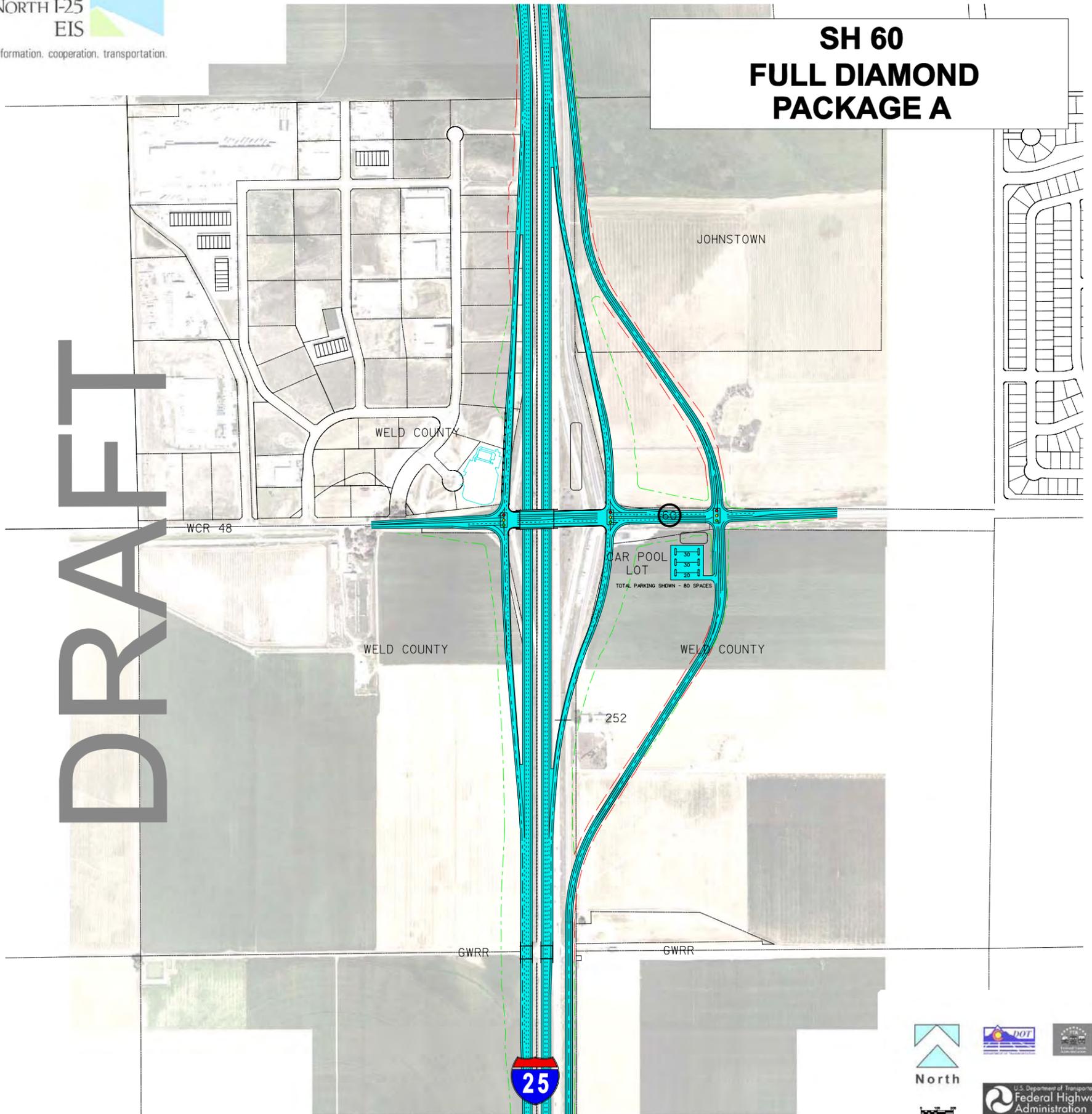


SH 60 FULL DIAMOND PACKAGE A

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North

October 1, 2007

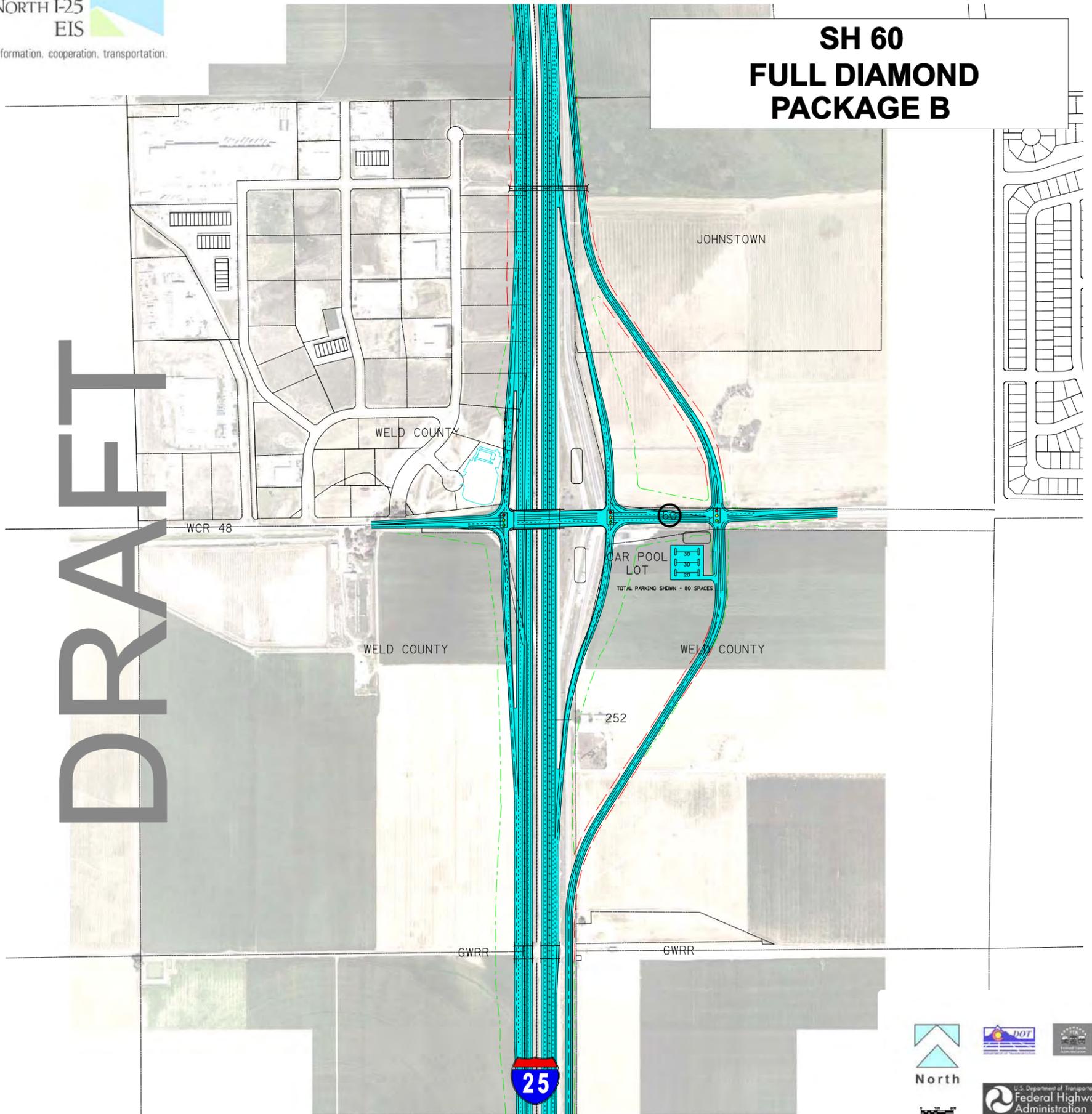


U.S. Department of Transportation
Federal Highway
Administration

SH 60 FULL DIAMOND

SH 60 FULL DIAMOND PACKAGE B

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SH 60 at I-25 DEIS Interchange Evaluation

August 20, 2007

Introduction

This report describes the existing traffic volumes at this interchange and the adjacent intersections, as well as future traffic conditions with an improved interchange.

Existing Conditions

The SH 60 interchange at I-25 was constructed in 1962. The interchange has a diamond configuration and is similar to several older diamond interchanges (i.e. SH 392, SH 402) in the corridor. The interchange ramps are one-lane without separate turn lanes at the ramp terminals.

The interchange area includes the following roadways:

SH 60. SH 60 is an east-west two lane arterial roadway that connects I-25 to the communities of Johnstown and Milliken to the east. East of Milliken SH 60 bends south and connects in to US 85. West of I-25 the SH 60 designation continues approximately one mile north of the SH 60/I-25 interchange (see Figure 1). West of I-25 at the SH 60 interchange, CR 48 connects CR 7 to I-25. The speed limit is 55 mph in the vicinity of the interchange, and there are no turn lanes at the stop-sign controlled ramp terminals.

East Frontage Road. A frontage road is located on the east side of the interchange, approximately 150 feet east of the northbound ramp intersection. There are no turn lanes at the intersection with SH 60. The intersection is stop-sign controlled.

Gateway Drive. Gateway Drive is located approximately 700 feet west of the southbound ramp terminals. This drive is the primary access to and from a commercial development on the northwest corner of the interchange. There are no turn lanes along SH 60 but the Gateway Drive southbound approach has both left and right turn lanes. Gateway Drive is stop-sign controlled.

Figure 2 summarizes the traffic counts collected in August 2004 at this interchange. As shown, average daily traffic on SH 60 is around 2,000 vehicles per day (vpd) west of the interchange and 11,000 vpd east of the interchange, illustrating the higher travel demand to and from the communities east of I-25. The northeast frontage road carried approximately 3,400 vehicles per day while the southeast frontage road and Gateway Drive had 1,000 vehicles or less daily.

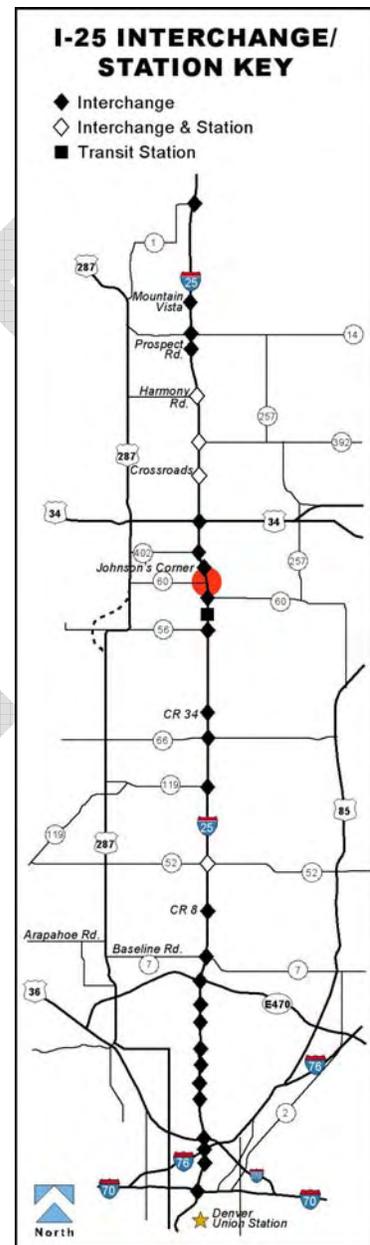


Figure 1. Vicinity Map

SH 60 at I-25 DEIS Interchange Evaluation

Page 2 of 16



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Daily ramp volumes range from 1,800 to 3,500 vehicles per day with a somewhat higher travel demand to and from the south. This pattern is also illustrated in the peak hour turning movements, where the westbound to southbound and the northbound to eastbound movement represent the highest turning volumes at the interchange in the AM and PM peak hours respectively.

Traffic Operations

An operational analysis of the interchange was conducted based on methodology developed in the Highway Capacity Manual (Transportation Research Board, 2000). The result of such analysis is a level of service (LOS) rating. Level of service is a qualitative assessment of the traffic flow based on the average stopped delay per vehicles at controlled intersections (i.e. traffic signal, stop-sign).

Levels of service are described by a letter designation ranging from “A” to “F”, with LOS A representing essentially uninterrupted flow, and LOS F representing a breakdown of traffic flow with excessive congestion and delay. Signalized intersection analyses result in a level of service rating for each movement and for the entire intersection but typically only the level of service for the entire intersection is reported. For unsignalized intersections a level of service rating is determined for each turn movement that must yield to another turn movement but an overall level of service rating is not determined for the entire intersection. The following table shows how average stopped delay at controlled intersections equates to levels of service.

Table 1. Equivalent Level of Service to Average Stopped Delay and Density

Level of Service	Average Delay at Signalized Intersections in (sec./veh.)	Average Delay at Stop-Controlled intersections in (sec./veh.)
A	0 to <=10	0 to <=10
B	> 10 to <= 20	> 10 to <= 15
C	> 20 to <= 35	> 15 to <= 25
D	> 35 to <= 55	> 25 to <= 35
E	> 55 to <= 80	> 35 to <= 50
F	> 80	> 50

Figure 2 illustrates existing peak period levels of service at the ramp terminals, adjacent intersections and ramp junctions with I-25. Currently, the northbound left turn movement at the northbound I-25 ramp junction operates at LOS F during the PM peak period, but the remaining movements in the vicinity of the interchange operate at LOS D or better.

SH 60 at I-25 DEIS Interchange Evaluation

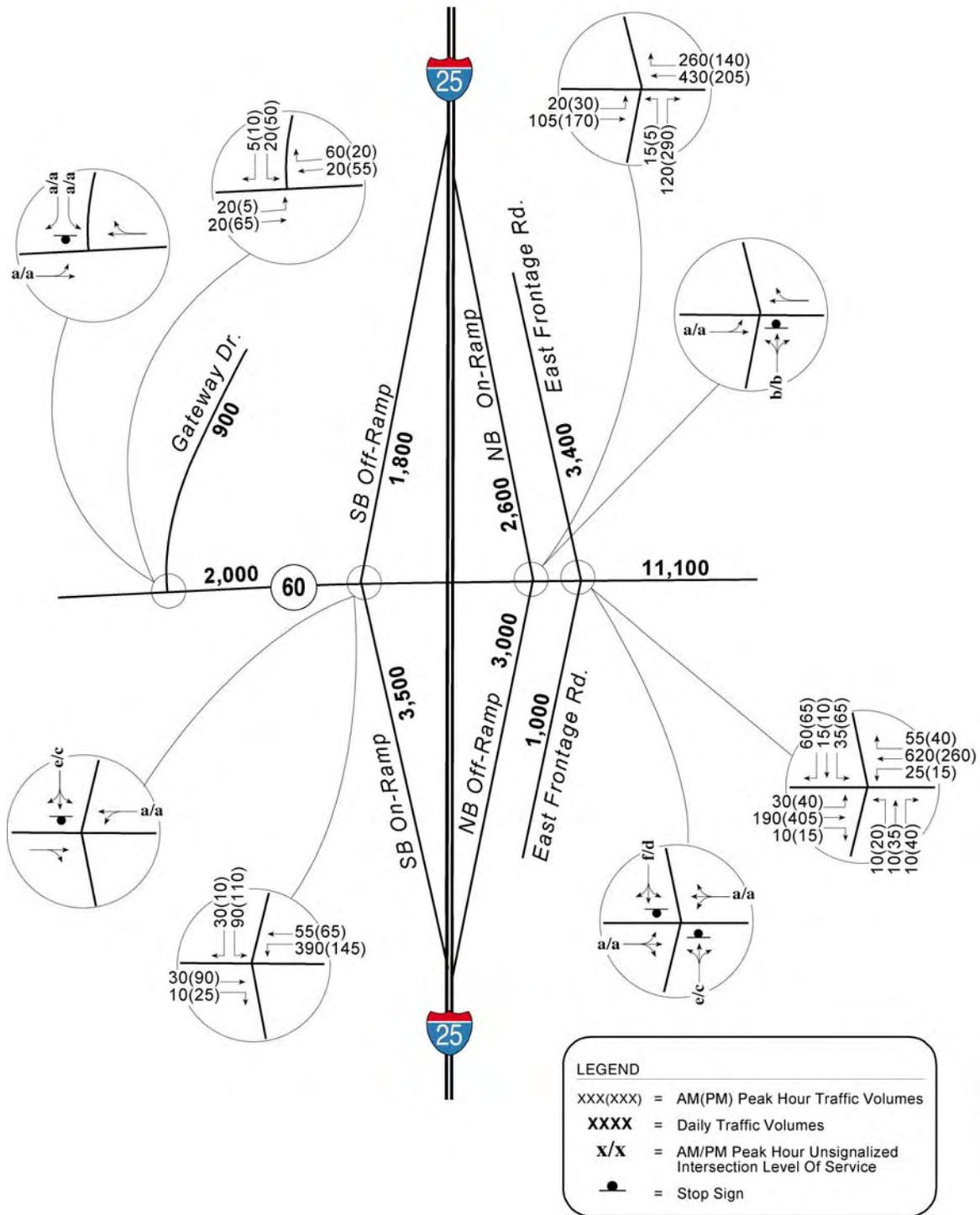


Figure 2. Existing Conditions

SH 60 at I-25 DEIS Interchange Evaluation

In addition to the intersection levels of service shown in the figure, Table 2 provides additional information for key movements at each intersection to provide further insight into existing operations at the interchange. Key movements are those movements that could have an impact on adjacent intersections or an impact to I-25. For example, east-west movements along SH 60 can queue into adjacent intersections and impede traffic flow at those locations, while vehicles on the ramps could queue back onto the interstate. North-south movements at the east frontage road intersection have not been included in the table because they would not impede traffic flow on SH 60. As shown in the table, the 95th percentile queue lengths for all movements were not greater than the distance between intersections or did not exceed the current storage length provided on the ramps.

Table 2. Existing Level of Service and Queue Lengths for Key Movements

Intersection / Movement	Level of Service		Estimated 95 th Percentile Queue ¹		Intersection Spacing and Storage Length Provisions
	AM	PM	AM	PM	
Southbound Ramp Terminal					
WB Approach	A	A	50'	50'	Distance to Adjacent Intersection – 460'
SB Approach	E	C	70'	70'	Ramp Length – 800'
Northbound Ramp Terminal					
EB Approach	A	A	50'	40'	Distance to Adjacent Intersection – 460'
NB Approach	B	B	70'	120'	Ramp Length – 800'
East Frontage Road Intersection					
EB Approach	A	A	60'	60'	Distance to Adjacent Intersection – 100'
¹ The queue lengths given in this table primarily come from SimTraffic with some engineering judgment. SimTraffic gives a queue length for each lane. For example, with dual left-turn lanes SimTraffic estimates a queue for each lane. In the table, for thru movements the queue length is the longest queue observed in any through lane. For multiple turn lanes (i.e. dual lefts), the queue length is the sum of the queues in each lane. For a single turn lane (i.e. right turn), the queue is just the queue for that lane.					

2030 Conditions

2030 traffic projections were developed for the three alternatives being considered:

- 1) No-Action Alternative
- 2) Package A: GPL + CR + CB 85
- 3) Package B: TEL+ BRT

These three packages are illustrated in Figures 3 through 5. In developing peak hour turning movements at the ramp terminals and the nearest adjacent intersections, model results were calibrated against existing traffic counts to derive an adjusted model forecast. These adjusted forecasts along with existing turning movement data were used in the NCHRP 255 balancing procedure to develop 2030 peak hour turning movement forecasts. These forecasts were further adjusted, as necessary, to balance between intersections and for reasonableness.

SH 60 at I-25 DEIS Interchange Evaluation

LEGEND

- ★ Major Structure Rehab by 2030
- Minor Structure Rehab by 2030
- Replace / Rehab Pavement by 2030
- Minor Safety Modifications by 2030
- FasTracks Rail Line

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Figure 3. No Action Alternative

SH 60 at I-25 DEIS Interchange Evaluation



LEGEND

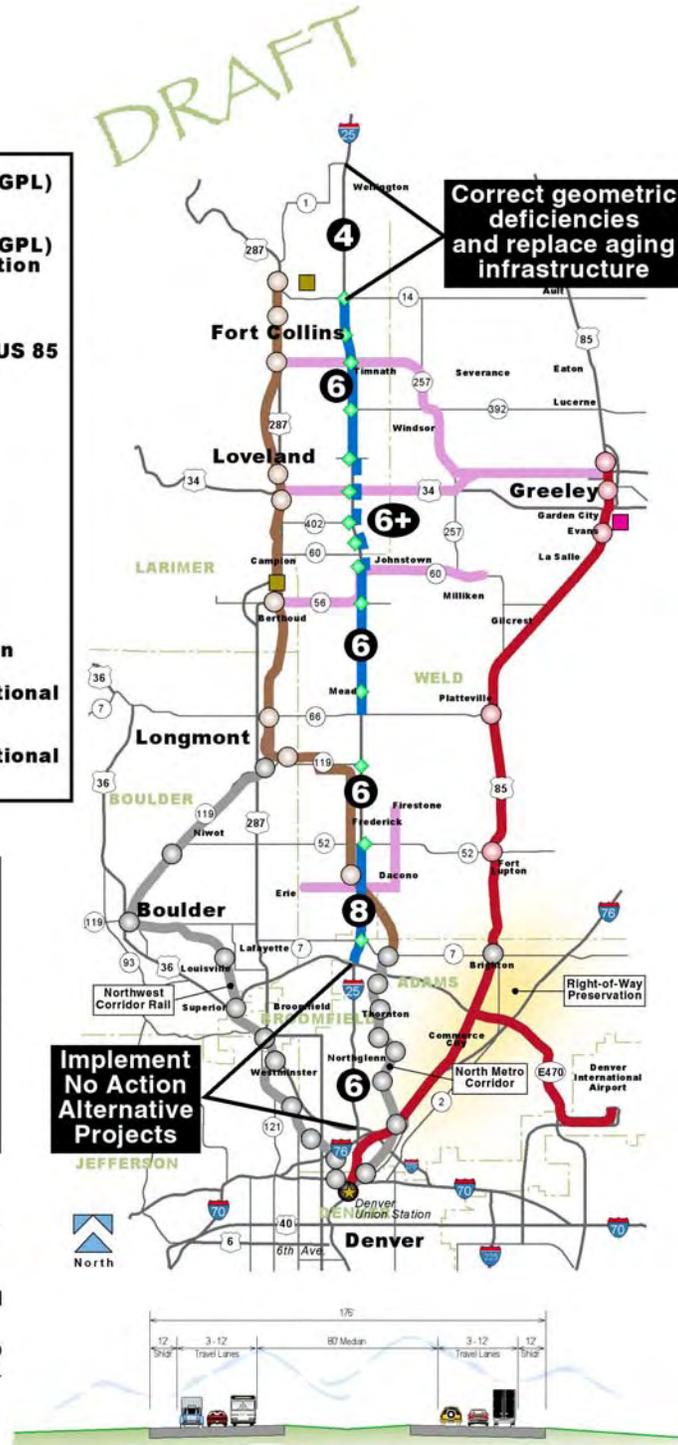
	1 New General Purpose Lane (GPL) in Each Direction
	1 New General Purpose Lane (GPL) + Auxiliary Lane in Each Direction
	Commuter Rail (CR)
	Commuter Bus (CB) Service on US 85
	Feeder Bus Service
	Interchange Upgrades
	Number of Lanes
	Commuter Bus Station / Stop
	Commuter Rail Station
	FasTracks Rail Line
	FasTracks / RTD Transit Station
	Potential Commuter Rail Operational & Maintenance Facility
	Potential Commuter Bus Operational & Maintenance Facility

Congestion Management Measures include:

- Enhanced carpool lot parking capacity and amenities
- Courtesy patrol (Incident management) from SH 14 to SH 7
- Variable messaging signs at all transit stations
- Automated Vehicle Locaters on all transit vehicles - "next bus" technology
- Links to local bike and pedestrian systems at station areas
- Support for development of Transportation Management Organization (TMO)

NOTE:

- Select sections of I-25 would require auxiliary lanes and / or an additional through lane in addition to this 6-lane cross section.
- Where widening is needed between SH 66 and SH 7, the median would be used.
- Commuter Rail Service without a Longmont to North Metro connection will also be evaluated.



TYPICAL I-25 CROSS SECTION - 6 GENERAL PURPOSE LANES

Figure 4. Package A

SH 60 at I-25 DEIS Interchange Evaluation



LEGEND

- 1 Buffer-Separated Tolled Express Lane (TEL) in Each Direction
- 2 Barrier-Separated Tolled Express Lanes (TEL) in Each Direction
- Bus Rapid Transit (BRT) Route (Uses TELs on I-25)
- Feeder Bus Service
- Interchange Upgrades
- X Number of Lanes: General Purpose/Tolled Express Lanes
- Bus Rapid Transit Station
- FasTracks Rail Line
- FasTracks / RTD Transit Station
- Potential Commuter Bus Operational & Maintenance Facility

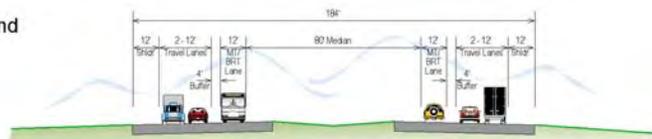
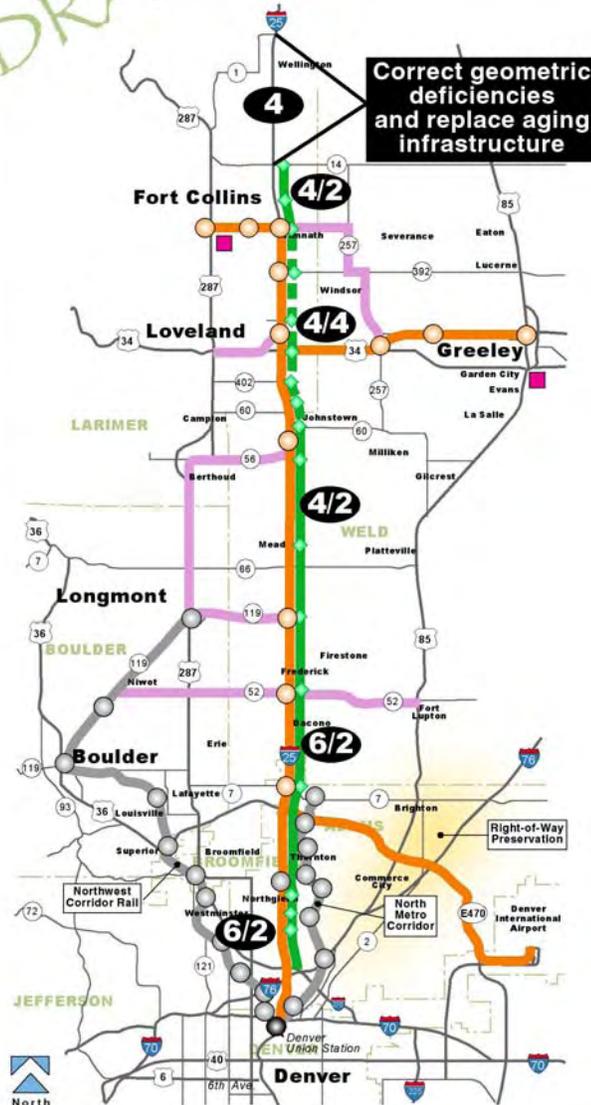
Congestion Management Measures include:

- Enhanced carpool lot parking capacity and amenities
- Courtesy patrol (incident management) from SH 14 to SH 7
- Variable messaging signs at all transit stations
- Automated Vehicle Locaters on all transit vehicles - "next bus" technology
- Links to local bike and pedestrian systems at station areas
- Support for development of Transportation Management Organization (TMO)

NOTE:

- A wider barrier and express lanes cross section is included between SH 60 and Harmony Road.
- BRT stations located within an expanded median area.
- Where widening is needed between SH 66 and SH 7, the median would be used.

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NOT TO SCALE

TYPICAL I-25 CROSS SECTION - BUFFERED SEPARATED TOLLED EXPRESS LANES

Figure 5. Package B

2030 No Action Traffic Volumes

Figure 6 depicts 2030 daily and peak hour No Action traffic projections for the SH 60 interchange and adjacent intersections. As shown, daily volume projections on SH 60 range from 19,600 vpd east of the interchange to 4,200 vpd west of the interchange, and ramp volumes range from approximately 3,000 to 6,500 vehicles per day.

2030 Package A Traffic Volumes

Figure 7 depicts 2030 daily and peak hour Package A traffic projections for the SH 60 interchange and adjacent intersections. As shown, Package A relocates the east frontage road east to provide better spacing between the frontage road and the northbound ramp terminal. Daily volume projections on SH 60, the interchange and the ramp terminals are in the same order of magnitude as the No Action volumes, but the traffic patterns are somewhat different due to the addition of on ramps at the nearby CR 16 interchange (Johnson's Corner).

2030 Package B Volumes

Figure 8 depicts 2030 daily and peak hour Package B traffic projections for the SH 60 interchange and adjacent intersections. The volumes in the figure generally depict patterns and volumes in the same order of magnitude as those in Package A.

2030 No Action Traffic Operations

Figure 6 shows the projected levels of service at the frontage road and ramp intersections on SH 60 under the No Action Alternative. As the figure indicates, the ramp terminals and the east frontage road side street movements operate at LOS F in both peak hours. Table 3 shows the projected queuing for key movements at the interchange and further underscores that the existing interchange would be significantly over capacity with the projected traffic volumes.

It should be noted that signalizing the ramp intersections and the east frontage road intersection without any widening improvements would improve operation but would still result in over-capacity operations at the ramp intersections in the AM peak and at the east frontage road intersection in both peak hours.

SH 60 at I-25 DEIS Interchange Evaluation

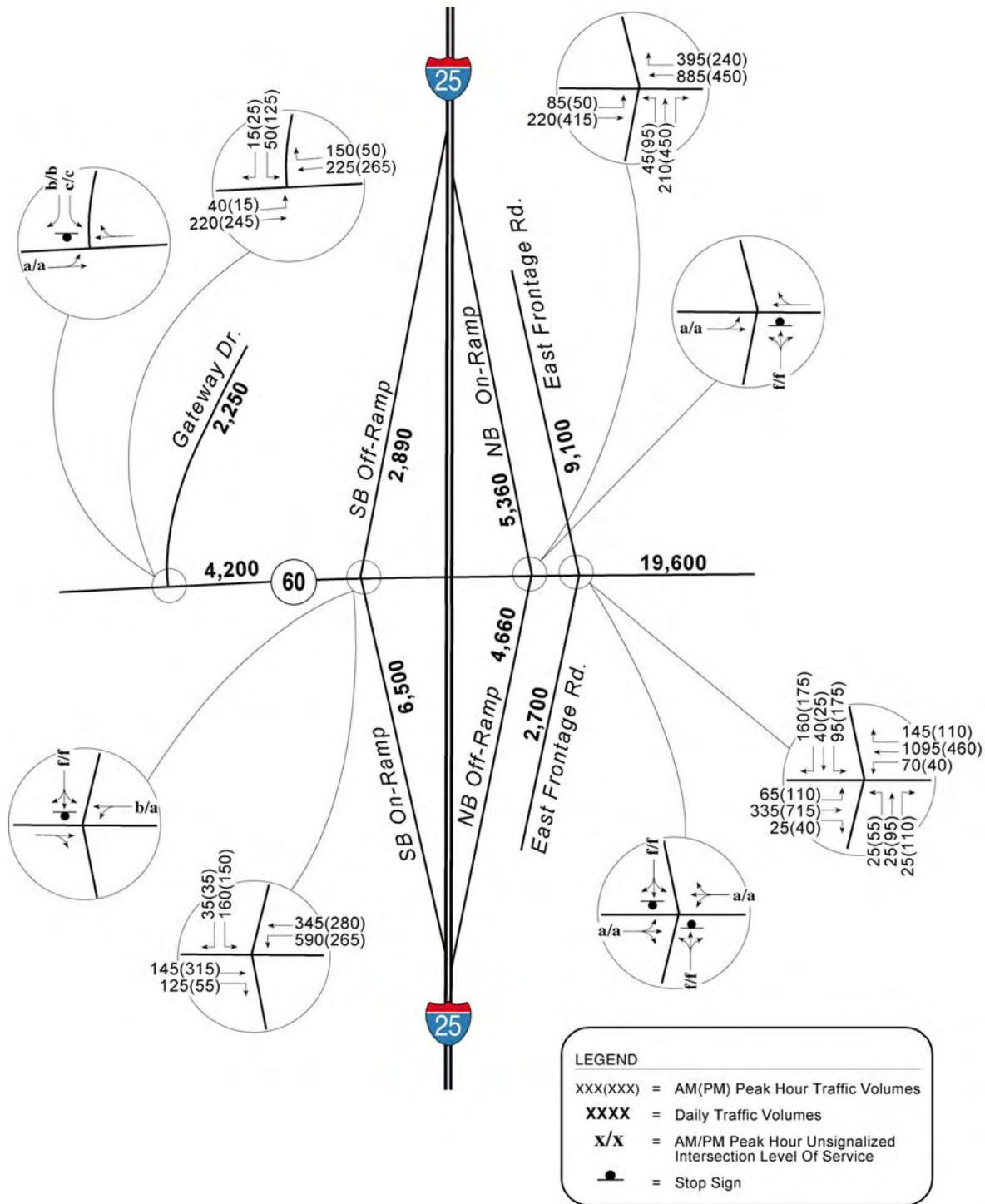


Figure 6. No Action Forecasts and Levels of Service

Table 3. 2030 No Action Level of Service and Queue Lengths for Key Movements

Intersection / Movement	Level of Service		Estimated 95 th Percentile Queue ¹		Intersection Spacing and Storage Length Provisions
	AM	PM	AM	PM	
Southbound Ramp Terminal					
WB Approach	E	C	220'	900'	Distance to Adjacent Intersection – 460'
SB Approach	F	C	830'	1300'	Ramp Length – 800'
Northbound Ramp Terminal					
EB Approach	E	B	540'	160'	Distance to Adjacent Intersection – 460'
NB Approach	E	D	>1000'	>1000'	Ramp Length – 800'
East Frontage Road Intersection					
EB Approach	B	F	80'	80'	Distance to Adjacent Intersection – 100'
¹ The queue lengths given in this table primarily come from SimTraffic with some engineering judgment. SimTraffic gives a queue length for each lane. For example, with dual left-turn lanes SimTraffic estimates a queue for each lane. In the table, for thru movements the queue length is the longest queue observed in any through lane. For multiple turn lanes (i.e. dual lefts), the queue length is the sum of the queues in each lane. For a single turn lane (i.e. right turn), the queue is just the queue for that lane.					

2030 Package A Traffic Operations

Interchange Configuration

The proposed configuration for the SH 60 DEIS interchange evaluation is a diamond configuration (Figure 7). The new interchange would increase the distance between the ramps to 600 feet and shift the east frontage road intersection to provide 580 feet of spacing from the northbound ramp terminal. SH 60 would be widened at the interchange to five lanes to accommodate dual left-turn lanes and a single through lane westbound and a single left and two through lanes eastbound. The southbound off ramps would be constructed with two left turn lanes (one would be shared with a through movement) and a right turn lane. The northbound ramp would be constructed with a shared left/through lane and a separate right turn lane. All three intersections would be signalized. Gateway Drive would remain stop-sign controlled.

Carpool Lot Location

Package A also includes a 90-space carpool lot located in the southeast quadrant of the interchange. Access to the lot would be provided approximately 200 feet south of SH 60 on the west side of the frontage road.

Interchange Operations

Figure 7 also shows the levels of service for the ramps and frontage road intersections, along with recommendations for laneage at each location. As shown, all three intersections in the vicinity of the ramp are anticipated to operate at LOS B or better with the forecasted traffic volumes and the enhancements identified.

SH 60 at I-25 DEIS Interchange Evaluation

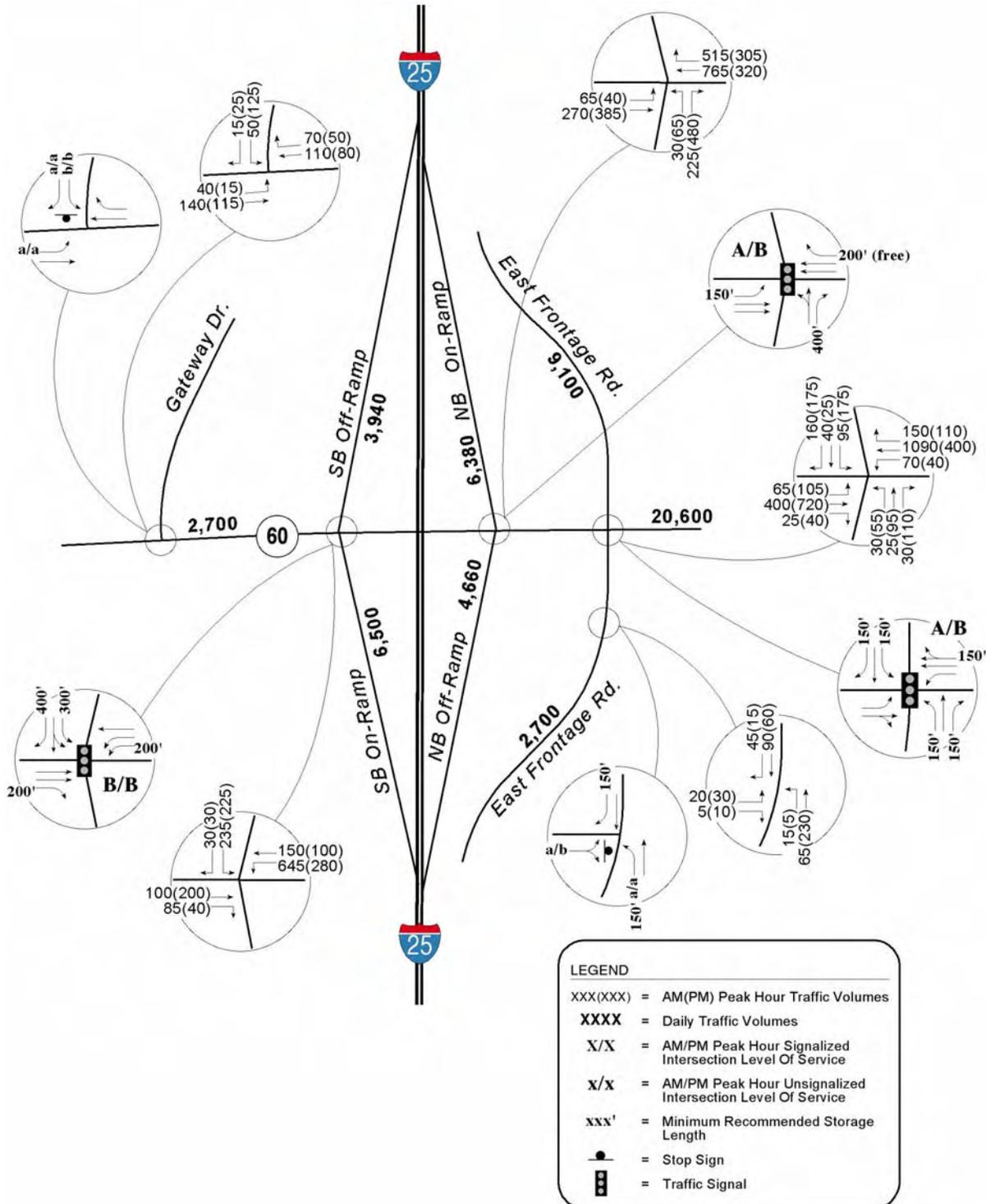


Figure 7. Package A Forecasts and Levels of Service

SH 60 at I-25 DEIS Interchange Evaluation

Table 4 summarizes the levels of service, queue lengths, intersection spacing and designed storage lengths for key movements at the interchange. As shown in the table, specific movement levels of service at this interchange range from LOS A to LOS D. No single movement operates with a substandard level of service; thus, the improvements identified at this interchange appear to provide good operations at both ramp terminals and at the frontage road intersection.

Table 4 also compares SimTraffic estimates of the 95th percentile queue length for key movements to the storage distance available for each. For turning movements, the distance listed is the planned turn lane storage length, while for through movements the length listed is the distance between intersections. The queuing analysis shows that in all cases the estimated 95th percentile queues would be contained within the turn bays or within the space between adjacent intersections. On both the northbound and southbound ramp terminals, the left and right turn queues would be accommodated well within the storage length and would not extend into the I-25 main lanes.

Table 4. 2030 Package A Level of Service and Queue Lengths for Key Movements

Intersection / Movement	Level of Service		Estimated 95 th Percentile Queue		Distance Between Intersections and Storage Length Provisions
	AM	PM	AM	PM	
Southbound Ramp Terminal					
EB Thru	B	A	70'	70'	Distance to Adjacent Intersection – 590'
EB Right	B	A	60'	40'	Storage Provided in Design – 200'
WB Left	B	B	610'	360'	Storage Provided in Design – 1340'
WB Thru	A	A	60'	40'	Distance to Adjacent Intersection – 610'
SB Left	D	C	210'	200'	Storage Provided in Design – 700'
SB Right	C	C	40'	50'	Storage Provided in Design – 400'
Northbound Ramp Terminal					
EB Left	A	B	70'	70'	Storage Provided in Design – 150'
EB Thru	A	A	40'	80'	Distance to Adjacent Intersection – 610'
WB Thru	A	A	150'	60'	Distance to Adjacent Intersection – 580'
WB Right	Free	Free	N/A	N/A	Storage Provided in Design – 200'
NB Left	D	C	70'	70'	Storage Provided in Design – 700'
NB Right	D	D	70'	140'	Storage Provided in Design – 400'
East Frontage Road Intersection					
EB Left	A	A	80'	140'	Storage Provided in Design – 580'
EB Thru/Right	A	A	140'	390'	Distance to Adjacent Intersection – 580'
Note: The queue lengths given in this table primarily come from SimTraffic with some engineering judgment. SimTraffic gives a queue length for each lane. For example, with dual left-turn lanes SimTraffic estimates a queue each lane. In the table, for thru movements the queue length is the longest queue observed in any through lane. For multiple turn lanes (i.e. dual lefts), the queue length is the sum of the queues in each lane. For a single turn lane (i.e. right turn), the queue is just the queue for that lane.					

2030 Package B Traffic Operations

Interchange Configuration

The proposed configuration for the Package B SH 60 DEIS interchange evaluation is a diamond configuration, with similar enhancements and lane configuration to that included in Package A.

Carpool Lot Location

Package B includes an 80-space carpool lot (10 spaces smaller than Package A) located in the southeast quadrant of the interchange. Access to the lot would be provided approximately 200 feet south of SH 60 on the west side of the frontage road.

Interchange Operations

Figure 8 also shows the levels of service for the ramps and frontage road intersections, along with recommendations for laneage at each location. As shown, all three intersections in the vicinity of the ramp are anticipated to operate at LOS B or better with the forecasted traffic volumes and the enhancements identified.

Table 5 summarizes the levels of service, queue lengths, intersection spacing and designed storage lengths for key movements at the interchange. As shown in the table, specific movement levels of service at this interchange range from LOS A to LOS D. No single movement operates with a substandard level of service; thus, the improvements identified at this interchange appear to provide good operations at both ramp terminals and at the frontage road intersection.

Table 5 also compares SimTraffic estimates of the 95th percentile queue length for key movements to the storage distance available for each. For turning movements, the distance listed is the planned turn lane storage length, while for through movements the length listed is the distance between intersections. The queuing analysis shows that in all cases the estimated 95th percentile queues would be contained within the turn bays or within the space between adjacent intersections. On both the northbound and southbound ramp terminals, the left and right turn queues would be accommodated well within the storage length and would not extend into the I-25 main lanes.

SH 60 at I-25 DEIS Interchange Evaluation

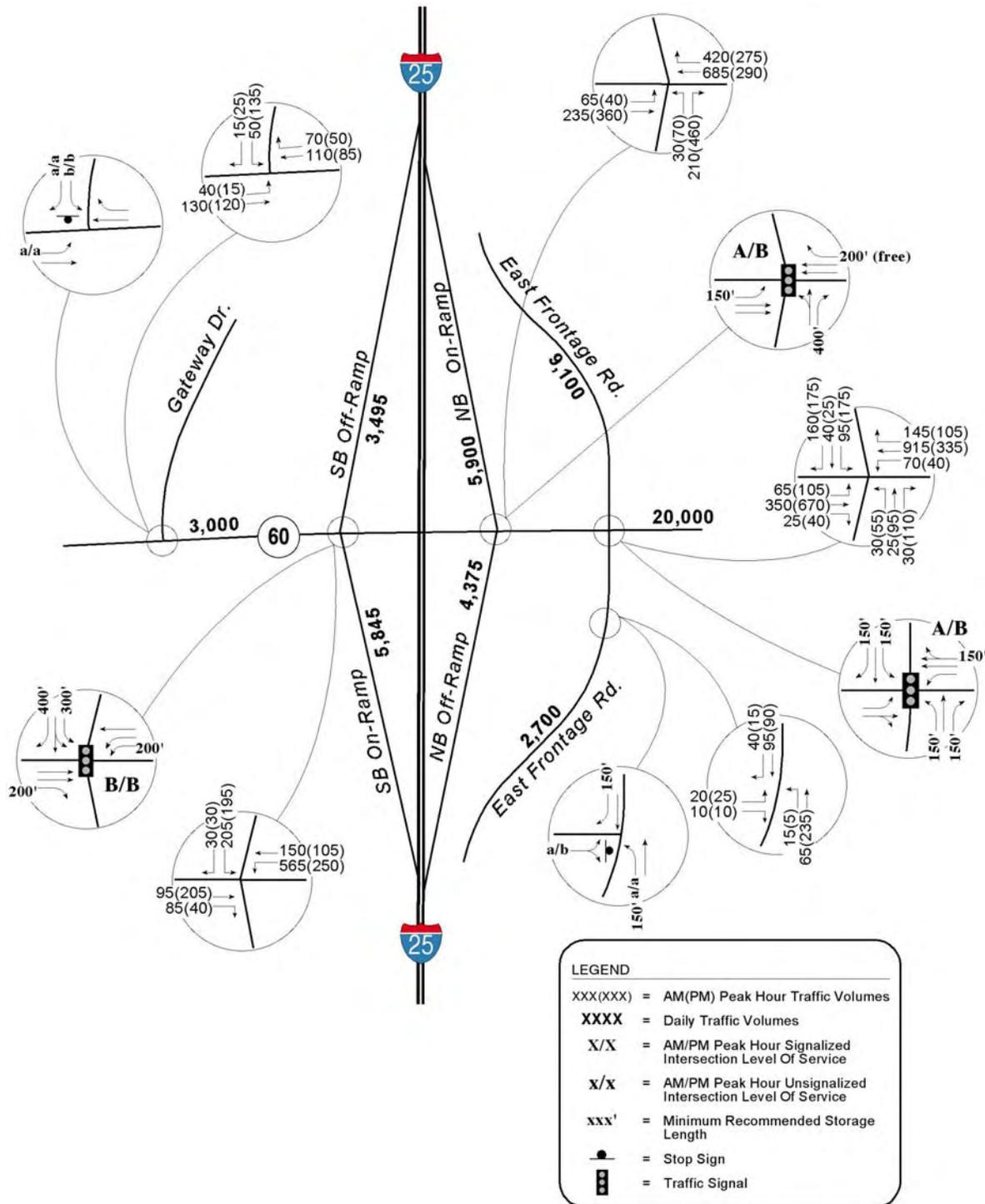


Figure 8. Package B Forecasts and Levels of Service

SH 60 at I-25 DEIS Interchange Evaluation

Table 5. 2030 Package B Level of Service and Queue Lengths for Key Movements

Intersection / Movement	Level of Service		Estimated 95 th Percentile Queue		Distance Between Intersections and Storage Length Provisions
	AM	PM	AM	PM	
Southbound Ramp Terminal					
EB Thru	B	A	70'	70'	Distance to Adjacent Intersection – 590'
EB Right	B	A	60'	40'	Storage Provided in Design – 200'
WB Left	B	B	650'	360'	Storage Provided in Design – 1340'
WB Thru	A	A	130'	40'	Distance to Adjacent Intersection – 610'
SB Left	D	C	210'	180'	Storage Provided in Design – 700'
SB Right	C	C	40'	40'	Storage Provided in Design – 400'
Northbound Ramp Terminal					
EB Left	A	B	80'	60'	Storage Provided in Design – 150'
EB Thru	A	A	20'	80'	Distance to Adjacent Intersection – 610'
WB Thru	A	A	80'	80'	Distance to Adjacent Intersection – 580'
WB Right	A	A	20'	20'	Storage Provided in Design – 200'
NB Left	D	C	60'	70'	Storage Provided in Design – 700'
NB Right	D	D	60'	130'	Storage Provided in Design – 400'
East Frontage Road Intersection					
EB Left	A	A	70'	80'	Storage Provided in Design – 580'
EB Thru/Right	A	A	60'	320'	Distance to Adjacent Intersection – 580'
<p>Note: The queue lengths given in this table primarily come from SimTraffic with some engineering judgment. SimTraffic gives a queue length for each lane. For example, with dual left-turn lanes SimTraffic estimates a queue each lane. In the table, for thru movements the queue length is the longest queue observed in any through lane. For multiple turn lanes (i.e. dual lefts), the queue length is the sum of the queues in each lane. For a single turn lane (i.e. right turn), the queue is just the queue for that lane.</p>					

SH 60 at I-25 DEIS Interchange Evaluation

Traffic Operational Analysis

Table 6 compares the levels of service and delay at the SH 60 interchange for the No Action Alternative and for both Package A and B. As the table indicates without improvements at this location, the east frontage road intersection and the ramp intersections with SH 60 would operate over capacity. Providing additional approach lanes and signaling these three intersections improves operations to at least LOS B at all locations. The levels of service and delays at each intersection are virtually the same for both alternatives, so either package would result in adequate operations at this interchange.

Table 6. Intersection Level of Service and Delay

Intersection	No Action		Package A		Package B	
	AM Peak	PM Peak	AM Peak	PM Peak	AM Peak	PM Peak
Gateway Drive	N/A	N/A	N/A	N/A	N/A	N/A
Southbound Ramps	LOS E (60 sec.)	LOS C (22 sec.)	LOS B (18 sec.)	LOS B (17 sec.)	LOS B (19 sec.)	LOS B (16 sec.)
Northbound Ramps	LOS F (>80 sec.)	LOS C (24 sec.)	LOS A (8 sec.)	LOS B (16 sec.)	LOS A (8 sec.)	LOS B (15 sec.)
East Frontage Road	LOS F (>80 sec.)	LOS F (>80 sec.)	LOS A (9 sec.)	LOS B (12 sec.)	LOS A (10 sec.)	LOS B (13 sec.)

1. This intersection analyzed with stop-sign control.

LOS X – Level of service

- Average delay in seconds per vehicle