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.