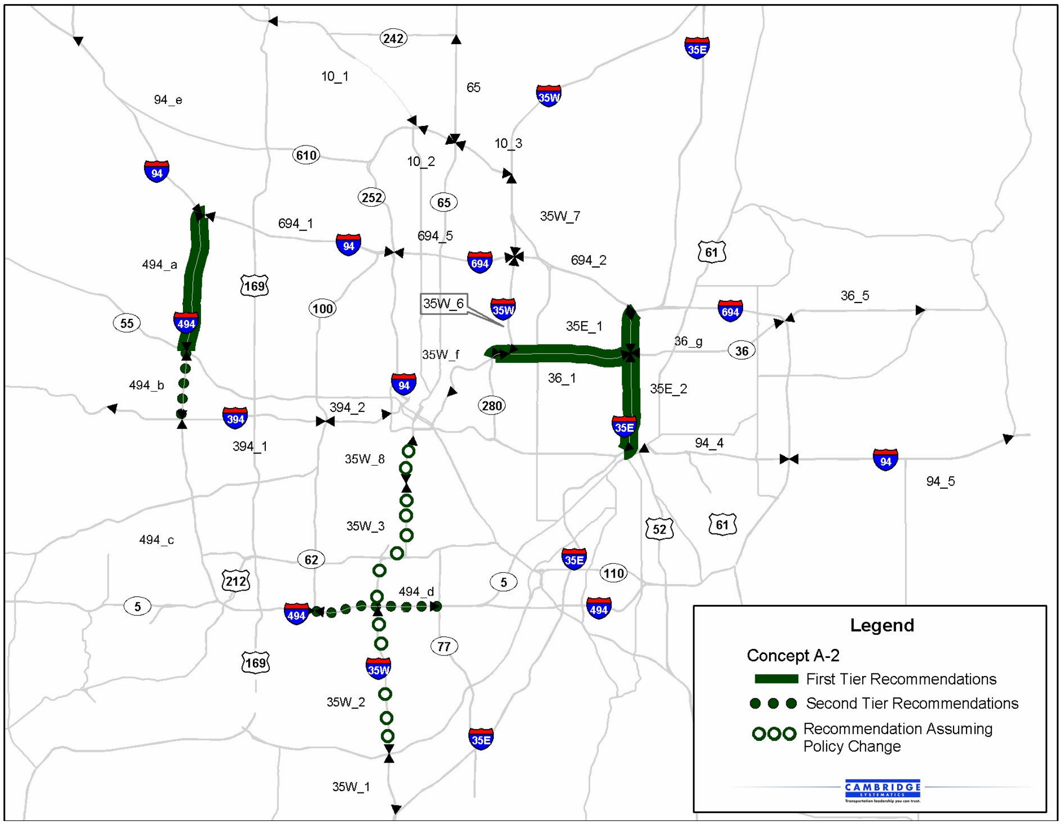


Figure ES.3 Consultant Recommended MnPASS System Assuming Leveraging TPP Contributions (Concept A-2)



The consultant-recommended system of MnPASS lanes under Concept A-1, including all three types of recommendations, would cost $1.2 billion, with a cost recovery ratio of 33 percent and a funding gap of $754 million (see Table E-2). Under Concept A-2, where the only cost of MnPASS implementation was assumed to be the cost of adding MnPASS features to lane additions that were already planned and funded, the capital cost of the consultant-recommended system (all three types of recommendations) was $378 million, with a cost recovery ratio of 45 percent and a funding gap of $188 million.[5]

Table ES.2 System Financial Performance Summary

	Capital Cost (2004$M)	Cost Recovery Ratio	Funding Gap (2004$M)
Concept A-1	$1,234	33%	$754
Concept A-2	378	45%	188

The projects that we found to be the most financially viable as "from scratch" projects are not in the Transportation Policy Plan. They are projects in rapidly growing areas on the outskirts of the metropolitan region that provide a combination of relatively low cost and relatively high demand. For example, the U.S. 10 corridor north of the Twin Cities and I-94 east of St. Paul were both identified as First Tier Recommendations. The stand-alone financial viability of projects decreases considerably as the projects get closer to the urban core – the result of the high cost of building in these denser areas. Advancing these projects that are not in the TPP would require modifying the TPP, and likely delaying other projects already in the plan.

By definition, the projects that are in the policy plan also require an infusion of public investment. Therefore, these TPP projects are also likely to be many years away in terms of potential implementation.

HOV Conversion Issues

Several of the MnPASS projects envisioned converting existing or planned HOV lanes to HOT lanes. Our analysis assumed that the "high occupancy" would continue to be defined as two or more people in a vehicle. Under those conditions, we found that HOVs would occupy most of the managed lane capacity by 2030, leaving little room to be sold to single-occupant vehicles. We have not conducted an independent assessment of the HOV forecasts generated by the Metropolitan Council's travel demand model. HOV use in the region and nationally has in fact declined as a share of total travel demand over the past few decades. Nevertheless, it is reasonable to assume that as traffic grows, so will the

[5] The consultant-recommended system using Concept A-2 includes the I-35W HOV conversion to HOT lanes, which is not included in the TPP.

volume of HOVs (if not the market share). Thus, the concern that too many HOVs will make tolling unfeasible is real. If HOV to HOT lane conversions are pursued, Mn/DOT should build some flexibility into the definition of HOVs, with the potential to evolve from the current 2+ passenger definition to a 3+ standard or to a vanpool and transit vehicle-only standard.[6]

Implications of Technical Findings

The findings of the Round 2 analysis were presented to the Technical Group and Steering Committee on January 28, 2005. The reaction of these groups was that there should be less emphasis on the immediate financial feasibility of individual segments or systems of segments, and more attention paid to an ultimate long-range system of MnPASS lanes in the Twin Cities region that would be built over time.

The study teams also felt that using financial payback criteria as a means of project selection was unusual in a metropolitan or statewide transportation planning context, since traditional highway projects do not contribute a revenue stream. Transit projects are different, in that they do generate revenue to help pay operating costs. Despite the finding that the MnPASS toll lane projects do not seem to be self-supporting, the idea that they can pay back some of their capital costs (lane construction costs and MnPASS incremental costs), albeit at the 22 percent level on average, is actually much more than any other type of capacity project can produce.

Another way to look at the financial potential of the MnPASS system is to consider the ability of the system to cover the incremental cost of building MnPASS lanes over and above the cost of building the lanes as traditional (non-tolled) lanes. Of the $3.5 billion in construction cost to build Concept A from scratch, about $0.6 billion is attributable to the incremental cost of making these lanes ready for MnPASS. This is the cost of buffer zones, gantries, and system connections. This amount is just about covered by the estimated $0.7 billion in net toll revenue expected from the MnPASS lanes (over and above operating costs, and discounted). The implication of these numbers is that we would expect the toll revenue from MnPASS to cover the incremental cost of building MnPASS, but would not provide significant dollars to the region's highway funding needs.

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[6] Similar issues would emerge with any variation in the definition of vehicles which might be allowed to use MnPASS lanes for free. For example, the study was asked to examine the feasibility of allowing hybrid technology vehicles into the lanes for free. If such a policy was "successful" in increasing the market share of hybrid vehicles in the region, the potential exists to overwhelm the MnPASS lanes with free users (carpools and hybrids). With little excess capacity to sell to SOV drivers, both the traffic management and revenue potential of the lanes would be compromised. This scenario is playing out right now on HOV lanes in Northern Virginia, particularly on I-95/395.

Because this study has shown that the financial benefits from MnPASS lanes are relatively small, the study team came to view MnPASS as more of a long-term traffic management solution rather than as a way to accelerate projects through toll revenue financing. MnPASS's revenue generating aspects are more of a side benefit. The study team also saw the potential long-range benefits of MnPASS leveraging the Twin Cities' transit system in terms of enhanced express bus or bus rapid transit (BRT) service.

With these findings and reactions in mind, the Round 2 results were used as a stepping stone to outline a broader vision of how the MnPASS concept could be integrated into the Twin Cities' long-term transportation system.

Potential 2030 MnPASS Vision

The result of the Technical Group's and Steering Committee's deliberations about the Round 2 findings was the desire to lay out a long-range plan for an interconnected system of MnPASS lanes. The consultant team worked with the project committees to develop a map of MnPASS projects that could be developed in the general timeframe of the current Transportation Policy Plan (about 25 years).

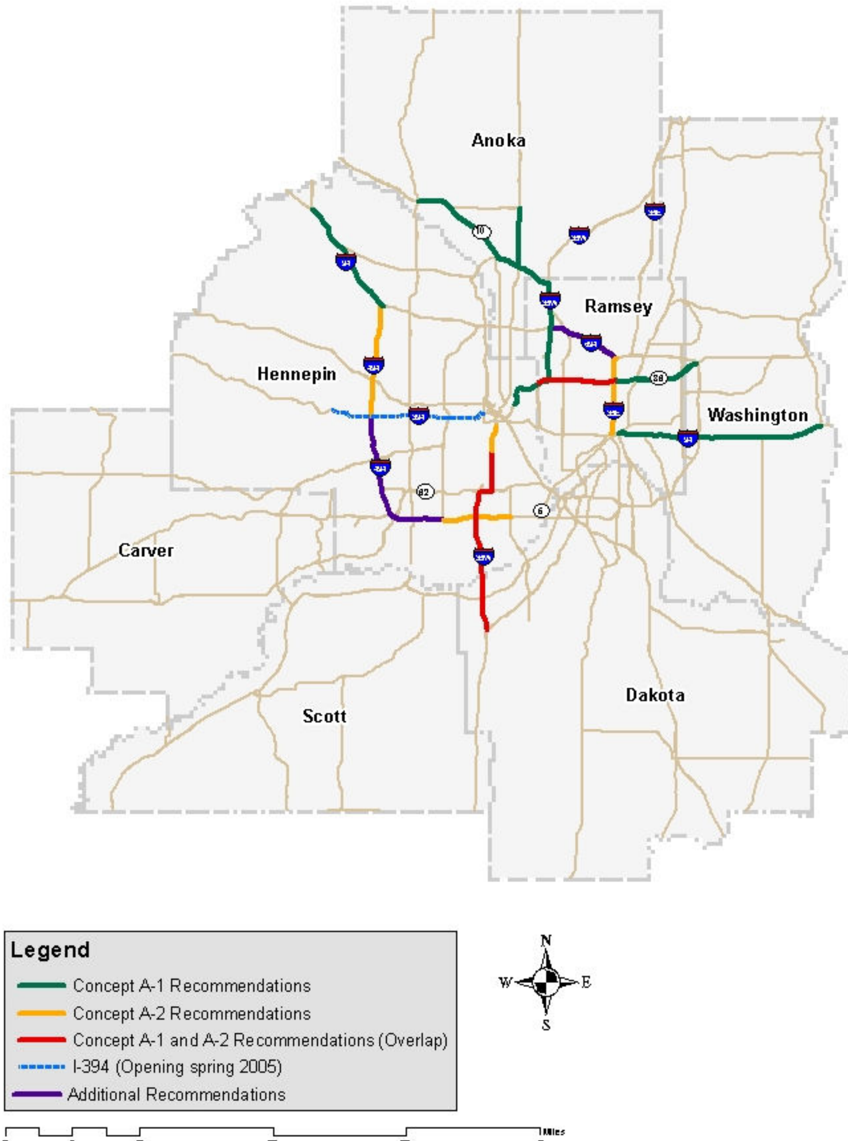
The proposed 2030 Vision Map (see Figure ES-4) is intended to show projects that would:

- Implement a portion of the current TPP as toll lanes, meaning all the projects shown in Concept A-2 in the previous section; and
- Implement other projects not yet in the TPP, but which were shown to be potentially viable; these are all of the projects that were included in Concept A-1, in addition to others that were not immediately recommended.

The study team was also interested in pursuing a policy that would ensure future capacity expansions are considered for the possible application of MnPASS lanes. This means that potential projects that are not on today's 2030 Vision Map might ultimately be developed as MnPASS lanes. The 2030 Vision Map represents current thinking on where MnPASS lanes would be the most effective; however, other future capacity expansions could be considered as MnPASS lanes and connected to the system as well.

The proposed 2030 Vision Map does not attempt to prioritize projects. It also does not distinguish between regular MnPASS lanes, where all drivers pay, and HOV lane conversions to HOT lanes, where HOVs drive for free. Certainly, the HOV lane conversions will need to address the issue of long-term HOV definition if toll lanes are to be advanced on these corridors. Finally, this Vision Map does not presume that MnPASS lanes are the preferred or most cost-effective solution to congestion and mobility in the Twin Cities region.

Figure ES.4 MnPASS 2030 Vision Map



Costs and Long-Term Revenue Potential of the 2030 Vision Map

To put the 2030 Vision Map in perspective, we developed an overall estimate of the costs and toll revenue potential of the projects on that map. We used the Concept A-2 view of considering costs, which results in a cost estimate that is over and above the costs already planned to be spent in the 2030 TPP. Table E-3 shows the cost and revenue potential of each of the segments on the 2030 Vision Map. Overall, the cost of implementing MnPASS on these highway segments would be $2,363 million greater than the amount planned to be spent in the TPP.

Table ES.3 Potential 2030 MnPASS Vision Financial Analysis, Concept A-2 Costs

Segment	Net Revenue (2004$M)		PV of Net Revenue Stream (2004$M)	Capital Cost (2004$M)	PV of Capital Cost (2004$M)	Cost Recovery Ratio	Funding Gap (2004 $M)	Average Daily Speed Savings in 2030 (Build versus No-Build) (mph)
	2010	2030	2008-2030					
I-494-a	$1.6	$2.8	$27.2	$34.7	$31.5	86%	$4.3	4.3
I-494-b	0.2	0.9	6.1	132.5	120.2	5%	114.1	2.2
I-494-c	3.0	6.2	55.2	265.6	240.8	23%	185.7	4.2
I-494-d	4.1	8.0	72.4	18.7	17.0	427%	-55.5	5.2
I-694-2	1.2	3.1	24.9	241.4	218.9	11%	194.0	4.2
I-94-e	0.6	2.3	16.5	115.5	104.7	16%	88.2	3.5
I-94-4	1.9	3.0	30.2	122.1	110.7	27%	80.5	13.2
I-94-5	1.2	2.3	21.5	105.4	95.6	23%	74.1	2.8
36-1	1.7	2.5	26.2	72.1	65.4	40%	39.2	5.2
36-g	2.5	4.4	42.0	172.6	156.5	27%	114.5	5.2
36-5	0.9	2.1	17.9	122.4	111.0	16%	93.1	7.3
I-35E-1	0.0	0.6	2.8	64.8	58.7	5%	55.9	3.5
I-35E-2	3.4	4.8	51.3	47.7	43.2	119%	-8.0	6.3
I-35W-1	-0.7	-1.6	-13.7	50.7	46.0	-30%	59.7	12.0
I-35W-2	0.0	-0.4	-1.9	3.0	2.7	-68%	4.6	-3.1
I-35W-3	-0.6	-1.6	-12.5	2.0	1.8	-684%	14.3	-8.4
I-35W-8	-1.0	-2.0	-18.0	2.0	1.8	-983%	19.8	6.9
I-35W-f	2.4	2.9	34.2	140.0	127.0	27%	92.7	3.8
I-35W-6	2.1	3.4	34.1	159.7	144.8	24%	110.7	3.9
I-35W-7	3.2	5.0	50.9	126.2	114.4	44%	63.5	3.2
10-1	4.4	7.0	70.9	141.4	128.2	55%	57.4	6.4
10-2	1.3	2.2	21.7	15.3	13.9	156%	-7.8	6.2
10-3	0.9	2.3	18.5	51.8	47.0	39%	28.5	4.0
65	2.6	5.3	47.4	155.6	141.1	34%	93.7	6.2
I-394-1	1.6	1.7	21.9	N/A	N/A	N/A	N/A	1.0
I-394-2	0.8	0.5	8.8	N/A	N/A	N/A	N/A	1.2
MnPASS Vision Total	**$39.3**	**$67.7**	**$656.2**	**$2,363.3**	**$2,143.0**	**31%**	**$1,486.8**	**3.7**

Notes: Real Discount Rate: 4%
Inflation Rate: 3%
PV = Present value of future cash flows, discounted to 2004.
Cost Recovery Ratio = PV of Net Revenue Stream/PV of Capital Cost.
Funding Gap = Net Present Value of discounted future costs minus revenue.

Assuming these projects were all built by 2008, the cost recovery ratio for this project set is forecast to be 31 percent, from a revenue stream whose present value is $656.2 million.[7]

In addition to revenue potential, the MnPASS system shown in the Vision map would be expected to generate other benefits, such as opportunities for improved transit service, improved reliability, reduced air pollutants, and the value of offering drivers an uncongested travel choice. Although not quantified in this study, these characteristics would also provide great benefit to the Twin Cities.

Potential Next Steps

The MnPASS System study has shown the user benefits and financial implications of MnPASS segments and systems of segments, and a proposed vision for a long-term system of MnPASS lanes around the Twin Cities. The study has also provided a forum for various stakeholders to express their ideas about how the MnPASS system might actually be developed. A separate document related to overall policy recommendations has been drafted by the MnPASS System Study Steering Committee.

If Mn/DOT chooses to move forward with implementing the MnPASS vision outlined above, numerous issues must still be addressed. This report lays out a potential series of next steps that Mn/DOT might undertake if it desires to move the MnPASS concept along. These steps include the following:

- Demonstrating the MnPASS concept through evaluation of the I-394 HOV lane conversion project that is to open in spring 2005;
- Conducting further systems analysis including the benefits and costs of MnPASS compared to other alternatives;
- Engaging in a case study of one or two corridors, where various technical issues can be explored in more detail; and
- Addressing institutional issues.

Institutional issues requiring further discussion include questions related to the role of the private sector in developing/operating MnPASS lanes, sources of

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[7] It is important to note that the assumption of all projects being built by 2008 is strictly an analytical device that allows one project to be compared to another on an even footing. In reality, these projects would be built over the cycle of the TPP, meaning that the actual revenue potential from a MnPASS system would be considerably less than indicated for the given period of time. However, projects developed later in the TPP cycle would have a life for purposes of analysis that extends beyond the 2030 timeframe. A more refined estimate of revenue over the life of the TPP would need to include some assumptions regarding the phasing of projects over time.

financing, how projects would be selected and advanced for implementation, how MnPASS revenues should be treated, how Mn/DOT and the Metropolitan Council should incorporate MnPASS into their project development processes, and how these findings relate to Mn/DOT's desire to issue a Request for Proposals for Partners (RFPP) to continue the development of MnPASS lanes.

Taking these steps will help Mn/DOT develop the proper strategies, standards, and policies necessary to move forward with the MnPASS program.

1.0 Introduction

The primary goal of the MnPASS System Study was to evaluate the impacts of overlaying a MnPASS toll lane system in the Twin Cities Metropolitan area of Minneapolis and St. Paul. MnPASS toll lanes are defined as special-use lanes adjacent to existing general purpose lanes where drivers can pay a toll to achieve more reliable travel times. In corridors where high-occupancy vehicle (HOV) lanes already exist, the HOV lanes would be converted to toll lanes in which HOVs would drive for free. In corridors without HOV lanes, the MnPASS toll lanes would be additional capacity, where the additional capacity is tolled.

The overall objective of the study was to identify a potential Twin Cities Metropolitan Area MnPASS tolling lane system and to provide the Minnesota Department of Transportation (Mn/DOT) and the Metropolitan Council with information on the cost, operational, revenue, and system implications of that system. The intent was not to evaluate the benefits of tolled versus nontolled capacity expansion, but rather to study a potential future system of express toll lanes. The study evaluated impacts that the toll lane system would have on existing transportation system and policy plans, and addressed operational and financial implications of alternative networks of MnPASS lanes in the Twin Cities Metropolitan area, seeking to determine the extent to which these lanes could be self-supporting and how they might fit into the larger transportation system.

To support the project's goals and objectives, the study considered both system performance as well as the performance of individual segments. The study also had two competing interests: to identify those segments that would be the best candidates for near-term implementation by private developers, as well as to draft a long-term regional vision. The original focus of the study was on the segments that could be built relatively quickly in partnership with the private sector, and as a result, the financial viability of potential MnPASS segments was an important factor in developing system recommendations. As the study progressed and it became clear that toll revenues would not recoup the required capital investment, the focus of the study shifted to developing a long-term MnPASS vision managed by the public sector. The initial vision was developed for the general timeframe of the current Transportation Policy Plan, which has a planning year horizon of 2030.[1] Beyond 2030, additional projects might be added to the vision.

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[1] The TPP was still being developed during this study. The analyses in this report are based on the draft plan dated November 16, 2004. The Metropolitan Council's final 2030 Transportation Policy Plan was adopted on December 15, 2004 and is available at: http://www.metrocouncil.org/planning/transportation/TPP/2004/summary.htm

Results from the MnPASS System Study are consistent with Mn/DOT's strategic objectives. The vision articulated in Mn/DOT's 2003 Strategic Plan calls for *"a coordinated transportation network that meets the needs of Minnesota's citizens and businesses for safe, timely and predictable travel."* The MnPASS System Study supports this vision by looking beyond individual corridors to a regionally interconnected system of toll lanes. In addition, the managed-lane concept would be dynamically priced so that the MnPASS lanes could consistently achieve higher speeds and more reliable travel times than the untolled lanes.

The MnPASS System Study is also consistent with Mn/DOT's strategic direction to "make the transportation network operate better." MnPASS supports the objectives of this strategic directive by addressing traffic congestion in the Twin Cities metropolitan area, improving mobility within highly traveled corridors (including transit improvements), and exploring potential partnerships with the private sector.

The study began with a blank slate – meaning that any existing or proposed highway in the metropolitan area was a candidate for MnPASS. The consultant team worked with a study Steering Committee and Technical Group to develop evaluation methods and criteria to narrow the focus of the study as more information became available. An early screening effort using readily available data led to two rounds of technical analysis aimed at understanding the financial and system implications of different combinations of MnPASS lanes.

A series of technical memoranda were prepared during the course of the project to bring interim results to the Steering Committee and Technical Group, and to serve as the basis for discussion that led to Mn/DOT's direction for the next steps of the study.[2] These technical memoranda are part of the project record, and provide additional detail on methods and findings not covered in this report:

- Technical Memorandum #1: Corridor Screening and Evaluation Criteria (September 2004).
- Technical Memorandum #2: Evaluation Criteria and Financial Analysis Framework (October 2004).
- Technical Memorandum #3: Travel Demand Forecasting Approach (November 2004).
- Technical Memorandum #4: Evaluation Results – Round 1 (December 2004).

[2] All technical memoranda are available through the MnPASS System Study website: http://www.mnpass.org/systemstudy.html

1.1 WHAT IS MNPASS?

MnPASS is Mn/DOT's name for what is becoming known as "express toll lanes."[3] The basic idea of MnPASS is to provide a faster, more reliable alternative to congested highway travel by charging a toll for drivers to use one or more specially designated highway lanes. Mn/DOT is considering two types of MnPASS lanes:

1. High-occupancy toll (HOT) lanes, whereby existing (or proposed) high-occupancy vehicle (HOV) lanes are opened up to non-HOV traffic for a toll; or
2. New highway capacity adjacent to existing highways (either freeways or conventional highways), where all traffic except transit vehicles pays a toll.

In both cases, these MnPASS lanes would have the following characteristics:

- Speeds at or near the posted limits would be maintained by a pricing policy that varies with demand and use of the lanes.
- Collection of the tolls would be automated, through the use of electronic toll collection – there would be no toll booths or cash transactions.
- Variable message signs would be used to advise drivers of the toll rate in place at any given time.
- Heavy trucks in excess of 26,000 pounds would be excluded from the MnPASS lanes.
- Transit vehicles would use the MnPASS lanes for free. Although the implications of MnPASS on future transit system performance were not explicitly evaluated, a simplified analysis was performed to illustrate the potential synergies between MnPASS and transit.
- Access into and out of the MnPASS lanes would be provided by slip "ramps" with the adjacent general purpose lanes, which would likely require periodic breaks in a double-striped lane to allow for merging and weaving between the facilities. Other options are possible, such as "T" ramps from a bridge

[3] Formerly known as FAST lanes – Freeing Alternatives for Speedy Transportation. This is the name included in Federal legislation in 2004 for the express toll lane concept that would have had specific statutory requirements associated with it. The current state administration favorably endorsed FAST lanes in a press conference on December 29, 2004, defining them as "… new publicly-owned lanes paid for by private entities which are repaid by users of the lanes." Since that time, Mn/DOT has adopted the MnPASS name to refer to any kind of tolled express lane in Minnesota, and MnPASS is used throughout this report.

above. However, the slip-ramp concept is consistent with Mn/DOT's I-394 toll lane demonstration, and was used as the basis for this study.

Other, numerous details regarding how MnPASS lanes might operate still need to be worked out. However, the above points provide the basic framework.

Mn/DOT is in the process of implementing the first MnPASS project on I-394, with an anticipated opening in May/June 2005. That MnPASS project is the conversion of the existing HOV lane to a HOT lane, and has specific design and operational characteristics which may or may not be relevant to other MnPASS lanes that might be implemented.

1.2 Structure of this Report

Sections 2.0 and 3.0 of this report summarize the progress of the work, from the initial screening exercise through development of a technical approach to travel demand forecasting, cost estimating and financial analysis. Section 3.0 also describes evaluation criteria. The results of the technical evaluation are presented in Section 4.0, followed by a synthesis of potential direction for MnPASS lanes in Section 5.0.

2.0 Corridor Screening

One of the initial tasks in this study was to develop candidate MnPASS systems for more detailed evaluation. Our approach was to use data from Mn/DOT's Traffic Management Center (TMC) and other sources to rank segments against a set of screening criteria. The following four types of segments were considered for the screening:

- **Instrumented Freeways (25 segments):** Segments were defined by available data from the Texas Transportation Institute (TTI) on instrumented freeways in the Twin Cities Metropolitan Area. These segments can be readily linked and analyzed with data from Mn/DOT's Traffic Management Center (TMC).
- **Noninstrumented Freeways (11 segments):** Segments were identified from the 2000 Metropolitan Council freeway network, excluding the instrumented freeway segments accounted for above.
- **Nonfreeways (seven segments)**: Segments were identified through discussions with the Steering Committee and Technical Committee. Examples include portions of TH 252, TH 65, and TH 36.
- **Transitways (seven segments):** Segments were identified from the Metropolitan Council 2005 Transitways Plan.

This initial list of 50 potential segments was screened against four criteria.

- **Current and Future Congestion.** We developed measures of current congestion, future congestion, and reliability for each segment, such as percent of annual weekday traffic traveling slower than 45 mph. The primary source of data was Mn/DOT's Traffic Management Center (TMC), supplemented with other Mn/DOT and Metropolitan Council reports, as well as the Metropolitan Council's travel demand model for forecasts of 2030 congestion.
- **Short-Term Revenue Potential.** To screen segments based on short-term revenue potential, we used measures of congested vehicle volume, such as the number of annual weekday vehicles-miles traveling slower than 45 mph during AM and PM peak periods. These measures represented an estimate of the number of vehicles that would potentially pay MnPASS tolls. Note that while the "Current and Future Congestion" criterion looked at the *percentage* of vehicles congested, the "Short-Term Revenue Potential" criterion considers the *number* of vehicles traveling in congested conditions. The primary source of data was the TMC, supplemented by annual average daily traffic (AADT) records for non-instrumented segments. Although these numbers do not reflect the fact that additional capacity provided by new MnPASS lanes would relieve congestion and reduce revenue potential in the

short term, they are adequate to compare segments against one another on a relative basis.

- **Constructability.** The constructability of additional lanes for each segment was scored based on geometrics, available median width, lane-miles at grade, lane-miles elevated, number of overpass reconstructions needed, number of new overpasses needed, and approximate age of existing structures.
- **Other Considerations.** We also considered other factors that could influence the attractiveness of a potential MnPASS segment, such as system connectivity and crashes per mile.

Because the focus of this planning study was on general congestion relief and not on transit improvements specifically, the viability of each segment as a transit corridor was not used as an independent initial screening criterion.

The segments that scored well using these screening criteria were shared with the Technical Team for their consideration. Based on the screening results and the Technical Team input, the consultant team worked with Mn/DOT staff to construct five systems for detailed evaluation. Note that in all cases, the I-394 HOT lane now under construction was assumed as a given. In addition, for purposes of this study, existing and proposed HOV lanes on I-35W were assumed to be converted to HOT lanes, where HOVs would drive for free. Figures 1 through 5 show the systems that resulted from this analysis. Details on the development of these systems are available in Technical Memorandum #1.

- System #1 consists of the entire beltway plus the I-35W HOT lane.
- System #2 is similar to System #1, except it reflects only that portion of the Beltway with the highest immediate traffic demand and need.
- System #3 consists of the core radials, I-35W and I-94, which have the highest traffic demand in the system but have significant constructability concerns.
- System #4 consists of segments that performed well in the screening analysis.
- System #5 includes the transitways that emerged from the screening as potentially constructible MnPASS lanes.

System #5 was ultimately excluded from the next round of analysis as an independent MnPASS system (see Section 4.1), because upon further study, the characteristics of these transitways were not compatible with potential MnPASS lanes. For example, the transitways were generally located in dense residential areas with at-grade intersections, running in mixed traffic, or running on roadway shoulders – all of which required significant conceptual changes to the transitway design and/or extensive community disruption in order to implement MnPASS. Rather than try to incorporate the MnPASS concept into the transitways plan, opportunities to incorporate improved transit into the MnPASS lanes was deemed to be a more effective solution. Potential MnPASS synergies with express bus were explored in a smaller case study (see Section 4.3).

Figure 1. System #1: Beltway plus I-35W HOT

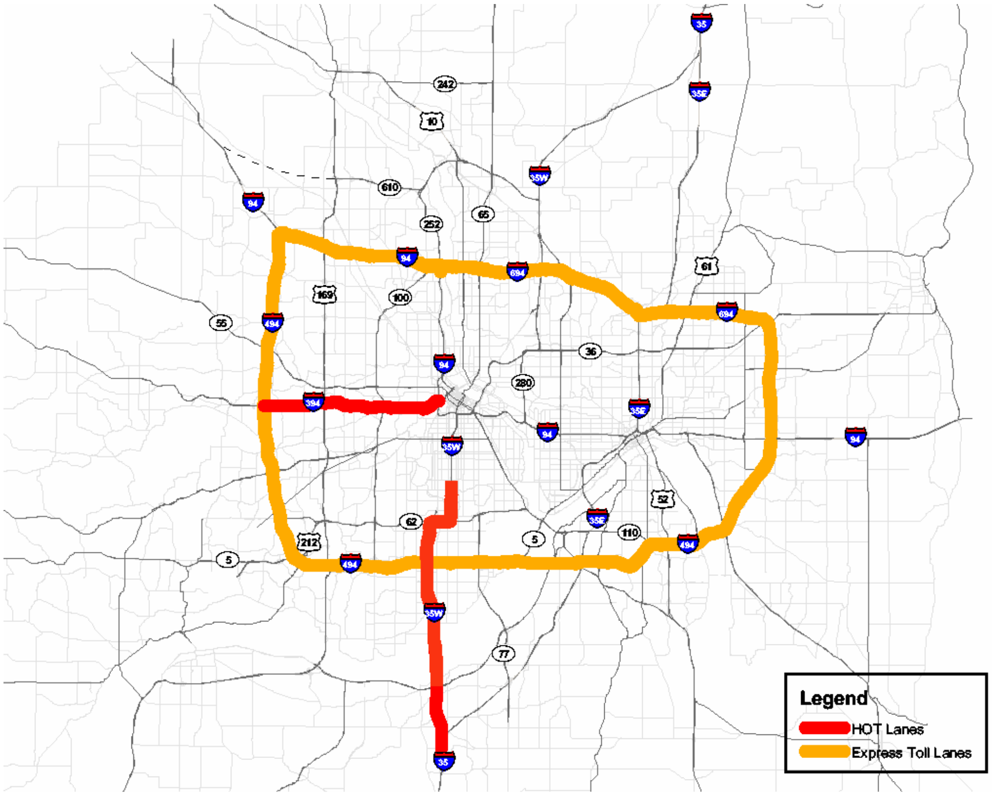


Figure 2. System #2: Partial Beltway plus I-35W HOT

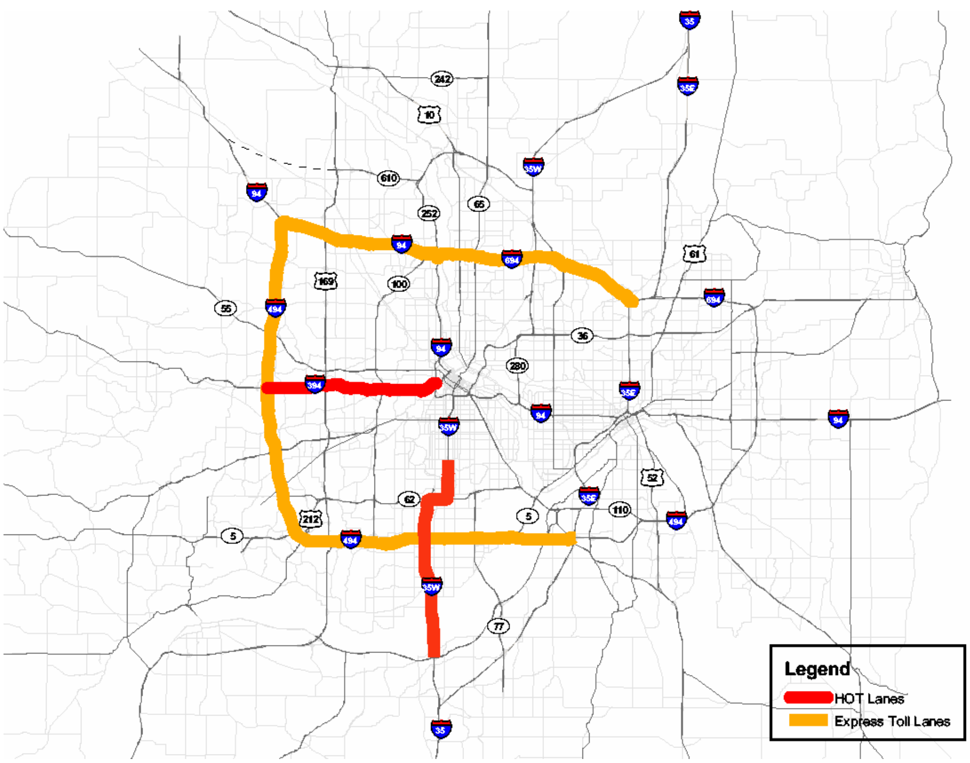


Figure 3. System #3: Core Radials

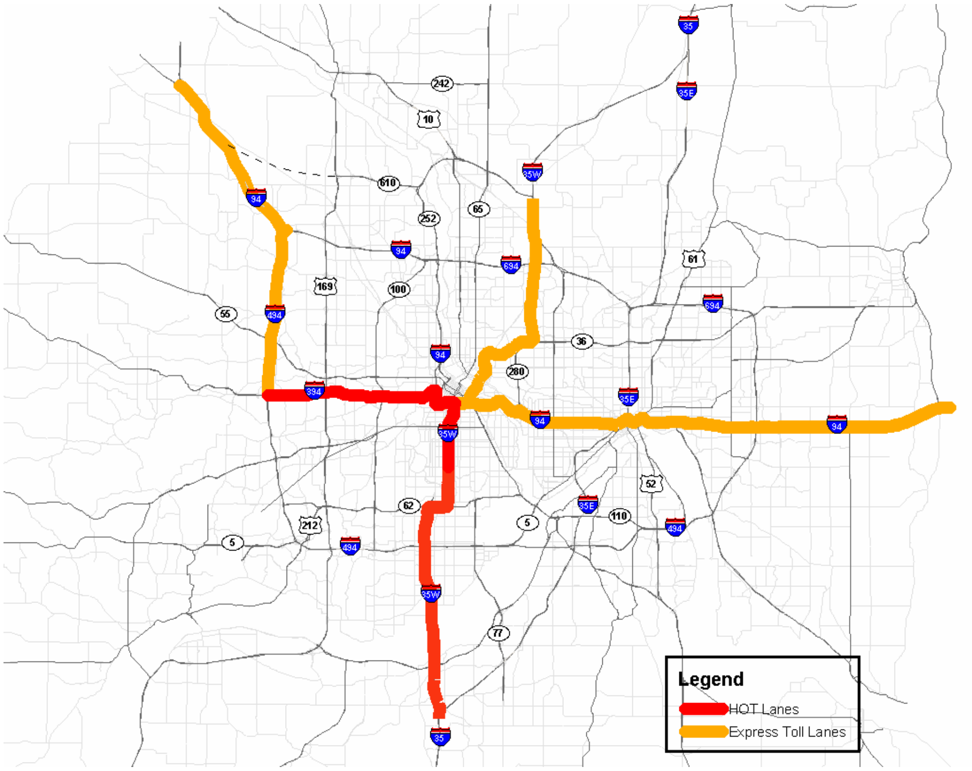


Figure 4. System #4: Best of the Screened Corridors

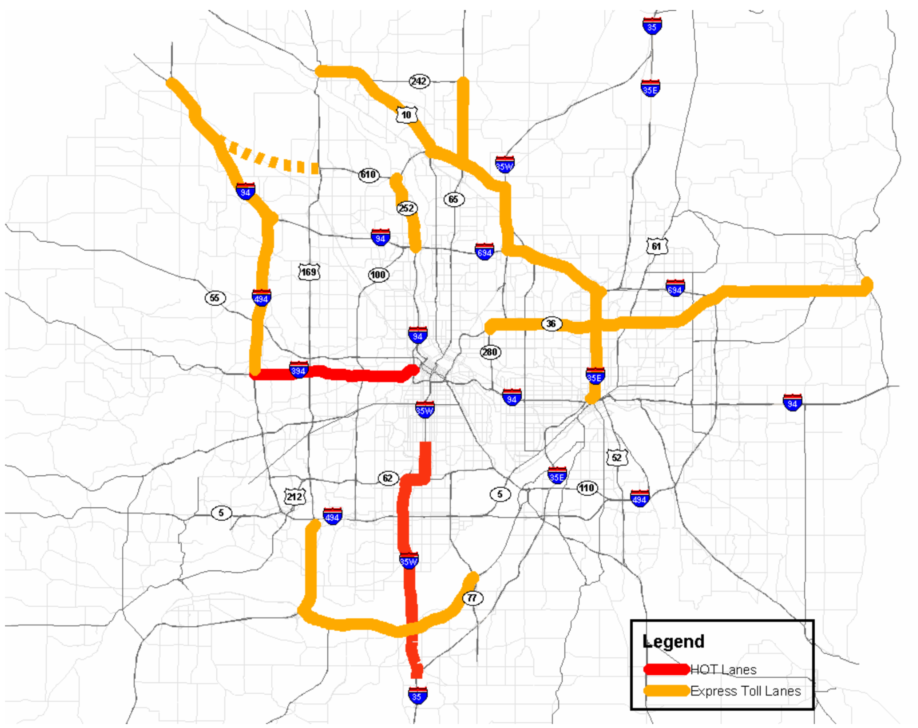
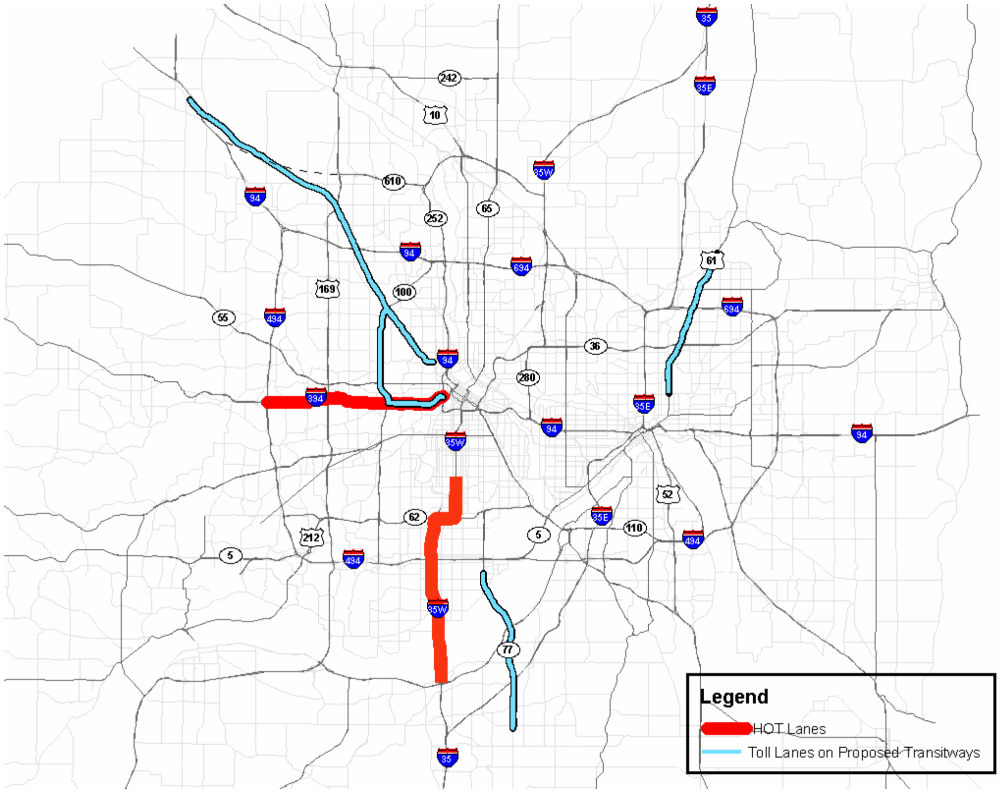


Figure 5. System #5: Toll Lanes on Proposed Transitways



3.0 Technical Approach and Evaluation Criteria

Potential systems and segments of MnPASS lanes were evaluated through two rounds of analysis. The first round was intended to provide an overall sense of the viability of particular corridors, leading to a refined set of corridors for more detailed evaluation. The basic evaluation procedures for both rounds of analysis were the same, although the refinements described below were made in Round 2. Our evaluation considered these basic components:

- Travel demand at different toll rates at different times of day, leading to estimates of toll revenue and changes in travel times;
- Capital costs; and
- Operating expenses.

We then evaluated these basic components to consider the financial viability of potential MnPASS segments or systems of segments.

3.1 Travel Demand Forecasting

The evaluation involved estimating the travel demand for the MnPASS system and addressing how many people would use the system at different toll rates. To evaluate the five initial systems, we modified the Metropolitan Council's travel demand forecasting model to allow us to analyze the impact of tolling. A summary of the travel demand forecasting methods used is provided below, with additional detail provided in Technical Memorandum #3.

Mode Choice Model

The most important modification was the inclusion in the mode choice model of new parameters to allow for the estimation of trips by tolled single-occupancy vehicles and trips by tolled high-occupancy vehicles. The Metropolitan Council's mode choice model allows for the introduction of new toll facilities both for SOVs and HOVs. However, it does not include any toll parameters, as no such facilities currently exist. To determine the toll parameters, we looked at models developed in the Mn/DOT Congestion/Road Pricing Study[4] and the SR-91 Impact Study in Southern California.[5]

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[4] The model development effort is summarized in *Congestion/Road Pricing Study Technical Memorandum 6: Results of Metrowide Personal Interviews* (January 1996) developed for

Footnote continued

The models that were developed for both the Congestion Road Pricing Study and the SR-91 study include parameters related to highway travel time and toll costs, as well as trip and traveler characteristics. Using decennial Census tabulations, we adapted these parameters to the Metropolitan Council model market segments.

Time-of-Day Factoring / Highway Assignment

The Metropolitan Council model factors peak and off-peak traffic volumes to 24 unequal time periods. We continued to use these time-of-day definitions for our analyses and did not change the basic structure of the assignment procedures. We did change the assignment routine to include the treatment of the two new assignment groups (SOV-toll and HOV-toll) and the appropriate constraints on using the various facilities.

Network Modifications

The MnPASS scenarios were represented by modifying different Metropolitan Council highway and transit networks, and applying forecast year trip tables to those network scenarios. The network/trip table forecast scenarios were:

- Year 2013 Scenarios – Metropolitan Council 2010 trip table assigned on networks consisting of projects in the region's Transportation Improvement Program (TIP) and in early years of Mn/DOT's Ten-Year Comprehensive Work Program; and
- Year 2030 Constrained Scenarios – Metropolitan Council 2030 trip table assigned on the 2013 networks described above.

Both of these scenarios illustrate the impacts of various systems of MnPASS lanes overlaid on the region's transportation projects planned for the next 10 years. The Year 2013 Base Case was selected to ensure a common basis for comparing the different MnPASS systems, in order to develop a long-term vision for this study. As such, the scenarios demonstrate the benefits of capacity addition *and* priced lanes over the base case. To isolate the incremental impacts of MnPASS pricing on congestion management, each scenario would have to be compared to an identical system modeled without tolls on the new lanes. [6]

State of Minnesota and Metropolitan Area of Minneapolis-St. Paul by Wilbur Smith Associates et al.

[5] See *Continuation Study to Evaluate the Impacts of the SR91 Value-Priced Express Lanes: Final Report* (December 2000) prepared for Caltrans Traffic Operations Program by Edward Sullivan, California Polytechnic State University.

[6] The second round of analysis was originally intended to include a long-range scenario of the Metropolitan Council 2030 trip table assigned on the 2030 network. Due to technical issues with the 2030 network, this scenario was ultimately dropped.

For the highway networks, the MnPASS lanes were included in the networks as new links with one of two new assignment groups – SOV toll facilities and/or HOV toll facilities. Standard SOV and HOV highway facilities were already included in the Metropolitan Council model. The capacities, free flow speeds, and per lane volume-capacity relationships for the toll facilities were established to be similar to the parallel freeways or arterials, and reflect network model coding for similar facilities elsewhere.

Toll Rates Tested

We structured our analysis to test a wide range of toll rates at different times of day, ranging from 10 cents to 50 cents per mile. For the sake of simplicity, for modeling purposes we assumed that the entire MnPASS system would be subject to the same toll rate at the same time of day. (In reality, we would expect the MnPASS toll rates to vary according to the travel demands at each segment of highway.)

To put these per-mile toll rates in perspective, older, more mature toll roads in the U.S. tend to have rates in the $0.03 to $0.10 per mile range. The more recent toll roads are in the $0.10 to $0.20 per mile range. The recent managed lane projects have rates typically in the $0.20 to $0.50 range, varying by conditions, with even higher rates during extreme traffic conditions.

Our traffic and revenue estimates were based on the toll rates that maximized the revenue of each potential MnPASS segment for each of the 24 time periods. In actual implementation, tolling would vary based on real-time traffic conditions to ensure that the lanes remain free flowing at all times. While alternative tolling policies might be possible (e.g., to maximize total corridor throughput), it is likely that the goals of revenue maximization are closely aligned with the goals of throughput.

Because the modeling is based on a single systemwide toll rate being applied at a given time period, traffic volume estimates on different segments do not represent continuous trips. Details of the results of the traffic analysis by time of day are provided in Appendix B for Concept A in Round 2.

Forecasting Issues

This is one of the first projects to use the Metropolitan Council's new regional travel demand model. Although this model is the best available tool to evaluate future travel patterns and options in the Twin Cities region, some limitations that could impact the results are:

- **Peak Spreading.** The current model assumes the same distribution of traffic over the course of the day as is evident today. It is reasonable to expect that over time, as congestion grows, the duration of peak traffic conditions will lengthen. This means that the demand for the proposed toll lanes will be higher in time periods that are not now currently congested, causing the revenue estimates in this memo to be understated. The Metropolitan Council plans to develop a peak spreading model in the near future, which would help to address this issue.

- **Fixed Trip Tables.** The Metropolitan Council's mode choice model iterates back through the trip distribution component, resulting in dynamic trip tables that vary between the No-Build and Build scenarios. While it is probably more behaviorally accurate to use this module and have the distribution of trips to origins and destinations change, the Round 1 models never achieved equilibrium due to the inclusion of trip distribution, and the results produced using the variable trip table were unstable. The Round 2 models were run using a fixed trip table (i.e., only iterating additional toll rates from mode choice through the assignment component). Using fixed trip tables is consistent with historical practices in the industry, and is reasonable for use in this study. However, this approach may underestimate the increase in travel demand and resulting congestion if MnPASS lanes were implemented.

- **System Connectivity.** Measures of travel demand were modeled based on entire systems that are more extensive than individual segments built separately. Modeling individual segments separately would produce different (probably lower) levels of travel demand.

- **HOV Utilization.** When Cambridge Systematics evaluated the HOV lane system several years ago, we concluded that the Metropolitan Council's travel demand model in use at the time was underestimating future demand for HOV. With the more recent model, the HOV utilization is considerably higher – so much so that by 2030, HOVs use up most of the capacity available in HOV lanes, leaving little space to sell to SOVs. Although we have not conducted an independent assessment of the reasonableness of the future HOV forecasts, changes to future HOV use could significantly impact the long-term viability of the HOT lane concept on I-35W and I-394.

- **Recreational Traffic.** Some facilities, such as I-94 between the Fish Lake interchange and Rogers, have heavy traffic flows related to recreational traffic that occurs outside of the normal weekday pattern. These recreational travel patterns are not accounted for in the travel demand model. This means that corridors with high recreational usage should have higher demands than indicated in this report.

- **Enhanced Bus Services.** MnPASS lanes offer an opportunity to provide enhanced bus or bus rapid transit (BRT) services. We did not modify the bus networks to take full advantage of these potential synergies. Improved bus services could reduce the demand for paying toll traffic in the MnPASS lanes while providing an attractive option to transit riders.

- **Traffic Operations Issues.** One of the most common causes of recurring congestion is bottlenecks caused by merges, diverges, and weaves, particularly around interchanges. The regional model does not take these conditions into account, and potentially underestimates the congestion and delay that might actually occur on the system. Similarly, the local street system may lack the ability to deliver or absorb the traffic on the freeway system indicated in the models. This could reduce the potential for traffic using the proposed MnPASS lanes.

- **Regional and Corridor Traffic Growth.** The traffic growth rates used in this study relate directly to those in the Metropolitan Council's travel demand model. We have not conducted an independent assessment of these growth rates. Such an independent assessment would be a critical element to moving forward with studies that rely on toll revenue to pay back bonds or loans.
- **Transportation Network Improvements.** Our analysis was based on projects that would be expected to be completed by 2013, in accord with the 10-year Comprehensive Work Program in place at the time the work was done (fall/winter 2004). Alternative assumptions regarding transportation network improvements in the Twin Cities could change the traffic demand estimates in particular corridors.
- **Ramp Metering.** Access to most freeways in the Twin Cities metropolitan area is controlled by ramp metering, the intent of which is to optimize traffic flow. The MnPASS toll lanes rely on a speed differential with the general purpose lanes to provide the value for the money spent on the toll. The Metropolitan Council's travel demand model used in this MnPASS system study does not account for the effects of ramp meters. Changing the ramp metering algorithm or policy would affect freeway congestion levels and travel demand for MnPASS toll lanes.

3.2 Capital Cost Estimates

The cost estimation methodology evolved to fit the different philosophies of the financial cost recovery frameworks that emerged over the course of the study, each of which applied capital cost estimates differently. URS Corporation (URS) developed generic typical cross-sections for the various segments, analyzing existing median widths and the concurrent and reversible flow designs. Based on the number of additional lanes and shoulders required, a cost per mile for each typical section was developed. URS used Mn/DOT's standard LWD (length, width, depth) cost estimating method for each generic typical cross section and multiplied that cost by the number of miles in each segment. This technique was the most effective method for estimating planning level costs, considering there were no proposed layouts available.

URS reviewed each potential MnPASS segment to determine the most effective typical section to use. Its evaluation considered factors such as existing geometrics, planned projects, and available right-of-way. In the Round 1 analysis, URS developed the cost per mile for each typical section and included most of the basic items that go along with road construction. URS evaluated all bridges individually and developed an average bridge replacement cost estimate per different type of bridge: Interstate, local streets, pedestrian, railroad, single point, or river crossings. A number of flyover bridges were required in the direct segment-to-segment connections and were estimated separately. The number of toll collection gantries was estimated based on the system concept drawings that were developed.

Round 1 cost estimates did *not* include retaining walls, utilities and drainage items, and right-of-way cost.

Round 2 cost estimates were different in that they addressed different philosophies regarding which costs would be applied to the financial analysis. In one scenario, **Concept A-1**,[7] the estimates represent the costs of building MnPASS lanes "from scratch," assuming the highway network committed to be built by 2013 is already in place. No contributions were assumed from projects in the 2030 TPP. In most cases, we assumed that the MnPASS lanes were added with no reconstruction of existing lanes, except in one case where building new lanes without reconstruction was deemed to be technically infeasible. This could tend to understate the cost of an actual project that Mn/DOT may want to build, but does reflect what it would take to just build an additional lane.

Concept A-2 included six out of 28 segments in the analysis**.** In **Concept A-2,** the estimates represent the incremental costs of converting a TPP lane-addition project to a MnPASS lane (gantries, striping, 10-foot buffers, etc.) For projects that were not in the TPP, the costs under Concepts A-1 and A-2 were the same. Again, the cost of reconstruction of existing lanes was not included.

The Round 2 cost estimates were more comprehensive than Round 1, and included:

- Roadway costs per mile, including buffers between the MnPASS lanes and the general purpose lanes;
- Bridge widening, reconstruction, or new construction;
- Retaining walls;
- Right-of-way;
- Traffic management system (TMS) components;
- Segment to segment connections;
- Gantries;
- Project delivery; and
- Area/facility risk multiplier.

[7] More detail on the concepts used in Round 2 of the analysis can be found in Section 4.2.

URS worked closely with Mn/DOT and Metropolitan Council staff to understand the limits and elements of cost estimates that were included in the 10-year Comprehensive Work Program and the draft 2030 Transportation Policy Plan (TPP) being circulated in November 2004.

Capital Cost Estimation Issues

The capital cost estimates were done using the same procedures used by Mn/DOT for planning studies, and do not represent detailed evaluation of each corridor. The following points should be understood in considering these cost estimates:

- Estimates of capital cost are based on entire systems and include the cost of direct connections between MnPASS segments. Not all of these connections are applicable to individual segments. Estimating individual segments separately would produce different capital costs (probably lower) as they would not include direct connections.
- Utility relocation costs are difficult to determine at the level of this analysis and are extremely variable. As a result, utility relocation cost is included in the area/facility risk multiplier.
- No specific facilities to accommodate transit or bus rapid transit were included.

3.3 Operating Cost Estimates

The main operational costs of MnPASS lanes relate to collecting tolls (including enforcement). For purposes of this study, we assumed toll collection services would be purchased from a central provider. This central provider could be either run by Mn/DOT or by a private entity. The cost of electronic toll collection varies widely from agency to agency, depending on how these costs are calculated within the overall system. Costs have been reported to range from $0.10 per transaction to $0.25 or higher.[8]

The estimates used for this study are intended to represent costs that could be expected in 2030. As electronic toll collection becomes more and more prevalent, we expect the cost of collection to drop. We therefore feel confident assuming toll collection costs at the lower end of the currently reported range, or $0.10 per transaction (in 2004 dollars), and the ultimate cost may even be lower than this. This value is being used solely to help estimate the cost of toll collection. It does not presume a particular contractual structure for actually obtaining toll

[8] These costs refer to the amount that Mn/DOT or a private concessionaire would pay for the service of having tolls collected. The actual price of the toll to the driver would depend on traffic levels.

collection services. The operating cost estimate does not account for the cost of enforcing the payment of tolls or the enforcement of the HOV lanes. We have made the simplifying assumption that the cost of enforcement would be offset by the revenue generated from the fines.

Other recurring costs associated with MnPASS lanes have not been included. These include maintenance of the lanes themselves, keeping the lanes free of stalled vehicles (incident management), and other traffic management and travel information costs, such as monitoring traffic levels and providing dynamic message signs to display current toll rates. Most of these functions would be borne by Mn/DOT whether the lanes were built as MnPASS lanes or as conventional lanes. Although the costs associated with maintenance and incident detection/removal for MnPASS lanes would likely be higher than conventional lanes, we have not attempted to estimate that differential, and have assumed that Mn/DOT would bear the costs. Further discussion of enforcement and operational issues is included in Section 4.5.

3.4 Evaluation Criteria

The evaluation of potential MnPASS segments and systems considered the following measures of transportation and financial performance. Note that the analysis framework for the MnPASS System Study provided for two rounds of analysis that were not identical in structure. The first round of analysis only considered traffic levels expected in 2030, whereas the second round also considered traffic levels expected in 2010. This structure meant that the evaluation criteria used for the first round did not consider the effect of costs and revenue over time.

Transportation Performance

The evaluation of potential MnPASS toll lanes considered both system and segment effectiveness. We considered the impacts on system performance as well as qualitative factors such as system connectivity.

System performance measures were handled the same way for both rounds of analysis, since there was no time stream component to this aspect of the evaluation (only to the revenue forecasts). When looking at system performance, we assessed the impact of the toll lane system on the overall regional network, as well as the performance of the individual segments being studied.

We conducted the evaluation at three levels, comparing the tolled scenario to the Future Base Conditions (2010 and 2030 trip tables on 2013 network):

- **Regional Network –** The entire Twin Cities metropolitan area regional transportation network as represented by the Metropolitan Council travel demand model;

- **MnPASS System –** The system of MnPASS toll lanes, and the toll-free lanes immediately adjacent to them. Measurements refer only to the lanes being built under that particular system scenario; and
- **Segment –** Individual segments in the MnPASS system.

From a regional network and MnPASS system perspective, we looked at changes between the future base condition (2010 and 2030 traffic levels assigned to a 2013 network) and the specific toll lane condition. We used these measures to evaluate network and system impacts for the AM peak period, PM peak period, and nonpeak period:

- Vehicle miles of travel (VMT);
- Vehicle hours of travel (VHT); and
- Average speed (VMT/VHT).

While network and MnPASS system performance measures are important, segment measures can provide a more "real world" perspective to those reviewing the work. Looking at performance measures at the segment level also allows us to see which components of a particular system might be operating more or less effectively than others.

The most effective way to look at segment performance is to compare the travel time on the tolled lanes to the travel time on the nontolled lanes during different times of day. For the AM peak period, PM peak period, and nonpeak period, we looked at the following information:

- Length of segment;
- Travel time (minutes) and vehicle-hours:
  - Future base condition; and
    - Main lanes.
  - Build condition.
    - Toll lanes; and
    - Main lanes.
- Travel time savings (minutes and percent):
  - Future base condition main lanes versus Build condition toll lanes; and
  - Build condition main lanes versus toll lanes.

We also noted any unusual operational or environmental considerations for each segment.

MnPASS lanes are also expected to improve system reliability. Reliability measures indicate the variation in travel times over expected times. However, while the travel demand models used in this study are designed to forecast volume, they do not accurately forecast unexpected delay. Therefore, reliability was not used independently as an evaluation criterion.

Financial Performance

A complete financial analysis of toll projects requires an understanding of costs and when these costs are incurred, as well as timing of revenue streams. Numerous assumptions go into developing a finance plan for major infrastructure projects, including:

- Sources of funds and type of financing;
- Interest rates for bonds or loans;
- Coverage ratios (i.e., the extent to which forecast revenue covers debt service requirements), capitalized interest, reserve funds;
- Construction period; and
- Growth in revenue over time.

For this planning study, we made some reasonable assumptions regarding these factors. Also, because the Round 1 analysis was conducted at 2030 traffic levels only, time stream effects could not be taken into account at that point in the analysis. Therefore, we used two different approaches for the first and second rounds of analysis.

Round 1

Since the Round 1 analysis only considered traffic levels expected in 2030, there was insufficient information on time-stream effects for a full analysis of revenue growth. Therefore, we developed indicators of financial self-sufficiency adequate to distinguish one segment from another for purposes of building Round 2 systems. For each MnPASS segment, we developed the following measures to compare segments and systems:

- Estimated annual debt service on a 30-year bond;
- Annual operating cost (assumed at 10 cents per toll transaction);
- Annual gross toll revenue;
- Annual net revenue (gross revenue minus operating cost); and
- Ratio of annual net revenue/annualized capital cost.

To estimate MnPASS capital costs, we developed conceptual designs for each segment. In Round 1, we looked at both reversible and concurrent flow lanes. The capital costs were estimated by major element: roadway, bridge, and gantries. The Round 1 cost estimates did not include some difficult-to-quantify items such as right-of-way, retaining walls, utilities, and drainage. More refined cost estimates were developed for the selected segments in Round 2.

Round 2

In the second round of analysis, we had both 2010 and 2030 analysis year forecasts, enabling us to consider cash flows. In order to treat each concept equally, we made consistent systemwide assumptions regarding the construction period, opening year, inflation rate, and discount rate.

We developed a mechanism to compare the present value of a stream of revenues to a stream of costs, without specific consideration to the many financing mechanisms that might be used for the MnPASS lanes. For each MnPASS segment, in addition to the basic cost and revenue metrics, we developed the following measures to compare segments:

- **Cost recovery ratio.** This is the present value of the net revenue stream divided by the present value of the capital cost stream. A value of 100 percent implies that the MnPASS segment might be fully self-sufficient given attractive financing terms.
- **Funding gap**. This is the difference between the present value of net revenue and the present value of the capital cost (the negative of the project's net present value). The funding gap is an indicator of the amount of investment that Mn/DOT may have to make over and above that which could be recovered through toll revenue.

Both the cost recovery ratio and funding gap provide insight into the financial viability of potential MnPASS segments. A high cost recovery ratio indicates that a substantial portion of a project's cost can be recovered with revenue – however, if this cost recovery ratio is for a high-cost segment, the funding gap may still be large in absolute dollars. Similarly, a project with a low cost recovery ratio may be a reasonable candidate if it is at low enough cost to generate a small funding gap.

3.5 Financial versus transportation System Considerations

The MnPASS System Study sought to accomplish two objectives in a short timeframe. One was to provide an indication of which potential MnPASS corridors would be appropriate for early implementation by potential private developers. The second was to consider the opportunities for and impact of potential long-term systems of MnPASS toll lanes in the Twin Cities region.

Although it was always acknowledged that overall system performance was extremely important, the evaluation process tended to focus on the financial components. There is some overlap in the performance measures that indicate "good" projects under both objectives. For example, a high degree of cost recovery indicates corridors with high demand and low implementation cost. High demand is a reasonable proxy for system effectiveness at a planning study level of analysis.

However, the two objectives could sometimes conflict with each other. For example, a segment might have high demand but be difficult and expensive to implement, resulting in poor cost recovery ratios and large funding gaps. Time and budget considerations limited the number of unique systems that could be studied and the true system performance of different groupings of lanes was never really possible to analyze given those constraints.

As a result, the detailed analysis tended to focus on how individual segments or logical combinations of segments would perform. We considered the financial criteria: cost recovery ratio and funding gap, and then how well particular segments fit into potential systems of MnPASS lanes. We also looked at the ability of different combination of segments to provide user travel time savings – another good surrogate measure of effectiveness.

The evaluation was also constrained by the assumptions which evolved during the course of the study as all of the participants sought the best way to structure the analysis using objective criteria to ensure consistent and comparable results. The Round 2 analysis of Concepts A-1 and A-2 was structured such that we analyzed project cost from the perspective of immediate development opportunities (Concept A-1) or how to best leverage the 25-year Transportation Policy Plan (Concept A-2). Other "rules" which helped to define the structure of the study were that a) no projects in the Ten-Year Work Plan could be considered for MnPASS conversion, and b) existing HOV lanes must be converted to HOT lanes rather than to express toll lanes with no HOV priority.

As the results of Concepts A-1 and A-2 started to emerge, showing that there were few opportunities for MnPASS projects to be self-financing, the Steering Committee became more interested in what a long-term system of MnPASS lanes might look like. In other words, the focus shifted to long-term system viability, effectiveness, and integration with the TPP, and away from short-term opportunities for public/private partnerships. This consultant team did not have the time or resources to thoroughly analyze all possible new alternative combinations which reflect this changed focus. However, as a result of intensive discussions with the Steering and Technical Committees, and relying on the extensive analysis already performed of various system segments and combinations, we were able to develop a map of a potential MnPASS system predicated on an approximately 25-year time horizon. This system is one that would best leverage existing projects in the Transportation Policy Plan, and go beyond the TPP to other projects that would generate high value in terms of time savings and cost recovery or revenue generation.

4.0 Evaluation of Potential MnPASS Systems

The MnPASS systems were evaluated in two rounds. The first round looked at several potential alternatives, while the second round considered the viability of individual segments and combinations of segments from different perspectives of cost allocation. Since Round 1 was a stepping stone to Round 2, our detailed discussion below focuses more on the Round 2 results, with only a brief summary of Round 1. Further details on the Round 1 analysis can be found in Technical Memorandum #4.

4.1 Round 1 Findings

The Round 1 analysis evaluated the five potential MnPASS toll lane systems developed from the initial screening exercise (see Section 2.0 and Figures 1 through 5 of this report). Upon closer study and after discussion with Mn/DOT and Metropolitan Council staff, we concluded that toll lanes on proposed dedicated transitways (System #5) were not viable as an independent MnPASS system. The transitways were generally located in dense residential areas with at-grade intersections, running in mixed traffic, or running on roadway shoulders – all of which required significant conceptual changes to the transitway design and/or large amounts of community disruption in order to implement MnPASS. Although we did not model System #5 independently in Round 1, we did explore opportunities for incorporating express bus-type services into MnPASS lanes through a Round 2 case study on the construction and operational implications of making TH 36 effective for express bus service.

The MnPASS system would have automatic toll collection via overhead gantries. Prices would be dynamic and respond to real-time traffic conditions in the MnPASS lane, thus ensuring a desired level of throughput. A combination of concurrent (one lane in each direction) and reversible MnPASS lanes are envisioned for various segments, depending on traffic patterns. Enforcement, crash removal, and surveillance are also important operational issues to consider for the MnPASS system. Costs were estimated on a conceptual basis using typical sections, estimates of new bridges and bridge replacements, and number of toll collection points. For this round of analysis, no allowances were made for right-of-way, retaining walls, or utilities, which could result in higher costs. These cost estimates were adequate, however, for the Round 1 purpose of comparing systems and segments to each other.

To evaluate the four systems, we modeled the MnPASS lanes using the Metropolitan Council's travel demand model. For all systems, we looked at 2030 traffic levels on the 2013 highway network, which represents projects committed in Mn/DOT's Ten-Year Work Program. This 2013 network was modified for each system to include the MnPASS lanes.

The main findings of the system evaluation were as follows:

1. MnPASS lanes offer an uncongested travel option during congested periods for those willing to pay the toll. On a daily basis, the expected difference in speed between the MnPASS lanes and the adjacent free lanes is on the order of 10 to 20 miles per hour. Forecast peak-period speed differences are even higher – around 25 miles per hour. Given that average speeds in the MnPASS lanes are close to the speed limit, a high degree of reliability could also be delivered assuming an operational strategy can be implemented to quickly clear any incidents or breakdowns. Traffic volumes can be calibrated by adjusting toll rates to approach maximum free flow throughput for parts of the peak periods.

2. Traffic levels in 2030 would result in the HOT lane portion of the system filling up with HOVs, leaving little room for additional SOV traffic to purchase surplus space. As a result, tolls 50 cents per mile would not be high enough to drive traffic levels to the point where the HOT lanes could remain uncongested. This means that under intense traffic demand in the future, the HOT lane concept is not sustainable in the long-term.[9]

3. None of the systems would pay for themselves, although individual segments might recover a significant portion of their capital costs. Our analysis compared the revenue derived from expected 2030 traffic levels to a rough estimate of annual debt service given a particular capital cost. It did not recognize that early year revenues are likely to be considerably lower than 2030 revenues.

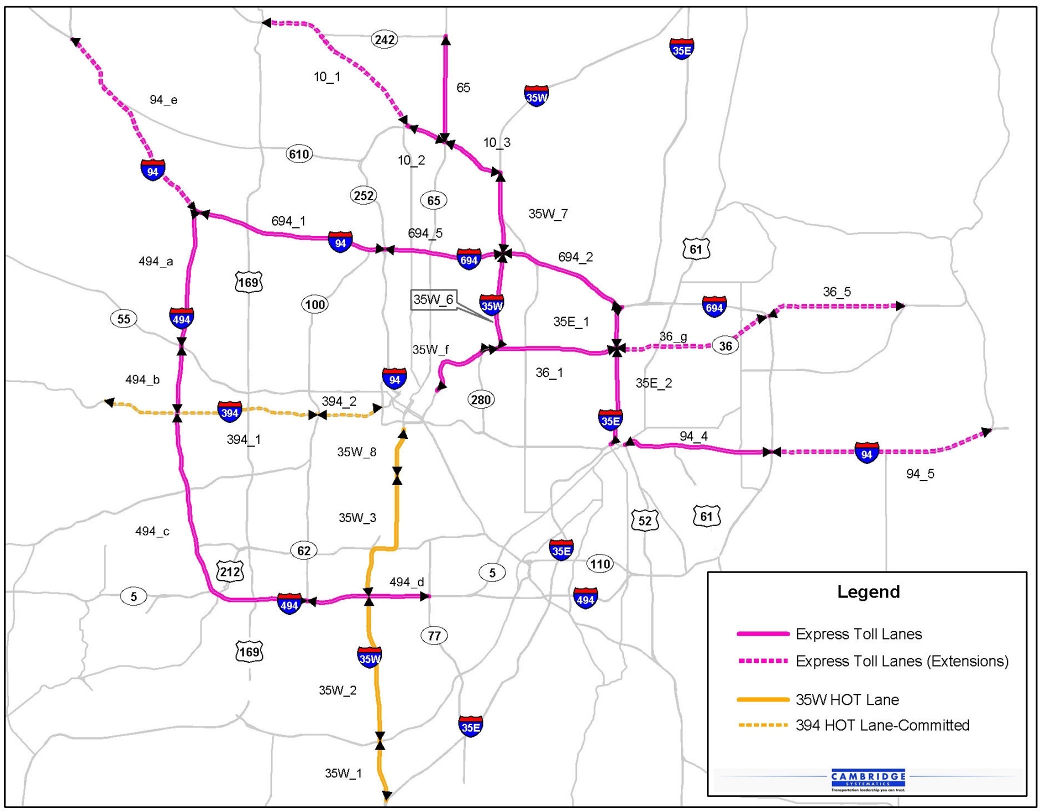
4. The Metropolitan Council's model does not address peak spreading – the idea that over time people will choose to start their trips earlier or later to avoid congestion. While some of the potential MnPASS lanes are forecast to attract high volumes in the peak periods, they attract relatively low volumes in the off-peak. This is an important factor in both the system performance and financial analysis. Additional peak spreading could improve cost-effectiveness, but the potential for this to occur cannot be definitively

[9] This finding differs markedly from the finding from the 2002 HOV System Study, which suggested that future demand for HOV lanes would not result in optimum highway system use and performance. Since the HOV system study was published, the Metropolitan Council extended its forecast horizon from 2020 to 2030, incorporated the high growth rates of the 1990s, and improved the capabilities of its travel demand model. That updated model is now forecasting considerably more HOVs. However, it should be noted that we did not perform an independent assessment of these HOV forecasts.

determined using the current model set. Therefore, in this regard, the financial estimates may be conservative.

Round 1 resulted in the development of "Concept A," a system that consists of the segments that performed well from a traffic management or financial perspective under the Round 1 framework. Figure 6 shows this system. In this figure, the "express toll lanes" represent the best segments from Round 1, and the "extensions" represent segments that performed less well, but might be combined with projects on other corridors. For more information on the Round 1 evaluation results, refer to Technical Memorandum #4.

Figure 6. Concept A Map



4.2 Round 2 Findings

In Round 2, we evaluated the proposed system of MnPASS toll lanes that emerged from Round 1 ("Concept A") and produced two conceptual MnPASS systems that represent the best segments under two analysis frameworks:

- **Concept A-1** represents those segments that could most easily be constructed soon, since they do not rely on money included in the Metropolitan Council's 2030 Transportation Policy Plan (TPP). These segments tended to have among the best cost recovery ratios and smallest funding gaps, but did not necessarily conform to the priorities of the TPP.

- **Concept A-2** represents those segments that could be leveraged by projects already in the 2030 TPP, but would need to wait for significant Mn/DOT contributions to make them feasible.

To evaluate Concept A, we modeled the MnPASS lanes using the Metropolitan Council's travel demand model. For all systems, we looked at 2010 and 2030 traffic levels on the 2013 highway network, which represents projects committed in Mn/DOT's Ten-Year Comprehensive Work Program (CWP). This 2013 network was modified to include the Concept A MnPASS lanes. These scenarios demonstrate the benefits of both the capacity addition *and* priced lanes over the Year 2013 base case. To isolate the incremental impacts of MnPASS pricing on congestion management, each scenario would have to be compared to an identical system modeled without tolls on the new lanes.

We evaluated the systems at three levels – the **regional network** (all roadways in the Twin Cities area), the **system** (Concept A MnPASS lanes and the free lanes adjacent to them), and the **segment** (parts of individual corridors). Key metrics used include vehicle-miles traveled (VMT), vehicle-hours traveled (VHT), average speed, present value of net revenue (2008-2030), present value of capital cost, cost recovery ratio, and funding gap.

As in Round 1, we found that the MnPASS lanes are expected to create improved travel conditions for motorists who choose to pay the tolls, as well as for those who stay in the toll-free general purpose lanes. The speed of the entire transportation system is also expected to improve. The 144.5-mile MnPASS system represented by Concept A could be expected to save almost 32,000 vehicle hours of travel (VHT) per day in 2010 and almost 177,000 VHT in 2030 when measured over the entire Twin Cities metropolitan area highway network (see Table 1). MnPASS users are also expected to travel around 20 mph faster than users of the adjacent untolled lanes, on an average daily basis.

However, significant public investment would be required – the systems would not be self-supporting. Some of the best potential projects are already underway or committed, and are not eligible for MnPASS treatment within the boundaries of our analysis framework. The projects that would be the best immediate projects (Concept A-1) are not included in the TPP; this raises the policy question as to whether the TPP should be modified to accommodate potential MnPASS projects. Projects that are the best long-term performers (Concept A-2) rely on leveraging TPP dollars that are many years away.

We also found that the conversion of HOV lanes to HOT lanes is not a sustainable idea under the current definition of HOV in the Twin Cities (two or more people in a car). The HOV lanes are expected to fill up with HOV traffic by 2030, leaving little excess room to sell to solo drivers. If the definition of HOV was changed to be three or more people in a vehicle, or transit vehicles only, then these projects would be more viable. It might be appropriate to consider a policy whereby Mn/DOT would have the option to change the HOV occupancy requirements over time as HOV volumes actually increase.

Concept A Network, System and Segment Performance

Concept A Regional Network Performance. Tables 1 and 2 provide an overall summary of total regional network performance with Concept A MnPASS lanes in place for the years 2010 and 2030.[10]

In 2010, the MnPASS system is expected to increase overall regional VMT from 90.2 million per day to 90.6 million per day, an increase of 0.4 percent. Since VHT is expected to decrease by almost 32,000 per day[11] as a result of MnPASS, the average speed by all vehicles increases from 33.6 mph in the No Build condition to 34.2 mph in the build condition. The No Build and Build scenarios use a fixed trip table, so changes in VMT and VHT are due to mode shifts and/or route diversions, not changes in trip distribution.

In 2030, overall regional VMT is expected to decrease from 121.6 million per day to 121.3 million per day, a decrease of 0.2 percent. The average speed by all vehicles increases from 26.6 mph in the No Build condition to 27.6 mph in the build condition. Average daily time savings in 2030 is estimated to be almost 177,000 vehicle hours, almost 5.6 times the time savings expected in 2010.

The decrease in system VMT is somewhat counter-intuitive, and tied to the operation of the mode choice model. Under 2030 travel conditions, we found a mode shift from SOV to HOV, meaning that the same number of people would be traveling in fewer vehicles. The fewer vehicles yield the lower level of VMT. This is the consistent with the finding of the HOV lanes filling up with HOV traffic in 2030.

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[10] As noted earlier, "regional network" performance refers to the entire Twin Cities metro area, while "system" performance refers to only the system of MnPASS lanes and the free lanes adjacent to them.

[11] Using vehicle hours alone as a measure of effectiveness is somewhat inaccurate, as it does not account for mode shifts from transit to autos, or from SOV to HOV. However, it does provide a general measure of effectiveness for purposes of this study.

Table 1. Concept A Regional Network Performance Summary, 2010

Measure	No-Build	Build
Vehicles Miles Traveled (VMT)	90,245,442	90,628,243
Vehicle Hours Traveled (VHT)	2,684,253	2,652,611
Average Speed, mph (VMT/VHT)	33.6	34.2

Table 2. Concept A Regional Network Performance Summary, 2030

Measure	No-Build	Build
Vehicles Miles Traveled (VMT)	121,629,162	121,344,309
Vehicle Hours Traveled (VHT)	4,570,698	4,393,985
Average Speed, mph (VMT/VHT)	26.6	27.6

Concept A System Performance. The performance of the MnPASS lanes relative to the free lanes adjacent to them for the entire extent of Concept A (including "extensions" as shown previously in Figure 6) is summarized in Tables 3 and 4 for the years 2010 and 2030. Since the MnPASS lanes in which everyone pays a toll are expected to perform differently than the HOT lanes (where HOVs are free), we have divided the evaluation into two parts. The top part addresses just the toll express lanes (HOVs pay), while the bottom part addresses the HOT lanes. Changes in VMT, VHT, and average speed (VMT/VHT) are shown.

In 2010, the overall average weekday VMT on the MnPASS lane system (including the adjacent free lanes) is expected to increase by about 3.4 percent, from about 11.6 million to 12.0 million. Over the course of the entire day, about 9.8 percent of the VMT on the MnPASS lane system is expected to be tolled; morning and evening peak-period percentages are 12.5 percent and 11.9 percent, respectively. VHT is expected to decrease, with the overall result being an increase in overall system speed from 44.4 mph to 48.0 mph. Average speed in the adjacent mainline lanes will increase by about 10 percent in the peak periods to 41.1 mph in the AM peak and 39.1 mph in the PM peak. Motorists who choose to pay tolls would enjoy even greater benefits, averaging a speed of 65.5 mph on the system.

Looking at the bottom portion of Table 3, dealing with the HOT lanes in 2010 only, we find that the average speeds in the HOT lanes are still expected to be greater than those in the regular lanes, although the speed benefit is not as great as in the express toll lanes.

In 2030, the overall VMT on the MnPASS lane system (including the adjacent free lanes) is expected to increase by about 3.8 percent, from about 14.3 million to 14.9 million. Over the course of the entire day, about 10.1 percent of the VMT on the MnPASS lane system is tolled; morning and evening peak-period percentages are 12.3 percent and 12.5 percent, respectively. VHT is expected to decrease as a result of MnPASS, with the overall result being an increase in overall system speed from 34.6 mph to 38.9 mph. Average speed in the adjacent mainline lanes will increase by about nine percent in the peak periods, to 30.2 mph in the AM peak and 30.0 mph in the PM peak. Speeds in the toll lane are still quite high, with an average speed of 59.0 mph on the system.

The percentage of vehicles in the MnPASS lanes is probably underestimated. This is because the actual traffic throughput of highway lanes under extreme conditions is considerably lower than the capacity of those lanes. The regional travel demand model does not reflect this. Given high levels of demand, the Metropolitan Council model will assign volumes far greater than available capacity to the free lanes, resulting in unrealistic volume/capacity ratios. Since the MnPASS lanes will be managed to maintain optimum flow, they will serve a higher percentage of the traffic flow than indicated. In addition, the ability to spread peak traffic across more hours could also increase the percentage of daily vehicle traffic using the MnPASS lanes.

Table 4 shows that the average speeds in the HOT lanes are expected to be about the same as those in the regular lanes. By 2030, extensive use of the HOT lanes by HOVs is forecast to occur, leaving little additional capacity for SOVs. The maximum toll rate tested was 50 cents per mile, which may be too low to restrain demand among SOVs and could overstate the SOV traffic on HOT lanes. Had higher toll rates been tested, HOT lane speeds would be expected to be higher.

Table 3. Concept A System Performance Summary, 2010

Part A – MnPASS Segments Where All Vehicles Pay

Measure	Time Period	No-Build	Build	Build: Free	Build: MnPASS	Percent MnPASS
Vehicle Miles Traveled (VMT)	AM Peak	3,085,711	3,240,470	2,834,775	405,695	12.5%
	Mid-Day	2,663,026	2,689,321	2,539,632	149,688	5.6%
	PM Peak	4,201,992	4,410,099	3,886,786	523,314	11.9%
	Night	1,683,321	1,695,188	1,600,297	94,891	5.6%
	Total	**11,634,050**	**12,035,079**	**10,861,490**	**1,173,588**	**9.8%**
Vehicle Hours Traveled (VHT)	AM Peak	79,277	75,360	68,992	6,368	8.4%
	Mid-Day	43,618	42,996	40,926	2,070	4.8%
	PM Peak	114,159	107,616	99,432	8,184	7.6%
	Night	25,217	24,982	23,676	1,306	5.2%
	Total	**262,271**	**250,954**	**233,026**	**17,928**	**7.1%**
Average Speed, mph (VMT/VHT)	AM Peak	38.9	43.0	41.1	63.7	
	Mid-Day	61.1	62.5	62.1	72.3	
	PM Peak	36.8	41.0	39.1	63.9	
	Night	66.8	67.9	67.6	72.6	
	Total	**44.4**	**48.0**	**46.6**	**65.5**	

Part B – MnPASS HOT Segments Where HOVs are Free (I-394 and I-35W)

Measure	Time Period	No-Build	Build	Build: Free	Build: MnPASS[1]	Percent MnPASS
Vehicle Miles Traveled (VMT)	AM Peak	882,119	1,011,545	817,614	193,931	19.2%
	Mid-Day	752,253	775,668	709,768	65,900	8.5%
	PM Peak	1,131,628	1,286,620	1,050,920	235,699	18.3%
	Night	478,175	487,217	452,077	35,140	7.2%
	Total	**3,244,176**	**3,561,050**	**3,030,380**	**530,671**	**14.9%**
Vehicle Hours Traveled (VHT)	AM Peak	24,851	25,224	20,736	4,488	17.8%
	Mid-Day	12,436	12,294	11,370	924	7.5%
	PM Peak	31,639	31,313	26,711	4,603	14.7%
	Night	6,875	6,941	6,454	487	7.0%
	Total	**75,801**	**75,772**	**65,271**	**10,502**	**13.9%**
Average Speed, mph (VMT/VHT)	AM Peak	35.5	40.1	39.4	43.2	
	Mid-Day	60.5	63.1	62.4	71.3	
	PM Peak	35.8	41.1	39.3	51.2	
	Night	69.6	70.2	70.0	72.2	
	Total	**42.8**	**47.0**	**46.4**	**50.5**	

Notes: [1] Includes HOVs not paying tolls on I-394 and on I-35W, south of Downtown Minneapolis.
AM Peak = 6:00 a.m. to 9:30 a.m.
Midday = 9:30 a.m. to 2:30 p.m.
PM Peak = 2:30 p.m. to 7:00 p.m.
Night = 7:00 p.m. to 6:00 a.m.

Table 4. Concept A System Performance Summary, 2030

Part A – MnPASS Segments Where All Vehicles Pay

Measure	Time Period	No-Build	Build	Build: Free	Build: MnPASS	Percent MnPASS
Vehicle Miles Traveled (VMT)	AM Peak	3,809,889	3,990,620	3,499,094	491,526	12.3%
	Mid-Day	3,299,162	3,346,109	3,146,031	200,078	6.0%
	PM Peak	5,098,893	5,394,571	4,718,055	676,517	12.5%
	Night	2,132,720	2,151,812	2,018,525	133,287	6.2%
	Total	**14,340,663**	**14,883,112**	**13,381,705**	**1,501,407**	**10.1%**
Vehicle Hours Traveled (VHT)	AM Peak	137,034	124,361	115,811	8,550	6.9%
	Mid-Day	58,423	57,115	54,334	2,780	4.9%
	PM Peak	186,133	169,308	157,049	12,259	7.2%
	Night	32,569	32,237	30,398	1,840	5.7%
	Total	**414,159**	**383,021**	**357,592**	**25,429**	**6.6%**
Average Speed, mph (VMT/VHT)	AM Peak	27.8	32.1	30.2	57.5	
	Mid-Day	56.5	58.6	57.9	72.0	
	PM Peak	27.4	31.9	30.0	55.2	
	Night	65.5	66.7	66.4	72.5	
	Total	**34.6**	**38.9**	**37.4**	**59.0**	

Part B – MnPASS HOT Segments Where HOVs are Free (I-394 and I-35W)

Measure	Time Period	No-Build	Build	Build: Free	Build: MnPASS[1]	Percent MnPASS
Vehicle Miles Traveled (VMT)	AM Peak	1,122,162	1,335,760	1,037,016	298,745	22.4%
	Mid-Day	881,243	927,004	828,571	98,432	10.6%
	PM Peak	1,370,509	1,627,139	1,276,048	351,090	21.6%
	Night	580,288	600,704	543,605	57,099	9.5%
	Total	**3,954,202**	**4,490,607**	**3,685,241**	**805,366**	**17.9%**
Vehicle Hours Traveled (VHT)	AM Peak	51,318	52,170	38,987	13,182	25.3%
	Mid-Day	16,296	15,511	14,113	1,398	9.0%
	PM Peak	56,651	56,560	44,244	12,317	21.8%
	Night	8,889	8,741	7,939	803	9.2%
	Total	**133,154**	**132,982**	**105,282**	**27,700**	**20.8%**
Average Speed, mph (VMT/VHT)	AM Peak	21.9	25.6	26.6	22.7	
	Mid-Day	54.1	59.8	58.7	70.4	
	PM Peak	24.2	28.8	28.8	28.5	
	Night	65.3	68.7	68.5	71.1	
	Total	**29.7**	**33.8**	**35.0**	**29.1**	

Notes: [1] Includes HOVs not paying tolls on I-394 and on I-35W, south of Downtown Minneapolis.

AM Peak = 6:00 a.m. to 9:30 a.m.
Midday = 9:30 a.m. to 2:30 p.m.
PM Peak = 2:30 p.m. to 7:00 p.m.
Night = 7:00 p.m. to 6:00 a.m.

Concept A Segment Evaluation. The performance of individual segments of Concept A is shown in Tables 5 and 6, for the years 2010 and 2030. Gross revenue potential relies not only on the percentage of the drivers choosing to pay tolls (at varying toll rates by time of day), but also on the length of the segment, since toll rates are assumed to be set on a per-mile basis. By 2030, the average speed savings for the HOT lanes on I-35W, where HOVs drive for free, is actually negative. This is because the HOT lanes are being filled with HOVs. Changing the current HOV definition from 2+ to either 3+ or transit vehicle-only would likely improve the performance of these segments.

Table 5. Concept A Segment Evaluation Summary, 2010

Segment	Length (Miles)	2010 Gross Revenue (2004$M)	2010 Operating Cost (2004$M)	2010 Net Revenue (2004$M)	Average Speed Savings, mph (No-Build versus Build)
I-494-a	5.6	$2.2	$0.6	$1.6	4.9
I-494-b	2.9	1.1	0.9	0.2	1.7
I-494-c	11.6	6.0	3.0	3.0	4.4
I-494-d	5.7	6.7	2.6	4.1	5.3
I-694-1	8.2	2.6	1.2	1.4	3.4
I-694-5	4.9	2.0	0.9	1.1	2.5
I-694-2	5.3	3.0	1.9	1.2	4.9
I-94-e	9.0	0.8	0.2	0.6	4.2
I-94-4	4.8	3.9	2.1	1.9	12.8
I-94-5	9.7	1.6	0.4	1.2	1.4
36-1	4.6	3.8	2.1	1.7	3.7
36-g	6.6	2.9	0.4	2.5	4.4
36-5	6.0	2.4	1.5	0.9	6.5
I-35E-1	1.8	0.4	0.4	0.0	3.6
I-35E-2	3.3	4.3	1.0	3.4	5.1
I-35W-1	1.8	0.9	1.6	(0.7)	10.1
I-35W-2	6.0	2.6	2.6	0.0	1.0
I-35W-3	4.6	1.8	2.4	(0.6)	2.9
I-35W-8	2.9	1.8	2.7	(1.0)	7.2
I-35W-f	3.7	4.1	1.7	2.4	3.0
I-35W-6	4.0	3.6	1.5	2.1	3.1
I-35W-7	3.2	4.2	1.0	3.2	3.4
10-1	7.6	6.6	2.1	4.4	5.2
10-2	1.9	1.3	0.0	1.3	2.7
10-3	2.8	2.7	1.8	0.9	3.3
65	4.3	3.1	0.6	2.6	4.7
I-394-1	8.3	1.6	0.0	1.6	3.3
I-394-2	3.4	0.8	0.0	0.8	3.3
Total	**144.5**	**$78.8**	**$37.2**	**$41.8**	

Table 6. Concept A Segment Evaluation Summary, 2030

Segment	Length (Miles)	2030 Gross Revenue (2004$M)	2030 Operating Cost (2004$M)	2030 Net Revenue (2004$M)	Average Speed Savings, mph (No-Build versus Build)
I-494-a	5.6	$3.7	$0.8	$2.8	4.3
I-494-b	2.9	2.0	1.0	0.9	2.2
I-494-c	11.6	10.1	3.9	6.2	4.2
I-494-d	5.7	11.7	3.7	8.0	5.2
I-694-1	8.2	4.7	1.2	3.5	3.8
I-694-5	4.9	3.5	1.0	2.6	2.8
I-694-2	5.3	5.2	2.1	3.1	4.2
I-94-e	9.0	2.5	0.2	2.3	3.5
I-94-4	4.8	5.8	2.7	3.0	13.2
I-94-5	9.7	3.0	0.7	2.3	2.8
36-1	4.6	5.0	2.5	2.5	5.2
36-g	6.6	4.9	0.6	4.4	5.2
36-5	6.0	3.7	1.6	2.1	7.3
I-35E-1	1.8	1.1	0.5	0.6	3.5
I-35E-2	3.3	6.1	1.3	4.8	6.3
I-35W-1	1.8	1.5	3.1	-1.6	12.0
I-35W-2	6.0	4.5	4.9	-0.4	(3.1)
I-35W-3	4.6	1.8	3.4	-1.6	(8.4)
I-35W-8	2.9	1.6	3.7	-2.0	6.9
I-35W-f	3.7	4.8	1.9	2.9	3.8
I-35W-6	4.0	5.1	1.7	3.4	3.9
I-35W-7	3.2	6.3	1.4	5.0	3.2
10-1	7.6	9.9	2.9	7.0	6.4
10-2	1.9	2.2	0.0	2.2	6.2
10-3	2.8	4.5	2.2	2.3	4.0
65	4.3	6.2	0.9	5.3	6.2
I-394-1	8.3	1.7	0.0	1.7	1.0
I-394-2	3.4	0.5	0.0	0.5	1.2
Total	**144.5**	**$123.6**	**$49.8**	**$73.8**	

Cost Estimates

URS developed conceptual design concepts for each segment of Concept A. Under the Concept A-1 analysis framework, where there is no TPP contribution, the total cost of all segments is over $3.5 billion. Under the Concept A-2 analysis framework, where MnPASS segments can leverage the TPP cost, the total cost of all segments is $2.7 billion. Table 7 summarizes the capital cost estimates under the Concept A-1 and Concept A-2 analysis frameworks. More details on the cost estimates are provided in Appendix A.

Concept A-1 Findings

Concept A-1 looks at the costs of implementing the MnPASS lanes by building the lanes on the base transportation network expected to be in place at the end of Mn/DOT's current 10-year Comprehensive Work Program (CWP). The costs represent simply adding new lanes to the existing system without reconstructing the existing roadway. The exception is the segment I-35W-8, where building a lane without reconstruction was deemed technically infeasible.

The results of the financial analysis using the Concept A-1 framework are summarized in Table 8, sorted by the funding gap, with the lowest funding gap results rising to the top. Table 9 is simply an alternative view of this data, sorted by the cost recovery ratio, with the highest ratios at the top. The revenues and cost recovery ratios for the I-35W HOV conversion segments are negative because forecast extensive use of the HOT lanes by HOVs will leave little additional capacity for paying SOVs. However, despite the fact that HOVs would not pay a toll, we assumed that there would be operational expenses associated with "collecting" zero tolls, since an enforcement effort would be needed to distinguish paying traffic from HOVs. This cost of collection from so many nontoll payers drives the net revenue for these segments negative. If toll rates above 50 cents per mile were tested, or if the current HOV definition were changed, these values might improve.

Table 7. Segment Construction Cost Estimates using Concepts A-1 and A-2 (2004$M)

Segment	Segment Cost[1] Using Concept A-1 (2004$M)	Segment Cost[2] Using Concept A-2 (2004$M)
I-494-a	$119.7	$34.7
I-494-b	132.5	132.5
I-494-c	265.6	265.6
I-494-d	406.9	18.7
I-694-1	159.1	159.1
I-694-5	149.3	149.3
I-694-2 [3]	226.3	241.4
I-94-e	115.5	115.5
I-94-4	122.1	122.1
I-94-5	105.4	105.4
36-1	83.1	72.1
36-g	172.6	172.6
36-5	122.4	122.4
I-35E-1	109.3	64.8
I-35E-2	76.0	47.7
I-35W-1	50.7	50.7
I-35W-2	3.0	3.0
I-35W-3	2.0	2.0
I-35W-8	311.0	2.0
I-35W-f	140.0	140.0
I-35W-6	159.7	159.7
I-35W-7	126.2	126.2
10-1	141.4	141.4
10-2	15.3	15.3
10-3	51.8	51.8
65	155.6	155.6
I-394-1	0.0	0.0
I-394-2	0.0	0.0
Total	**$3,522.5**	**$2,671.7**

Notes: 1 Cost for adding a lane each direction without reconstructing existing lanes, except for I-35W-8, where omitting reconstruction is infeasible.

2 For TPP projects, cost for converting a lane each direction to MnPASS. For non-TPP projects, cost for adding a lane each direction without reconstructing existing lanes.

3 Concept A-2 cost is higher because it assumes a 10-foot buffer provided during segment reconstruction. Concept A-1 cost assumes the existing four-foot buffer.

Table 8. Segment Financial Analysis Using Concept A-1, Sorted by Funding Gap

Segment	Net Revenue (2004$M)		PV of Net Revenue Stream (2004$M)	Capital Cost (2004$M)	PV of Capital Cost (2004$M)	Cost Recovery Ratio	Funding Gap (2004$M)	Rank by Funding Gap	Average Speed Savings (Build versus No-Build) (mph)	
	2010	2030	2008-2030						2010	2030
10-2	$1.3	$2.2	$21.7	$15.3	$13.9	156%	$-7.8	1	2.7	6.2
I-35W-2	0.0	-0.4	-1.9	3.0	2.7	-68%	4.6	2	1.0	-3.1
I-35W-3	-0.6	-1.6	-12.5	2.0	1.8	-684%	14.3	3	2.9	-8.4
I-35E-2	3.4	4.8	51.3	76.0	69.0	74%	17.7	4	5.1	6.3
10-3	0.9	2.3	18.5	51.8	47.0	39%	28.5	5	3.3	4.0
36-1	1.7	2.5	26.2	83.1	75.3	35%	49.1	6	3.7	5.2
10-1	4.4	7.0	70.9	141.4	128.2	55%	57.4	7	5.2	6.4
I-35W-1	-0.7	-1.6	-13.7	50.7	46.0	-30%	59.7	8	10.1	12.0
I-35W-7	3.2	5.0	50.9	126.2	114.4	44%	63.5	9	3.4	3.2
I-94-5	1.2	2.3	21.5	105.4	95.6	23%	74.1	10	1.4	2.8
I-94-4	1.9	3.0	30.2	122.1	110.7	27%	80.5	11	12.8	13.2
I-494-a	1.6	2.8	27.2	119.7	108.5	25%	81.3	12	4.9	4.3
I-94-e	0.6	2.3	16.5	115.5	104.7	16%	88.2	13	4.2	3.5
I-35W-f	2.4	2.9	34.2	140.0	127.0	27%	92.7	14	3.0	3.8
36-5	0.9	2.1	17.9	122.4	111.0	16%	93.1	15	6.5	7.3
65	2.6	5.3	47.4	155.6	141.1	34%	93.7	16	4.7	6.2
I-35E-1	0.0	0.6	2.8	109.3	99.1	3%	96.3	17	3.6	3.5
I-35W-6	2.1	3.4	34.1	159.7	144.8	24%	110.7	18	3.1	3.9
I-694-5	1.1	2.6	21.8	149.3	135.4	16%	113.6	19	2.5	2.8
I-494-b	0.2	0.9	6.1	132.5	120.2	5%	114.1	20	1.7	2.2
36-g	2.5	4.4	42.0	172.6	156.5	27%	114.5	21	4.4	5.2
I-694-1	1.4	3.5	28.7	159.1	144.2	20%	115.6	22	3.4	3.8
I-694-2	1.2	3.1	24.9	226.3	205.2	12%	180.3	23	4.9	4.2
I-494-c	3.0	6.2	55.2	265.6	240.8	23%	185.7	24	4.4	4.2
I-494-d	4.1	8.0	72.4	406.9	369.0	20%	296.5	25	5.3	5.2
I-35W-8	-1.0	-2.0	-18.0	311.0	282.0	-6%	300.0	26	7.2	6.9
I-394-1	1.6	1.7	21.9	0.0	0.0	N/A	-21.9	N/A	3.3	1.0
I-394-2	0.8	0.5	8.8	0.0	0.0	N/A	-8.8	N/A	3.3	1.2
Total	**$41.9**	**$73.7**	**$706.7**	**$3,522.5**	**$3,194.2**	**22%**	**$2,518.1**			

Notes: Real Discount Rate: 4%
Inflation Rate: 3%
PV = Present value of future cash flows, discounted to 2004.
Cost Recovery Ratio = PV of Net Revenue Stream/PV of Capital Cost.
Funding Gap = Net Present Value of discounted future costs minus revenue.

Table 9. Segment Financial Analysis Using Concept A-1, Sorted by Cost Recovery Ratio

Segment	Net Revenue (2004$M)		PV of Net Revenue Stream (2004$M)	Capital Cost (2004$M)	PV of Capital Cost (2004$M)	Cost Recovery Ratio	Funding Gap (2004 $M)	Rank by Cost Recovery Ratio	Average Speed Savings (Build versus No-Build) (mph)	
	2010	2030	2008-2030						2010	2030
10-2	$1.3	$2.2	$21.7	$15.3	$13.9	156%	$-7.8	1	2.7	6.2
I-35E-2	3.4	4.8	51.3	76.0	69.0	74%	17.7	2	5.1	6.3
10-1	4.4	7.0	70.9	141.4	128.2	55%	57.4	3	5.2	6.4
I-35W-7	3.2	5.0	50.9	126.2	114.4	44%	63.5	4	3.4	3.2
10-3	0.9	2.3	18.5	51.8	47.0	39%	28.5	5	3.3	4.0
36-1	1.7	2.5	26.2	83.1	75.3	35%	49.1	6	3.7	5.2
65	2.6	5.3	47.4	155.6	141.1	34%	93.7	7	4.7	6.2
I-94-4	1.9	3.0	30.2	122.1	110.7	27%	80.5	8	12.8	13.2
I-35W-f	2.4	2.9	34.2	140.0	127.0	27%	92.7	9	3.0	3.8
36-g	2.5	4.4	42.0	172.6	156.5	27%	114.5	10	4.4	5.2
I-494-a	1.6	2.8	27.2	119.7	108.5	25%	81.3	11	4.9	4.3
I-35W-6	2.1	3.4	34.1	159.7	144.8	24%	110.7	12	3.1	3.9
I-494-c	3.0	6.2	55.2	265.6	240.8	23%	185.7	13	4.4	4.2
I-94-5	1.2	2.3	21.5	105.4	95.6	23%	74.1	14	1.4	2.8
I-694-1	1.4	3.5	28.7	159.1	144.2	20%	115.6	15	3.4	3.8
I-494-d	4.1	8.0	72.4	406.9	369.0	20%	296.5	16	5.3	5.2
36-5	0.9	2.1	17.9	122.4	111.0	16%	93.1	17	6.5	7.3
I-694-5	1.1	2.6	21.8	149.3	135.4	16%	113.6	18	2.5	2.8
I-94-e	0.6	2.3	16.5	115.5	104.7	16%	88.2	19	4.2	3.5
I-694-2	1.2	3.1	24.9	226.3	205.2	12%	180.3	20	4.9	4.2
I-494-b	0.2	0.9	6.1	132.5	120.2	5%	114.1	21	1.7	2.2
I-35E-1	0.0	0.6	2.8	109.3	99.1	3%	96.3	22	3.6	3.5
I-35W-8	-1.0	-2.0	-18.0	311.0	282.0	-6%	300.0	23	7.2	6.9
I-35W-1	-0.7	-1.6	-13.7	50.7	46.0	-30%	59.7	24	10.1	12.0
I-35W-2	0.0	-0.4	-1.9	3.0	2.7	-68%	4.6	25	1.0	-3.1
I-35W-3	-0.6	-1.6	-12.5	2.0	1.8	-684%	14.3	26	2.9	-8.4
I-394-1	1.6	1.7	21.9	0.0	0.0	N/A	-21.9	N/A	3.3	1.0
I-394-2	0.8	0.5	8.8	0.0	0.0	N/A	-8.8	N/A	3.3	1.2
Total	**$41.9**	**$73.7**	**$706.7**	**$3,522.5**	**$3,194.2**	**22%**	**$2,518.1**			

Notes:
Real Discount Rate: 4%
Inflation Rate: 3%
PV = Present value of future cash flows, discounted to 2004.
Cost Recovery Ratio = PV of Net Revenue Stream/PV of Capital Cost.
Funding Gap = Net Present Value of discounted future costs minus revenue.

Our recommendations for Concept A-1 projects represent subjective judgments regarding a number of factors, generally in this order:

- **Cost recovery ratio.** A segment should recover the cost of its operations, and ideally recover most of its capital cost over time. Any decision to set a minimum cost recovery ratio would have to be a policy decision made by Mn/DOT. The total recovery ratio for all the projects under Concept A-1 was 22 percent, with individual segments ranging from three percent to 156 percent. Most cost recovery ratios clustered in the 15 to 55 percent range assuming a four percent discount rate. The HOT lane segments on I-35W were found to have negative cost recovery ratios over time, due to lack of excess capacity to sell and the need to expend resources to distinguish HOVs from toll-paying traffic.

    A sensitivity analysis on the impact of the discount rate on the cost recovery ratio is provided in Appendix C. We found that a discount rate of 10 percent drops the typical cost recovery ratios to a range of eight to 40 percent.

- **Funding gap.** A high cost recovery ratio for an expensive project could still result in a large funding gap. The funding gaps for projects under Concept A-1 ranged from zero (a $7.8 million surplus on Segment 10-2, a short 1.9-mile segment) to $300 million.

- **System connectivity.** Although an individual segment may look favorable on the basis of cost recovery and the funding gap, the segment needs to serve the greater system. For example, a stand-alone two-mile segment of MnPASS lane is not likely to be successful without connections to adjacent segments.

- **User benefit.** The proposed systems should deliver a reasonable level of benefit to users of the MnPASS system and to users of the adjacent highway as well. We used the average speed savings on segments between the Build and No Build conditions as a proxy for user benefit.

Figure 7 shows the consultants' recommendations for projects under the Concept A-1 framework. The first tier recommendations represent the most attractive segments, the second tier recommendations represent segments that are promising but performed less well. The HOV conversion on I-35W is recommended, along with the proviso that HOV eligibility criteria have the potential to be adjusted in the future. These recommendations incorporate subjective value judgments regarding what constitutes "reasonable" funding gaps or cost recovery ratios, as well as benefits to system connectivity. Others looking at the same information might come to different conclusions.

Figure 7. Consultant Recommended Segments for Concept A-1

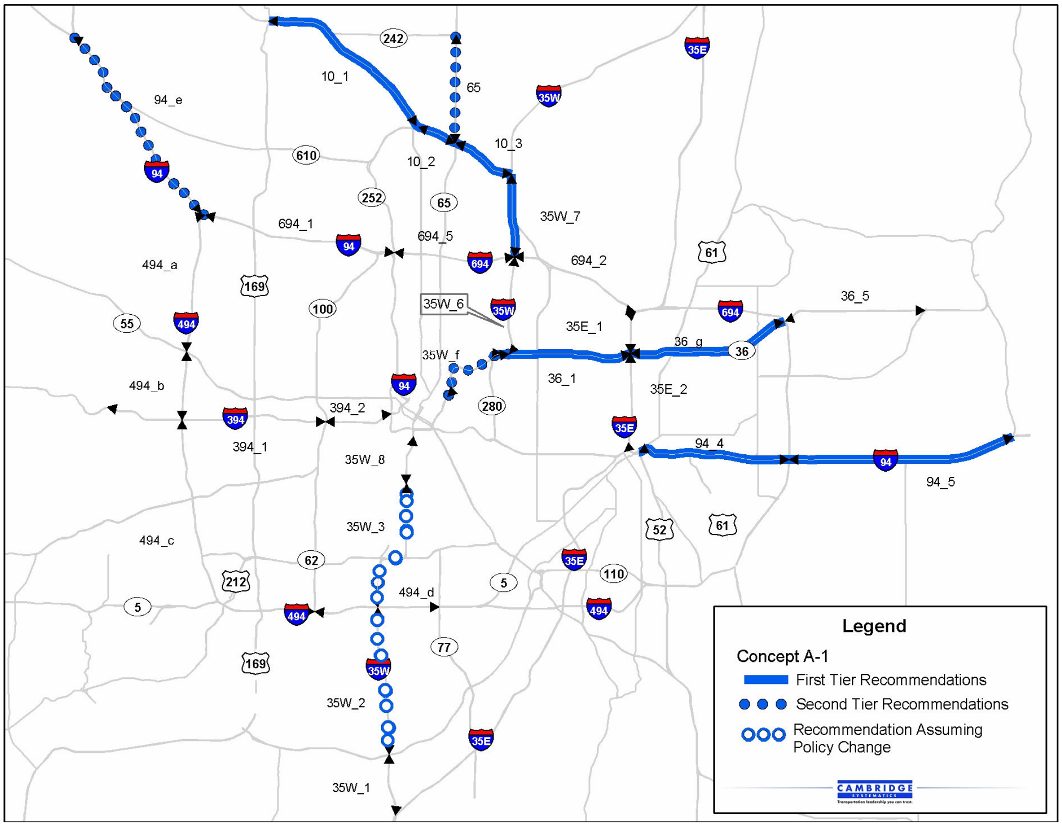
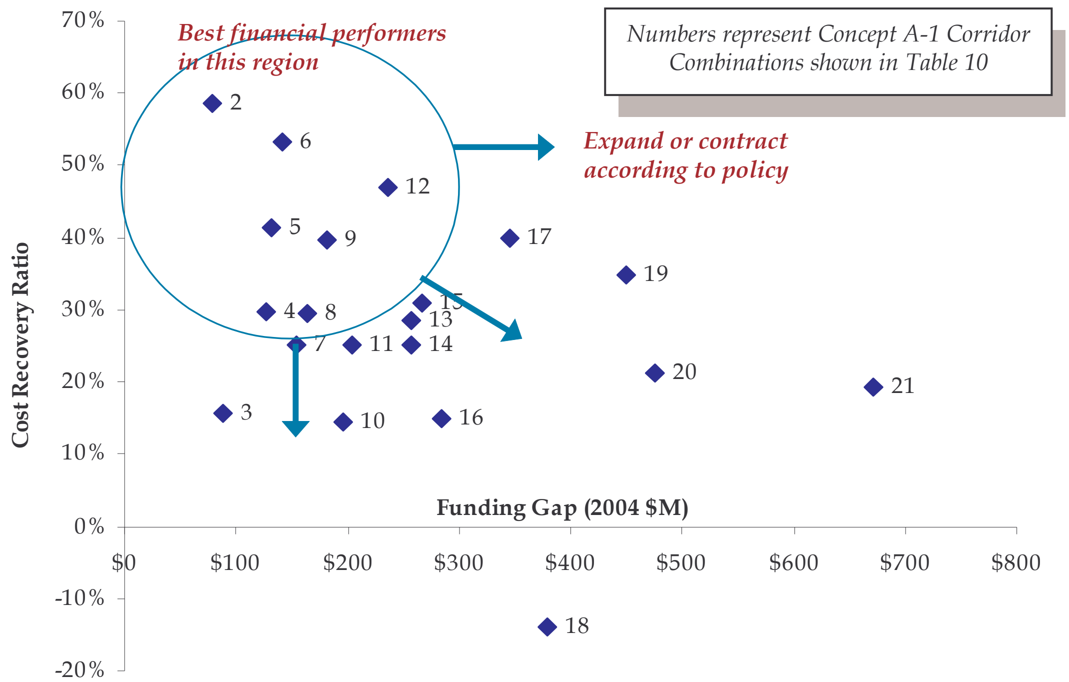


Table 10 groups the segments into various combinations of complete corridors, to enable us to consider segments as part of a larger system. Systems with the lowest funding gap are on top. To aid in analyzing the multiple dimensions of this analysis, we have developed a chart that compares the cost recovery ratio on the Y-axis and the funding gap on the X-axis of the systems shown in Table 10 (see Figure 8). Projects that rank well on both measures (low funding gap and high cost recovery ratio) tend to cluster in the top left portion of the chart. Depending on Mn/DOT's tolerance for public investment on these projects, this chart helps identify those projects that have the best cost recovery ratio.

Table 10. Corridor Combinations Using Concept A-1, Sorted by Funding Gap

ID	Corridor	Composed of	Funding Gap (2004$M)	Cost Recovery Ratio
1	I-35W south existing HOV conversion only	35W-2, 35W-3	$18.9	-314%
2	Northern Radial (TH 10 only)	10-1, 10-2, 10-3	78.2	59%
3	Western Radial – 94 northwest	94-e	88.2	16%
4	Central Radial – 35E	35E-1, 35E-2	114.0	32%
5	Central Radial – St Paul to 36 east	35E-2, 36-g	132.2	41%
6	Northern Radial to Beltway	10-1, 10-2, 10-3, 35W-7	141.7	53%
7	Eastern Radial – 94 east	94-4, 94-5	154.6	25%
8	Eastern Radial – 36 inside Beltway	36-1, 36-g	163.7	29%
9	Central Radial – St. Paul to 36 west and east	35E-2, 36-1, 36-g	181.3	40%
10	Western Beltway – 494 northwest	494-a, 494-b	195.4	15%
11	I-35W north to Beltway	35W-6, 35W-f	203.5	25%
12	Northern Radial to Beltway, plus 65	10-1, 10-2, 10-3, 35W-7, 65	235.4	47%
13	Eastern Radial – 36 inside Beltway to Minneapolis	36-1, 36-g, 35W-f	256.4	29%
14	Eastern Radial – 36	36-1, 36-g, 36-5	256.7	25%
15	I-35W north past Beltway	35W-7, 35W-6, 35W-f	267.0	31%
16	Western Radial – 94/494 northwest corridor	94-e, 494-a, 494-b	283.7	15%
17	Northern Radial to Minneapolis	10-1, 10-2, 10-3, 35W-7, 35W-6, 35W-f	345.1	40%
18	I-35W south HOV conversion with both extensions	35W-1, 35W-2, 35W-3, 35W-8	378.6	-14%
19	Northern Radial to St. Paul	10-1, 10-2, 10-3, 35W-7, 694-2, 35E-1, 35E-2	435.9	36%
20	Western Beltway – 494 southwest	494-c, 494-d	482.2	21%
21	Western Beltway – 494	494-a, 494-b, 494-c, 494-d	677.6	19%

Figure 8. Cost Recovery Ratio versus Funding Gap: Concept A-1 Corridor Combinations



A summary of the analysis that went into these recommendations is provided below, by major corridor groupings.

Northern Radials

The segments on TH 10 and I-35W north of I-694 (Segments 10-2, 10-2, 10-3, 35W-7) have high cost recovery ratios and low funding gaps, both individually and collectively, and have reasonable levels of speed savings. About 25 percent of the cost of the 35W-7 segment ($32.6 million) is due to system connections at the south end. If these system connections are not made, this segment would be even more financially attractive.

The TH 65 spur of this northern system also has a relatively favorable cost recovery ratio (34 percent), but a relatively high funding gap for a short segment ($93.7 million).

A system encompassing segments 10-1, 10-2, 10-3, plus 35W-7 would provide a continuous toll lane for 15.5 miles, bringing drivers to the edge of the beltway with meaningful time savings. The combined cost recovery ratio is 53.7 percent, and the funding gap is $141.7 million. This could be a viable system, and is recommended for inclusion in Concept A-1. The spur to TH 65 increases the funding gap to $235.4 million, and drops the cost recovery ratio to 47 percent. We have shown TH 65 on the Concept A-1 map as a second-tier potential addition to this northern radial system.

Eastern Radials

The segments of I-94 east of downtown St. Paul (94-4 and 94-5) have relatively high cost recovery ratios (27 percent and 23 percent, respectively). The funding gaps are $80.5 million and $74.1 million. Since no direct connections were assumed, there would be no cost savings if this were built on its own. The segment inside the beltway (94-4) shows a significant increase in speed from MnPASS – exceeding 12 miles per hour in both 2010 and 2030. Taken together, these segments are 14.5 miles long, which would make a good continuous MnPASS project. The segment inside the beltway is 4.8 miles, which would be at the lower end of what would be reasonable as a stand-alone MnPASS project.

The TH 36 system of eastern radials performs marginally well under Concept A-1. Segment 36-g (from I-35E to I-694) has a cost recovery ratio of 27 percent, and segment 36-5 has a ratio of 16 percent. This suggests the portion east of I-694 should not be considered for MnPASS treatment in the short term. The segment between I-35E and I-35W (36-1) has a cost recovery ratio of 35 percent and a funding gap of 49.1 million, although it is only 4.6 miles long. Together, the segments from I-35W to I-694 (36-1 and 36-g) show a cost recovery ratio of 29 percent and a funding gap of $163.7 million over a total distance of 11.2 miles.

Extending the TH 36 system from I-35W to I-694 west toward downtown on segment 35W-f (from I-35W to University Avenue/4th Street) provides better accessibility to downtown. Segment 35W-f on its own has a cost recovery ratio of 27 percent and a funding gap of $92.7 million. Taken together with segments 36-1 and 36-g, this represents a 14.9-mile system with a cost recovery ratio of 29 percent and a funding gap of $256.4 million.

In this corridor, we suggest that the segments of TH 36 inside the beltway (36-1 and 36-g) would make good first tier choices, while an extension west into Minneapolis with segment 35W-f would be a second tier recommendation.

Western Radials and Beltway

The segment 94-e (from the Fish Lake interchange northwest to TH 101) has a low cost recovery ratio of 16 percent, but a relatively modest funding gap of $88.2 million, considering that the segment is 9.0 miles long. Throughout the project we have cautioned that the travel demand estimates from the average weekday model may underestimate the potential of this corridor due to the high level of demand related to weekend recreation travel. We therefore think that this corridor warrants further consideration, despite its low cost recovery ratio.

The segment of I-494 from the Fish Lake interchange to TH 55 (494-a) has a cost recovery ratio of 25 percent and a funding gap of $81.3 million. This segment is 5.6 miles long, but has little value without a connection to I-394. Adding in segment 494-b results in a combined cost recovery ratio of 15 percent and a funding gap of $195.4 million. The cost of these two segments is high under Concept A-1 because 494-b will be re-built and widened as part of the ongoing design-build project. MnPASS would add an additional lane beyond that project, and the

494-a segment is planned in the TPP. These segments are not recommended as part of Concept A-1, but are recommended for Concept A-2. The cost for the 494-a segment could be reduced if connections are not made to I-694 and/or I-94. The value of connecting these segments to the I-394 HOT lane is minimized under the current policy of allowing 2+ HOVs to use this lane for free, as there will be little excess capacity to sell to paying MnPASS users accessing I-394 from I-494.

Other segments of the Beltway – the northern tier of 694-1 and 694-5 (from the Fish Lake Interchange to I-35W), and the southwest quadrant from I-394 to TH 77 (segments 494-c and 494-d) – are very expensive to build. All have low cost recovery ratios and high funding gaps.

Central Radials and Beltway

I-35E, from I-694 south to TH 36 (segment 35E-1) has an extremely high cost for such a short segment, and as a result has a very low cost recovery ratio (three percent) under Concept A-1. The next segment to the south, 35E-2 (from TH 36 to downtown St. Paul) has a very high cost recovery ratio (74 percent) and low funding gap ($17.7 million). This segment is, however, very short – only 3.3 miles – and would be an unlikely candidate as a stand-alone project.

I-694-2 has a low cost recovery ratio and high funding gap because of its high cost, and is not recommended for Concept A-1.

I-35W HOT Lanes

There are two types of projects in the HOT lane conversion element of this project. Segments 35W-2 and 35W-3 are conversions of pre-existing (or soon to be built) HOV lanes. The cost to build these is very low. However, both the 2010 and 2030 travel demand forecasts show high levels of HOV use in these segments. Since HOVs would not pay a toll, these segments suffer a double-impact: the loss of revenue and the cost of operating the HOT system, even for motorists who are not paying a toll. We have assumed the same toll collection cost per vehicle for HOVs as for toll payers. As a result, we show these facilities having a negative cost recovery ratio.

Segments 35W-1 and 35W-8 would require new lane construction, making these projects even more expensive.

The simple conversion of HOV to HOT lanes could be accomplished in the short-term for segments 35W-2 and 35W-3, as is underway now on I-394, and might provide several years of benefit before the HOV volumes ultimately overwhelm the system. At that point, Mn/DOT might choose to change the HOV priority to 3+, or modify the HOV lane to become a vanpool or vanpool/bus transitway, eliminating auto-based HOVs entirely. However, without such an "exit strategy" in place, pursuing HOT lanes in this corridor might lead to long-term issues.[12]

Since the segments of I-35W that are conversions of existing and proposed HOV lanes are relatively inexpensive, we have included them as recommended projects in Concept A-1 on the condition that there is flexibility in the definition of HOV either immediately, or in the future.

Concept A-2 Findings

Concept A-2 represents a way of looking at the costs of implementing the MnPASS lanes by leveraging projects that are in the TPP and constructing them as MnPASS lanes. For projects that are not in the TPP, the costs are the same as in Concept A-1.

The results of the financial analysis using the Concept A-2 framework are summarized in Tables 11 and 12, sorted by funding gap and cost recovery ratio, respectively. Only projects in the TPP or on existing HOV lanes are shown.

Our recommendations for Concept A-2 projects are based on the same rationale as for Concept A-1, except that a different cost basis was used.

Figure 9 shows the consultants' recommendations for projects under the Concept A-2 framework. As with Concept A-1 recommendations, the first tier recommendations represent the most attractive segments, the second tier recommendations represent segments that are promising but performed less well, and the HOV conversion on I-35W is recommended assuming the potential to modify HOV eligibility criteria in the future. As with Concept A-1, these recommendations incorporate subjective value judgments regarding what constitutes "reasonable" funding gaps or cost recovery ratios, as well as benefits to system connectivity. Others looking at the same information might come to different conclusions.

[12] Cambridge Systematics' study of the HOV lane system in 2002 showed that this corridor had a much higher incidence of violations and difficulty with HOV enforcement than the I-394 corridor. The enforcement issue is an important one, and should be considered in any decision to proceed with MnPASS lanes on I-35W.

Table 11. Segment Financial Analysis Using Concept A-2, Sorted by Funding Gap

Segment	Net Revenue (2004$M)		PV of Net Revenue Stream (2004$M)	Capital Cost (2004$M)	PV of Capital Cost (2004$M)	Cost Recovery Ratio	Funding Gap (2004 $M)	Rank by Funding Gap	Average Speed Savings (Build versus No-Build) (mph)	
	2010	2030	2008-2030						2010	2030
I-494-d	$4.1	$8.0	$72.4	$18.7	$17.0	427%	$-55.5	1	5.3	5.2
I-35E-2	3.4	4.8	51.3	47.7	43.2	119%	-8.0	2	5.1	6.3
I-494-a	1.6	2.8	27.2	34.7	31.5	86%	4.3	3	4.9	4.3
I-35W-2	0.0	-0.4	-1.9	3.0	2.7	-68%	4.6	4	1.0	-3.1
I-35W-3	-0.6	-1.6	-12.5	2.0	1.8	-684%	14.3	5	2.9	-8.4
I-35W-8	-1.0	-2.0	-18.0	2.0	1.8	-983%	19.8	6	7.2	6.9
36-1	1.7	2.5	26.2	72.1	65.4	40%	39.2	7	3.7	5.2
I-35E-1	0.0	0.6	2.8	64.8	58.7	5%	55.9	8	3.6	3.5
Total	**$9.2**	**$14.6**	**$147.5**	**$245.1**	**$222.2**	**66%**	**$74.7**			

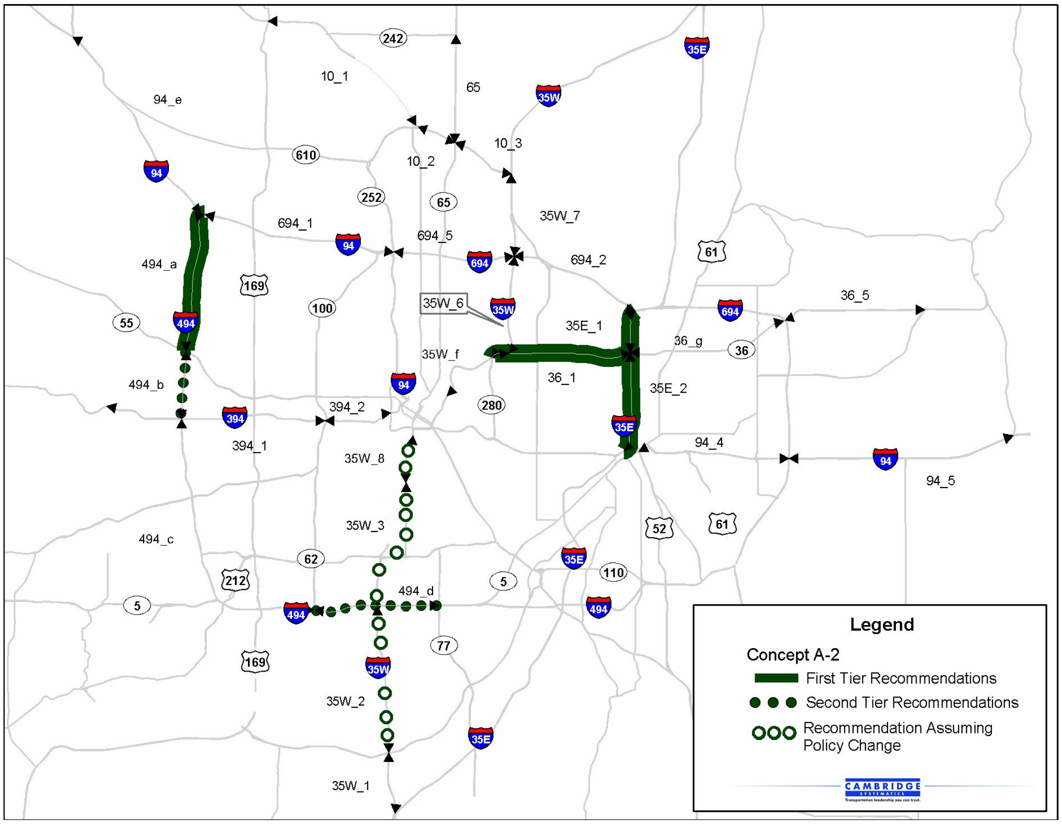
Notes: Real Discount Rate: 4%
Inflation Rate: 3%
PV = Present value of future cash flows, discounted to 2004.
Cost Recovery Ratio = PV of Net Revenue Stream/PV of Capital Cost.
Funding Gap = Net Present Value of discounted future costs minus revenue.

Table 12. Segment Financial Analysis Using Concept A-2, Sorted by Cost Recovery Ratio

Segment	Net Revenue (2004$M)		PV of Net Revenue Stream (2004$M)	Capital Cost (2004$M)	PV of Capital Cost (2004$M)	Cost Recovery Ratio	Funding Gap (2004 $M)	Rank by Cost Recovery Ratio	Average Speed Savings (Build vs. No-Build) (mph)	
	2010	2030	2008-2030						2010	2030
I-494-d	$4.1	$8.0	$72.4	$18.7	$17.0	427%	$-55.5	1	5.3	5.2
I-35E-2	3.4	4.8	51.3	47.7	43.2	119%	-8.0	2	5.1	6.3
I-494-a	1.6	2.8	27.2	34.7	31.5	86%	4.3	3	4.9	4.3
36-1	1.7	2.5	26.2	72.1	65.4	40%	39.2	4	3.7	5.2
I-35E-1	0.0	0.6	2.8	64.8	58.7	5%	55.9	5	3.6	3.5
I-35W-2	0.0	-0.4	-1.9	3.0	2.7	-68%	4.6	6	1.0	-3.1
I-35W-3	-0.6	-1.6	-12.5	2.0	1.8	-684%	14.3	7	2.9	-8.4
I-35W-8	-1.0	-2.0	-18.0	2.0	1.8	-983%	19.8	8	7.2	6.9
Total	**$9.2**	**$14.6**	**$147.5**	**$245.1**	**$222.2**	**66%**	**$74.7**			

Notes: Real Discount Rate: 4%
Inflation Rate: 3%
PV = Present value of future cash flows, discounted to 2004.
Cost Recovery Ratio = PV of Net Revenue Stream/PV of Capital Cost.
Funding Gap = Net Present Value of discounted future costs minus revenue.

Figure 9. Consultant Recommended Segments for Concept A-2



Since Concept A-2 is restricted to projects that are in the TPP, only six segments are eligible. Each is discussed below, in order of cost recovery ratio.

- **494-d (I-494 from TH 100 to TH 77).** This segment has a positive cost recovery ratio (427 percent) and a negative funding gap, i.e., it generates a surplus of $55.5 million. While by those measures it should be an easy choice for recommendation, it may produce little time savings. The segment is only 5.7 miles long, and because it straddles I-35W, much of the traffic may travel only half its length. Since these estimates were generated with this segment being connected to a larger MnPASS system, the actual results may be less. Moreover, this segment has a complicated arrangement of ramps that might be difficult to serve with MnPASS lanes. That said, however, we have included this segment as a potential candidate worth further investigation.
- **35E-2 (I-35E from TH 36 to downtown St. Paul).** This is a short, 3.3-mile segment with a positive cost recovery ratio (118 percent) and a surplus of $8 million. Such a short segment would be unlikely to do well as a stand-alone project, although the level of through traffic from TH 36 to downtown St. Paul is probably a significant part of the traffic flow.

- **494-a (I-394 to I-94).** This segment has a high cost recovery ratio (86 percent) and a low funding gap ($4.3 million). It is 5.6 miles long, and does not provide system continuity unless included as part of 494-b, the segment that continues south to I-394. We suggest consideration of this corridor only in conjunction with additional widening of that southern segment; the combined cost recovery ratio of these two projects is 22 percent with a funding gap of $118.3 million.
- **36-1 (TH 36 from I-35W to I-35E).** This 4.6-mile segment has a 40 percent cost recovery ratio and a $39.2 million funding gap. Given its location between the two north-south interstates, it probably has a sizeable amount of through traffic, which could work well as a MnPASS lane, despite the short length. There are also opportunities to connect this segment to MnPASS lanes on I-35E, making for a longer system.
- **35E-1 (I-35E from TH 36 to I-694).** This is another short (1.8 mile) segment that would be very expensive to build. The cost recovery ratio is only five percent and the funding gap is $55.9 million.
- **35W-8 (46th Street to 24th Street at the 4th and 5th Avenue Ramps).** This 2.9-mile segment is proposed for construction as a HOV lane. While converting this lane to HOT would be inexpensive, the longer-term prospect of HOVs crowding out potential toll payers is an issue here, as it is on other segments of I-35W.

Looking at the potential value of these segments in combination, we conclude that a system of MnPASS lanes incorporating I-35E from I-694 to downtown St. Paul (segments 35E-1 and 35E-2) has a combined cost recovery ratio of 53 percent and a funding gap of $48.0 million. Adding the spur toward Minneapolis on TH 36 (36-1), drops the cost recovery ratio to 48 percent, and raises the funding gap to $87.1 million. This T-shaped system could be worth pursuing under the Concept A-2 framework.

The stand alone segment of I-494 from TH 100 to TH 77 should be considered because it fared so well financially; however there are significant concerns about the ultimate viability of this segment.

The northwest portion of I-494 should be considered together with the portion between TH 55 and I-394. It is a moderate performer, and connects to the I-394 HOT lane project.

Segment 35W-8 is very short, and should only be considered if the portion of I-35W immediately to the south (Segments 35W-3 and 35W-2) is also converted to HOT lanes. As in Concept A-1, the existing and proposed I-35W HOV lanes should be considered for conversion to HOT lanes if there are immediate or eventual opportunities to redefine HOV occupancy levels.

4.3 Potential to Improve Transit Service with MnPASS Lanes

There is a natural synergy between the MnPASS concept and bus rapid transit (BRT) or enhanced express bus service. BRT needs dedicated right-of-way to operate without congestion, and MnPASS lanes can provide a very high level of service. Since buses carry many multiples of the number of person-trips that autos do (whether SOV or HOV), there is a strong incentive for transportation policy makers to incorporate BRT or express bus into the MnPASS system.

Improving transit service on Twin Cities freeways has been an important issue in recent years. Through an innovative program, Mn/DOT and the Metropolitan Council have already implemented 224 miles of bus-only shoulders in the Twin Cities metropolitan area, and project that an additional 221 miles will be needed in the next 20 years. These shoulders allow transit buses to use designated bus-only shoulders during times of congestion (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. Due to the inherent speed advantages that toll-free use of MnPASS lanes would provide to BRT or express bus, MnPASS implementation may replace the need for some existing and/or planned bus-only shoulders on various corridors.

However, there are also numerous issues associated with making BRT or express bus work with MnPASS lanes. This collaboration is the topic of ongoing study in many locations. Some of the key issues that relate to the MnPASS situation are:

- **Access to and from the lanes.** Buses would benefit from direct access to and from the MnPASS lanes, without having to weave across general purpose lanes. However, such direct connections are expensive, and require careful placement.
- **Need for adequate transit stops.** Highways are not pleasant waiting environments for passengers. Ideally, buses would be able to stop without significant deviation from their mainline path. However bus stops in the middle of the highway are difficult to get to, and potentially unpleasant for passengers. Dedicated transit stations adjacent to the highways, in conjunction with park and ride lots makes for a better access environment, but requires buses to deviate more from their mainline path.
- **Operating speeds.** MnPASS lanes will be most successful if near free-flow freeway speed operating speeds can be maintained. Buses are less maneuverable and may not be able to maintain these speeds, leading to potential degradation of conditions on the MnPASS lanes since auto drivers are unable to pass in a single-lane operation.

To evaluate the potential increase to transit ridership that might result from allowing express buses to take advantage of MnPASS lanes, we conducted a test model run under the following conditions:

- 2010 travel demand;
- MnPASS toll rate of 30 cents per mile for autos; and
- Enhanced service for two lines in the TH 36 corridor, both of which run from downtown Minneapolis to TH 36 at U.S. 61 (and then beyond). The two routes were coded as routes 52 and 270 in the Metropolitan Council's travel demand model.

Both of these lines already run express bus service on TH 36 (not BRT), with one of them making one stop at the Rosedale Mall near the I-35W junction. The main difference between current operation and the proposed operation would be the ability to use the uncongested MnPASS lanes instead of the congested mainline. The net result of these improvements is summarized in Table 13.

Table 13. Potential Effect of MnPASS on Transit Ridership, TH 36

Transit ridership on TH 36 lines without realignment to MnPASS Lanes	1,947
Transit ridership on TH 36 lines with realignment to MnPASS Lanes	2,068
Additional riders	121
Percent increase	6.2%

These are modest, but measurable increases in transit ridership. Changing the headways or service characteristics of the service (which may be possible with an enhanced transit mode) could improve these results.

4.4 Potential Impact of HOVs and Hybrids on MnPASS Lanes

In identifying a potential MnPASS tolling lane system, our basic assumption is that all traffic will pay tolls to access the MnPASS lanes, except for transit vehicles. The two exceptions are for I-394 and I-35W south, where HOV lanes already exist. These HOV lanes will be converted to HOT lanes, with HOVs and transit vehicles continuing to enjoy free access. Mn/DOT expressed interest in a limited off-model analysis to address the potential impacts of allowing HOVs and/or hybrid vehicles free access into **all** MnPASS lanes. This strategy provides additional incentives to HOV formation and hybrid use.

Key Issues

In framing the analysis, we considered these questions:

- How much of current traffic flow is represented by HOVs and hybrids?
  - The Metropolitan Council 2000 Travel Behavior Inventory found that 42 percent of all trips in the seven-county area are carpools. However, when considering just home-based work and work-related trips (which are more likely to use MnPASS lanes), only eight percent of all trips are carpools.
  - According to 2003 data, Minnesota ranked nationally in the bottom 30 states for hybrid vehicle registration (fewer than 600 registered hybrids).
- How much will that relationship change over time?
  - Carpooling in the seven-county metro area has been declining. The Metropolitan Council 1990 Travel Behavior Inventory found that 44 percent of all trips were carpools (declining to 42 percent in 2000) and that 11 percent of home-based work trips were carpools (declining to eight percent in 2000). For the entire state of Minnesota, work-related carpools have also declined – from 13.4 percent in 1990 to 11.8 percent in 2000. However, the regional travel demand model forecasts increasing HOV usage over time. In the No Build condition, the percent of total VMT attributable to HOVs is predicted to grow from 2.3 percent in 2010 to five percent in 2030.
  - In 2003, total U.S. hybrid vehicle registrations saw a 25.8 percent increase compared with 2002. Since the introduction of hybrid vehicles in model year 2000, hybrid vehicle sales have increased over 570 percent with a compound annual growth rate of 88.6 percent. J.D. Power and Associates expects U.S. consumers to purchase approximately 350,000 hybrid vehicles annually by 2008.
- What impact might a policy that allows HOVs and hybrids in a MnPASS system for free have on HOV and hybrid makeup in traffic?
  - In Virginia, the number of vehicles registered with special clean fuel plates has risen dramatically since hybrids were allowed to drive in the HOV lanes on I-95, I-395, I-66, and the Dulles Toll Road in Northern Virginia. Without including travel time savings, the literature suggests that it would take hybrids roughly 333,000 miles until the cost savings (gas) recoups the higher purchase cost. Anecdotal evidence suggests that hybrid access to the HOV lanes has contributed to spurring hybrid sales. Virginia is planning to abandon its experiment to allow hybrid vehicles into Northern Virginia's HOV lanes because the policy has been so successful at attracting hybrids that it is congesting the HOV lanes.
  - There is conflicting literature on whether HOV lanes actually increase carpooling mode share. However, a policy of allowing HOVs to drive for free in special lanes does reward carpoolers and may encourage the formation or enhancement of regional ride-sharing programs particularly in areas of extreme congestion.

- How will hybrids and HOVs impact traffic and revenue on the toll lane system?
  - Hybrids and HOVs would switch into MnPASS lanes as part of their normal driving. There would be less room for paying customers, so SOVs would be shifted out (by means of a higher toll rate) to ensure that the lanes can still flow smoothly. We could also expect hybrids and HOVs to change their routes and make more/longer trips to take advantage of the MnPASS lanes.
  - The effect on net revenue is unclear, since there will be fewer paying customers but they will be paying higher toll rates. The effect on net revenue ultimately depends on the mix of paying and nonpaying customers.
  - The 2030 analysis showed that HOVs are expected to virtually fill up the proposed I-35W HOT lanes. Although there would still be some room for paying customers in 2010, the analysis of the I-35W HOT lanes indicates the extent to which carpools limit the revenue potential without cutting back significantly on the costs of operations.
- What are the operational issues?
  - Toll collection and enforcement become extremely difficult when the system has to distinguish SOVs from HOVs and hybrids. HOVs and hybrids could be given a transponder device that prevents tolls from being charged, but there is no simple way to prevent such a device from being used by drivers when traveling alone or in a nonhybrid vehicle. Enforcement also becomes complicated because law enforcement agencies would have to verify hybrid or HOV status for nonpaying customers. It is possible that emerging technologies in HOV screening could help simplify enforcement issues in the future.
- What are the institutional or legal issues?
  - Allowing hybrids into HOV lanes built with Federal funds (e.g., I-394 and I-35W) violates current Federal law. Because of the reduced emissions and improved fuel economy of hybrid vehicles, Arizona, California, and Virginia have all sought Federal approval to allow hybrids in HOV lanes.[13] All three versions of the Federal highway reauthorization bill that failed to pass Congress last year would have changed the law to allow highly fuel efficient vehicles, such as hybrids, into the HOV lanes. We do not know whether any provision will be included in the reauthorization legislation which ultimately passes.

[13] Although Virginia law now allows hybrids in HOV lanes, the Commonwealth has never received approval from the Federal Highway Administration for this practice.

- Allowing hybrids free passage on HOV lanes also raises equity issues, perhaps even more so than the issues raised by toll lanes. Hybrids cost several thousand dollars more than comparable non-hybrid vehicles. In effect, allowing hybrids into HOV lanes is just another means for allowing people to choose to pay for improved travel conditions, just like MnPASS lanes. However, unlike MnPASS lanes which operate on a pay-as-you-go basis, purchasing a hybrid requires a significant upfront capital outlay which is more likely to limit the universe of users to higher-income drivers.

Summary

From a policy perspective, allowing HOVs and hybrid vehicles free access to travel time savings supports the environmentally beneficial policies of encouraging carpools and hybrid utilization. However, unlike HOV lanes (which cannot be accessed by SOVs), the MnPASS lanes can also be accessed by paying a toll. The tradeoff for MnPASS users becomes the toll cost versus the purchase cost of a hybrid or the lifestyle/flexibility cost of a carpool. Because the toll cost is relatively small, it is unclear whether granting free MnPASS access will actually encourage new HOV formation and hybrid utilization.

From a traffic perspective, the number of HOVs and hybrid vehicles using MnPASS lanes cannot be managed through dynamic toll rates. Allowing free passage to these vehicles therefore limits Mn/DOT's ability to use MnPASS lanes as a traffic management tool, since the MnPASS lanes could become congested with HOVs and hybrids. High numbers of HOVs and hybrids would also limit the effectiveness of integrating MnPASS lanes with Bus Rapid Transit, since BRT needs to operate without congestion.

In deciding whether to implement this policy, Mn/DOT should weigh the impact on MnPASS traffic, revenue, and operations against the anticipated benefits in encouraging or rewarding hybrid and HOV use. Mn/DOT should also consider that other incentives besides travel time savings are available to encourage new hybrids and HOVs – for example, additional tax credits.

4.5 Operations and Design Issues

Express toll lanes are a new type of transportation "product." There are only three operating toll express lane projects in the United States. None of these operating systems have the kind of complexity envisioned in a system of MnPASS lanes, with multiple access points and lack of barrier or baton separation between toll lanes and toll-free lanes. Although similar toll lane concepts are under study in several regions of the U.S., no industry standards are yet in place. Furthermore, each region has unique considerations in terms of roadway configurations, traffic patterns, and weather conditions.

There are numerous operation and design issues associated with implementation of MnPASS lanes. What follows below is an overview of some of the main issues, and some potential direction for how these issues might be resolved – at least to the point of providing a basis for use in preparing this study.

Toll Collection Concepts

Express toll lanes require electronic toll collection. Each vehicle must carry a unique device to identify itself as a valid toll payer, and equipment in the lane is needed to record the passage of vehicles. Equipment and systems to enforce the payment of tolls is also needed. This section provides an initial discussion of toll collection and related issues such as enforcement and incident management.

Pricing Strategy

Since traffic levels vary by time of day and the MnPASS lanes must be kept free flowing under all traffic demand conditions, the system must be able to accommodate different prices at different times of day. One way to accomplish this is to publish a fixed toll schedule according to historical traffic patterns. However, it is not possible to predict with absolute certainty that day-to-day traffic will conform to historical norms and that a particular toll rate will keep the lanes free flowing.

The other approach is to use dynamic pricing, in which sensors in the MnPASS lane monitor volume and speed, and adjust prices according to a pricing algorithm. Although more complex than using a published toll schedule, dynamic pricing is better able to manage day-to-day and hour-to-hour traffic variations, and keep traffic flowing. Dynamic pricing will be used for the I-394 MnPASS express toll lane facility currently under implementation.

Toll Collection Points

There are two common approaches for assessing user charges in the United States. The first is to charge a flat rate per toll collection point, irrespective of where the user enters or exits the system. The second is to record the specific points that a customer enters and exits the system, and calculate the toll based on a predefined interchange-to-interchange toll schedule (usually oriented to a per-mile system). Under either system, it is important not to allow toll-free movements.

The MnPASS express toll lane system poses unique challenges that differ both from standard toll roads and from the HOT lane projects that are already in service. In a traditional toll road, well-defined highways and on- and off-ramps provide relatively easy opportunities to construct toll plazas or tolling gantries. HOT lanes already in operation around the nation provide single entry and exit points and single toll collection points.

The proposed MnPASS system is very different. It will have numerous access points, and will therefore need numerous locations to record the passage of cars.

Although there may be locations where barriers may be erected, the toll lanes may only be separated from the regular lanes by a double-white stripe, and the points of entry and exit to the toll lane will be simply a virtual on or off "ramp" designated by paint and signing. Practical considerations would preclude the placement of toll collection gantries on these virtual on- and off- ramps.

Therefore, toll collection points will have to be somewhere on the "mainline" portion of the toll lane. This means that tolling gantries will need to be placed across the road at every point where a vehicle may enter or exit the toll lane. The toll for each gantry could be set to represent the toll that would maximize revenue or vehicle throughput on the lane.

Equipment Needs

The tolling system will require transponder equipment in the vehicle and an overhead gantry in the lane. Communications equipment will be necessary to move data from the lanes to a central location, and a back-office system will be necessary to collect and process the transaction data. A system of dynamic message signs will provide information in advance on toll rates, so that motorists have enough time to decide whether they want to enter an MnPASS lane.

Since Mn/DOT is already implementing a toll lane system on I-394, we have assumed that the same basic system will be used. This will enable the average MnPASS user to access and utilize all MnPASS lanes without having to maintain separate accounts.

Overhead Equipment

Current technologies involve locating the antenna array serving the lane directly above the lane with vehicles driving underneath. The ideal location for mounting transponders is on vehicle windshields behind rear view mirrors. The antenna array would be mounted in close proximity to the radio frequency (RF) module which serves it, usually within 50 feet or less. In most cases, the RF modules would be mounted on the same structure on which the antenna array is mounted.

Also mounted above the flow of traffic would be a series of cameras and illuminators. These devices would be dedicated to violation enforcement and would constitute the violation enforcement system (VES). In some configurations, a VES takes a picture of each vehicle passing through the read zone and then subsequently eliminates images of any vehicles not in violation. In other systems, the VES operates only when it has been determined a violation has been incurred. In either system, the images to be saved are fed to a storage system adjacent to the gantry for later download to the back office for review and processing. In most states, special legislation is required to allow the VES photos as prima facie evidence that a violation has occurred. In addition, that legislation places the onus for the violation on the owner of the vehicle not on its operator at the time. Presently, Minnesota law does not allow VES. This could be a significant issue in maintaining the integrity of the toll collection system, which relies entirely on electronic toll collection.

The number of antennas, RF modules, cameras, and illuminators will be a function of the coverage desired and the functions to be served.

Lane Equipment

In-lane equipment would consist of a series of detector loops and piezo-electric or similar type sensors. The detector loops would be designed to provide information about the vehicle passing above them, where the vehicle begins, where it ends, and its length as a means to classifying the vehicle. The loops would be similar in appearance to those used for traffic signals, but more sensitive. Because of this sensitivity, the loops should be installed in non-reinforced concrete pavement with a positive separation between the loops and any ferromagnetic material adjacent to the loops of three to four feet minimum to avoid false readings. Two sets of loops are generally used. One set would be located before the read zone and would provide initial data about the vehicle being tolled. These loops would be called the pre-classification loops. A second set of loops could be and often are installed for use as the vehicle exits the read zone of the lane. These loops would generate the same type of information as the pre-classification loops produce. The two sets of data would then be compared to assure consistency and accuracy of data.

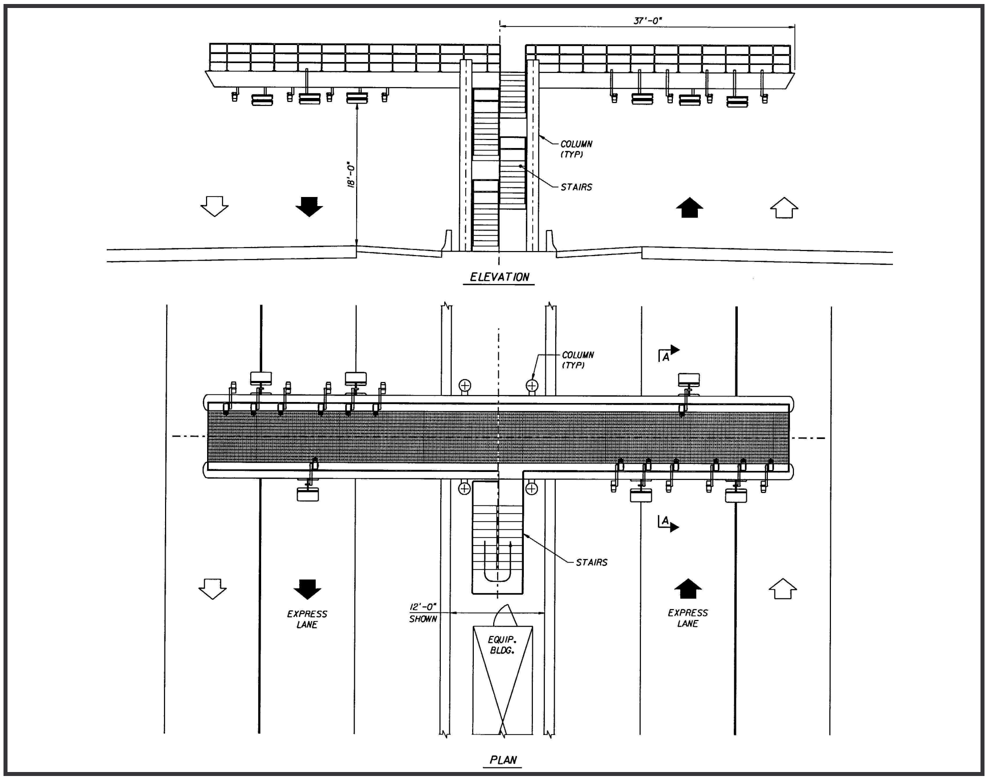
Loop detectors would also be required in the toll lanes to determine volumes and speeds to provide data to the dynamic pricing system.

Tolling Gantry Configuration

A primary consideration in placing tolling equipment in lanes to be tolled is how to maintain that equipment without interfering with the flow of traffic or creating an unsafe condition for maintenance personnel. The required antennas, RF modules, cameras, and illuminators can be mounted on conventional overhead sign structures. Accessing that equipment for maintenance and upkeep will require the use of bucket trucks thereby resulting in the closure of the affected lane to traffic. Closure will force traffic normally using that lane into the more congested adjacent lanes. In addition, setting up the lane closure when needed requires extensive planning and use of traffic control devices.

A number of agencies operating electronic toll collection lanes of the type envisioned for the Minneapolis-St. Paul area have determined that it is advisable to set up their gantries to allow for service of the gantry-mounted equipment without having to close the affected lane to traffic. These gantries provide a working platform for maintenance personnel and mechanisms to allow access to the equipment to be maintained without closing the lane below. A possible gantry design that can be implemented for the MnPASS lanes is shown in Figure 10. This gantry design draws on concepts developed by URS for the Florida Turnpike Enterprise's Signature SunPass Electronic Toll Collection Gantry.

Figure 10. Conceptual Gantry Design



Housings or enclosures for lane controllers, data processing and storage units, communications equipment, uninterruptible power supplies or standby generators, and other equipment supporting the operation of the equipment on the gantry are also needed. Depending on the systems to be provided at each gantry location, the enclosures could range from a series of traffic signal type control boxes to a small building. The exact type of housing should be a function of the equipment needed for a particular location and the environmental constraints within which that equipment is designed to operate. The housings should also facilitate maintenance and upkeep of the equipment. Since maintenance may take place in inclement weather, the gantry concept includes a small building to house that equipment. The building would be environmentally controlled and would provide a safe, protected area for maintenance personnel.

As an alternative to constructing an expensive gantry, it is possible to mount antennas, RF modules, cameras, and illuminators on existing overhead structures, provided there is adequate clearance between the roadway and equipment. These structures could include existing overpasses and existing sign structures. However, this approach may have several drawbacks. First, it does not permit maintenance of the mounted equipment without closing the affected lane to traffic. Second, antennas and cameras are sensitive to vibration and existing overhead structures may not be rigid enough to permit the equipment to operate as intended. A gantry intended for electronic toll collection purposes is designed to provide rigidity and stiffness. Third, mounting equipment on existing overpasses and other overhead structures does not eliminate the need to house equipment supporting the antennas and other equipment mounted on the existing structures.

Enforcement Issues

Since the MnPASS lane may be separated from the other lanes only by a pair of white stripes, meticulous and consistent enforcement is needed to prevent the MnPASS lane being taken over by non-MnPASS traffic. While most drivers will honor the intent of the double white stripes, the temptation to use the MnPASS lane will be high. A persistent law enforcement presence and observation of the usage of the lane is a necessity.

The lack of physical separation between the MnPASS lane and adjacent lane could pose another enforcement challenge as well. Drivers using the MnPASS lane could avoid paying the toll by moving across the double white stripes into the adjacent non-tolled lane to avoid the tolling gantry. This would threaten the financial stability of the MnPASS system. If photographic images could not be used as prima facie evidence of a violation, a physical law enforcement presence would become crucial for enforcement. Weaving from lane to lane to avoid the gantries would also increase the risk of crashes.

The I-394 HOT lane project will enhance the enforcement capabilities of the law enforcement agencies through the use of enforcement transponders, mobile enforcement readers, and enforcement beacons. These devices will allow roving patrol officers to determine whether drivers in the MnPASS lane have paid a toll. On the HOT lane portions of the system, the officers will visually assess whether a vehicle has one or more occupants, so as not to charge HOVs with a toll violation offense.[14]

Surveillance and Crash Removal Issues

The success of the MnPASS system is highly dependent on the ease with which drivers can use the MnPASS lanes. Any impedance to entrances and exits will discourage motorists from using the lanes. Vehicles blocking a MnPASS lane, whether from mechanical malfunction or from crashes, will be the most serious deterrent. The swift removal of these vehicles will be critical to the success of the MnPASS lanes. Road patrols, circulating tow trucks, and other common means of addressing the problem of disabled vehicles will not provide the quick response that will be required. Real-time or near real-time information is needed so that blocked lanes can quickly be cleared. Prior to implementing the MnPASS

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[14] Further details on the I-394 enforcement scheme can be found in the I-394 Community Task Force Final Report, at http://www.dot.state.mn.us/information/mnpass/394/finalreport.html.

system, Mn/DOT should ensure that the camera coverage now provided by the Traffic Management Center (TMC) can identify blockages as they occur and trigger the appropriate response from authorities. These cameras might also assist in monitoring lane violations. The monitoring staff could then notify the appropriate law enforcement agency to observe the suspect activity and to take appropriate action. It may be necessary to provide additional monitoring staff for this purpose.

System Connections

This study assumed that direct system connections should be provided, whenever possible, between the MnPASS lanes on one highway and the MnPASS lanes on another. Ideally, MnPASS users would not have to exit the toll lanes, merge with other vehicles in the interchange, and then re-enter the MnPASS system.

However, system connections are extremely costly. Omitting them would result in substantial cost savings, but would also reduce the effectiveness of the system. Moreover, without direct connections, autos and buses would be required to weave more frequently across the general purpose lanes to access the MnPASS lanes. This increased merging and weaving has safety and congestion implications that are not captured in the Metropolitan Council's travel demand model, and would be better studied in an advanced corridor simulation.

One potential alternative to direct system connections is to allow MnPASS users to bypass the ramp meters that control many of the interchanges in the Twin Cities metropolitan region. At several locations, HOVs are already allowed to bypass the ramp meters via a separate lane. Using these bypasses would significantly reduce the cost of system connections; however, enforcement would be a major issue. It is not possible to model ramp meter bypasses in the Metropolitan Council's travel demand model – more detailed corridor simulations are needed to capture these effects.

Ultimately, the decision as to whether system connections are desirable should be made on a case by case basis.

Assumptions Regarding Buffer Zones

An important consideration in the design of an MnPASS lane is the treatment of the transition between the general purpose lanes and the MnPASS lanes. The general purpose lanes will often be operating under congested, reduced-speed conditions, and the MnPASS lanes will be managed to be always free flowing. The resulting speed differential is a potential safety concern. One way to address this concern is to create a buffer zone between the two types of facilities large enough to allow for acceleration, deceleration, and merging/weaving. The ideal buffer zone would be 10 feet; however it may not be realistic to assume that full 10-foot buffers can be provided in all locations.

For purposes of generating a cost estimate, URS prepared typical cross sections and applied them to each of the highway segments studied in Concept A. In addition to considering other factors, these cross sections assumed different buffer widths based on the prevailing conditions expected to be in place at the time of MnPASS lane construction. The rationale for choice of buffer widths for different segments is described below.

- For segments 494-b and 494-c most bridges are long enough to accommodate a fourth lane, therefore an additional 10-foot buffer and a fourth lane is an unrealistic expectation. In these segments the buffer width was assumed to be two to three feet.
- For segment 694-1, the widening was assumed to be to the outside. The existing inside shoulder is 15 feet wide. URS reduced the inside shoulder width to 11 feet and allocated four feet to the buffer.
- For segment 694-2, it was assumed for this study that the 10-year work program will add a third lane to the outside by 2013 (the segment has recently been removed from the Mn/DOT Ten-Year Work Program). MnPASS will add a fourth lane to the inside. The assumption is that Mn/DOT will provide a wide enough median to provide a 10-foot buffer.
- For segments 35W-3 and 35W-8, HOV lanes will be converted to HOT lanes similar to I-394. A minimum of a two-foot buffer would be possible. Mn/DOT's current proposed section for 35W provides a 14-foot HOV and a 13-foot enforcement lane. These widths could be adjusted at little or no cost.
- Segments 494-a, 494-d, 36-1, 35E-1 and 35E-2 are in the TPP and are planned for construction in the distant future (2014-2030). In these segments, URS used the Mn/DOT concept plan and the TPP cost. The additional lane would be "taken away" and converted to a MnPASS lane.
  - The MnPASS incremental cost in these circumstances is equal to a 25 percent risk factor multiplied by the sum of the construction, project delivery, and right of way costs. The construction cost is calculated as the cost of a 10-foot buffer, plus the cost of gantries, plus the cost of connections. The project delivery cost is simply 20 percent of the construction cost.
- In all other segments, buffer width varies between two feet and four feet. Most of the concepts involve widening to the inside, and increasing the width of the buffer significantly increases costs.

These assumptions were developed to provide a reasonable basis for cost estimating, without addressing detailed design issues. Their inclusion in this document does not indicate Mn/DOT's intention to build lanes to these standards. Before any MnPASS projects would be developed, it would be necessary to develop design standards in cooperation with the Federal Highway Administration.

4.6 Summary of Technical Findings

MnPASS lanes are a new transportation "product" that provides new capacity that will not fill up with congestion, as long as tolls are charged and effective enforcement and operational policies are in place. Few other transportation strategies can accomplish this.

However, our analysis shows that these lanes require significant public investment. On average, 22 percent of the regional MnPASS system capital costs could be expected to be recovered from tolls if the toll lanes are built "from scratch" in accord with the Concept A-1 method of looking at costs. Under the Concept A-2 view of costs – i.e., that the lanes be built in conjunction with the Transportation Policy Plan, the cost recovery ratios are much better. There are, however, only a few highway widening projects in the TPP.

The projects that we found to be the most financially viable are not in the Transportation Policy Plan. They are projects on the outskirts of the metropolitan area that provide a combination of relatively low cost and relatively high demand. The financial viability of projects decreases considerably as the projects get closer to the urban core – the result of the high cost of building in these denser areas. Advancing these projects that are not in the TPP would require modifying the TPP. Since these projects are not self-supporting, advancing them would likely mean that other projects that are already in the plan would have to be delayed.

The projects that are in the TPP also require an infusion of public investment. Therefore, these projects are also likely to be many years away in terms of potential implementation.

MnPASS projects on two corridors (I-394 and I-35W in the south) envisioned converting existing or planned HOV lanes to HOT lanes. Our analysis assumed that the HOVs would continue to be defined as two or more people in a vehicle. Under those conditions, we found that HOVs would occupy most of the managed lane capacity during the peak travel periods, leaving little room to be sold to SOVs by 2030. We have not conducted an independent assessment of the HOV forecasts that are generated by the Metropolitan Council's travel demand model. However, it is reasonable to assume that as traffic grows, so will use of the HOV lane by HOVs, so the concern is real. If HOV to HOT lane conversion is pursued, Mn/DOT should build in some flexibility in the definition of HOVs, from today's 2+ standard to a future 3+ standard or transit vehicle-only standard.

Finally, several technical issues should be understood when reviewing these findings:

- **Peak Spreading.** The current model assumes the same distribution of traffic over the course of the day as is evident today. It is reasonable to expect that over time, as congestion grows, the duration of peak traffic conditions will lengthen. This means that the demand for the proposed toll lanes will be higher in time periods that are not now currently congested, which means that the revenue estimates in this memo may be understated. The Metropolitan Council plans to develop a peak spreading model in the near future, which would help address this issue.

- **Fixed Trip Tables.** The Metropolitan Council's mode choice model iterates back through the trip distribution component, resulting in dynamic trip tables that vary between the No-Build and Build scenarios. While it is probably more behaviorally accurate to use this module and have the distribution of trips to origins and destinations change, the Round 1 models never achieved equilibrium due to the inclusion of trip distribution, and the results produced using the variable trip table were unstable. The Round 2 models were run using a fixed trip table (i.e., only iterating additional toll rates from mode choice through the assignment component). Using fixed trip tables is consistent with historical practices in the industry, and is reasonable for use in this study. However, this approach may underestimate the increase in travel demand and resulting congestion if MnPASS lanes were implemented.
- **System Connectivity.** Measures of travel demand were modeled based on entire systems that are more extensive than individual segments built separately. Modeling individual segments separately would produce different (probably lower) levels of travel demand.
- **Recreational Traffic.** Some facilities, such as I-94 between the Fish Lake interchange and Rogers have heavy traffic flows related to recreational traffic that occurs outside of the normal weekday pattern. These recreational travel patterns are not accounted for in the travel demand model. This means that corridors with high recreational usage may have higher demands than indicated in this report.
- **Enhanced Bus Services.** MnPASS lanes can provide enhanced bus or bus rapid transit service. We did not modify the bus networks to take full advantage of these potential synergies. Improved bus services could reduce the demand for paying toll traffic in the MnPASS lanes but provide a high level of service to transit users.
- **Traffic Operations Issues.** One of the most common causes of recurring congestion is bottlenecks caused by merges, diverges, and weaves, particularly around interchanges. The regional model does not take these conditions into account, and potentially underestimates the congestion and delay that might actually occur on the system.
- **Regional and Corridor Traffic Growth.** The traffic growth rates used in this study relate directly to those in the Metropolitan Council's travel demand model. We have not conducted an independent assessment of these growth rates, which would be critical for studies that rely on toll revenue to pay back bonds or loans.

- **Transportation Network Improvements.** Our analysis was conducted entirely on the basis of projects expected to be in place by 2013, in accord with the 10-year Comprehensive Work Program (CWP) in place at the time the study was done (fall/winter 2004). Alternative assumptions regarding transportation network improvements in the Twin Cities could change the traffic demand estimates in particular corridors. We also assumed that projects in the CWP could not be converted to MnPASS lanes. Some members of the Steering Committee would like to change that assumption, which would in turn change the results of the study.
- **Ramp Metering.** Access to most freeways in the Twin Cities metropolitan area is controlled by ramp metering, the intent of which is to optimize traffic flow. The MnPASS toll lanes rely on a speed differential with the general purpose lanes to provide the value for the money spent on the toll. The Metropolitan Council's travel demand model used in this MnPASS system study does not account for the effects of ramp meters. Changing the ramp metering algorithm or policy would affect freeway congestion levels and travel demand for MnPASS toll lanes.

4.7 Implications of Technical Findings

The findings of the Round 2 analysis were presented to the Technical Group and Steering Committee on January 28, 2005. These groups felt that there should be less emphasis on the immediate financial feasibility of individual segments or systems of segments, and more attention to an ultimate long-range system of MnPASS lanes in the Twin Cities region that would be built over time.

These two groups also felt that using financial payback criteria as a means of project selection was unusual in a metropolitan or statewide transportation planning context, since traditional highway projects do not contribute a revenue stream. Transit projects are different, in that they do generate revenue to help pay operating costs. Despite the finding that the MnPASS toll lane projects do not seem to be able to be self-supporting, the idea that they can pay back some of their capital costs (lane construction costs and MnPASS incremental costs), albeit at the 22 percent level on average, is actually much more than any other type of capacity project can produce.

Another way to look at the financial potential of the MnPASS system is to consider the ability of the system to cover the incremental cost of building MnPASS lanes over and above the cost of building the lanes as traditional (non-tolled) lanes. Of the $3.5 billion in construction cost to build Concept A from scratch, about $0.6 billion is attributable to the incremental cost of making these lanes ready for MnPASS. This is the cost of buffer zones, gantries, and system connections. This amount is just about covered by the estimated $0.7 billion in net toll revenue expected from the MnPASS lanes (over and above operating costs, and discounted). The implication of these numbers is that we would expect the toll revenue from MnPASS to cover the incremental cost of building

MnPASS, but would not provide significant dollars to the region's highway funding needs.

Because this study has shown that the financial benefits from MnPASS lanes are relatively small, the Technical Group and Steering Committee came to view MnPASS as a long-term traffic management solution rather than a way to accelerate projects through toll revenue financing. The revenue generating aspects of these projects were more of a side benefit. They also saw the potential long-range benefits of MnPASS to the Twin Cities' transit system.

With these findings and reactions in mind, the Round 2 results were used as a stepping stone to outline a broader vision of how the MnPASS concept could be integrated into the Twin Cities' long-term transportation system. This potential vision is described in the next section of this report.

5.0 Potential 2030 MnPASS Vision and Next Steps

5.1 Potential MnPASS Vision

In response to the Round 2 findings, the Technical Group and Steering Committee expressed the desire to plan an interconnected system of MnPASS lanes. The consultant team worked with the project committees to develop a map of MnPASS projects that might be developed over the next 25 years in the general timeframe of the current Transportation Policy Plan (TPP).

The proposed 2030 Vision Map is intended to show projects that would:

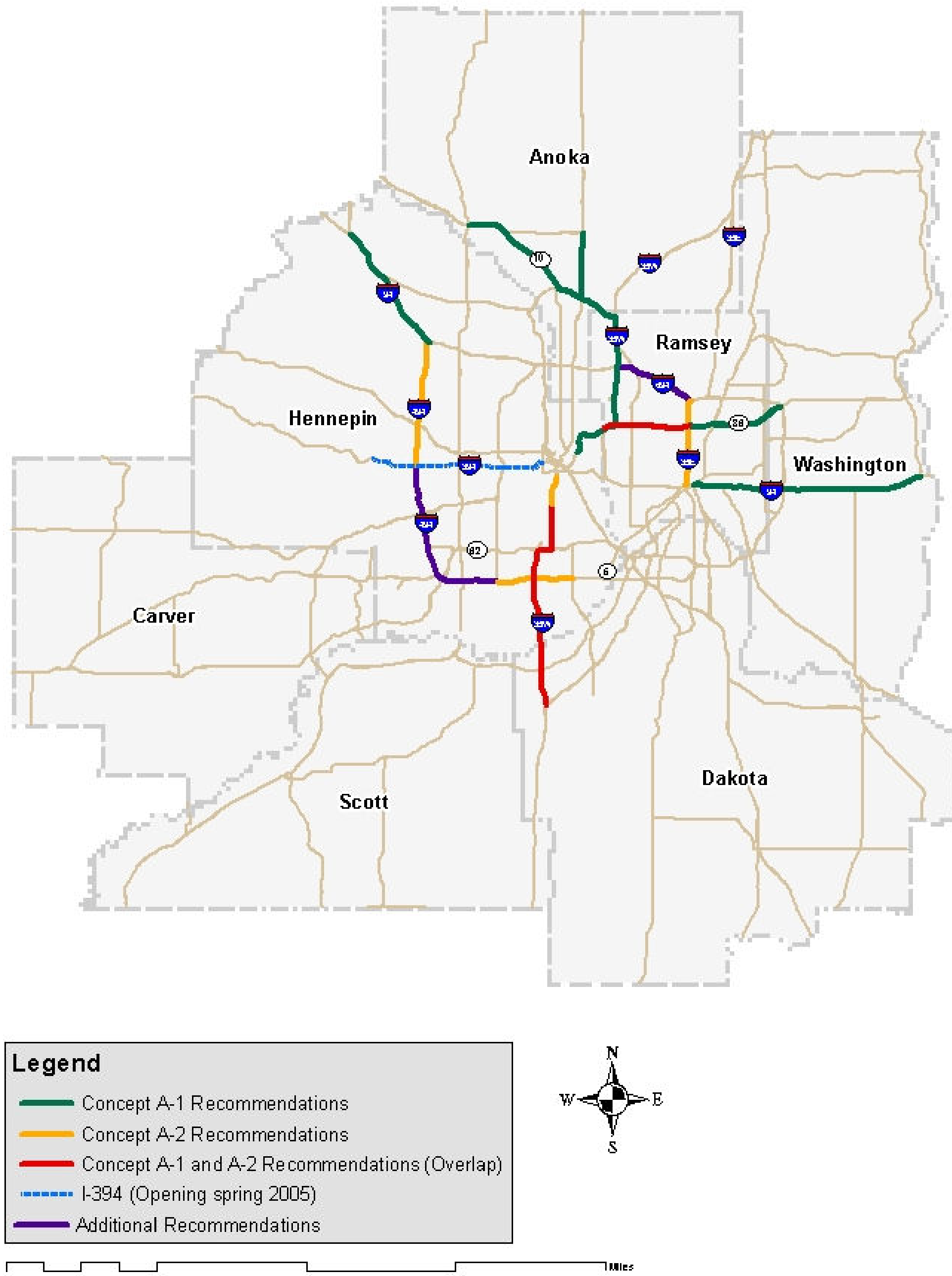
- Implement a portion of the current TPP as toll lanes, meaning all the projects shown in Concept A-2 in the previous section; and
- Implement other projects not yet in the TPP, but which were shown to be potentially viable; these are all of the projects that were included in Concept A-1, in addition to others that were not immediately recommended.

The Vision Map, shown in Figure 11, includes most of the projects that were in Concept A, with the exception of the segments of I-694 between I-494 and I-35W (segments 694-1 and 694-5). These two segments were not included because these sections were recently widened, and the need for additional improvement was not anticipated within the 25-year time horizon. Early in the study, the project committees agreed that no existing lanes could be converted to toll lanes, except for short segments needed for system continuity. However, not all members of the committees agree with this "rule."

The committees were also interested in pursuing a potential policy that would ensure any future capacity expansions are considered for MnPASS lanes. This means that potential projects that are not on the 2030 Vision Map might ultimately be developed as MnPASS lanes. For example, the eastern portion of the Beltway did not pass the initial screening exercise to become part of Concept A. This was primarily because the need for expansion of these segments was not anticipated within the forecast time horizon (2030). However, since Mn/DOT's goal is to make the entire beltway three lanes in each direction, there is no reason not to consider this ultimate expansion as MnPASS lanes when the time comes. The same might be true for the northern portion of the beltway between I-494 and I-35W.

The proposed 2030 Vision Map does not attempt to prioritize projects. It also does not distinguish between regular MnPASS lanes where all drivers pay and HOV lane conversions to HOT lanes. Certainly, the HOV lane conversions will need to address the issue of HOV definition if toll lanes are to be advanced on these corridors. Finally, this Vision Map does not presume that MnPASS lanes are the preferred or most cost-effective solution to congestion and mobility in the Twin Cities region.

Figure 11. Potential 2030 MnPASS Vision



Costs and Long-Term Revenue Potential of the 2030 Vision Map

To put the 2030 Vision Map in perspective, we developed an overall estimate of the costs and toll revenue potential of the projects on that map. We used the Concept A-2 view of considering costs, which results in a cost estimate over and above the costs already planned to be spent in the 2030 TPP. Table 14 shows the cost and revenue potential of each of the segments on the Vision Map.

Additional detail regarding the metrics associated with each of the segments, including costs, cost recovery ratio, funding gap, and other issues related to MnPASS development is provided in Appendix D.

Overall, the cost of implementing MnPASS on these highway segments would be $2,363.3 million. Assuming these projects were all built by 2008, the cost recovery ratio for this project set is forecast to be 31 percent, from a revenue stream whose present value is $656.2 million. It is important to note that the assumption of all projects being built by 2008 is strictly an analytical device that allows us to compare projects to one another on an even footing. In reality, these projects would be built over the cycle of the TPP, meaning that the actual revenue potential from a MnPASS system would be considerably less for the period of time indicated. However, projects developed later in the TPP cycle would have a life for purposes of analysis that extend beyond the 2030 timeframe. A more refined estimate of revenue over the life of the TPP would need to include some assumptions regarding the phasing of projects over time.

In addition to revenue potential, the MnPASS system shown in the Vision map would be expected to generate other benefits, such as opportunities for improved transit service, improved reliability, reduced air pollutants, and the value of offering drivers an uncongested travel choice. Although not quantified in this study, these characteristics would also provide great benefits to the Twin Cities.

Table 14. Potential 2030 MnPASS Vision Financial Analysis, Concept A-2 Costs

Segment	Net Revenue (2004$M)		PV of Net Revenue Stream (2004$M)	Capital Cost (2004$M)	PV of Capital Cost (2004$M)	Cost Recovery Ratio	Funding Gap (2004 $M)	Average Daily Speed Savings in 2030 (Build versus No-Build) (mph)
	2010	2030	2008-2030					
I-494-a	$1.6	$2.8	$27.2	$34.7	$31.5	86%	$4.3	4.3
I-494-b	0.2	0.9	6.1	132.5	120.2	5%	114.1	2.2
I-494-c	3.0	6.2	55.2	265.6	240.8	23%	185.7	4.2
I-494-d	4.1	8.0	72.4	18.7	17.0	427%	-55.5	5.2
I-694-2	1.2	3.1	24.9	241.4	218.9	11%	194.0	4.2
I-94-e	0.6	2.3	16.5	115.5	104.7	16%	88.2	3.5
I-94-4	1.9	3.0	30.2	122.1	110.7	27%	80.5	13.2
I-94-5	1.2	2.3	21.5	105.4	95.6	23%	74.1	2.8
36-1	1.7	2.5	26.2	72.1	65.4	40%	39.2	5.2
36-g	2.5	4.4	42.0	172.6	156.5	27%	114.5	5.2
36-5	0.9	2.1	17.9	122.4	111.0	16%	93.1	7.3
I-35E-1	0.0	0.6	2.8	64.8	58.7	5%	55.9	3.5
I-35E-2	3.4	4.8	51.3	47.7	43.2	119%	-8.0	6.3
I-35W-1	-0.7	-1.6	-13.7	50.7	46.0	-30%	59.7	12.0
I-35W-2	0.0	-0.4	-1.9	3.0	2.7	-68%	4.6	-3.1
I-35W-3	-0.6	-1.6	-12.5	2.0	1.8	-684%	14.3	-8.4
I-35W-8	-1.0	-2.0	-18.0	2.0	1.8	-983%	19.8	6.9
I-35W-f	2.4	2.9	34.2	140.0	127.0	27%	92.7	3.8
I-35W-6	2.1	3.4	34.1	159.7	144.8	24%	110.7	3.9
I-35W-7	3.2	5.0	50.9	126.2	114.4	44%	63.5	3.2
10-1	4.4	7.0	70.9	141.4	128.2	55%	57.4	6.4
10-2	1.3	2.2	21.7	15.3	13.9	156%	-7.8	6.2
10-3	0.9	2.3	18.5	51.8	47.0	39%	28.5	4.0
65	2.6	5.3	47.4	155.6	141.1	34%	93.7	6.2
I-394-1	1.6	1.7	21.9	N/A	N/A	N/A	N/A	1.0
I-394-2	0.8	0.5	8.8	N/A	N/A	N/A	N/A	1.2
MnPASS Vision Total	**$39.3**	**$67.7**	**$656.2**	**$2,363.3**	**$2,143.0**	**31%**	**$1,486.8**	**3.7**

Notes: Real Discount Rate: 4%
Inflation Rate: 3%
PV = Present value of future cash flows, discounted to 2004.
Cost Recovery Ratio = PV of Net Revenue Stream/PV of Capital Cost.
Funding Gap = Net Present Value of discounted future costs minus revenue.

5.2 Potential Next Steps

The MnPASS System study has developed, at a planning level of analysis, two types of results. First, the study has shown the potential user benefits and financial implications of individual segments and several systems of MnPASS lanes. Second, the study has developed a proposed vision for a long-term (25-year) system of MnPASS lanes around the Twin Cities. The study has also provided a forum for various stakeholders to express their ideas about how the MnPASS system might actually be developed. A separate document related to overall policy recommendations has been drafted by the MnPASS System Study Steering Committee. If Mn/DOT chooses to move forward with implementing the MnPASS vision outlined above, numerous issues still remain to be addressed. The following is an outline of the potential next steps that Mn/DOT might pursue.

Demonstrate the MnPASS Concept

MnPASS represents a new way of building highway capacity. There are numerous questions relating to how the system would operate, the benefits it would generate, and the revenue it would raise. As a potential course of action to advance the MnPASS concept, we suggest closely monitoring the I-394 HOT lane conversion project, scheduled to open in the spring of 2005. This project will be the first in the country to have dynamically priced lanes with multiple on and off opportunities. Mn/DOT and the transportation community in general will learn much by watching and evaluating what happens here.

Mn/DOT should also consider:

- Conducting an analysis that compares the benefits and costs of the MnPASS approach to improving transportation system effectiveness to other potential approaches, such as traditional "free" lanes or dedicated BRT facilities. Such an analysis should more fully capture the user and societal benefits and costs of MnPASS, including quantifying the value of time savings, reliability, improved transit service, and improved air quality. Alternative discount rates and different values of time should be used to capture the uncertainties of benefits and costs in the analysis.
- Analyzing other toll-setting strategies, such as optimizing level of service in lieu of maximizing revenue.
- Evaluating the effect of a high-quality express bus system integrated with the MnPASS lanes, and determining the best way for transit to access these lanes. There is a tradeoff between the cost of building direct access ramps with the safety and congestion benefits from reducing transit and automobile weaving movements in the free lanes.

Corridor Case Study

It will also be instructive to conduct more focused analysis of one or two potential MnPASS corridors that Mn/DOT thinks it may like to advance in the next few years. This analysis could delve more deeply into issues such as:

- **Design standards.** There are numerous issues related to design standards, such as:
  - Treatment of entry and exit points to and from the toll lanes,
  - Distance between entry and exit points,
  - Distance between entry and exit points and general purpose lane interchanges, and
  - Width of buffer zones.
- **Access/exit options.** These include:
  - At grade connections between general purpose lanes and MnPASS lanes versus direct connections from major interchanges versus ramp meter bypasses,
  - Tradeoffs between MnPASS lanes being on the inside versus on the outside, and
  - Value versus cost of direct connections to other MnPASS lanes in the system.
  - Tradeoffs between a single lane in each direction, or two reversible lanes.
- **HOV policy.** For example, when and how changes to HOV policy should be considered.

A corridor case study might include:

- Detailed evaluation of corridor traffic patterns by time of day and day of week using data from the traffic management center.
- Independent assessment of overall growth forecasts for the corridor, HOV growth, effects of ramp metering, and peak spreading.
- Consideration of entry and exit patterns on the highway, and traffic patterns on roads that bring traffic to and take traffic from the highway.
- Consideration of the ultimate origins and destinations of travelers in the corridor.
- Development of a corridor simulation model to simulate current operational considerations, as well as conditions as they may be in the short-term and long-term future. Growth patterns might be extracted from the regional travel demand model, and the capability to address diversion from the project under different toll scenarios might be built in, allowing for the model to be used for both operational testing and revenue estimation.

- Testing of alternative configurations of entry/exit points using the simulation model.
- Comparisons to alternative system approaches (e.g., “free” lanes).

Address Institutional Issues

Moving forward with MnPASS will require answers to numerous institutional questions. For example:

- What role should the private sector play in developing and/or operating these toll lanes?
- How will MnPASS lanes be financed, if the toll revenues are not sufficient to cover capital costs?
- How do these findings relate to Mn/DOT’s desire to issue a Request for Proposals for Partners (RFPP) to continue the development of MnPASS lanes?
- How should Mn/DOT and the Metropolitan Council modify their project development process to incorporate MnPASS?
- How should Mn/DOT treat revenue from MnPASS lanes? What are valid uses of these funds?
- How should future MnPASS lanes be integrated with policies in place for the current I-394 MnPASS conversion, particularly for HOVs?

Answering these questions will help Mn/DOT to develop the proper strategies, standards, and policies necessary to move forward with the MnPASS program.