9.8 TRAFFIC OPERATIONS REPORT

CENTRAL CORRIDOR TRANSIT STUDY

TRAFFIC OPERATIONS REPORT

Draft

Prepared For:
Ramsey County Rail Authority

Prepared By:
URS/BRW

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EXECUTIVE SUMMARY

Introduction

This report is a supporting document to the Draft Environmental Impact Statement (EIS) for the Ramsey County Railroad Authority (RCRRA) Central Corridor Transit Study in Minneapolis and St. Paul, Minnesota. This report provides traffic operations analysis results and recommendations for the transportation engineering improvements within the Central Corridor study area.

Background

This Traffic Operations Report inventories the existing transportation conditions in the Central Corridor and the potential transportation impacts of the proposed alternative Light Rail Transit (LRT) or Bus Rapid Transit (BRT) alignments. This analysis process includes the following:

- A review of the existing roadway system in the Central Corridor, along with all planned or programmed improvements and developments.
- Assessments of the need for improvements at grade crossings of the surface streets at selected locations to maintain an acceptable level of service (LOS), including the potential for grade separation.
- A roadway segment and intersection LOS impact analyses for select street segments and intersections that may be impacted by the proposed LRT or BRT alignments.
- An assessment of the potential impacts to the supporting transportation network, including an analysis of station area traffic impacts.

A Traffic Analysis Committee was organized in order to utilize the vast expertise from the agencies impacted by the project. The Committee also provided the agencies with the opportunity to participate in developing the traffic analysis methodology, to provide input into the assumptions made that were necessary to complete the traffic analysis, and to provide reaction to the analysis results.

Methodology and Assumptions

Four conditions were considered in the traffic analysis for the Central Corridor project:

- **Existing Condition**– documents the traffic operations as it exists in the year 2001
- **Baseline Year 2020 Condition**– includes programmed and planned improvements and forecasted background growth in population, employment, and traffic
- **Build BRT Year 2020 Alternative Condition**– in addition to the BRT alignment, this alternative includes the baseline improvements and forecasted growth in population, employment, and traffic volumes
- **Build LRT Year 2020 Alternative Condition**– in addition to the LRT alignment, this alternative includes the baseline improvements and forecasted growth in population, employment, and traffic volumes

Some of the key methodologies and assumptions established in the traffic operations report include:

- Both macroscopic and microscopic analyses were utilized for this study, including a detailed microscopic analysis of the most controversial area of the corridor.
- The traffic operations report included both an evaluation of at-grade roadway crossings of transit facilities and of roadway segments and intersections.
- A single peak hour from 4:30 to 5:30 PM was selected for analysis.
- Existing volumes and other data was field collected.
- Forecast volumes were developed for the Baseline and Build conditions by using the existing intersection turn movement counts, an applied growth rate, and adjustments for any significant changes to the roadway alignment due to the BRT or LRT alignments.
- Signal timing and phasing was spot optimized for both the Baseline and Build conditions and all parallel left-turn movements to the alignment were assumed to require exclusive left-turn phases.
- Three different model software programs were utilized in conducting the traffic analysis: Synchro5.0 (macroscopic analysis), SimTraffic5.0 (microscopic analysis), and Vissim3.5 (detailed microscopic).
- The transit operations assumed 16 light rail vehicles or 30 buses during the peak travel periods, which would operate with the signals, not by priority timing.
- The proposed station areas along the Central Corridor for both BRT and LRT are expected to produce a minimal amount of new traffic because no parking facilities are provided.

The results for each condition evaluated included a threshold level for the at-grade crossing analysis, a level of service for the roadways segment analysis, the overall intersections analysis and the individual intersection movement analysis, and an identification of the relationship between the queue length and the storage length of an intersection movement for the queue analysis.

The following standards were applied when conducting the traffic analysis in this report to determine if an impact or deficiency will occur for a roadway segment, an intersection, an intersection movement, or a queue length, and if the deficiency warrants the need to consider a roadway improvement or a mitigation measure.

- Grade crossings reported at threshold Level 3 should be mitigated, and transit grade crossings at Level 4 should be grade separated.
- Roadway segments reported to be operating at a LOS E or F.
- Overall intersections reported to be operating at a LOS E or F.
- Intersection movements reported to be operating at a LOS E or F, unless the movement has a low volume or is not expected to impact the overall intersection operations.
- Queue lengths that exceed storage lengths, unless the queue length exceeds the storage length by only a short distance or if the queue diminishes (clears out) regularly throughout the peak hour and the movement is not expected to significantly disrupt upstream traffic.
- The mitigation applied for overall intersections or intersection movements reported at LOS E or F as a result of increased traffic volumes due to the project would only be responsible to return the LOS back to the existing (background) traffic conditions.

Grade Separation Analysis Results

A grade separation analysis was conducted for the Existing and Build conditions in order to measure the impacts associated with forecasted traffic growth and geometric changes due to implementing rail or bus transit technologies. A summary of the results of the grade separation analysis for each of the four conditions analyzed is provided in **Table 1**.

Table 1: Summary of Grade Separation Analysis Results

Map Ref No.	Roadway	From	To	Existing Condition LRT Threshold #[1]	Existing Condition BRT Threshold #[1]	Build Condition LRT Threshold #[1]	Build Condition BRT Threshold #[1]
1	Hennepin Ave [2]	6th St S	4th St S	2	2	3	3
3	5th Ave S [2]	6th St S	4th St S	2	3	3	3
6	Malcolm Ave	Orlin Ave SE	4th St SE	1	1	1	1
7	Eustis Ave	Territorial Rd	Franklin Ave	2	2	2	2
8	Cromwell Ave	Territorial Rd	Franklin Ave	2	3	3	3
10	Raymond Ave	Territorial Rd	Wabash Ave	2	2	2	3
11	Fairview Ave	Thomas Ave	Shields Ave	1	2	1	2
14	Snelling Ave	Thomas Ave	Shields Ave	2	3	3	3
17	Hamline Ave	Thomas Ave	St. Anthony Ave	1	2	1	2
18	Lexington Pkwy	Thomas Ave	St. Anthony Ave	2	3	2	3
20	Dale St	Thomas Ave	St. Anthony Ave	2	2	2	3
21	Marion St	Thomas Ave	St. Anthony Ave	2	2	2	2
22	Rice St	Como Ave	John Ireland Blvd	2	2	2	2
24	Robert St	Capitol Heights	Columbus Ave	2	2	2	2
25	12th St E	St. Peter St	Jackson St	2	2	2	3
26	11th St E	St. Peter St	Jackson St	2	2	2	2
27	7th St	St. Peter St	Jackson St	2	2	2	2
28	6th St	St. Peter St	Jackson St	1	2	2	2
29	5th St	St. Peter St	Jackson St	1	2	2	2
31	Robert St	5th Street	Kellogg Blvd	1	2	1	2
32	Jackson St	5th Street	Kellogg Blvd	2	2	2	2

Source: Light Rail Transit Grade Separation Guidelines, ITE Journal 1993

[1] Threshold number is based on the transit vehicle exposure to traffic

[2] Data collected from SRF Consulting Group, April 2000.

Roadway Segment Analysis Results

Roadway segment analysis was conducted for the Existing, Baseline and Build BRT and LRT conditions. A summary of the results of the roadway segment analysis for each of the four conditions analyzed is included in **Table 2**.

Table 2: Summary of Roadway Segment Analysis Results

Map Ref. No.	Facility	Segment	Existing LOS	Baseline LOS	Build Condition BRT LOS	Build Condition LRT LOS
A	5th St	3rd Ave N to Park Ave [1]	C	F	F	F
B	4th St	Chicago Ave and Washington Ave Bridge	C	C	C	C
C	Washington Ave Bridge	4th St and Pleasant St Ramps	D	D	D	F
D	Washington Ave	Pleasant St Ramps and University Ave	D	D	D	D
E	University Ave	Washington Ave and Highway 280	D	D	D	D
F	University Ave	Highway 280 and Snelling Ave	D	D	D	D
G	University Ave	Snelling Ave and Lexington Ave	D	D	D	D
H	University Ave	Lexington Ave and Dale St	D	D	D	D
I	University Ave	Dale St and Rice St	D	E	E	E
J	University Ave	Rice St and Robert St	D	D	D	F
K	Robert St	University Ave and Columbus Ave	C	C	C	D
L	Columbus Ave	Robert St and Cedar Ave	C	C	C	C
M	Cedar Ave	11th St and 4th St	C	C	C	E
N	4th St	Cedar Ave and Sibley Ave	C	C	C	D

Source: Florida Department of Transportation Level of Service Handbook 1998 and URS Corp. 2001.
[1] Data collected from SRF Consulting Group, April 2000.

Intersection Analysis Results

Intersection capacity analysis was conducted for the Existing, Baseline and Build BRT and LRT conditions. A summary of the results for the PM peak hour intersection capacity analysis for each of the four conditions analyzed is provided in **Table 3**.

Table 3: Summary of PM Peak Hour Intersection Level of Service Analysis

Map Ref No.	Intersection	Existing LOS	Baseline LOS	Build Condition BRT LOS	Build Condition LRT LOS
1	Hennepin Avenue / 5th Street South	B	E	E	E
2	Marquette Avenue / 5th Street South	B	E	E	D [2]
3	5th Avenue South / 5th Street South	A	A	A	A
4	Washington Avenue / Church Street	B	B	B	B
5	29th Street / University Avenue	A	A	A	A
6	Malcolm Avenue / University Avenue	B	B	B	E [3]
7	Hwy 280 SB (Eustis Ave) / University Avenue	D	D	F [4]	F [4]
8	Hwy 280 NB (Cromwell Ave) / University Avenue	C	C	C	C
9	Franklin Avenue / University Avenue	B	B	A [4]	A [4]
10	Raymond Avenue / University Avenue	E	F	F	F
11	Fairview Avenue / University Avenue	B	C	E	E
12	Aldine Street / University Avenue	B	B	F [4]	F [4]
13	Fry Street / University Avenue	A	A	E [4]	E [4]
14	Snelling Avenue / University Avenue	C	D	E [1]	E [1]
15	Pascal Avenue / University Avenue	C	B	C	C
16	Albert Street / University Avenue	A	B	B	B
17	Hamline Avenue / University Avenue	C	C	E [4]	E [4]
18	Lexington Parkway / University Avenue	D	E	F [1]	F [1]
19	Victoria Street / University Avenue	B	C	C	C
20	Dale Street / University Avenue	D	F	F	F
21	Marion Street / University Avenue	C	E	F [4]	F [4]
22	Rice Street / University Avenue	D	F	F [1]	F [1]
23	Constitution Avenue / University Avenue	B	C	F [4]	F [4]
24	Robert Street / University Avenue	B	B	B	F [6]
25	12th Street / Cedar Avenue	B	B	B	C
26	11th Street / Cedar Avenue	B	B	B	D
27	7th Street / Cedar Avenue	B	B	B	F [6]
28	6th Street / Cedar Avenue	B	B	B	D
29	5th Street / Cedar Avenue	B	A	A	F [6]
30	Cedar Avenue / 4th Street	A	A	A	A
31	Robert Street / 4th Street	B	B	B	A
32	Minnesota Street / 4th Street	A	B	B	B
33	Jackson Street / 4th Street	B	C	C	C
34	Sibley Avenue / 4th Street	B	B	B	B

[1] These intersections have a significant impact on the operations of the adjacent intersection. Mitigation measures at these intersections may result in considerable improvements to the adjacent intersections.

[2] Build condition reported improved from Baseline condition due to removal or restricted turn movements.

[3] No exclusive left-turn lanes were provided, thus split phase timing was required for the Build condition.

[4] Intersection impacted by poor operations and queuing at adjacent intersection potentially resulting in improved level of service reported due to the inability of vehicles to access the intersection.

[5] Intersection signalized for Existing and Baseline conditions, but unsignalized for Build Condition.

[6] Intersection operations reduced due to turn movements across LRT tracks.

[7] Intersection unsignalized for the Existing, Baseline and Build BRT condition; signalized for the Build LRT condition.

Potential Roadway Improvements and Mitigation Measures

The purpose of this section is to identify potential roadway improvements and mitigation measures that could be made through roadway construction or through modifying the signal system that would improve the intersection level of service, intersection movement level of service, or the queue lengths to acceptable. A list of improvements was developed with the help of the Traffic Analysis Committee to include in the Draft EIS text as a general list to address traffic related impacts.

- Modify Signal Operations
- Far Side Intersection Bus Stops
- Limit Development Trips
- Increase Turn Bay Lengths
- Add Cross-Street Lanes
- Add Mainline Turn Lanes
- Divert Trips
- Improve Parallel Roadways
- Reduce Access Locations
- Add Mainline Through Lanes

Not only could each of the improvements discussed above be evaluated independently to determine the impact at a location, but the treatments could also be applied concurrently to gain additional benefits.

One potential mitigation measure not discussed in the above section would be to grade-separate roadways creating an interchange. Due to the cost and construction impacts to grade separate roadways, especially in a built out area, this mitigation measure should only be considered for traffic impact reasons if all of the other improvements discussed above are not expected to improve conditions to an adequate level of operation.

INTRODUCTION

This report is a supporting document to the Draft Environmental Impact Statement (EIS) for the Ramsey County Railroad Authority (RCRRA) Central Corridor Transit Study in Minneapolis and St. Paul, Minnesota. The EIS documents the impacts of incorporating either Light Rail Transit (LRT) or Bus Rapid Transit (BRT) in the core of the Twin Cities area, specifically connecting the two central business districts (CBD) of Minneapolis and St. Paul. This report provides traffic operations analysis results and recommendations for the transportation engineering improvements within the Central Corridor study area.

The report is based on field surveys and traffic operational analysis along the corridor. The report documents Level of Service (LOS) at intersections and roadways for base year and future year conditions, under various build LRT or BRT and "Baseline" scenarios. The LOS analysis was performed at a macroscopic level for intersections and roadways and further analyzed at a microscopic level at specific locations involving LRT and BRT. In addition, this report documents a planning level analysis of the feasibility of at-grade crossings at select locations.

The Traffic Operations Report is divided into six main sections, namely: Background; Methodology and Assumptions; Existing Conditions Results; Baseline Conditions Results; Build Conditions Results; and Potential Roadway Improvements and Mitigation Measures. The Background and Methodology and Assumptions sections document the non-analytical information to assist the reader in interpreting the analysis. The Existing, Baseline and Build Condition Results sections provide a summary of the results of the analysis conducted. Finally, the Potential Roadway Improvements and Mitigation Measures section includes a discussion of potential mitigation measures to be analyzed as a part of the Final EIS project.

BACKGROUND

Overview

At-grade highway crossings of rail facilities known as grade crossings or highway-rail intersections are subject to operational concerns with respect to interference between roadway and fixed guideway traffic. These concerns include delay impacts to vehicular traffic due to activation of railroad warning systems and occupancy of the grade crossing by trains, secondary traffic operational impacts such as disruption of traffic signals by rail preemption, and safety concerns, either due to violation of traffic control devices or by queuing of highway vehicles in the grade crossing area. Additionally, although the fixed guideway modes have the right-of-way at grade crossings, to the extent that traffic operational problems develop, the transit operating speeds may be affected. In addition, strategies utilized to manage conflicts and improve safety at LRT or BRT-type grade crossings may result in measurable delays to the rail operations plan.

For these reasons, careful consideration should be given to the design issues including the physical configuration of the grade crossing as well as traffic and train control equipment and operational strategies. An integrated approach that includes a combination of warning and control will provide the best solution. The best solution is one that maximizes safety while balancing delay and operational impacts.

To define the potential impacts of the LRT or BRT system in the Twin Cities metropolitan area, an extensive evaluation of existing and future traffic operations was conducted. The results of this analysis provide valuable insight into the areas where the fixed guideway system provides the best ability to increase mobility and reduce traffic delay.

Traffic Analysis Committee

A Traffic Analysis Committee was organized as a part of the Draft EIS development. The Committee was formed by the project team in order to utilize the vast expertise from the agencies impacted by the project throughout the Draft EIS process. The Committee also provided the agencies with the opportunity to participate in developing the traffic analysis methodology, to provide input into the assumptions made that were necessary to complete the traffic analysis, and to provide reaction to the analysis results. The agencies invited to participate in the Traffic Analysis Committee Meetings included:

- Ramsey County
- Hennepin County
- Mn/DOT
- Metropolitan Council
- City of St. Paul
- City of Minneapolis
- University of Minnesota
- Ramsey County Railroad Authority

A series of three meetings were held by the project team during the course of the Draft EIS process, during which the above agencies participated and consented to many critical decisions related to the traffic analysis. At the first meeting, the Committee helped establish the analysis methodology including the intersections to be analyzed, the time period during which to analyze, the data to be collected, the software to be used, and other important analysis assumptions. In addition, the Committee provided a list of concerns to keep in consideration while conducting the analysis.

At the second meeting, the Committee reviewed the existing condition analysis results and provided direction on areas to make revisions in order to calibrate the analysis so as to obtain results that match the real life existing traffic conditions. In addition, at the second meeting the Committee helped establish the forecast condition analysis assumptions.

At the third and final meeting held during the Draft EIS process, the Committee reviewed the revised existing conditions analysis results and the forecast condition analysis results. In addition, the Committee participated in developing a list of potential mitigation measures associated with the project findings of traffic impact.

Purpose of the Study

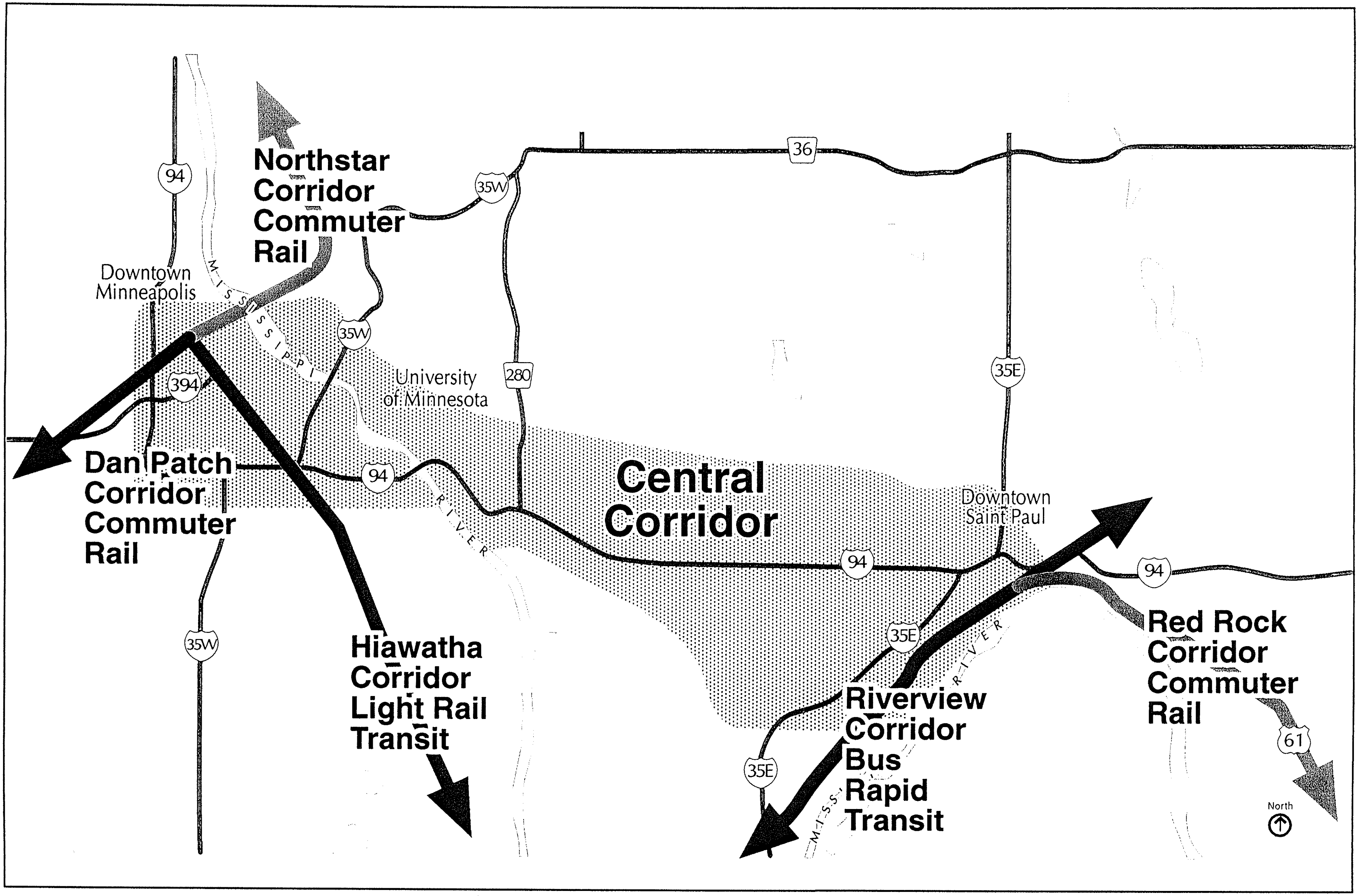
This Traffic Operations Report inventories the existing transportation conditions in the Central Corridor and the potential transportation impacts of the proposed alternative Light Rail Transit (LRT) or Bus Rapid Transit (BRT) alignments. This analysis process includes the following:

- A review of the existing roadway system in the Central Corridor, along with all planned or programmed improvements and developments.
- Assessments of the need for improvements at grade crossings of the surface streets at selected locations to maintain an acceptable level of service (LOS), including the potential for grade separation.
- A roadway segment and intersection LOS impact analyses for select street segments and intersections that may be impacted by the proposed LRT/BRT alignments.
- An assessment of the potential impacts to the supporting transportation network, including an analysis of station area traffic impacts.

Grade crossings, roadway segments, and intersections perceived to be impacted by the proposed LRT/BRT alternatives in the Corridor were chosen for analysis. Various grade crossing locations with high roadway volumes may be candidates for special treatments to manage safety and mobility conflicts between vehicular traffic and the proposed fixed guideway transit alternatives. In addition, roadway segments were analyzed to measure their respective operating characteristics. Finally, key intersections near the LRT or BRT alignments were chosen for analysis to assess the impacts of the alternatives to the traffic stream characteristics. The analysis of the roadway infrastructure and operations can be expected to assess most potential impacts that the proposed alternatives may create when introduced in the Central Corridor.

Study Area

The Central Corridor study area is an 11-mile corridor extending between Minneapolis and Saint Paul, Minnesota on the west and east, and bounded by the Burlington Northern-Santa Fe (BNSF) Northern Mainline and the Canadian Pacific Railroad (CP Railway) Shortline Railroad on the north and south. The proposed Central Corridor is the heart of the Twin Cities and connects the central business districts (CBD) of Minneapolis and St. Paul, and the University of Minnesota, and serves the transit-dependent population located within the study area. The location of this corridor, the "backbone" of the existing transportation system, is highlighted in **Figure 1**.



THE CENTRAL CORRIDOR

Study Area

April 2002 *revised May 2002*

Figure 1

Description of LRT and BRT Alignments

Overall, the LRT and BRT alignments are similar through much of the corridor, though their operating characteristics are different in the two downtown areas and in the University of Minnesota campus area. In these areas, it is proposed that the BRT system would operate within the mix of vehicular traffic, instead of in its own right-of-way, similar to that of the existing bus system. In addition, the LRT alignment through the university campus area will be tunneled, which is expected to have minimal impacts on the local traffic network after construction is completed. In general, on University Avenue, both alternatives would primarily operate in an exclusive guideway down the center of University Avenue. Both alternatives would include all facilities associated with the construction and operations of the system, including right-of-way, structures, and stations, as well as BRT and LRT, feeder bus, and rail operating plans.

Existing Roadway System

The existing roadway system in the study area includes limited access roadways, principal and minor arterial streets, collector streets, and local streets. Limited-access roadways, such as the interstate system, are physically separated from the surface street system and include grade-separated crossings of the surface streets. These roadways, such as Interstate 94, provide both inter-city and regional travel. Access to the street network is provided via interchange ramps, typically at principal or minor arterial roadways. Principal arterials, such as University Avenue, accommodate trips across the region and typically include at-grade intersections with other surface streets. Minor arterial streets supply access to sub-regions. Collector streets connect local and residential streets with either principal or minor arterial roadways, while local streets provide access to individual residences or businesses.

Safety Considerations at Grade Crossings

The principal traffic safety consideration at a grade crossing is to avoid collisions between trains and highway vehicles. An additional consideration is limiting secondary accidents that may involve only the roadway vehicular mode as a result of train activity or activation of the grade crossing warning system (similar to the concern with rear end type accidents, which occur at red traffic signals).

The primary safety concern is met if clear warning and positive traffic control is provided and if drivers do not violate the established safety devices. Safety is enhanced if sight distance is available to roadway vehicles and train operators approaching the crossing. Where sight distance is limited, grade crossing warning and protective systems that typically include flashing lights, audible devices and automatic gates are essential to maintain safety. Setting aside the issues related to violations and enforcement, safety is also improved if provisions are taken to minimize the possibility that vehicles will become trapped on the tracks behind a queue of vehicles or waiting for gaps in traffic at a parallel roadway immediately downstream from the grade crossing. For this reason, traffic control devices and traffic design in the vicinity of the grade crossing needs to include provisions to limit queuing on the tracks and positively clear vehicles prior to the arrival of trains at the crossing.

A wide range of measures is available to keep the crossing clear, including:

- Roadway geometric features to provide vehicular storage downstream from the grade crossing;

- Roadway shoulders to provide a refuge area downstream from the crossing;
- Stop signs for frontage (parallel) roadway traffic at unsignalized intersections;
- Use of active warning devices;
- Use of "pre-signals" (traffic signals ahead of the grade crossing which turn red prior to downstream traffic signals);
- Use of "queue cutters" (traffic signals ahead of the grade crossing which break the traffic flow into platoons which can clear the tracks);
- Use of "metering" of traffic from upstream traffic signals so that queuing on the tracks does not occur; and
- Preemption of downstream traffic signals to provide track clearance phases.

Mobility Considerations at Grade Crossings

Total vehicular delay accrues to each vehicle queued up while the grade crossing is blocked and continues to accrue until all of the vehicles in the queue have regained the initial travel speed.

For fixed-guideway type (LRT or BRT) at-grade crossings, given the relatively small blocking times per transit vehicle, the total hourly impact of the crossing closure will typically be far less than the delay which occurs at signalized intersections along the cross street upstream and downstream from the grade crossing.

The anticipated LRT operating plan can be up to 16 trains per hour. With about 35 seconds gate blocking per train, the hourly Volume/Capacity impact at the grade crossing would be 0.15, which equals an effective green time percentage of 85 percent. This can be compared to the typical maximum green time to total cycle time of 40 to 45 percent that is typically available to a major movement at a signalized intersection. Therefore, the hourly impacts to traffic at LRT grade crossings would be minimal.

In addition to the average hourly impact, additional traffic operational impacts can occur when grade crossing closures impact platoons of vehicles that are moving through a progressive, coordinated traffic signal system. A portion of the platoon may be cut off and vehicles may or may not be able to clear a downstream traffic signal in the green band when released from the grade crossing.

Additional impacts may occur if an adjacent traffic signal is preempted in conjunction with grade crossing gate activation. Preemption is provided so that a traffic signal can provide a "track clearance" phase that will display a green signal indication to assure that vehicles on the trackway at the time of activation can clear off the tracks prior to train arrival. In addition, preemption sequences ordinarily provide a "limited service" phase that allows non-conflicting roadway movements to continue during gate blocking and train passage. Although preemption can provide benefits to parallel roadways, the traffic signal is randomly pulled out of coordination and the disruption to flow may extend to several signal cycles after train passage.

Traffic Control Techniques

For locations which are not closed and for which grade separation is not warranted, a range of traffic control options are available, including:

- Passive Devices

- Flashing Light Devices
- Automatic Gates
- Traffic Signals
- Supplemental Passive Controls
- Supplemental Active Devices

Passive Devices

Passive devices consist of signage and pavement markings, such as the "cross bucks" sign, that consists of a white reflectorized background with the words "Railroad Crossing" in black lettering. Ordinarily, passive devices are not the sole forms of traffic control for LRT grade crossings. However, for certain low volume, low speed crossings, especially those which serve private roads and driveways for which there is no requirement for active devices such as flashing light devices and automatic gates, passive devices alone may be appropriate.

Flashing Light Devices

The flashing light device consists of two 12-inch diameter, round red light units, which flash alternately at a rate of 45 to 65 times per minute. Thus, like its predecessor the "wigwag" it simulates a watchman swinging a red lantern back and forth. A supplemental audible device, usually a bell, accompanies this device. Flashing light devices are typically aimed not at the cross street approaches, but at all other approaches to the grade crossing including frontage roads and major driveways, which discharge into the crossing area. When warranted for improved visibility, and conventionally for multi-lane highways, supplemental median mounted flashing light devices are used or the flashing light devices are mounted on a cantilever over the roadway with the devices directly aimed at approaching traffic lanes.

Flashing light devices are normally dark. When activated, a flashing light device has the same traffic status as a flashing red traffic signal – vehicles are required to stop ahead of the tracks but may legally proceed across if safe to do so prior to the arrival of a train. Flashing light devices do not preclude vehicles from crossing the tracks and in fact studies have indicated that traffic flow will commence after flashing light devices have been activated continuously for 30-40 seconds, if no trains are on imminent approach to the grade crossing. Therefore, activation circuitry should avoid long warning times.

Automatic Gates

Automatic gates provide a physical barrier that prevents vehicles from crossing the trackway and therefore are used when it is not desired to allow drivers to decide whether they may safely cross. Automatic gates are used when higher speeds are involved because it is hard for motorists to judge the speed of oncoming trains from a distance. Automatic gates are also used with higher speed cross street approaches due to the diminished sight distance typically associated with higher approach speeds.

Automatic gates are installed along with flashing light devices and bells – the flashing lights and bells will be activated for a few seconds before the gate arm begins to descend. Vehicles are not legally allowed to enter the trackway after the gate has begun descending.

Studies have shown that drivers will violate automatic gates that have been lowered for 60 seconds if no trains are on imminent approach by "driving around" the gates on the wrong side of the roadway. Therefore, it is important to avoid excessive lead times on gate activation. In order to limit violations of closed crossing gates.

Medians have been effective at discouraging drivers from attempting to evade lowered crossing gates. For problem locations, more sophisticated techniques such as photo enforcement have been successful. (Use of gates on the roadway departure legs, so called "four quadrant gates", is not standard practice in the United States at the present time, although demonstration projects are underway at a number of locations.)

An evolving standard is placement of automatic gates behind the sidewalk where present so that pedestrians are controlled in the quadrants where automatic gates are provided. Automatic pedestrian gates can be used either on all sidewalk approaches or on the quadrants not protected by vehicular gates if the vehicular gates are placed in a manner to control the sidewalks.

Locations which involve significant train speeds and highway traffic levels will ordinarily be provided with conventional Automatic Highway Crossing System (AHCS) equipment which would include train-activated automatic crossing gates, flashing light devices, and an audible device such as a bell. The initial activation will involve the bell and flashing lights; within three seconds, the automatic gate arm(s) will begin to descend. Within ten seconds, the crossing will be physically closed with the crossing gates in a level position.

The activation of the AHCS gear is required to be 20-25 seconds minimum prior to arrival of the train at the grade crossing. (Although additional warning time may be provided, experience has indicated that compliance with warning devices diminishes rapidly with excessive warning times.) At a grade crossing equipped with automatic gates, the flashing light device will be active for 3 seconds before the gates descend. The gates will be horizontal within ten seconds of the initial crossing gear activation. Roadway vehicles tend to scoot across the crossing as the gates begin to fall. Therefore, the roadway will be blocked for about 15 to 20 seconds prior to the train arrival.

The crossing will continue to be blocked during train passage. Currently the operations analysis shows that the LRT operation will entail using two-car trains. For this equipment consist, which is approximately 180 feet in length, the train passage time ranges from two seconds at 60 miles per hour operation to 5 seconds with 25 miles per hour operation. In addition, the crossing gate will not begin to ascend until after the train has cleared the track circuit ("island circuit") at the grade crossing, so an additional one to 3 seconds is required before the gates will begin to rise. Within 12 seconds the crossing gate will be fully vertical. Vehicles will also begin to enter the crossing before the gate arms have fully returned to the vertical position. Therefore, the effective net blockage per train is about 30 to 40 seconds with a two-car train as proposed in the transit operations plan.

At near side stations, if the crossing gates are activated as the train pulls into the station, additional gate blocking may occur if special provisions are not made to prevent lowering the gates while the train is on approach to or dwelling at the station. Various remedies including "constant warning time gates", delay timers, manual activation of gates and countdown timers for departure can be utilized to hold warning time close to the minimum.

Traffic Signals

Traffic signals can be used to control traffic at LRT grade crossings. At locations where the LRT trackage is on street, in an exclusive trackway between intersections it is typical to use traffic signals to control traffic on the cross streets.

Traffic signals may also be used to control traffic at low-speed LRT crossings in lieu of providing crossing gates. This application is particularly appropriate in urban street grids where traffic signals are prevalent. Similar issues to those which are encountered with automatic gates pertain if traffic signals are used to control traffic at grade crossings – since traffic signals must respect various minimum green, yellow and red times (sometimes including flashing don't walk time) on conflicting phases, even more time may be required to clear the crossing for the train movement.

Traffic Signal Coordination

On cross streets where signals are closely and/or regularly spaced in the vicinity of the grade crossing, use of coordination will result in vehicles traveling in "platoons" – groups of continuously flowing vehicles with no gaps in traffic. The size of the platoons will be dependent upon the traffic demand level and the amount of green time provided at each traffic signal – called the "green band". By establishing regularly spaced platoons of vehicles separated by much less dense flow, and by progressing the platoons down the roadway, the tendency for very long queues to develop that would potentially spill back across a grade crossing is reduced. Therefore, coordination can be used to improve safety at the grade crossings.

Traffic Signal Preemption

At locations where queues develop between grade crossings and adjacent traffic signals (either progressing across the trackway or spilling back from the tracks to the nearest cross street) it is recommended practice to "preempt" the adjacent traffic signal. Preemption provides a number of advantages that include the following. Primarily, vehicles, which may be queuing in the vicinity of the trackway or on the tracks at the time the train is on approach, can be positively cleared from the tracks. Secondly, during train passage, traffic phases across the tracks can be shut down and parallel, non-conflicting phases can be served. Traffic signal preemption is also a suitable means of serving LRT movements along segments where the LRT tracks are on street, in which case there may be no crossing gates involved.

Supplemental Passive Controls

Supplemental passive controls consist of pavement markings and signage that is used to provide supplementary regulatory or warning messages. Examples of supplemental regulatory signs include:

NO PASSING ZONE sign – used to prohibit use of grade crossing for passing maneuvers.

DO NOT STOP ON TRACKS sign – used to prohibit vehicles from queuing on tracks.

STOP HERE ON RED sign – used to designate stop bar location ahead of tracks.

Examples of supplemental warning devices include:

R X R advance warning sign – yellow circular sign.

Yellow warning sign for frontage road – indicating presence of tracks across cross street.

R X R advance pavement marking – white pavement marking between 2' white bars.

Supplemental Active Devices

Supplemental active devices typically consist of illuminated "blank out" message signs that provide additional regulatory or warning messages to be displayed in conjunction with activation of the primary traffic control devices.

Examples of supplemental active regulatory devices include:

RED RIGHT/LEFT TURN arrow – traffic signal indication displayed to hold traffic in turn bay on parallel roadway during activation of grade crossing devices for cross street.

NO RIGHT/LEFT TURN sign – blank out sign used to prohibit turns onto grade crossing from frontage roadway while grade crossing warning devices on cross street are activated (used with or without turn bay).

DO NOT STOP ON TRACKS sign – blank out sign used to prohibit vehicles from stopping on tracks when queues spill back from downstream location (usually activated by loop detectors).

Examples of supplemental active warning devices include:

TRAIN COMING sign – blank out sign used to warn of the additional risk of violating traffic control devices at grade crossing.

SECOND TRAIN COMING sign – blank out sign used near station areas to alert pedestrians to look both ways for trains.

DO NOT STOP ON TRACKS sign – blank out sign activated by queue detectors to warn vehicles not to stop on trackway.

METHODOLOGY AND ASSUMPTIONS

The purpose of this section is to identify the process followed in conducting the traffic analysis for the Draft EIS and to document the necessary assumptions used for conducting the analysis. The following assumptions were established with the support of the Traffic Analysis Committee for purposes of the traffic analysis conducted for the Draft EIS.

Analysis Scenarios

Four conditions were considered in the analysis of this 11-mile transportation corridor. First, the existing condition was inventoried in the Year 2001 in order to establish for the traffic operations, which could be calibrated and used to develop the future conditions. Second, a Baseline condition was considered, which is a 2020 forecast of traffic volumes that included all programmed improvements and reasonable planned enhancements to the existing transportation system. This condition estimated future conditions without any major capital investments in the Corridor, such as the fixed-guideway alternatives. Third and fourth, the Build condition considered two alternatives that were included in this study—a LRT alignment and a BRT alignment.

The four conditions are defined as follows:

- **Existing Condition**– documents the traffic operations as it exists in the year 2001
- **Baseline Year 2020 Condition**– includes programmed and planned improvements and forecasted background growth in population, employment, and traffic
- **Build BRT Year 2020 Alternative Condition**– in addition to the BRT alignment, this alternative includes the baseline improvements and forecasted growth in population, employment, and traffic volumes
- **Build LRT Year 2020 Alternative Condition**– in addition to the LRT alignment, this alternative includes the baseline improvements and forecasted growth in population, employment, and traffic volumes

Both the Project Management Team (PMT) and the Traffic Analysis Committee (TAC) approved the analysis conditions.

Level of Study Detail

Two levels of analysis detail were utilized for this study, specifically macroscopic and microscopic. Macroscopic analyses considers the traffic stream characteristics (flow, speed, and density) or platoons of vehicles. This type of evaluation incorporates analytical relationships to model the traffic flow. Microscopic analysis considers the characteristics, movements, and interactions between individual vehicles to model traffic flow. A detailed microscopic analysis was also included, which evaluates transit operations and provides a more thorough analysis of the corridor. The level of detail is higher for the microscopic analysis, as it is more data intensive and establishes more detailed relationships of the individual vehicle.

The complete evaluation of the corridor included a grade separation analysis, a roadway segment analysis and an intersection capacity analysis. A grade separation analysis was completed using the Institute of Transportation Engineers (ITE) Recommended Practice for threshold analysis at grade crossings. The roadway segment level of service analysis was developed using Florida Department of Transportation (FDOT) Level of Service (LOS) Guidelines. Both the FDOT and

ITE guidelines are considered macroscopic approaches. The intersection level of service analysis was developed using both macroscopic and microscopic analysis tools. Finally, to further analyze the incorporation of LRT at grade intersections, a detailed microscopic analysis was conducted in the Snelling Avenue and Lexington Avenue area. The methodologies of each of these analyses are described in this section of the Traffic Operations Report.

Grade Separation Crossings Studied

At-grade roadway crossings of transit facilities, known as grade crossings, are subject to operational concerns with respect to interference between roadway and transit (LRT and BRT) traffic. The Traffic Analysis Committee recognized the at-grade crossings that may impact the existing traffic or transit operations. The need for grade separation of an at-grade crossing was considered for the locations documented in **Table 4**.

Table 4: Grade Separation Analysis Locations

Map Reference No.	Roadway	From	To
1	Hennepin Avenue	6th Street S	4th Street S
3	5th Avenue South	6th Street S	4th Street S
6	Malcolm Avenue	Orlin Avenue SE	4th Street SE
7	Eustis Avenue	Territorial Rd	Franklin Ave
8	Cromwell Avenue	Territorial Rd	Franklin Ave
10	Raymond Avenue	Territorial Rd	Wabash Ave
11	Fairview Avenue	Thomas Ave	Shields Ave
14	Snelling Avenue	Thomas Ave	Shields Ave
17	Hamline Avenue	Thomas Ave	St. Anthony Ave
18	Lexington Parkway	Thomas Ave	St. Anthony Ave
20	Dale Street	Thomas Ave	St. Anthony Ave
21	Marion Street	Thomas Ave	St. Anthony Ave
22	Rice Street	Como Avenue	John Ireland Blvd
24	Robert Street	Capitol Heights	Columbus Ave
25	12th Street E	St. Peter St	Jackson St
26	11th Street E	St. Peter St	Jackson St
27	7th Street	St. Peter St	Jackson St
28	6th Street	St. Peter St	Jackson St
29	5th Street	St. Peter St	Jackson St
31	Robert Street	5th Street	Kellogg Blvd
32	Jackson Street	5th Street	Kellogg Blvd

As noted above, this analysis generally evaluates the location the BRT or LRT traverses the cross streets. The next section, the analysis of roadway segments, investigates the roadway system that operates directly adjacent to the transit alignment

Analysis Roadway Segments Studied

The Traffic Analysis Committee identified roadway segments for analysis based on whether the proposed alignments are located within the existing roadway system. The selected roadway segments are shown in the **Appendix Figures A1 through A11**. For each of the roadway segments chosen for this analysis, which covers the entire proposed alignments, the following information was collected:

- Roadway geometry (number of lanes)
- Estimated daily traffic capacity
- Average Daily Traffic (ADT)

The corridor was divided into segments to represent each unique area of the project with respects to the traffic operations and adjacent land uses. The segments selected and included in the analysis are listed in **Table 5** below:

Table 5: Analysis Segments

Segment Identification	Facility	Segment
A	5th Street	3rd Avenue North to Park Avenue
B	4th Street	Chicago Avenue to Cedar Avenue
C	Washington Avenue Bridge	Cedar Avenue to Pleasant Street ramps
D	Washington Avenue	Pleasant Street Ramps to University Avenue
E	University Avenue	Washington Avenue to Highway 280
F	University Avenue	Highway 280 to Snelling Avenue
G	University Avenue	Snelling Avenue to Lexington Avenue
H	University Avenue	Lexington Avenue to Dale Street
I	University Avenue	Dale Street to Rice Street
J	University Avenue	Rice Street to Robert Street
K	Robert Street	University Avenue to Columbus Avenue
L	Columbus Avenue	Robert Street to Cedar Avenue
M	Cedar Avenue	11th Street to 4th Street
N	4th Street	Cedar Avenue to Sibley Avenue

Analysis Intersections Studied

Key intersections along the project corridor were selected for analysis based on knowledge of the existing operations, the configuration of the project alignment, and anticipated impacts due to the project. The committee identified intersections, both signalized and unsignalized, significant to the operations of the roadway network that may be impacted by the proposed LRT or BRT alignments will operate. The intersections selected for the analysis are illustrated in **Appendix Figures A1 through A11** and listed in **Table 6**.

Table 6: Analysis Intersections

Int. No.	Intersection	Type of Analysis [1]
1	Hennepin Avenue / 5th Street South	Macroscopic
2	Marquette Avenue / 5th Street South	Macroscopic
3	5th Avenue South / 5th Street South	Macroscopic
4	Washington Avenue / Church Street	Microscopic
5	29th Street / University Avenue	Microscopic
6	Malcolm Avenue / University Avenue	Microscopic
7	Highway 280 Southbound (Eustis Avenue) / University Ave	Microscopic
8	Highway 280 Northbound (Cromwell Ave) / University Ave	Microscopic
9	Franklin Avenue / University Avenue	Microscopic
10	Raymond Avenue / University Avenue	Microscopic
11	Fairview Avenue / University Avenue	Detailed Microscopic
12	Aldine Street / University Avenue	Detailed Microscopic
13	Fry Street / University Avenue	Detailed Microscopic
14	Snelling Avenue / University Avenue	Detailed Microscopic
15	Pascal Avenue / University Avenue	Detailed Microscopic
16	Albert Street / University Avenue	Detailed Microscopic
17	Hamline Avenue / University Avenue	Detailed Microscopic
18	Lexington Parkway / University Avenue	Detailed Microscopic
19	Victoria Street / University Avenue	Detailed Microscopic
20	Dale Street / University Avenue	Microscopic
21	Marion Street / University Avenue	Microscopic
22	Rice Street / University Avenue	Microscopic
23	Constitution Avenue / University Avenue	Microscopic
24	Robert Street / University Avenue	Microscopic
25	12th Street / Cedar Avenue	Macroscopic
26	11th Street / Cedar Avenue	Macroscopic
27	7th Street / Cedar Avenue	Macroscopic
28	6th Street / Cedar Avenue	Macroscopic
29	5th Street / Cedar Avenue	Macroscopic
30	Cedar Avenue / 4th Street	Macroscopic
31	Robert Street / 4th Street	Macroscopic
32	Minnesota Street / 4th Street	Macroscopic
33	Jackson Street / 4th Street	Macroscopic
34	Sibley Avenue / 4th Street	Macroscopic

[1] Three different model software programs were utilized in conducting the traffic analysis as described in the *Model Software* section below.

Peak Hour

Based on the existing conditions along the corridor, the PM peak period was chosen for the analysis in order to accurately represent operations at adjacent intersections and simplify the analysis process for the Draft EIS. Typically, the PM peak period occurs between 4:00 PM and 6:00 PM. To complete the analysis, a single peak hour was selected for analysis for the entire corridor, from 4:30 to 5:30 PM. The peak hour is defined as a one-hour period during which the greatest number of vehicles enters into an individual intersection.

Traffic Volumes

Existing data was collected at all of the intersections identified in **Table 6**, including peak hour turning movement counts, roadway geometry, and signal timing. Project team personnel collected a majority of the volumes and geometry in the field during September and October of 2001. The downtown Minneapolis intersection volumes were obtained from the SRF Consulting Group report "Downtown Minneapolis Transportation Study" from April 2000 due to construction activities during the data collection effort. The downtown St. Paul intersection volumes were not collected until December of 2001 after the alignment around the Capitol Area and the downtown had been established. Signal timing data for each intersection was obtained from the respective operating agencies.

The existing condition intersection turn movement volumes are provided in the **Appendix Table A1**.

In addition, volume and roadway geometry data was collected at intersections adjacent to the corridor in order for input into the traffic analysis models. However, no analysis results were provided for these additional intersections.

Forecast volumes were developed for the Baseline and Build conditions. The forecast volumes were developed by using the existing intersection turn movement counts, an applied growth rate, and adjustments for any significant changes to the roadway alignment due to the BRT or LRT alignment. Development of the forecast volumes took into consideration the impacts due to proposed future developments along the corridor, the impact of revisions to the roadway geometry due to the project, and the effect on pedestrian volumes due to the project.

The resulting forecast Baseline and Build condition volumes are included in the **Appendix Table A1**.

Growth Rates

Different growth rates were established for three segments of the corridor: downtown Minneapolis, downtown St. Paul and the remainder of the corridor along University Avenue. The forecast volume percentages used along the corridor were based on information gathered to develop the ridership forecasts for the project using the Twin Cities Regional Travel Demand Model, from the Metropolitan Council.

- Downtown Minneapolis volumes were taken from the SRF Consulting Group report "Downtown Minneapolis Transportation Study" from April 2000, which assumed Hiawatha LRT operations along 5th Street for the Baseline condition. However, these forecast volumes provided in the report were for the Year 2010. Therefore, an average annual growth rate of 1.0 percent was applied to the volumes from Year 2010 to Year 2020 to develop the forecast volumes used for the future condition analyses.
- In downtown St. Paul, based on previous projects and at the direction of SRF, an average annual growth rate of 1.4 percent was applied to the existing volume counts to develop Year 2020 forecast volumes.
- Along University Avenue through the remainder of the project corridor, an average annual growth rate of 0.9 percent was applied to the existing volume counts to develop Year 2020 forecast volumes.

Proposed Corridor Adjacent Developments

There are proposed developments along the corridor, which could impact the future analysis conditions. However, due to lack of information on the size and status of the proposed developments at the time of the analysis, in combination with the growth rate assumed for the corridor, the proposed developments were assumed to be a part of the background growth in traffic. None of the known developments in the corridor are expected to generate a significant amount of new traffic.

Project Roadway Geometric Changes

As a part of the alignment for both the LRT and BRT alternatives, there are several proposed roadway geometry changes that will impact the forecast volumes. One signalized intersection is being removed (University Avenue at Albert Avenue), several signalized intersections are being added along the corridor, and many left-turn movements are being eliminated. However, the only adjustment to restricted movements was made for the westbound left-turn movement along University Avenue at the Albert Avenue intersection. These left-turn movements were reassigned to the intersections at Hamline Avenue (75%) and Pascal Avenue (25%) based on the existing traffic distribution in the area. No additional volume adjustments were made along the corridor for the following reasons:

- Along University Avenue where movements are being removed as a part of the project, opposing left-turn movements are being eliminated. The removal of these opposing movements was assumed to balance the impact to University Avenue.
- Since the land use along University Avenue is already mostly built-out, the variations in and additions to movements due to project-related closures were assumed to be accounted for by the future Background growth in traffic.
- A portion of the volume from the restricted movements were assumed to divert using alternative routes to parallel roadways, which were found to have adequate access.

Downtown St. Paul traffic volumes were diverted only for movements that are proposed to be eliminated due to the alignment for the Build conditions.

Pedestrian Forecast Volumes

Pedestrian forecast intersection volumes were developed in order to account for the general growth in pedestrians and to account for expected increases in pedestrians due to station locations along the corridor. The pedestrian volume growth rates were assumed to be consistent with the corresponding segment, as described above. However, an additional 30 percent growth in pedestrian volumes was assumed at intersections along the corridor where stations are proposed to be located, based on general ridership forecasts in the corridor.

Signal Timing

Signal timing and phasing was spot optimized for both the Baseline and Build conditions, including increasing cycle lengths and splits and adjusting offsets where necessary. In order to maintain a safe operation of either the LRT or BRT system, all parallel left-turn movements to the alignment were assumed to require exclusive left-turn phases for the Build conditions. The only location where the layouts did not include an exclusive left-turn lane along University Avenue was at the intersection with Malcolm Avenue. Therefore, the intersection of University Avenue and Malcolm Avenue was assumed to operate split-phased on University Avenue.

Model Software

Three different model software programs were utilized in conducting the traffic analysis. A macroscopic analysis using Synchro5.0 was conducted for the Downtown Minneapolis Area (3 intersections) and Downtown St. Paul Area (10 intersections) where select isolated intersections were analyzed out of a grid network system. A microscopic analysis using SimTraffic5.0 was conducted for the University of Minnesota Area (3 intersections), TH 280 Interchange Area (4 intersections), and Dale Street / State Capitol Area (5 intersections). In these locations, intersections were closely spaced and the operations at one intersection could impact the results at adjacent intersections.

A detailed microscopic analysis using Vissim3.5 was conducted for the Snelling Avenue / Lexington Parkway Area (9 intersections) to include the impact of buses and a more detailed account of the proposed transit operations. The Snelling Avenue / Lexington Parkway area roadway operations are a concern because of high traffic volumes and the regional significance of this area to the transportation network. Issues have been raised that the LRT or BRT crossings at Snelling Avenue and Lexington Parkway will need to be grade separated due to unacceptable intersection delays and queues when the new transit system is introduced. A microscopic traffic simulation analysis was completed for this area to assist in the decision making process in determining whether these crossings need to be grade separated. This type of traffic analysis considers the characteristics, movements, and interactions of individual vehicles. In addition, the Vissim software was the only analysis conducted that took into consideration bus or LRT routes and included additional pedestrian growth due to proposed project station locations.

Transit Operational Assumptions

The LRT and BRT vehicles were assumed would operate with the signals, <u>not</u> by priority timing. Priority timing for the transit vehicles could result in additional traffic delays depending on the signal timing parameters applied and the intersection signal controller system used. In most instances, the impact to traffic would be expected to be minimal; therefore, the impact will likely not be reflected in the level of service analysis. Because of the complexity of traffic operations and high density of traffic in an urbanized location such as the Central Corridor, priority signal timing could minimize the disruptions to the existing traffic network because it will not significantly impact the coordinated signal system. This could be addressed in future analyses.

The LRT operations plan assumed 16 trains per hour service during the peak travel periods. This operating plan equates to eight trains at 7.5-minute headway for each direction. It is assumed that each train will require 35 seconds to clear an intersection or grade crossing. The BRT operations plan assumed 30 buses per hour service, which equates to a headway of approximately 4-minutes in each direction. BRT is proposed to operate similar to the existing bus services in Downtown

Minneapolis, the University of Minnesota Campus, and Downtown St. Paul, as it will operate in the mix of vehicular traffic. In the remainder of the Corridor, the BRT system will be operating in its own right of way similar to the operations of the light rail vehicles, generally operating in the center of the street.

Station Locations

The proposed station areas along the Central Corridor for both BRT and LRT are expected to produce a minimal amount of new traffic because no parking facilities are provided. Overall, each station has limited opportunities for drop-and-ride facilities, so it is expected that most riders on the system would primarily access the Central Corridor BRT or LRT system through other transit mode transfers (i.e., bus, Hiawatha LRT) or by walking to a station. Due to the limited opportunities for parking or drop-off facilities, the amount of neighborhood "cut-through" traffic was expected to be minimal. For these reasons, a detailed traffic impact study was not completed at each station site because the traffic generated by the station sites through automobile access can be expected to be negligible.

Grade Separation Analysis

Grade crossing locations that have excessive interference between roadway traffic and transit vehicles or where traffic safety is significantly diminished due to adverse configuration of the grade crossing, it may be necessary to grade separate the two modes. Some of the concerns include: vehicular traffic delay due to the activation of railroad or bus warning systems; occupancy of the grade crossing by trains or buses; traffic operational impacts such as disruption of the traffic signal system; and safety concerns due to violation of traffic control devices or by queuing of roadway vehicles in the grade crossing area. Grade separations are used when other reasonable and effective traffic mitigation measures are not feasible and no physical, environmental, financial, or other constraints would preclude a grade separation system.

Intersections within the study area that may be affected by LRT or BRT were chosen by the TAC for analysis of the appropriateness of grade separation or other traffic control measures. The Institute of Transportation Engineers (ITE) threshold exposure methodology was used for this analysis, from "Light Rail Transit Grade Separation Guidelines" from the *ITE Journal, 1993.* The ITE methodology provides guidance for identifying crossings which are good candidates for grade separation based on density of highway traffic (vehicles per hour per lane) and gate activation (determined by the number of LRT trains per hour). This methodology provides four "threshold" levels representing increasing levels of interference between vehicular flow and rail traffic. They are interpreted as follows:

- **Threshold Level 1**: At-Grade Separation Is Feasible
- **Threshold Level 2**: At-Grade Separation Should Be Feasible
- **Threshold Level 3**: At-Grade Separation Possible with Delay to LRT Trains
- **Threshold Level 4**: May Require Grade Separation

The methodology is meant as a general guideline and not a hard and fast rule. There may be occasions in which a grade separation can be avoided, even with high levels of interference. For example, in congested urban areas where travel speeds are very low and where the travel time savings provided by a grade separation would not be significant. In addition, in other situations a grade separation may be highly desirable even if the quantitative threshold is not met.

At Level 2, and especially at Level 3, it is important to consider the design of the crossing activation system and traffic control devices, as well as the train operating and signaling circumstances, so that the grade crossing impacts can be mitigated even though a grade separation is not provided.

The following threshold numbers, which are a function of the level of exposure of the Light Rail Vehicle to traffic (See **Table 7**), aid in the determination of the feasibility of crossing the surface street system at-grade.

Table 7: Vehicular Traffic Exposure to Transit Vehicles at Grade Crossings

Threshold Levels	Threshold Definition	LRT Peak Hour Vehicles per Lane (# of vehicles)[1]	BRT Peak Hour Vehicles per Lane (# of vehicles)[2]
1	Light Rail at-grade is feasible	Less than 345	Less than 216
2	Light Rail at-grade should be feasible, though minimal delay may be expected	Less than 716	Less than 540
3	Possible traffic signal solutions if Light Rail vehicle delay is acceptable	Less than 1095	Less than 1025
4	At-grade crossing is probably not feasible	Greater than or equal to 1095	Greater than or equal to 1025

Source: Light Rail Transit Grade Separation Guidelines, ITE Journal 1993

[1] Based on the assumed operations plan of 16 light rail vehicles per hour

[2] Based on the assumed operations plan on 30 BRT vehicles per hour

Capacity Analysis

A capacity analysis is a process that estimates the quality of traffic flow along segments of roadway and intersections. The key factors affecting capacity includes: roadway geometry, traffic volumes, incidents, and intersection control.

Level of Service Definitions

The results of a capacity analysis are typically presented in the form of a letter grade (A through F) that provides a qualitative indication of the operational efficiency or effectiveness. In general, the LOS is a function of average delay or density of traffic at a given intersection or roadway segment. The letter grade assigned to the analysis is referred to as level of service (LOS). By definition, LOS A conditions represent high-quality operations (i.e., motorists experience very little delay or interference) while LOS F conditions represent failing operations (i.e., extreme delay or severe congestion).

LOS for roadway segments and intersections typically range from A to F and can be defined as:

- **LOS A** – represents virtually free flow of traffic with no congestion or delay.
- **LOS B** – represents stable traffic flow, but other vehicles in the flow are noticeable.
- **LOS C** – represents stable flow, but marks the beginning of the range where individual vehicles become significantly affected by interactions with other vehicles in the traffic stream.
- **LOS D** – represents high density of traffic but stable flow.

- **LOS E** – represents operating conditions at or near the capacity level. All speeds are reduced to a low but relatively uniform flow.
- **LOS F** – represents a breakdown in the operating conditions resulting in significant congestion and delay.

Roadway Segment Capacity Analysis

Using the information collected for the analysis segments, the resulting roadway segment level of service (LOS) was estimated. The segments were analyzed following the methodologies defined by the Florida Department of Transportation Level of Service Handbook. These methodologies, which are essentially an implementation adaptation of the HCM, establish a measure of effectiveness based on average travel speed on a given roadway segment.

Table 8, which was extracted for this analysis, is the basis for the LOS valuation given to the existing and forecasted roadway segment analysis. This table, referenced as Table 5-4 in the LOS Handbook, was developed for use on non-state roadways or major city/county roadways in urbanized areas.

Table 8: Average Daily Traffic Volume Thresholds for Roadway Segment LOS

Lane Geometries	Level of Service				
	A	B	C	D	E
2 – Undivided	N/A	N/A	8,600	14,600	16,000
4 – Divided	N/A	N/A	19,800	31,700	33,900
6 – Divided	N/A	N/A	30,800	47,800	51,000

Source: Florida DOT Level of Service Handbook 1998 and URS/BRW

Adjustment factors were applied to the AADT thresholds to take into consideration one-way roadway facilities, left-turn bays, and medians. One-way roadway facilities AADT were calculated by applying the equivalent two-way volumes and adjusting the indicators by 60% of the baseline volumes. Left-turn bays were also adjusted for, dependent on the roadway facilities and the existence of a median. The following adjustment factors were used when determining the representative LOS:

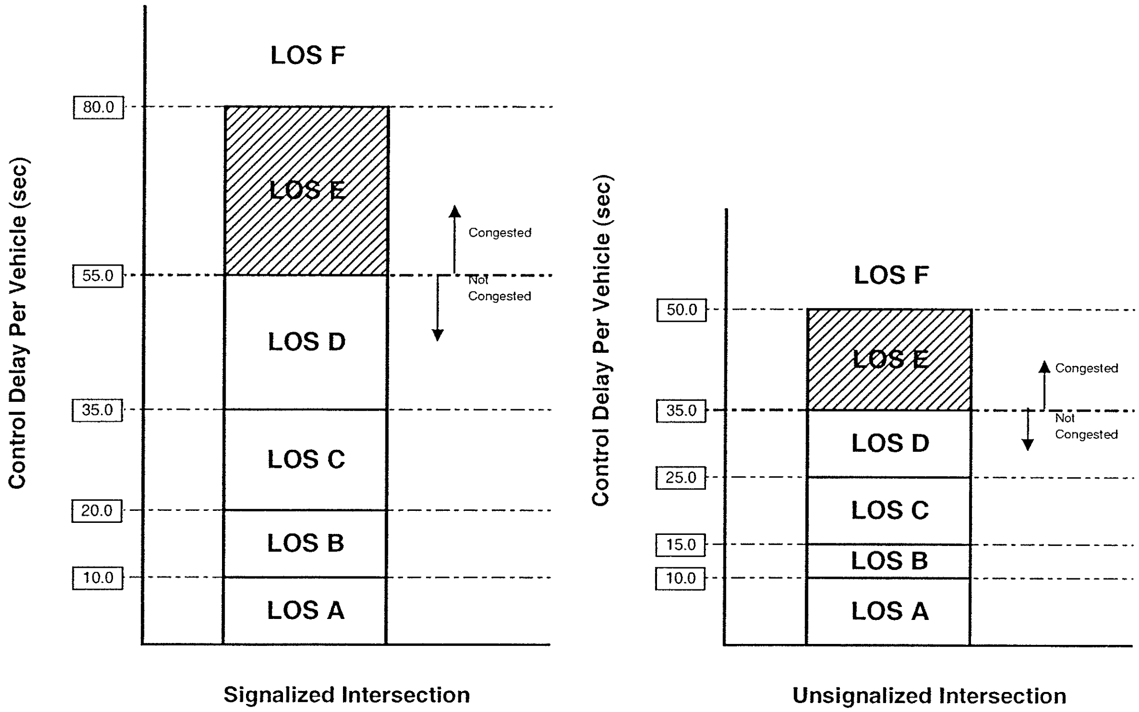
- 2-lane divided roadway with left-turn bays (+5 percent)
- 2-lane undivided roadway with no left-turn bays (-20 percent)
- Multi-lane undivided roadway with left-turn bays (-5 percent)
- Multi-lane undivided roadway with no left-turn bays (-25 percent)

Intersection Capacity Analysis

Using the information collected for the analysis intersections, the resulting intersection level of service (LOS) was estimated. Each movement (left turn, through, and right turn) at an intersection approach has a corresponding LOS grade. The overall intersection LOS is calculated by using a weighted average of the volumes and delay associated with each individual movement.

Figure 2 shows a graphical interpretation of level of service for intersections.

Figure 2: Level of Service Criteria



Source: Highway Capacity Manual, 2000 – Based on Exhibit 16-2 and Exhibit 17-2

It should be noted that the LOS designations defined by the HCM, as described in the LOS Definitions, are used to present the Vissim and SimTraffic5 results as well, but note that the calculation of delay in HCM and microscopic models are not identical. The delay calculations in both Vissim and SimTraffic5 include the control (traffic signal) delay, in addition to accounting for delay on each particular approach. Some of the delay could be attributed to lane changes or vehicles braking in response to upstream vehicle movements, among other typical characteristics in the traffic stream. Although the delay calculated using Vissim and SimTraffic5 accounts for "other" travel delay, this amount is typically insignificant in comparison to that created from the traffic control device; therefore, the HCM designated LOS is felt to be appropriate for labeling both the Vissim and SimTraffic5 results.

Intersection Queuing Analysis

An analysis of delay (LOS) alone would neglect potential queuing issues resulting from the background traffic or a proposed development. A queue is defined as a line of one or more vehicles waiting to be serviced by the system. For this analysis, the system is represented by a signalized intersection. Therefore, a queuing analysis was conducted to determine if adequate storage length for left and right turn lanes exists. In addition, the queuing analysis indicates issues with through traffic extending back into the upstream intersection. If through traffic were to extend back through the upstream intersection, this would be considered a significant traffic operational deficiency.

Storage length, for this traffic analysis, is defined as the length of the turn lane (not including the length of the taper into the turn lane) or the distance between intersections (from the near side of the downstream intersection to the far side of the upstream intersection). The queue lengths reported for the analysis were the 95th percentile queues that are expected to occur during the peak hour. In some instances, the 95th percentile queue length may exceed the storage length only once during the peak hour; however, the queue length is still reported as exceeding the storage length.

A queue length from a left or right turn lane can exceed the storage length of the lane because of background traffic and/or project related traffic. Roadway improvements to accommodate the background traffic or mitigation measures to handle project related traffic might not be necessary unless it is determined that the queue has a significant impact on the operations at that intersection or the next upstream intersection. Examples where the queue lengths would be considered a significant traffic operational deficiency such that roadway improvements or mitigation measures should be considered include:

1. A queue length at a particular intersection exceeds the storage length causing through traffic to spill back through the next upstream intersection.
2. A queue length at a particular intersection exceeds the storage length and does not clear out throughout the peak hour, with the result that traffic volumes for the entire system begin to decrease.

Examples where the queue length would not be considered a significant traffic operational deficiency and roadway improvements or mitigation measures would not be imperative include:

1. A queue length at a particular intersection exceeds the storage length by only a small distance.
2. A queue length at a particular intersection exceeds the storage length but it does clear out throughout the peak hour.

Defining Impacts

Traffic impacts with transit operations can be defined in a number of ways including: a) by the threshold level of the grade crossing, b) by the level of service of the roadway segment, c) by the level of service of the entire intersection, d) by the level of service of individual movements within an intersection, and e) by the relationship between the queue length and the storage length of an intersection movement.

For the grade separation analysis, an acceptable threshold for grade crossings is a Level 2 or better. As defined by the ITE Light Rail Grade Separation guidelines, a Level 3 grade crossing should be mitigated and a Level 4 grade crossing is considered unfeasible for standard operations. In general, LOS A through D is typically considered acceptable in the Twin Cities Metropolitan Area for roadway segments and intersections. Typically, designing a new roadway for a LOS D is practical in a built urban environment, such as the Central Corridor. In general, metropolitan areas consider a LOS E or F to be unacceptable, as this indicates that the roadway has reached or exceeded its capacity, resulting in extended travel delays and substantial congestion.

To determine if an impact or deficiency will occur in a roadway segment, an overall intersection, an intersection movement, or a queue length, the following standards are applied:

- For a grade crossing, the threshold level changes to be at a Level 3 or 4.
- For a roadway segment, the overall level of service of a segment changes to be at a LOS E or F;

- For an intersection, the overall level of service of an intersection changes to be at a LOS E or F;
- For one or more individual movements at an intersection, the level of service changes to be at a LOS E or F, which results in a significant decrease in the overall operational efficiency at the intersection; or
- For one or more queue lengths, the queue length changes to exceed the storage length, which results in significant upstream traffic impacts.

The next step is to determine if the deficiency warrants a roadway improvement (if as a result of an increase in background traffic) or mitigation measure (if as a result of the addition of Site-generated traffic). The following guidelines are applied when conducting the traffic analysis and identifying the need to consider roadway improvements or mitigation measures:

- All grade crossings reported at threshold Level 3 should be mitigated, and transit grade crossings at Level 4 should be grade separated.
- All roadway segments operating at a LOS E or F as a result of background traffic or site-generated traffic would be considered for potential roadway improvement or mitigation measures, respectively.
- All intersections operating at a LOS E or F as a result of background traffic or site-generated traffic would be considered for potential roadway improvement or mitigation measures, respectively.
- Not all intersection movements expected to be at a LOS E or F require roadway improvements or mitigation measures. For example, if an individual movement operates at a LOS E or F but has a low volume, the movement would not be expected to significantly decrease the overall operation at the intersection.
- Queue lengths that exceed storage lengths do not always necessitate roadway improvements or mitigation measures. For example, if a queue length exceeds the storage length but by only a short distance, the queue would not be expected to have a significant upstream impact. Or if the queue diminishes (clears out) regularly throughout the peak hour, the movement would not be expected to significantly disrupt upstream traffic.
- Intersections or specific movements at an intersection that warrants consideration for mitigation due to the increased traffic volumes from a development would only be applied to return the intersection or specific movement back to the existing (background) traffic conditions. For example, if a particular intersection operates at a LOS E under existing conditions and a LOS F with the addition of development volumes, mitigation measures would be considered to return the intersection to a LOS E condition. Mitigation to improve the intersection to an acceptable (LOS D) condition, which would be better than the existing conditions, would not be considered.

EXISTING CONDITION ANALYSIS

Base year operational analyses were performed using the field data collected to evaluate the existing traffic operating conditions. The results of the grade separation, roadway segment, and intersection analyses provide a measurement of the potential impacts of the forecasted Baseline, Build BRT and LRT conditions.

Grade Separation Analysis and Results

A grade separation analysis was conducted to determine the impact of implementing rail or bus transit technologies crossings, at-grade level, of the existing and future surface street system. Although the BRT or LRT will not be implemented in the existing conditions, the grade separation analysis was completed to measure the impacts associated with forecasted traffic growth and geometric changes. This analysis was completed using the Institute of Transportation Engineers procedure described in the methodology section. The headway that was assumed for this analysis was 7.5 minutes for LRT and 4 minutes for BRT, resulting in a total of 16 LRT vehicles and 30 BRT vehicles per hour. These assumptions were used at the selected 21 highest volume traffic crossings of the proposed alignments during the PM peak hour.

The calculation of the threshold level, as defined by ITE, is a function of Average Daily Traffic (ADT), peak hour directional distribution, and geometry of the crossing. The ADT used in this analysis was determined using the data collected in the turning movement counts collected in the field by personnel from the project team, which also provided the peak hour directional volumes. In addition, the geometry was collected as part of the data collection process.

Table 9 presents the results for the selected grade crossings analysis. In the existing conditions, no grade crossings warrant a grade separation recommendation as a result of the LRT threshold analysis. None of the grade crossings analyzed for LRT or BRT met the threshold Level 4, which indicates that an at-grade crossing is probably not feasible.

In addition, the LRT analysis resulted in no locations reaching a threshold Level 3. The BRT analysis resulted in four locations attaining a Level 3, due to the increased frequency of BRT crossings with a 4-minute headway. As noted above, BRT is expected to be feasible for these crossings, as long as increased delays can be expected or vast improvements are made to the area. Two of the highest volume crossings, Snelling Avenue and Lexington Parkway, that attained the Level 3 for BRT were located in the Vissim simulation area and will be looked at further in the intersection analysis results. The other two areas that reached a threshold Level 3 were at the Highway 280 area (Cromwell Avenue) and at 5th Street in Downtown Minneapolis. The analysis in Downtown Minneapolis included the addition of the Hiawatha LRT line, which when combined with Central Corridor results in a 1-3/4 minute headway during the peak hour, essentially making 5th Street a dedicated transitway.

All of the other crossings analyzed attained a threshold Level 1 or 2, which typically dictates that operating at-grade should be feasible in the existing conditions. As noted before in the Methodologies and Assumptions Section, the results of this analysis do not present a hard and fast rule, but a planning level of analysis to determine the feasibility of an at-grade crossing.

Table 9: Existing Condition Grade Separation Peak Hour Analysis Results

Map Ref No.	Roadway	From	To	Total Number of Lanes	ADT[1]	Build LRT/BRT Approach Volume	Build LRT/BRT Vehicles per lane	LRT Threshold #[2]	BRT Threshold #[2]
1	Hennepin Ave[3]	6th St S	4th St S	3	16,200	1460	490	2	2
3	5th Ave S[3]	6th St S	4th St S	3	18,700	1680	560	2	3
6	Malcolm Ave	Orlin Ave SE	4th St SE	2	3,000	270	130	1	1
7	Eustis Ave	Territorial Rd	Franklin Ave	3	12,400	1120	370	2	2
8	Cromwell Ave	Territorial Rd	Franklin Ave	2	14,000	1260	630	2	3
10	Raymond Ave	Territorial Rd	Wabash Ave	2	10,600	960	480	2	2
11	Fairview Ave	Thomas Ave	Shields Ave	4	9,700	870	220	1	2
14	Snelling Ave	Thomas Ave	Shields Ave	4	29,900	2690	670	2	3
17	Hamline Ave	Thomas Ave	St. Anthony Ave	4	12,400	1120	280	1	2
18	Lexington Pkwy	Thomas Ave	St. Anthony Ave	5	31,200	2810	560	2	3
20	Dale St	Thomas Ave	St. Anthony Ave	4	20,800	1870	470	2	2
21	Marion St	Thomas Ave	St. Anthony Ave	4	15,400	1390	350	2	2
22	Rice St	Como Ave	John Ireland Blvd	4	16,800	1520	380	2	2
24	Robert St	Capitol Heights	Columbus Ave	2	8,000	720	360	2	2
25	12th St E	St. Peter St	Jackson St	3	15,300	1370	460	2	2
26	11th St E	St. Peter St	Jackson St	3	13,300	1200	400	2	2
27	7th St	St. Peter St	Jackson St	4	17,100	1540	380	2	2
28	6th St	St. Peter St	Jackson St	3	10,300	930	310	1	2
29	5th Street	St. Peter St	Jackson St	3	10,600	960	320	1	2
31	Robert Street	5th Street	Kellogg Blvd	4	12,800	1150	290	1	2
32	Jackson Street	5th Street	Kellogg Blvd	3	14,700	1320	440	2	2

Source: Light Rail Transit Grade Separation Guidelines, ITE Journal 1993

[1] ADT was calculated using turning movement data, assuming the PM peak period represented 9 percent of the daily volumes.

[2] Threshold number is based on the transit vehicle exposure to traffic

[3] Data collected from SRF Consulting Group, April 2000.

Roadway Segment Analysis and Results

The Traffic Analysis Committee identified roadway segments for analysis based on whether the proposed alignments are located within the existing roadway system. The selected roadway segments are shown in **Appendix Figures A1 through A11**. As noted in the Methodologies and Assumptions Section, for each of the roadway segments chosen for this analysis, which covers the entire proposed alignments, information was collected in regards to roadway geometry, estimated capacity, and average daily traffic (ADT). Using this information, the resulting roadway segment level of service (LOS) was estimated.

Table 10 summarizes the results of the existing condition analysis for the major and principal arterials that may be impacted by the proposed LRT or BRT alignments throughout the Central Corridor study area.

Table 10: Existing Roadway Segment LOS

Map Reference Letter	Facility	Segment	Estimated ADT (Year 2001)[1]	2001 Existing LOS
A	5th St	3rd Ave N to Park Ave[2]	8,800	C
B	4th St	Chicago Ave and Washington Ave Bridge	7,200[3]	C
C	Washington Ave Bridge	4th St and Pleasant St Ramps	22,500	D
D	Washington Ave	Pleasant St Ramps and University Ave	18,000	D
E	University Ave	Washington Ave and Highway 280	25,000	D
F	University Ave	Highway 280 and Snelling Ave	25,000	D
G	University Ave	Snelling Ave and Lexington Ave	25,000	D
H	University Ave	Lexington Ave and Dale St	25,000	D
I	University Ave	Dale St and Rice St	27,500	D
J	University Ave	Rice St and Robert St	20,000	D
K	Robert St	University Ave and Columbus Ave	8,000	C
L	Columbus Ave	Robert St and Cedar Ave	1,200	C
M	Cedar Ave	11th St and 4th St	6,800	C
N	4th St	Cedar Ave and Sibley Ave	5,600	C

Source: Florida Department of Transportation Level of Service Handbook 1998 and URS Corp. 2001.

[1] ADT was calculated using turning movement data collected in September and December 2001, assuming the PM peak period represented 9 percent of the daily volumes.

[2] Data collected from SRF Consulting Group, April 2000.

[3] ADT was taken from the 2000 Mn/DOT Flow Maps

No roadway segments in the existing condition analysis are expected to operate below the acceptable threshold of LOS D on a daily basis.

Intersection Analysis and Results

The capacity analysis and queuing analysis were conducted to determine the existing traffic volume impacts on the existing roadway geometry. As indicated in the methodology section, three different software programs were utilized to complete the intersection capacity analysis conducted for the PM peak hour traffic operations. Two separate results were reported for the capacity analysis. The more general analysis results of the macroscopic analysis utilizing the Synchro software and the microscopic analysis utilizing the SimTraffic software were reported together. The results of the detailed microscopic analysis utilizing Vissim for the Snelling Avenue / Lexington Parkway area were reported separately.

All of the existing condition analysis consisted of using the field counted turning movement volumes collected for the intersections included in the study. These volumes were then used in conjunction with existing roadway geometry and existing signal timing to develop the existing condition level of service and queue length results.

General Intersection Analysis Results

The PM peak hour macroscopic intersection LOS was estimated for the base year (2001) for the key intersections chosen by the Traffic Analysis Committee. The peak period geometry, traffic volumes, and signal timings were collected and entered into Synchro. In addition, for some analysis intersections, the data was transferred into the SimTraffic modeling software to more accurately account for impacts due to closely spaced intersections, as noted in the methodology section.

Intersection Level of Service

The results of the intersection level of service analysis are included in **Table 3**. During the PM peak hour, all intersections included in this analysis were reported to be operating at a LOS D or better except for the Raymond Avenue / University Avenue intersection, which operates at a LOS E.

Intersection Movement Level of Service

During the PM peak hour, all individual movements at each intersection were reported to be operating at a LOS D or better, except those listed in **Table 11**.

Table 11: Existing PM Peak Hour Intersection Movements at LOS E and F

Intersection	Movement	Movement LOS
Eustis Street / University Avenue	North Approach LT	F
Cromwell Avenue / University Avenue	West Approach LT	E
Raymond Avenue / University Avenue	North Approach All	F
Dale Street / University Avenue	East and North Approach LT	E
Marion Street / University Avenue	South Approach LT	E
Rice Street / University Avenue	South Approach LT and North Approach TH	E
	North Approach LT	F

Note: LT = Left Turn movement; RT = Right Turn movement; TH = Through movement; All = All Movements for the approach

Queuing Analysis

During the PM Peak hour, the locations where the queue lengths were reported to be exceeding the storage lengths or the distances between intersections included those movements listed in **Table 12**.

Table 12: Queue Lengths Exceeded in Existing PM Peak Hour

Intersection	Movement	Queue Length exceeds Storage Length by (feet)
Marquette Avenue / 5th Street	South Approach Shared LT/TH Lane, TH Lane	135, 135
Eustis Street / University Avenue	North Approach Shared LT/TH Lane	110
Cromwell Avenue / University Avenue	West Approach LT West Approach TH Lanes East Approach RT	59 80 [a] 51
Robert Street / University Avenue	South Approach Shared TH/RT Lane	45
11th Street / Cedar Street	West Approach Shared TH/RT Lane	4

Note: LT = Left Turn movement; RT = Right Turn movement; TH = Through movement; All = All Movements for the approach

[a] Average length used for movements with multiple lanes where the queue exceeded the storage length or distance between intersections.

Queue lengths that exceeded the available turn bay storage length by 50 feet or less were not considered deficiencies. The analysis assumed that the taper length leading into the turn bay would be able to accommodate these vehicles. Any through lane queue that was reported to exceed the available storage length or distance to the adjacent intersection was reported as a deficiency. A through lane queue indicates that vehicles are extending into the adjacent intersection and potentially impacting the operations at that intersection.

Snelling Avenue / Lexington Parkway Area Analysis Results

The detailed microscopic analysis evaluated all intersections and access points that are currently located between Fairview Avenue and Victoria Street along University Avenue, which included the Snelling Avenue and Lexington Parkway intersections. As completed for the macroscopic traffic analyses, the PM peak period turning movement counts, geometry of each intersection, and their respective signal timings were input into the simulation software. The signal timing plans were entered for each intersection to reflect existing operations conditions.

Intersection Level of Service

The results of the intersection level of service analysis are included in **Table 3**. During the PM peak hour, all intersections included in this analysis were reported to be operating at a LOS D or better.

Intersection Movement Level of Service

During the PM peak hour, all individual movements at each intersection were reported to be operating at a LOS D or better, except those listed in **Table 13**.

Table 13: Existing PM Peak Hour Movements at LOS E and F

Intersection	Movement	Movement LOS
Aldine Street / University Avenue	North Approach LT and South Approach RT	E
Snelling Avenue / University Avenue	North Approach LT East Approach LT	E F
Lexington Parkway / University Avenue	North Approach LT and TH, South Approach LT and TH, and West Approach LT East Approach LT	E F

Note: LT = Left Turn movement; RT = Right Turn movement; TH = Through movement; All = All Movements for the approach

Queuing Analysis

During the PM Peak hour, the locations where the queue lengths were reported to be exceeding the storage lengths or the distances between intersections included those movements listed in **Table 14**.

Table 14: Queue Lengths Exceeded in Existing PM Peak Hour

Intersection	Movement	Queue Length exceeds Storage Length by (feet)
Fairview Avenue / University Avenue	West Approach RT	69
Snelling Avenue / University Avenue	South Approach RT South Approach TH Lanes South Approach LT	328 394 [a] 509
Pascal Street / University Avenue	West Approach RT	94
Hamline Avenue / University Avenue	North Approach Shared TH/RT Lane West Approach RT	40 140
Lexington Parkway / University Avenue	North Approach RT, TH Lanes South Approach TH Lanes West Approach RT	148, 316 [a] 238 [a] 51
Victoria Street /University Avenue	North Approach Shared RT/TH/LT South Approach Shared RT/TH/LT	29 43

Note: LT = Left Turn movement; RT = Right Turn movement; TH = Through movement; All = All Movements for the approach

[a] Average length used for movements with multiple lanes where the queue exceeded the storage length or distance between intersections.

Queue lengths that exceeded the available turn bay storage length by 50 feet or less were not considered deficiencies. The analysis assumed that the taper length leading into the turn bay would be able to accommodate these vehicles. Any through lane queue that was reported to exceed the available storage length, or distance to the adjacent intersection, was reported as a deficiency. A through lane queue indicates that vehicles are extending into the adjacent intersection and potentially impacting the operations at that intersection.

Potential Roadway Improvements

A general discussion of potential roadway improvements and mitigation measures to be considered for the Final EIS is included in the Potential Roadway Improvements and Mitigation Measure section later in this report.

BASELINE CONDITION ANALYSIS

The Baseline Alternative defines a combination of relatively low cost capital improvements that can increase capacity and improve operations to the existing transportation facilities, including all programmed improvements to roadway and transit services. This alternative does not include investments in capital intensive fixed guide-way transit projects within the Corridor, though. In other words, the Baseline Alternative is the "best that can be done" to improve the transportation network and transit service in the Central Corridor without a major capital investment in new infrastructure. This Alternative is a combination of the traditional "No-Build" and "Transportation System Management" conditions.

Grade Separation Analysis and Results

A grade separation analysis was not conducted for the Baseline condition. The Baseline condition does not assume the presence of either LRT or BRT operations.

Roadway Segment Analysis and Results

The Roadway Segment analysis was performed for the forecast 2020 Baseline conditions. Essentially, the only roadway geometry that changed in this Alternative was on 5th Street in Downtown Minneapolis, due to the implementation of the Hiawatha LRT that is projected to be operating by Year 2004. This LRT system will cut the existing geometry on 5th Street from 3-travel lanes one-way down to one-lane, changing the function of the roadway. In addition, traffic growth is included in this analysis, following the methodologies in the Growth Rate section of Section 3. **Table 15** documents the results of this analysis.

Table 15: Baseline Condition Segment Analysis Results

Map Reference Letter	Facility	Segment	Baseline ADT [1]	Baseline LOS
A	5th Street[2]	3rd Ave North to Park Ave	11,800	F
B	4th Street[3]	Chicago Ave to Cedar Ave	9,400	C
C	Washington Ave Bridge	Cedar Ave to Pleasant St Ramps	26,700	D
D	Washington Ave	Pleasant St Ramps to University Ave	21,400	D
E	University Ave	Washington Ave to Highway 280	29,700	D
F	University Ave	Highway 280 to Snelling Ave	29,700	D
G	University Ave	Snelling Ave to Lexington Pkwy	29,700	D
H	University Ave	Lexington Ave to Dale St	29,700	D
I	University Ave	Dale St to Rice St	32,700	E
J	University Ave	Rice St to Robert St	23,800	D
K	Robert St	University Ave to Columbus Ave	9,500	C
L	Columbus Ave	Robert St to Cedar Ave	1,500	C
M	Cedar Ave	11th St to 4th St	8,900	C
N	4th Street	Cedar Ave to Sibley Ave	7,300	C

Source: Florida Department of Transportation Level of Service Handbook 1998 and URS Corp. 2001.

[1] ADT was calculated using turning movement data collected in September and December 2001, assuming the PM peak period represented 9 percent of the daily volumes.

[2] Data collected from SRF Consulting Group, April 2000.

[3] ADT was taken from the 2000 Mn/DOT Flow Maps

Two of the Roadway Segments are forecasted to be operating below the acceptable LOS D in the Baseline condition. 5th Street in Downtown Minneapolis, which as noted before, will only provide one travel lane because of the implementation of the Hiawatha LRT system. Many of the forecasted trips on this roadway are expected to divert to parallel routes in the grid transportation network in Downtown Minneapolis. The segment of University Avenue between Dale Street and Rice Street is also expected to operate at LOS E. All other roadway segments analyzed in the Corridor are expected to operate at an acceptable LOS in the Baseline condition.

Intersection Analysis and Results

The capacity analysis and queuing analysis were conducted to determine the Baseline condition impacts at key intersections in the corridor. As with the Existing condition, two separate results were reported for the capacity analysis—general intersections and the Snelling Avenue / Lexington Parkway area. The Baseline condition analysis consisted of using the forecast turning movement volumes for the intersections included in the study. The Baseline condition volumes are included in **Appendix Table A1**. These volumes were then used in conjunction with existing roadway geometry and optimized signal operations to develop the Baseline condition LOS and queue length results.

General Intersection Analysis Results

The PM peak hour intersection level of service was evaluated for the future Baseline condition (Year 2020) for the key intersections chosen by the Traffic Analysis Committee. Because the signal timing is optimized for the Baseline condition, some overall intersection and/or intersection movement levels of service may actually improve compared to the Existing condition.

Intersection Level of Service

The results of the intersection level of service analysis are included in **Table 3**. During the PM peak hour, all intersections included in this analysis were expected to operate at a LOS D or better, except those intersections listed in **Table 16**.

Table 16: Baseline PM Peak Hour Intersections at LOS E and F

Intersection	Overall Intersection LOS
Hennepin Avenue / 5th Street	E
Marquette Avenue / 5th Street	E
Raymond Avenue / University Avenue	F
Dale Street / University Avenue	F
Marion Street / University Avenue	E
Rice Street / University Avenue	F

Intersection Movement Level of Service

During the PM peak hour for the forecasted 2020 Baseline alternative, all individual movements at each intersection were expected to operate at a LOS D or better, except those listed in **Table 17**.

Table 17: Baseline PM Peak Hour Intersection Movements at LOS E and F

Intersection	Movement	Movement LOS
Hennepin Avenue / 5th Street	East Approach TH	F
Marquette Avenue / 5th Street	East Approach TH and RT	F
Eustis Street / University Avenue	West Approach TH	E
Raymond Avenue / University Avenue	North Approach All	F
Dale Street / University Avenue	West Approach LT South Approach LT and TH, and North Approach All	E F
Marion Street / University Avenue	North Approach LT West Approach All	E F
Rice Street / University Avenue	South Approach RT West Approach LT, South Approach LT and TH, and North Approach All	E F
Constitution Ave / University Ave	North Approach LT	E
Jackson Street / 4th Street	East Approach LT and TH	E

Note: LT = Left Turn movement; RT = Right Turn movement; TH = Through movement; All = All Movements for the approach

Queuing Analysis

During the PM Peak hour, the locations where the queue lengths were expected to exceed the storage lengths or the distances between intersections included those movements listed in **Table 18**.

Table 18: Queue Lengths Exceeded in Baseline PM Peak Hour

Intersection	Movement	Queue Length exceeds Storage Length by (feet)
Hennepin Avenue / 5th Street	East Approach TH South Approach Shared LT/TH South Approach TH Lanes	474 258 258 [a]
Marquette Avenue / 5th Street	East Approach Shared TH/RT	103
Cromwell Avenue / University Avenue	West Approach LT, TH East Approach RT	104, 52 [a] 56
Raymond Ave / University Ave	North Approach Shared LT/TH, TH/RT	649, 859
Dale Street / University Avenue	South Approach LT, TH Lanes	65, 124 [a]
Marion St / University Ave	West Approach LT	56
Rice Street / University Avenue	North Approach Shared LT/TH, TH/RT	264, 243
Constitution Ave/University Ave	West Approach TH, Shared TH/RT	35, 35
Robert St / University Ave	South Approach LT, Shared TH/RT	99, 78
11th Street / Cedar Street	West Approach Shared LT/TH, TH/RT	5, 20
Jackson Street / 4th Street	East Approach Shared LT/TH North Approach Shared LT/TH, TH	30 86, 45

Note: LT = Left Turn movement; RT = Right Turn movement; TH = Through movement; All = All Movements for the approach

[a] Average length used for movements with multiple lanes where the queue exceeded the storage length or distance between intersections.

Queue lengths that exceeded the available turn bay storage length by 50 feet or less were not considered deficiencies. The analysis assumed that the taper length leading into the turn bay would be able to accommodate these vehicles. Any through lane queue that was reported to exceed the available storage length, or distance to the adjacent intersection, was reported as a deficiency. A through lane queue indicates that vehicles are expected to be extending into the adjacent intersection and potentially impacting the operations at that intersection.

Snelling Avenue / Lexington Parkway Area Analysis Results

The detailed microscopic analysis evaluated all intersections and access points that are currently located between Fairview Avenue and Victoria Street along University Avenue, which included the Snelling Avenue and Lexington Parkway intersections. As completed for the macroscopic traffic analyses, the PM peak period turning movement counts and geometry of each intersection were input into the simulation software for the Baseline condition. The signal operations were optimized for each intersection to accommodate the future operating conditions. Because the signal timing is optimized for the Baseline condition, some overall intersection and/or intersection movement levels of service may actually improve compared to the Existing condition.

Intersection Level of Service

The results of the intersection level of service analysis are included in **Table 3**. During the PM peak hour, all intersections included in this analysis were expected to operate at a LOS D or better, except the intersection of Lexington Parkway and University Avenue, which is expected to operate at a LOS E. In addition, although the intersection of Snelling Avenue and University Avenue is reported as being expected to operate at LOS D, due to the close proximity to the adjacent intersection to the south on Snelling Avenue and the expected queue lengths, this intersection is expected to operate worse than a LOS D and impact the operations at adjacent intersections in the area.

Intersection Movement Level of Service

During the PM peak hour, all individual movements at each intersection were expected to operate at a LOS D or better, except those listed in **Table 19**.

Table 19: Baseline PM Peak Hour Movements at LOS E and F

Intersection	Movement	Movement LOS
Fairview Avenue / University Avenue	North Approach LT and South Approach LT	F
Aldine Street / University Avenue	North Approach LT and South Approach RT	E
Snelling Avenue / University Avenue	North, East and South Approach LT	F
Lexington Parkway / University Avenue	South Approach TH North, East and South Approach LT, and West Approach All	E F
Victoria Street / University Avenue	North Approach All and South Approach LT	E

Note: LT = Left Turn movement; RT = Right Turn movement; TH = Through movement; All = All Movements for the approach