SECTION 4
MOTOR VEHICLE OPERATIONS

4.01 SUMMARY OF OPERATIONAL ANALYSIS

Congestion on the Beltline occurs in both directions during the morning and evening peak periods. During the morning peak hour, congestion is worse in the westbound direction particularly from I-39 west to South Towne with speeds routinely dropping to 20 miles per hour (mph) or less. West of South Towne speeds vary from about 20 to 40 mph to Verona Road. During the evening peak hour, congestion is worse in the eastbound direction with rolling queues apparent from Whitney Way east to Monona Drive where speeds routinely drop below 30 mph.

There are several locations that trigger congestion for the whole corridor. These “bottlenecks” are typically a result of high ramp traffic volumes merging into already high traffic volumes on the Beltline. The resulting weaving and high density of vehicles leads to slow to stopped speeds on the mainline which produces a shockwave or rolling queue of vehicles that negatively impacts operations upstream of the bottleneck. Locations during the morning peak hour that trigger congestion include the Park Street, South Towne Drive, and US 51/Stoughton Road interchanges. Similarly, during the evening peak hour, the John Nolen Drive eastbound freeway merge and Todd Drive westbound freeway merge experience substantial congestion. Extensive queueing is also observed on many exit ramps and arterials in the morning and evening peak hours throughout the study area, with some queues occasionally reaching the Beltline mainline.

4.02 BELTLINE FREEWAY OPERATIONS

Level of Service (LOS) is a measure of congestion that ranges from LOS A (no congestion) to LOS F (severe congestion). For corridors such as the Beltline, WisDOT has established LOS D in the future design year as the acceptable LOS threshold. Freeway (LOS) is defined by the average density of passenger cars per lane per mile (pcplpm) for a corridor. In the WisDOT Facilities Development Manual (FDM), LOS along highways is defined by an alpha scale and an alphanumeric scale. The thresholds of LOS for each type freeway segment are shown in Table 4.02-1. Generally densities exceeding 35 passenger cars/mile/lane lead to reduced travel speeds and ultimately unstable traffic flow where minor events/incidents can cause a total breakdown.

Figure 4.02-1 Aerial image of Stoughton Road and Beltline

A. <u>Beltline Freeway Densities</u>

Time lapse aerial photography (TLAP) used 16 cameras to photograph the length of the Beltline once every second for 90 minutes during the morning and evening peak periods of a single day in September 2012 along the Beltline corridor. These photos were used to determine freeway densities by counting the number of vehicles on the Beltline from end to end in each direction, and dividing each total by the average number of lanes. Separate densities were calculated for each of the 16 interchange to interchange sections on the Beltline form Airport Road to I-39/90 multiple times in both the AM and PM 90-minute flight windows. The photos and calculated densities show the heaviest congestion westbound during the morning peak hour and eastbound during the evening peak hour. An example of the photos taken during the flight can be seen in Figure 4.02-1.

LOS	Density (passenger cars/mile/lane)			
	Basic	Merge/Diverge	Freeway Weaving	Typical Roadway Conditions
A	0-11	0-10	0-10	Primarily free-flow operations
B	11-18	10-20	10-20	Ability to maneuver in traffic is slightly restricted
C	18-26	20-28	20-28	Stable operations with ability to maneuver being restricted
Low-D	26-30.5	28-31.5	28-31.5	Small increases in traffic volumes may cause substantial increases in delay
Mid-D	30.5	31.5	31.5	
High-D	30.5-35	31.5-35	31.5-35	
E	35-45	> 35	> 35	Significant delay and poor travel speeds can be expected
F	Demand exceeds capacity, > 45	Demand exceeds capacity	Demand exceeds capacity	Delays are unacceptable for most drivers

Table 4.02-1 HCM 2010 Freeway Segment LOS Thresholds

The TLAP data was broken up into 15-minute intervals. A summary of the freeway densities observed along the Beltline can be found in Tables 4.02-2 and 4.02-3. The highest 15-minute density is reported for each segment. Eighteen of the thirty two total sections on the Beltline had densities exceeding the 45 pcplpm threshold (LOS F operations) eastbound or westbound during the AM or PM peak periods.

1. AM Peak Hour

The heaviest densities during the data collection period were during the AM peak period. Westbound densities between I-39/90 and the Beltline and Stoughton Road interchange reached 143 pcplpm. This is more than three times the density threshold for LOS F in the *Highway Capacity Manual*. Figure 4.02-2 displays a summary of the highest 15-minute density for each segment during the AM collection period.

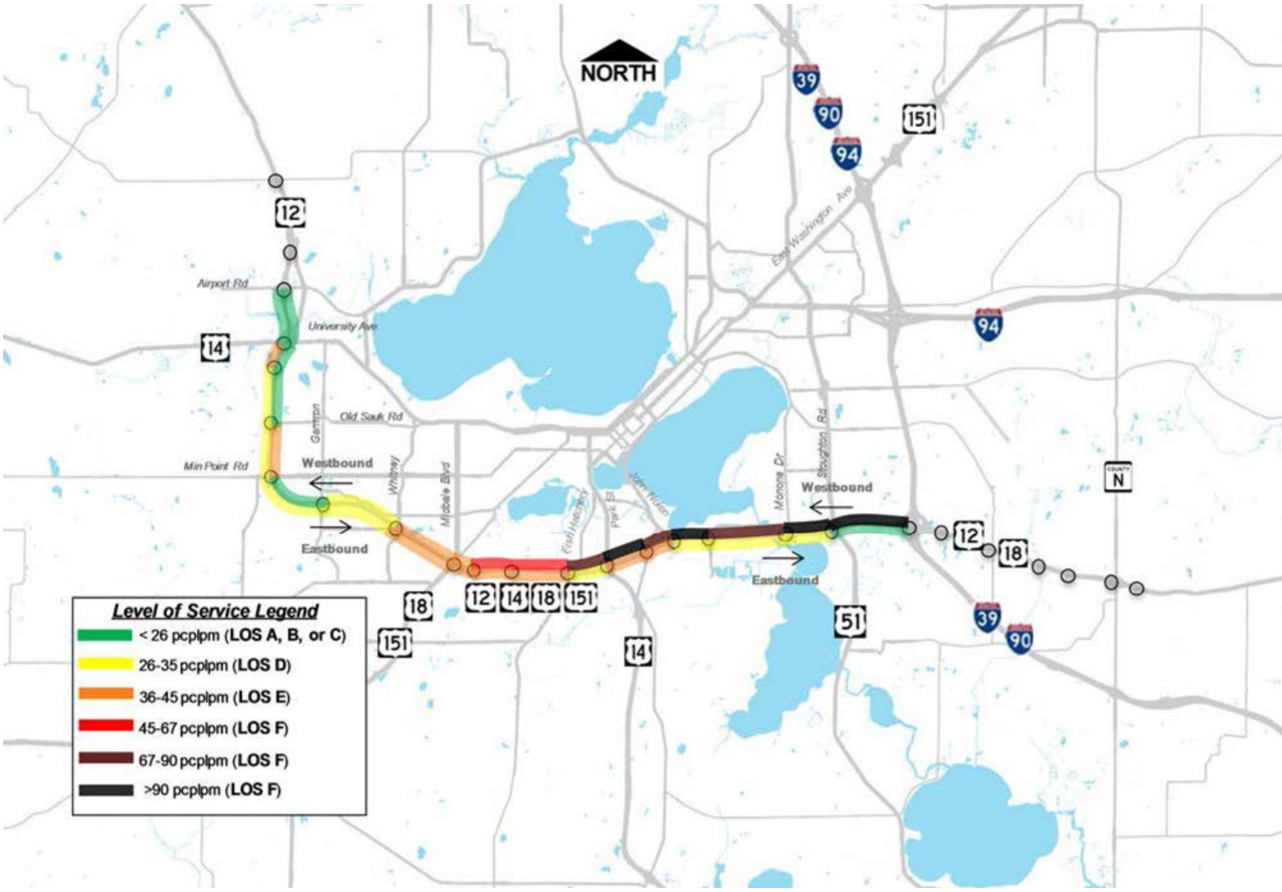


Figure 4.02-2 AM Highest 15-Minute Period Density and LOS

a. Eastbound segments that experience LOS E or F are listed west to east below with the respective highest average 15-minute density experienced.

- University Avenue to Greenway Boulevard, 44 pcplpm (LOS E)
- Whitney Way to Midvale Boulevard, 43 pcplpm (LOS E)
- Midvale Boulevard to Seminole Highway, 37 pcplpm (LOS E)
- Seminole Highway to Fish Hatchery Road, 39 pcplpm (LOS E)
- Park Street to Rimrock Road, 36 pcplpm (LOS E)
- Rimrock Road to John Nolen Drive, 39 pcplpm (LOS E)

b. Westbound segments that experience LOS E or F are listed west to east below with the respective highest average 15-minute density experienced.

- Old Sauk Road to Mineral Point Road, 39 pcplpm (LOS E)
- Whitney Way to Midvale Boulevard, 37 pcplpm (LOS E)
- Midvale Boulevard to Seminole Highway, 45 pcplpm (LOS E)
- Seminole Highway to Fish Hatchery Road, 51 pcplpm (LOS F)
- Fish Hatchery Road to Park Street, 84 pcplpm (LOS F)
- Park Street to Rimrock Road, 92 pcplpm (LOS F)

- Rimrock Road to John Nolen Drive, 84 pcplpm (LOS F)
- John Nolen Drive to South Towne Drive, 93 pcplpm (LOS F)
- South Towne Drive to Monona Drive, 83 pcplpm (LOS F)
- Monona Drive to US 51 (Stoughton Road), 129 pcplpm (LOS F)
- US 51 (Stoughton Road) to I-39/90, 143 pcplpm (LOS F)

2. PM Peak Hour

During the PM data collection period, the eastbound Beltline experienced heavy delays and high densities. The heavy congestion starts at Monona Drive and continues back (upstream) to Gammon Road. Overall in the westbound direction, the highest densities occurred in the stretch from Seminole Highway back to east of Park Street. Figure 4.02-3 displays a summary of the highest 15-minute density for each segment during the PM collection period.

Figure 4.02-3 PM Highest 15-Minute Period Density and LOS

a. Eastbound segments that experience LOS E or F are listed west to east below with the respective highest average 15-minute density experienced.

- Old Sauk Road to Mineral Point Road, 47 pcplpm (LOS F)
- Gammon Road to Whitney Way, 75 pcplpm (LOS F)

- Whitney Way to Midvale Boulevard, 68 pcplpm (LOS F)
- Midvale Boulevard to Seminole Highway, 74 pcplpm (LOS F)
- Seminole Highway to Fish Hatchery Road, 73 pcplpm (LOS F)
- Fish Hatchery Road to Park Street, 79 pcplpm (LOS F)
- Park Street to Rimrock Road, 80 pcplpm (LOS F)
- Rimrock Road to John Nolen Drive, 80 pcplpm (LOS F)
- John Nolen Drive to South Towne Drive, 78 pcplpm, (LOS F)
- South Towne Drive to Monona Drive, 53 pcplpm, (LOS F)

b. Westbound segments that experience LOS E or F are listed west to east below with the respective highest average 15-minute density experienced.

- Whitney Way to Midvale Boulevard, 38 pcplpm (LOS E)
- Seminole Highway to Fish Hatchery Road, 59 pcplpm (LOS F)
- Fish Hatchery Road to Park Street, 68 pcplpm (LOS F)
- Park Street to Rimrock Road, 42 pcplpm (LOS E)

The AM and PM observed freeway densities in 15-minute intervals can be seen in Tables 4.02-2 and 4.02-3. The tables illustrate that congestion predominantly occurs in the westbound direction during the morning peak hour and in the eastbound direction during the evening peak hour. More detailed observed density tables of the Beltline are located in Appendix A for the AM and PM peak hours.

Beltline (US 12 / US 14)
Level-of-Service (Density)
September 11, 2012 (Morning)

MORNING

WESTBOUND

Time	Airport Rd – University Ave	University Ave – Greenway Bld	Greenway Bld – Old Sauk Rd	Old Sauk Rd – Mineral Point Rd	Mineral Point Rd – Gammon Rd	Gammon Rd – Whitney Way	Whitney Way – Verona Road	Verona Road – Seminole Hwy
7:00 a.m.	A (5)	B (15)	B (12)	B (14)	B (14)	C (20)	C (26)	E (45)
7:15 a.m.	A (6)	B (17)	C (19)	B (18)	B (17)	C (21)	C (24)	D (33)
7:30 a.m.	A (8)	B (17)	C (24)	D (29)	C (20)	C (21)	D (29)	E (38)
7:45 a.m.	A (7)	B (18)	C (25)	E (39)	D (30)	D (35)	D (35)	D (30)
8:00 a.m.	A (11)	A (10)	C (25)	C (26)	B (17)	D (34)	C (22)	E (36)
8:15 a.m.	A (6)	B (14)	C (20)	C (21)	C (20)	C (24)	E (37)	D (35)

Time	Seminole Hwy – Fish Hatchery Rd	Fish Hatchery Rd – Park St	Park St – Rimrock Rd	Rimrock Rd – John Nolen Rd	John Nolen Rd – South Towne Dr	South Towne Dr – Monona Dr	Monona Dr – US 51 (Stoughton Rd)	US 51 (Stoughton Rd) – I-39
7:00 a.m.	D (33)	D (33)	D (27)	B (14)	C (24)	E (43)	F (63)	E (42)
7:15 a.m.	F (51)	F (84)	F (46)	D (34)	D (32)	F (50)	F (90)	F (82)
7:30 a.m.	E (43)	F (84)	F (84)	F (79)	F (93)	F (61)	F (86)	F (108)
7:45 a.m.	E (44)	F (80)	F (92)	F (84)	F (82)	F (68)	F (129)	F (143)
8:00 a.m.	F (49)	F (68)	F (80)	F (57)	F (52)	F (63)	F (107)	F (132)
8:15 a.m.	D (33)	F (56)	F (78)	F (76)	F (82)	E (44)	F (69)	F (78)

BELTLINE

EASTBOUND

Time	Airport Rd – University Ave	University Ave – Greenway Bld	Greenway Bld – Old Sauk Rd	Old Sauk Rd – Mineral Point Rd	Mineral Point Rd – Gammon Rd	Gammon Rd – Whitney Way	Whitney Way – Verona Road	Verona Road – Seminole Hwy
7:00 a.m.	B (13)	B (17)	B (17)	C (19)	A (10)	B (17)	C (25)	B (16)
7:15 a.m.	D (28)	A (10)	D (33)	B (15)	C (19)	D (27)	D (33)	D (27)
7:30 a.m.	C (22)	C (26)	D (30)	B (13)	C (26)	D (30)	D (31)	D (28)
7:45 a.m.	C (22)	C (22)	D (34)	C (25)	C (22)	D (27)	E (43)	E (37)
8:00 a.m.	B (13)	E (44)	D (30)	D (27)	C (22)	C (25)	C (22)	D (28)
8:15 a.m.	A (10)	E (40)	C (23)	C (19)	D (29)	C (23)	C (23)	C (25)

Time	Seminole Hwy – Fish Hatchery Rd	Fish Hatchery Rd – Park St	Park St – Rimrock Rd	Rimrock Rd – John Nolen Rd	John Nolen Rd – South Towne Dr	South Towne Dr – Monona Dr	Monona Dr – US 51 (Stoughton Rd)	US 51 (Stoughton Rd) – I-39
7:00 a.m.	B (18)	B (14)	C (20)	C (20)	C (24)	C (19)	A (10)	B (14)
7:15 a.m.	C (25)	C (25)	C (26)	D (31)	C (26)	C (22)	C (21)	B (17)
7:30 a.m.	D (29)	C (21)	E (36)	E (39)	C (26)	C (24)	A (10)	B (16)
7:45 a.m.	E (39)	C (26)	D (30)	D (31)	D (32)	D (27)	B (17)	B (17)
8:00 a.m.	E (36)	D (31)	D (35)	C (21)	C (25)	C (24)	C (19)	B (14)
8:15 a.m.	D (28)	C (19)	C (26)	C (23)	B (14)	C (23)	D (34)	B (18)

LEGEND

COLORS	DENSITY
(white)	< 35 pcplpm
yellow	35-45
orange	> 45-60
red	> 60

Table 4.02-2 AM Observed Beltline Densities and LOS

Beltline (US 12 / US 14)
Level-of-Service (Density)
September 11, 2012 (Evening)

EVENING

WESTBOUND (←)

Time	Airport Rd – University Ave	University Ave – Greenway Bld	Greenway Bld – Old Sauk Rd	Old Sauk Rd – Mineral Point Rd	Mineral Point Rd – Gammon Rd	Gammon Rd – Whitney Way	Whitney Way – Verona Road	Verona Road – Seminole Hwy	Seminole Hwy – Fish Hatchery Rd	Fish Hatchery Rd – Park St	Park St – Rimrock Rd	Rimrock Rd – John Nolen Rd	John Nolen Rd – South Towne Dr	South Towne Dr – Monona Dr	Monona Dr – US 51 (Stoughton Rd)	US 51 (Stoughton Rd) – I-39
3:45 p.m.	B (16)	C (24)	C (21)	A (9)	B (17)	C (24)	C (26)	D (31)	D (28)	D (30)	E (36)	D (32)	D (30)	C (23)	B (15)	B (15)
4:00 p.m.	A (10)	D (35)	B (13)	C (22)	B (16)	B (16)	D (29)	B (15)	D (27)	C (20)	C (26)	C (23)	C (24)	C (21)	C (19)	A (10)
4:15 p.m.	B (17)	C (19)	C (20)	C (26)	C (20)	C (24)	E (38)	D (29)	C (23)	D (27)	C (25)	C (26)	C (22)	D (27)	C (21)	B (13)
4:30 p.m.	C (21)	C (23)	C (24)	D (27)	B (18)	D (28)	D (28)	D (27)	D (31)	C (20)	E (38)	B (16)	C (19)	C (22)	B (14)	B (15)
4:45 p.m.	C (20)	D (28)	C (26)	C (26)	C (25)	D (28)	D (28)	D (29)	F (57)	E (39)	E (37)	B (17)	D (33)	C (19)	D (27)	A (11)
5:00 p.m.	B (12)	C (24)	D (29)	C (24)	B (18)	D (32)	D (30)	D (30)	F (59)	F (68)	E (42)	C (21)	C (25)	C (25)	B (13)	A (10)

EASTBOUND (→)

Time	Airport Rd – University Ave	University Ave – Greenway Bld	Greenway Bld – Old Sauk Rd	Old Sauk Rd – Mineral Point Rd	Mineral Point Rd – Gammon Rd	Gammon Rd – Whitney Way	Whitney Way – Verona Road	Verona Road – Seminole Hwy	Seminole Hwy – Fish Hatchery Rd	Fish Hatchery Rd – Park St	Park St – Rimrock Rd	Rimrock Rd – John Nolen Rd	John Nolen Rd – South Towne Dr	South Towne Dr – Monona Dr	Monona Dr – US 51 (Stoughton Rd)	US 51 (Stoughton Rd) – I-39
3:45 p.m.	A (7)	C (22)	C (25)	B (18)	C (26)	D (28)	C (24)	E (36)	E (37)	D (30)	E (36)	E (36)	D (35)	E (36)	D (28)	C (26)
4:00 p.m.	A (5)	B (13)	C (24)	C (24)	B (16)	C (21)	C (24)	E (42)	F (53)	D (31)	C (25)	C (25)	D (29)	D (34)	C (20)	D (30)
4:15 p.m.	A (11)	B (14)	C (20)	C (22)	D (30)	E (37)	F (59)	F (74)	F (63)	D (30)	D (28)	D (28)	D (35)	E (41)	D (29)	C (24)
4:30 p.m.	B (16)	A (8)	B (15)	C (22)	B (16)	F (56)	F (68)	F (56)	F (59)	C (25)	D (35)	D (35)	F (78)	F (53)	B (17)	C (21)
4:45 p.m.	A (11)	B (12)	B (18)	F (47)	C (25)	F (75)	F (60)	D (34)	F (73)	F (57)	F (80)	F (80)	F (87)	E (45)	C (25)	C (25)
5:00 p.m.	A (9)	B (17)	C (24)	C (21)	B (16)	C (20)	F (57)	D (33)	F (72)	F (78)	F (71)	F (71)	F (81)	F (47)	C (22)	B (16)

LEGEND

COLORS	DENSITY
(white)	< 35 pcplpm
yellow	35-45
orange	> 45-60
red	> 60

Table 4.02-3 PM Observed Beltline Densities and LOS

B. <u>Factors and Constraints Contributing to Congestion</u>

Using TLAP imagery, the Beltline was reviewed for bottlenecks that have a significant impact on mainline operations. In general, these observed bottlenecks coincide with interchanges that experience heavy on-ramp traffic volumes that are merging onto the Beltline that in turn cause operations breakdowns because of increased densities and weaving movements. Figure 4.02-4 shows the on-ramp volumes for Beltline interchanges for the morning peak hour, and Figure 4.02-9 shows ramp volumes for the evening peak hour. Although large portions of the Beltline experience LOS F, the bottlenecks are particularly problematic with vehicle densities up to three times the LOS F threshold of 45 pcplpm.

1. AM Peak Hour

During the AM peak hour, the westbound Beltline is generally heavily congested with rolling queues and high traffic densities (LOS F) from the Verona Road interchange east to I-39/90. Conversely, eastbound traffic generally experiences steady flow with relatively lower densities with no bottlenecks and no locations experiencing LOS F. As mentioned, Figure 4.02-4 summarizes the entering ramp volumes for each interchange along the Beltline in the AM peak hour.

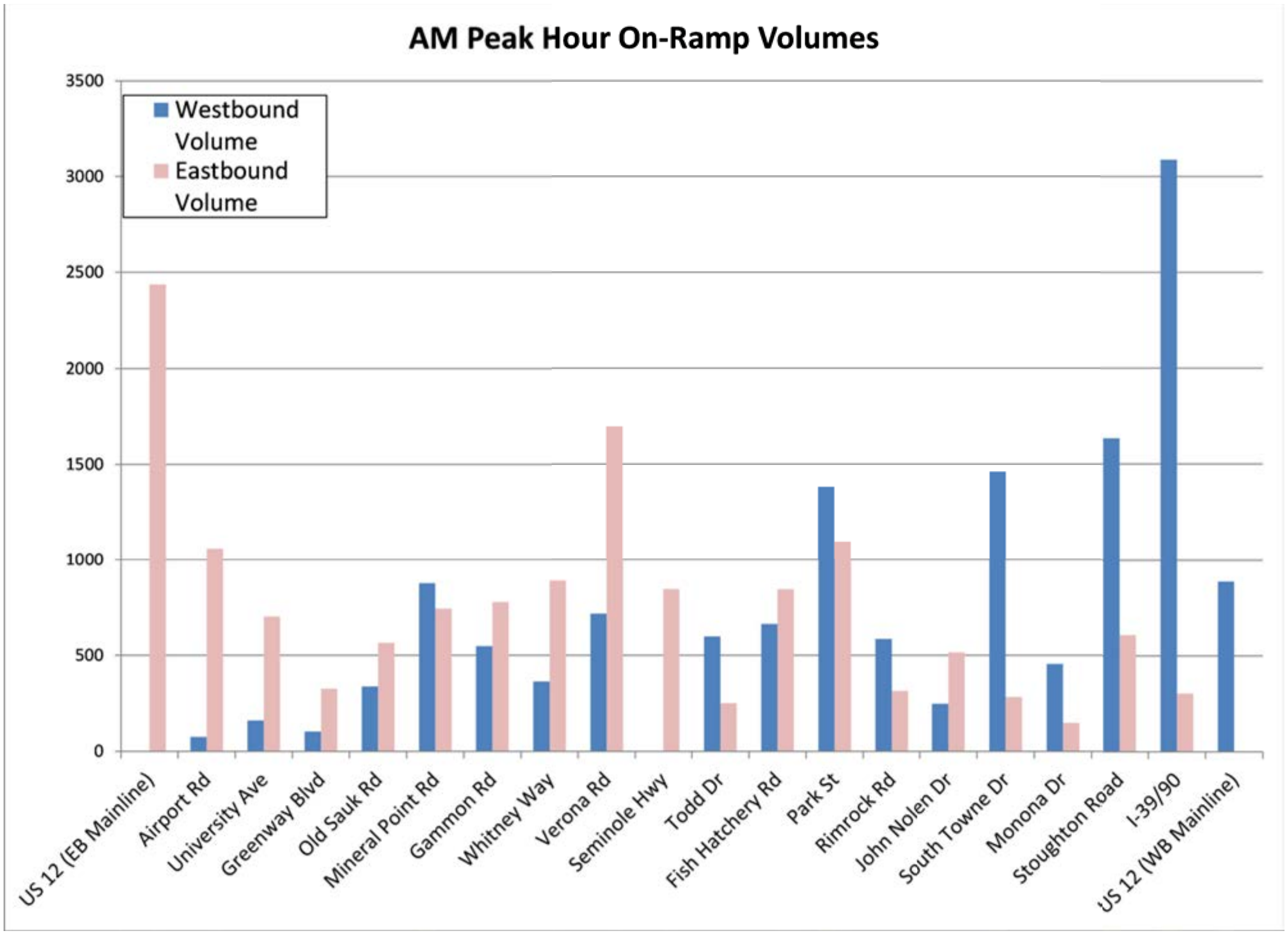


Figure 4.02-4 AM Peak Hour On-Ramp Volumes

Four service interchanges have substantially higher on-ramp volumes when compared to other locations. For westbound AM traffic, the interchanges of Park Street, South Towne Drive, and Stoughton Road each have on-ramp volumes around 1,500 vehicles per hour (vph) or greater. For comparison, the typical capacity of a single freeway lane is about 1,800 to 2,100 vph. At these on-ramp locations, there is essentially a full freeway lane's worth of capacity merging onto the Beltline, causing dramatic density increases along with decreases in speed.

For the eastbound Beltline in the AM peak hour the Verona Road interchange has the highest on-ramp volume with 1,700 vph entering. However this entering volume receives its own lane on the Beltline as eastbound through lanes increase from two to three at this location. The following paragraphs summarize the operations at high volume interchange on-ramps:

a. Park Street AM–Westbound

During the AM peak, the high merging/weaving volume of the northbound-to-westbound on-ramp at the Park Street interchange in conjunction with heavy Beltline volume produce a noticeable density increase that impedes traffic flow throughout the majority of the AM peak hour. Figure 4.02-5 below shows an aerial image of the Park Street interchange at 7:36 A.M. in September 2012 and illustrates the observed congestion that is typical at this location during the AM peak hour.

The northbound-to-westbound Park Street on-ramp enters into a 2,100-foot auxiliary lane that extends to the westbound Fish Hatchery Road off-ramp. Observed densities at this location on the westbound Beltline are approximately 100 pcplpm, which is more than double the LOS F threshold.

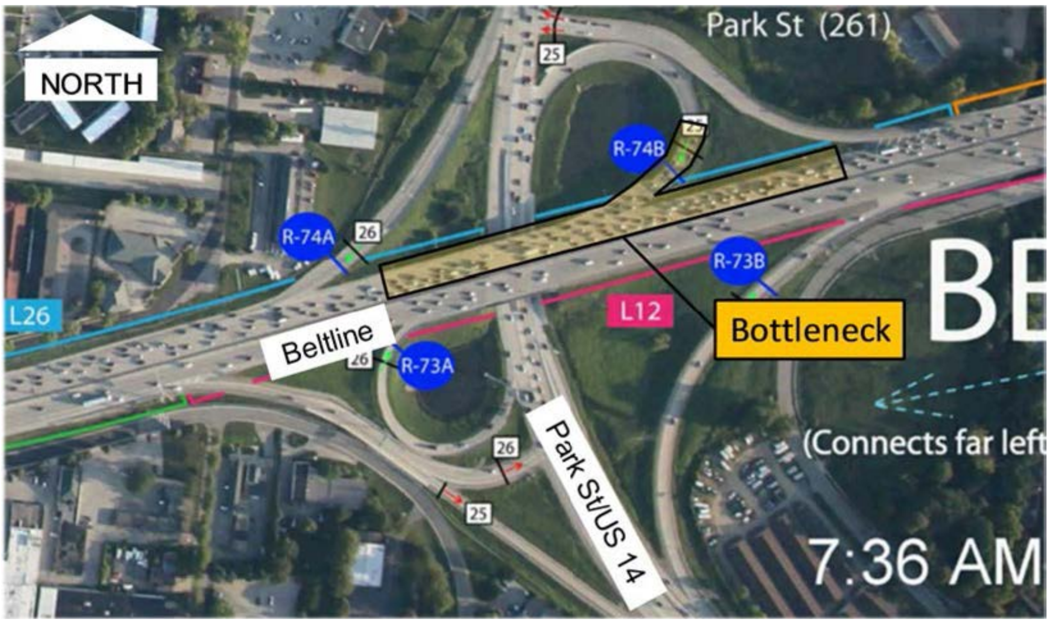


Figure 4.02-5 Westbound Beltline Bottleneck at Park Street

The downstream interchanges of Todd Drive (westbound on-ramp) and Verona Road (westbound off-ramp) begin to experience increased congestion because of queuing vehicles at the Verona Road westbound off-ramp and merging/weaving traffic from the Todd Drive westbound on-ramp. Once the Park Street interchange begins to experience increased congestion, the congestion in effect meters traffic, decreasing downstream volumes. This causes the operational issues/unstable flow downstream at Todd Drive and Verona Road to be relieved. The bottleneck at Park Street meters westbound Beltline traffic to the point where operations at downstream interchanges see benefit. These observations suggest that if the bottleneck at the Park Street interchange were removed, it is possible that downstream interchanges (such as Todd Drive or Verona Road) would experience increased congestion. It should be noted that even with the metering of traffic at Park Street, the westbound Beltline from Fish Hatchery Road to Verona Road is still at or near the LOS F threshold, yet it flows at speeds of 30 mph to 40 mph.

Interchanges upstream (to the east) are impacted by the westbound rolling queues/ congestion at Park Street. The westbound Beltline at Rimrock Road, John Nolen Drive and South Towne Drive experiences increased densities because of the congestion and rolling queues that propagate upstream from the Park Street interchange.

b. South Towne Drive AM–Westbound

Similar to the Park Street interchange, during the AM peak hour, the high merging/weaving volume of the westbound on-ramp at the South Towne Drive interchange in conjunction with heavy volume on the Beltline produce a noticeable density increase that is present throughout the majority of the AM peak hour. Figure 4.02-6 shows an aerial image of the South Towne Drive interchange at 7:34 A.M. in September 2012. Contributing to the congestion at South Towne Drive are rolling queues that travel upstream from the congestion present at Park Street.

The westbound South Towne Drive on-ramp enters into a 2,200-foot auxiliary lane that extends to the westbound John Nolen Drive off-ramp. Observed densities at this location on the westbound Beltline are nearly three times the LOS F threshold at approximately 120 pcplpm.

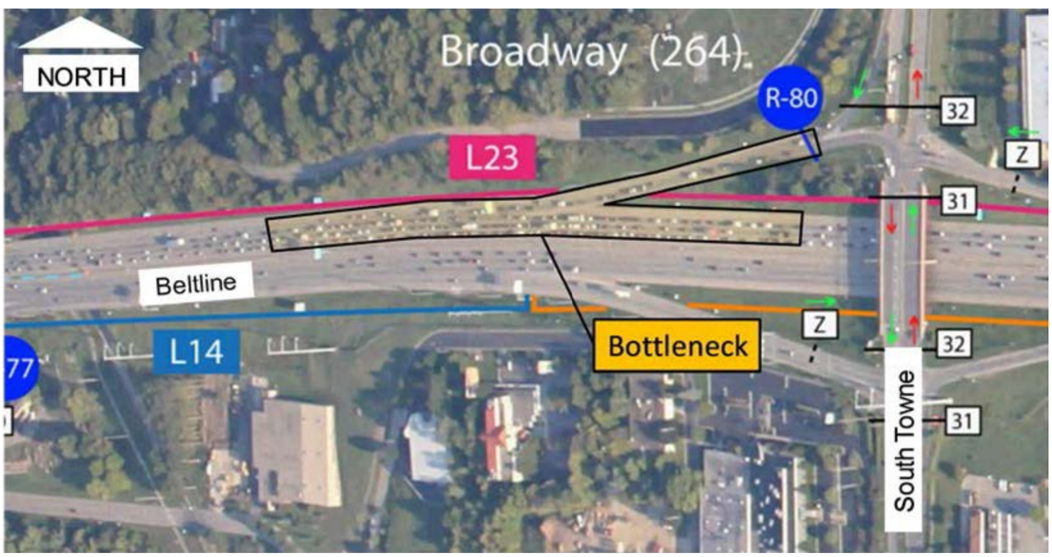


Figure 4.02-6 Westbound Beltline Bottleneck at South Towne

The congestion at the South Towne Drive interchange is not limited to the Beltline. Vehicles coming from the north on Broadway and using the westbound on-ramp to the Beltline regularly queue the full ramp length and onto Broadway.

c. Stoughton Road AM–Westbound

During the AM peak, the Stoughton Road interchange westbound traffic experiences the highest degree of congestion observed in the AM peak hour. The high merging/weaving volume of the westbound on-ramp at Stoughton Road of 1,630 vph in conjunction with heavy volume on the Beltline produce severe densities that are present throughout the majority of the AM peak hour. The congestion sometimes extends upstream to I-39/90. Figure 4.02-7 shows the Stoughton Road interchange at 7:37 A.M. in September 2012.

The westbound Stoughton Road on-ramp enters into a 1,750-foot auxiliary lane that extends to the westbound Monona Drive off-ramp. Densities at this location are around three times the LOS F threshold and approach 130 pcplpm.

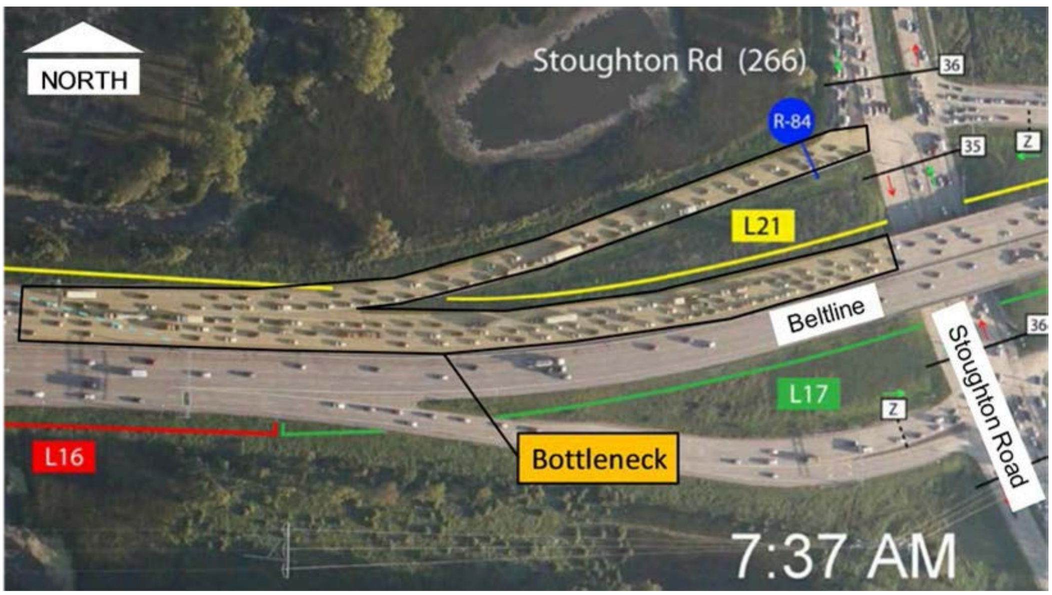


Figure 4.02-7 Westbound Beltline Bottleneck at Stoughton Road

The congestion at the Stoughton Road interchange affects vehicles coming from the north on Stoughton Road and using the westbound on-ramp to the Beltline. These vehicles regularly queue back the full length of the ramp and onto Stoughton Road sometimes blocking the northbound-to-westbound maneuver resulting in green signal time that cannot be fully used at the ramp terminal. Observed delays for vehicles turning onto the westbound on-ramp until they enter the Beltline traffic stream are over one minute.

d. Verona Road AM–Eastbound

During the AM peak hour, the eastbound Beltline at Verona Road experiences densities at LOS E. The eastbound Verona Road on-ramp has one of the highest volumes of any ramp in the AM peak hour with about 1,700 vph. The impacts of this merging traffic are mitigated as the Verona Road eastbound on-ramp enters its own travel lane on the Beltline and the number of eastbound basic lanes increases from two to three. Because of the added lane, there is not a substantial increase in densities. Figure 4.02-8 shows an aerial image of the Verona Road interchange during the AM peak hour and shows the additional lane that is added to the Beltline at this location. Densities at this location on the westbound Beltline are about 40 pcplpm.

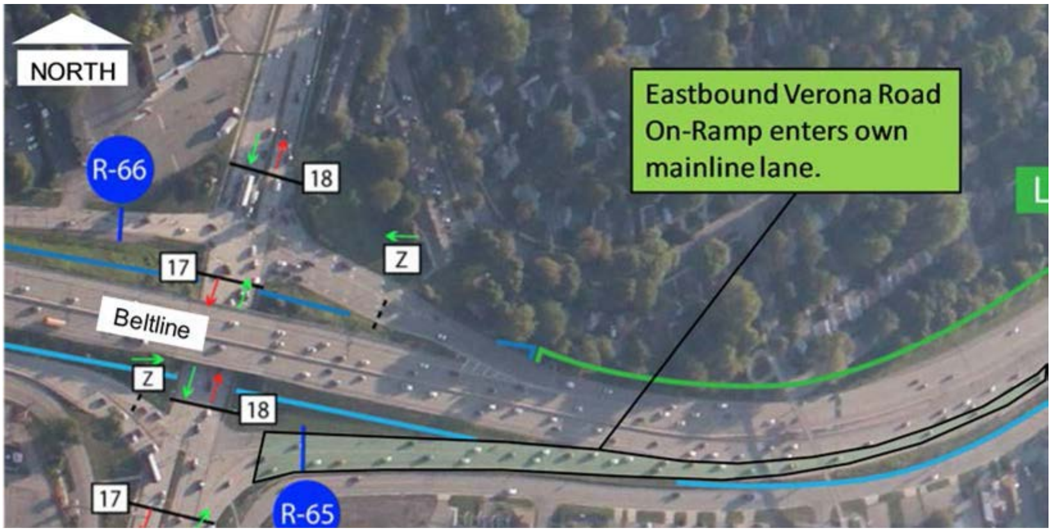


Figure 4.02-8 Eastbound Beltline at Verona Road

2. PM Peak Hour

During the PM peak hour, the eastbound lanes of the Beltline are heavily congested with high traffic densities (LOS F) and occasional rolling queues from the Monona Drive interchange west to the Whitney Way interchange. Congestion occurs, but flow is generally stable and slowdowns are not as severe or sustained as in the AM peak hour. Westbound PM peak-hour traffic has one area of consistent congestion between the Todd Drive on-ramp and Verona Road. This bottleneck impacts the upstream interchanges of Fish Hatchery Road and Park Street. Outside the Todd Drive to Park Street segment, the westbound Beltline generally experiences steady flow with relatively moderate densities when compared to the AM peak hour. Well-defined severe congestion areas such as those in the AM peak hour do not occur in the PM peak hour except at the westbound Todd Drive ramp and eastbound at the John Nolen Drive on-ramp and Park Street on-ramp. Figure 4.02-9 displays a summary of the entering ramp volumes for each interchange along the Beltline in the PM peak hour.

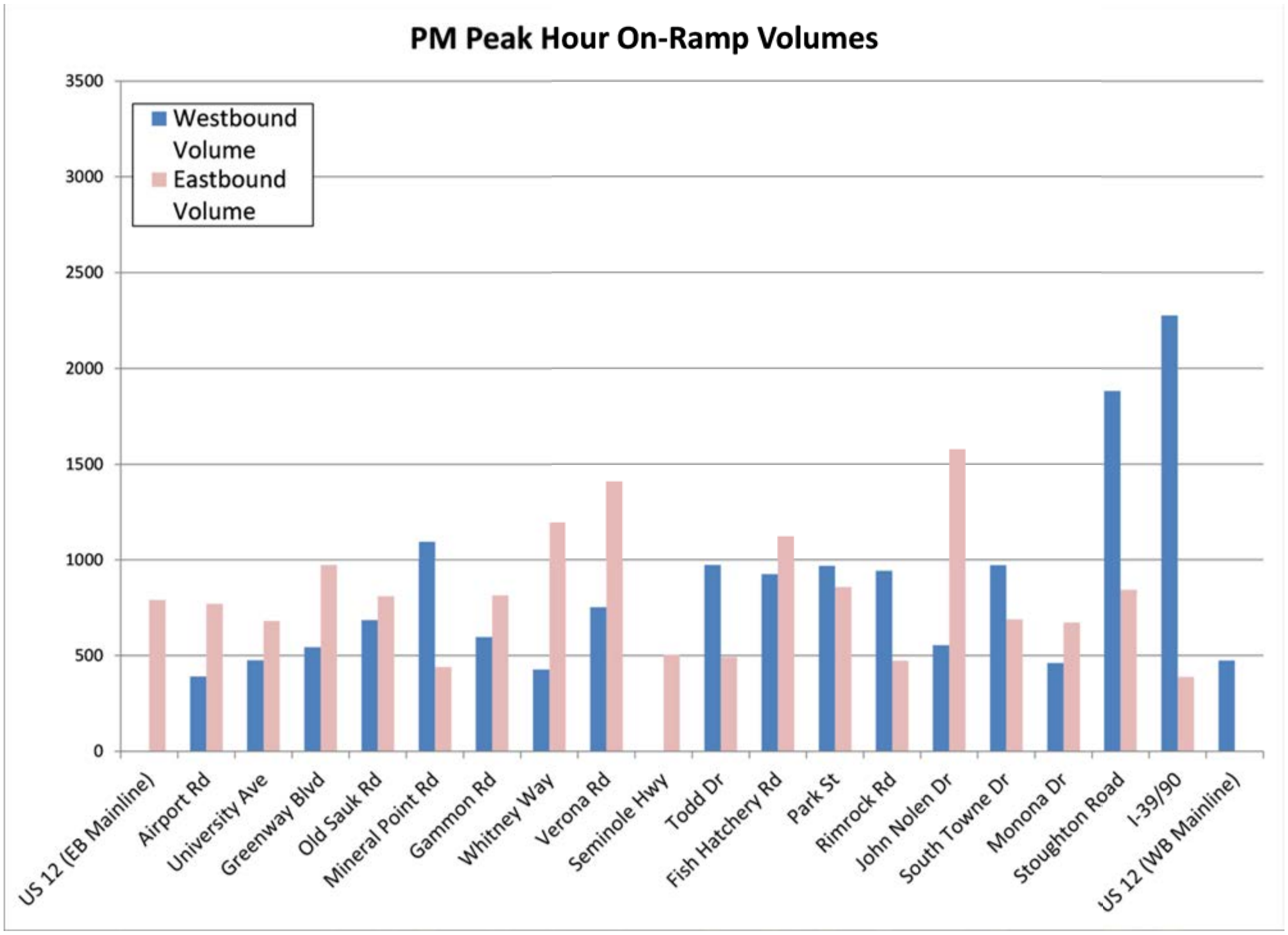


Figure 4.02-9 PM Peak-Hour On-Ramp Volumes

Several interchanges have substantially higher on-ramp volumes. Although not as severe as the AM peak hour, congestion on the Beltline in the areas of these interchanges is influenced by these higher ramp volumes, particularly in the eastbound direction. Again, congestion in the PM peak hour is not as severe or well-defined. For eastbound PM traffic, the interchanges of Whitney Way, Verona Road, and John Nolen Drive each have on-ramp volumes between about 1,250 to 1,500 vph. For comparison, the capacity of a typical freeway lane is about 1,800 to 2,100 vph, so at these on-ramp locations there is about three-quarters to almost a full freeway lane's worth of capacity entering the Beltline. These three interchanges are discussed further.

For the westbound Beltline in the PM peak hour, the Stoughton Road interchange has the highest on-ramp volume of around 1,900 vph. Lower mainline volumes at this location, however, result in densities generally in the LOS C to LOS D range. The Fish Hatchery Road interchange also had high on-ramp volumes of 1,500 vph. This interchange has since been reconstructed with different ramp geometry/configuration. The operation, therefore, could vary from what was observed from the TLAP imagery taken in September 2012. Figure 4.02-10 shows the merging volume of traffic affected by the geometric reconfiguration at Fish Hatchery Road.

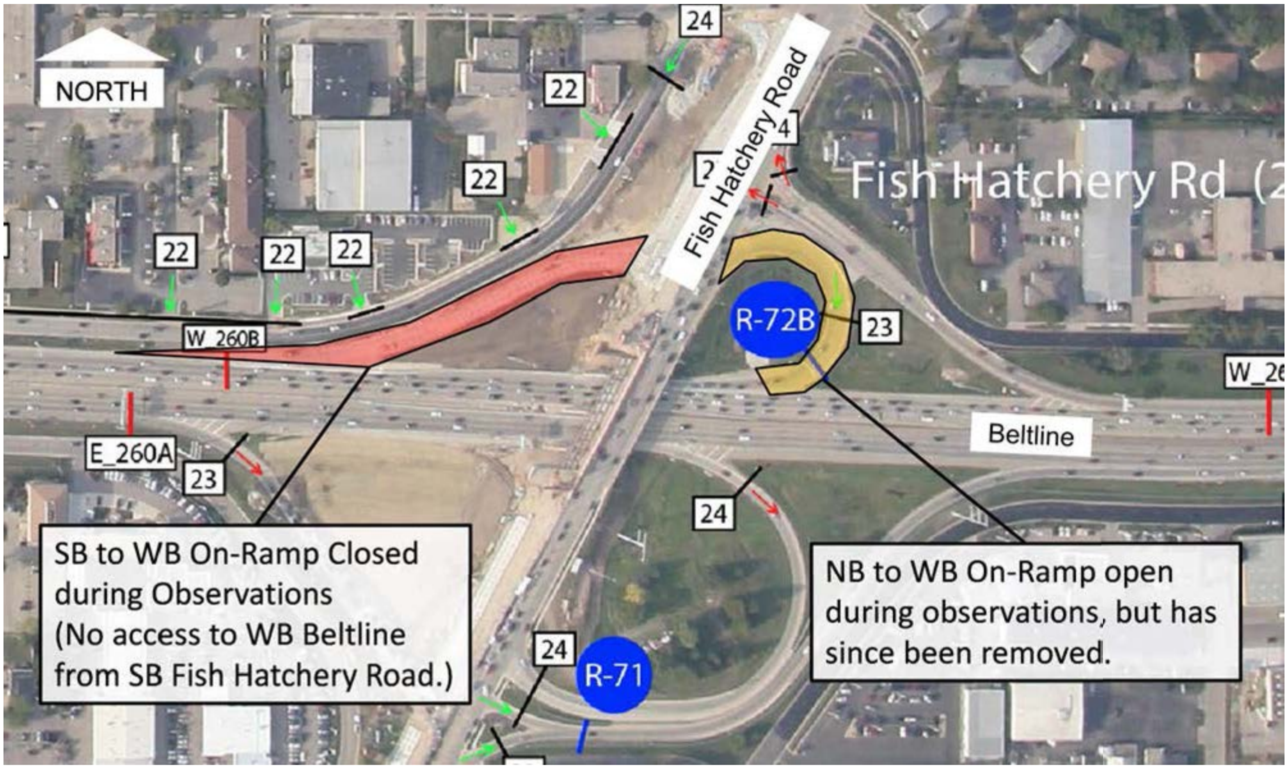


Figure 4.02-10- Fish Hatchery Road Interchange Geometry Modifications

Although not having high on-ramp volumes when compared to other interchanges, the westbound on-ramp at Todd Drive produces noticeable congestion during the PM peak hour that impacts upstream interchanges. The following paragraphs summarize the observed congestion at each of the above locations.

a. Todd Drive PM–Westbound

During the PM peak, the merging/weaving volume of the westbound on-ramp at the Todd Drive interchange in conjunction with heavy volume on the Beltline produce a noticeable density increase that is present from about 4:45 to 5:45 P.M. Figure 4.02-11 shows an aerial image of the Todd Drive interchange at 5:10 P.M. in September 2012. It illustrates the observed congestion that is typical at this location during the PM peak hour.

The westbound Todd Drive on-ramp enters into a 600-foot acceleration lane that does not extend to the next interchange. Densities at this location on the westbound Beltline are approximately 73 pcplpm, which is greater than 1.5 times the LOS F density threshold.

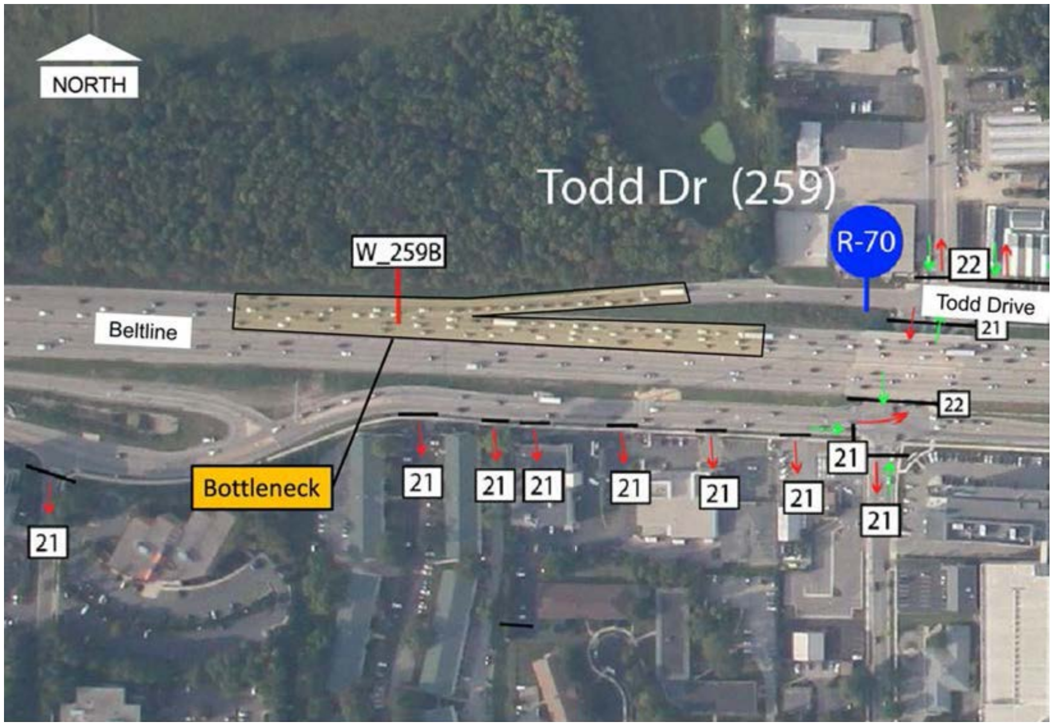


Figure 4.02-11 Westbound Beltline Bottleneck at Todd Drive (PM Peak)

Prior to the congestion and slowdowns at Todd Drive, the downstream Verona Road interchange (westbound off-ramp) begins to experience increased congestion because of westbound queuing at the off-ramp terminal. As with conditions downstream of the congestion at Park Street during the morning peak hour, once the Todd Drive interchange experiences congestion, the downstream operational issues at Verona Road are no longer apparent. This suggests that the Todd Drive congestion is metering westbound Beltline traffic to the point where operations at Verona Road benefit as the traffic is being held up at Todd Drive. These observations suggest that if the bottleneck at the Todd Drive interchange were removed, the downstream interchange of Verona Road would experience increased congestion.

The merging volume on the westbound Todd Drive on-ramp is about 1,000 vph and may have been impacted by the construction (closed ramp) at the Fish Hatchery Road interchange. A contributing factor to the congestion may include the proximity of the Verona Road interchange where the outside mainline travel lane drops. The Verona Road westbound off-ramp likely leads to increased lane use in the outside lane for those vehicles exiting at Verona Road. At this location, the basic number of westbound lanes drops from three to two. Furthermore, the westbound Todd Drive on-ramp traffic not only has to merge into the outside Beltline lane but also has to weave into the middle Beltline lane to avoid the dedicated exit lane at the Verona Road interchange.

Upstream, interchanges to the east are impacted by the westbound rolling queues/congestion at Todd Drive. The westbound Beltline experiences increased congestion at the Fish Hatchery Road and Park Street interchanges because of the congestion and queuing that propagates upstream from the Todd Drive interchange. Although these interchanges contribute to the operational issues, they appear to be significantly impacted by rolling congestion from the Todd Drive Interchange.

Figure 4.02-12 shows an aerial image of the Park Street interchange at 5:10 P.M. in September 2012 and illustrates the congestion that is typical upstream of the Todd Drive interchange all the way to John Nolen Drive from about 5 to 5:45 P.M.

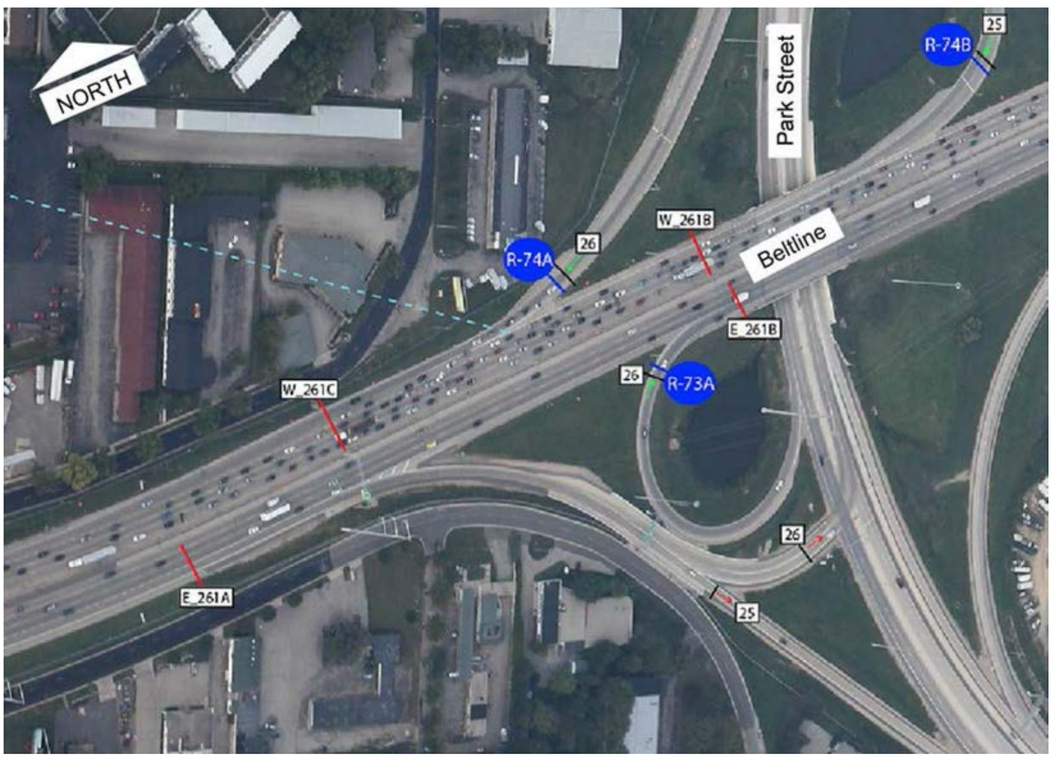


Figure 4.02-12 - Westbound Congestion at Park Street (PM Peak)

b. Stoughton Road PM–Westbound

During the PM peak, the Stoughton Road westbound on-ramp has one of the highest volumes at any interchange with 1,900 vph entering. Observed operations during the PM peak westbound are generally stable and free from congestion. Figure 4.02-13 shows an aerial image of the Stoughton Road interchange at 5 P.M. in September 2012 and illustrates the stable operations and flow that are typical at this location during the PM peak hour.

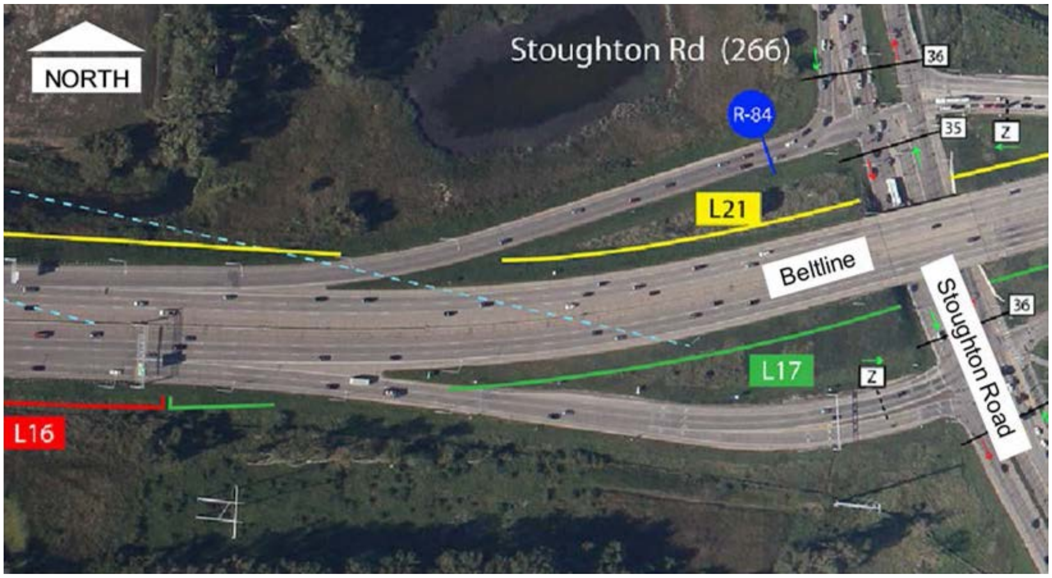


Figure 4.02-13 Stable PM Peak Operations at Stoughton Road (PM Peak)

The westbound Stoughton Road on-ramp enters a 1,750-foot auxiliary lane that extends to the westbound Monona Drive off-ramp. Operations on the Beltline at this location are at LOS D with densities of about 30 pcplpm.

The difference between the stable/LOS D operations in the PM peak and the severe congestion/LOS F operations in the AM peak at Stoughton Road may be attributed to the difference in volume of traffic approaching the Stoughton Road interchange on the westbound Beltline.

In the AM peak, the 1,700 vph volume on the Stoughton Road westbound on-ramp merges with a 4,000 vph volume from US 12/18 and I-39/90 resulting in a total volume of 5,700 vph. If this 5,700 vph volume is distributed evenly over the three Beltline travel lanes, it results in about 1,900 vph for each travel lane, which is about equal to the typical capacity of a freeway lane.

In the PM peak the 1,900 vph volume on the Stoughton Road westbound on-ramp merges with only 2,800 vph volume from US 12/18 and I-39/90 resulting in a total volume of 4,700 vph. This total volume is 1,000 vph less than the AM peak hour. If the 4,700 vph volume is distributed evenly over the three travel lanes, it results in about 1,600 vph for each travel lane, which is below the typical capacity of a freeway lane.

b. Fish Hatchery Road PM–Westbound

During the PM peak hour, the high merging/weaving volume of the westbound Fish Hatchery Road on-ramp in conjunction with heavy volume on the Beltline produce occasional rolling queues; however, severe congestion is not present. Figure 4.02-14 shows an aerial image of the Fish Hatchery Road interchange at 5:08 P.M. in September 2012 and illustrates the observed congestion that is typical at this location during the PM peak hour and appears to be primarily a result of the downstream Todd Drive interchange.

The westbound Fish Hatchery Road on-ramp entered into a 500-foot auxiliary lane during the time the TLAP imagery was taken. The interchange was under construction and access to the westbound Beltline from southbound Fish Hatchery Road was not possible. Observed densities at this location on the westbound Beltline are 1.7 times the LOS F threshold at approximately 79 pcplpm.

Figure 4.02-14 Westbound Beltline Congestion at Fish Hatchery Road (PM Peak)

The congestion at the Fish Hatchery Road interchange could have been affected by the closure of access from southbound Fish Hatchery Road to the westbound Beltline. Observed Beltline operations and densities could have been worse had the interchange not been under restricted access. In addition, prior to construction the interchange had two westbound on-ramps (one for southbound Fish Hatchery Road and one for northbound Fish Hatchery Road), whereas after construction the interchange has only one westbound on-ramp.

c. Park Street PM–Eastbound

During the PM peak hour, the high merging/weaving volume of the southbound-to-eastbound Park Street on-ramp in conjunction with heavy volume on the Beltline produce occasional rolling queues; however, severe congestion is not present. Figure 4.02-15 shows an aerial image of the Park Street interchange at 4:45 P.M. in September 2012 and illustrates the observed congestion that is typical at this location during the PM peak hour and appears to be primarily a result of the heavy on-ramp volumes and congestion downstream at John Nolen Drive.

The southbound-to-eastbound Park Street on-ramp enters into a 3,800-foot auxiliary lane. Observed densities at this location on the westbound Beltline are 1.8 times the LOS F threshold at approximately 80 pcplpm.

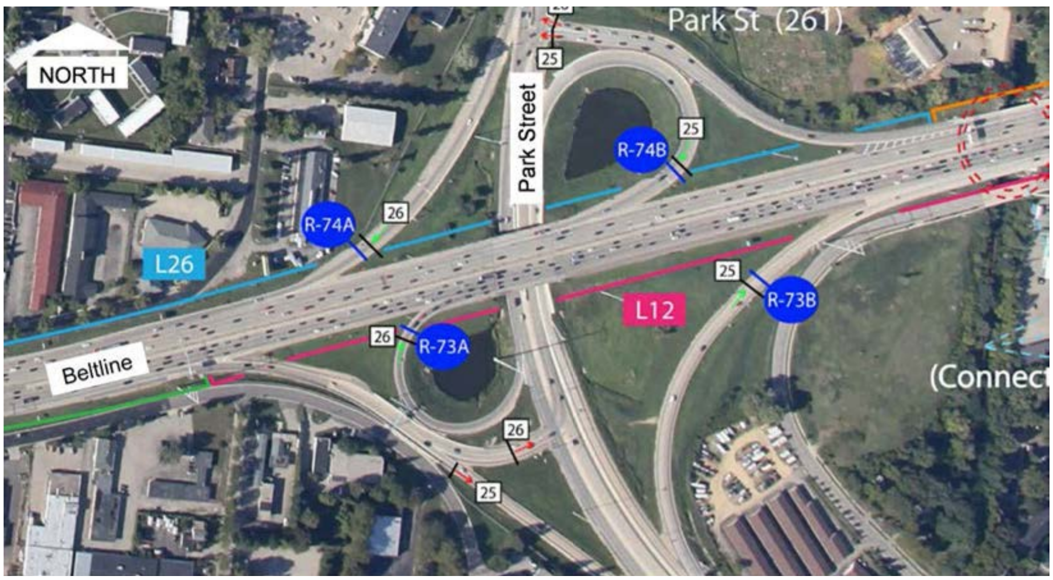


Figure 4.02-15 Eastbound Beltline Congestion at Park Street (PM Peak)

d. John Nolen Drive PM–Eastbound

During the PM peak hour, the high merging/weaving volume of the eastbound John Nolen Drive on-ramp in conjunction with heavy volume on the Beltline produce rolling queues with periods of severe congestion. Figure 4.02-16 shows an aerial image of the John Nolen Drive interchange at 4:40 P.M. in September 2012 and illustrates the observed congestion that is typical at this location during the PM peak hour and appears to be primarily a result of large platoons of vehicles entering the beltline on the eastbound on-ramp.

The eastbound John Nolen Drive on-ramp enters into a 2,100-foot auxiliary lane. Observed densities at this location on the westbound Beltline are 1.7 times the LOS F threshold at approximately 78 pcplpm.

Figure 4.02-16 Eastbound Beltline Congestion at John Nolen Drive (PM Peak)

4.03 TRAVEL TIME

Travel data collected from Bluetooth detectors was used to gather travel time values along the Beltline mainline for different periods during the AM and PM peak hours. These detectors pick up anonymous Bluetooth signals from cars and personal electronics. By matching paired signals, origins, destinations, and travel times (speed), can be obtained. A deployment map of the Bluetooth detectors, as of November 7, 2012, is shown in Figure 4.03-1 and in Appendix B.

Figure 4.03-1 2012 Bluetooth Detector Field Location Map in Madison Area
(September 2012)

Travel time and speed data were reviewed for weekdays occurring in September 2012 along the Beltline from US 51 (Stoughton Road) to US 14 (University Avenue). The data was summarized into two formats. For the purposes of providing speeds between Bluetooth stations on the date of the TLAP flight (September 2012), the Beltline corridor was divided into eight segments from north of the Airport Road/Century Avenue interchange to just west of the I-39/90 interchange. The eight segments vary from 1 mile to nearly 3.5 miles in length. These segments are shown in Figure 4.03-2 for the eastbound and westbound Beltline.

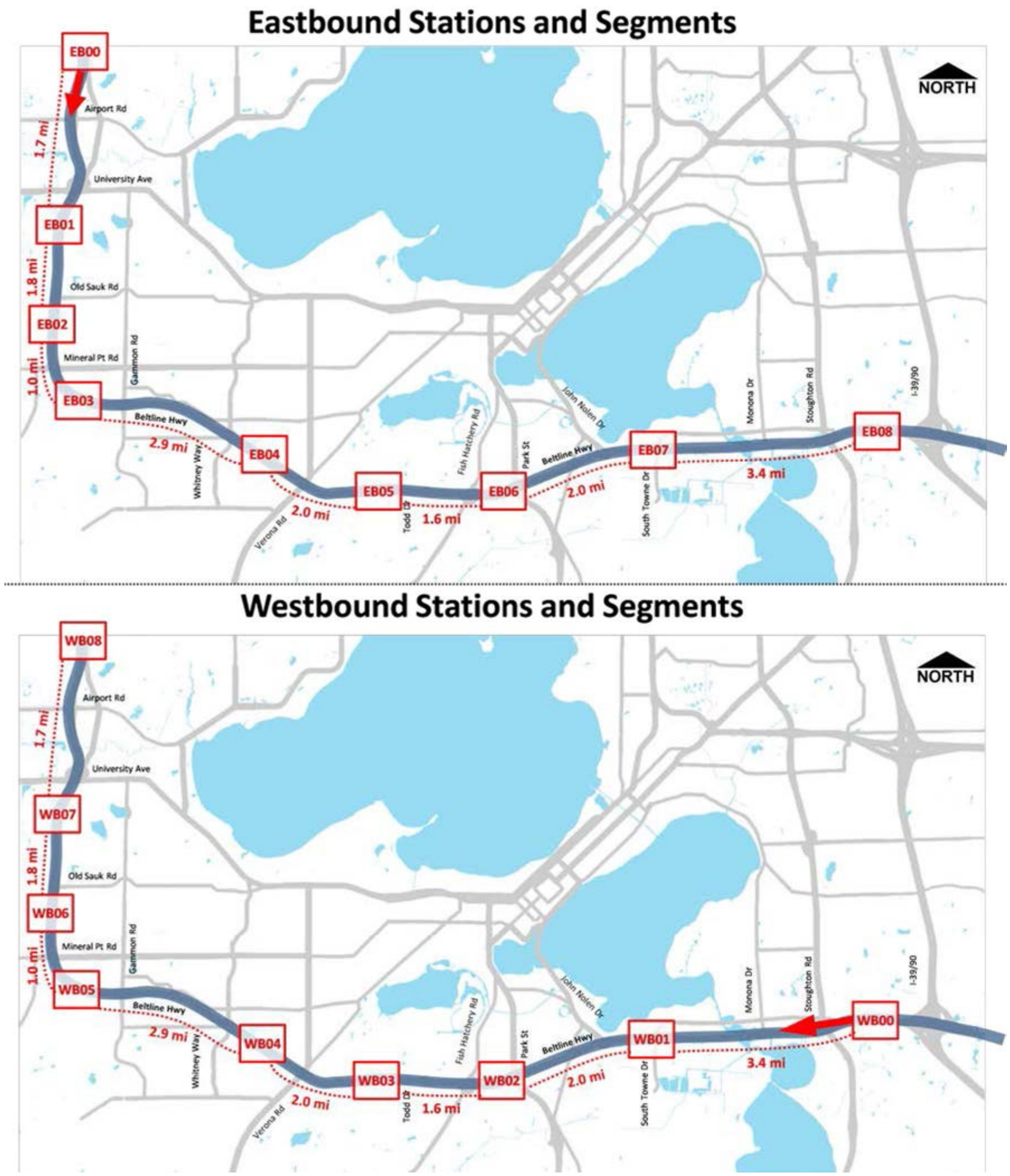


Figure 4.03-2 Beltline Bluetooth Travel Time Segments

Observed speeds were calculated in 15-minute intervals for the AM peak period between 6:30 and 8:30A.M. (8 total intervals) and for the PM peak period between 3:15 and 6:15 P.M. (12 total intervals) on September 11, 2012. These speeds, times, and locations are summarized in Figures 4.03-3 through 4.03-4.

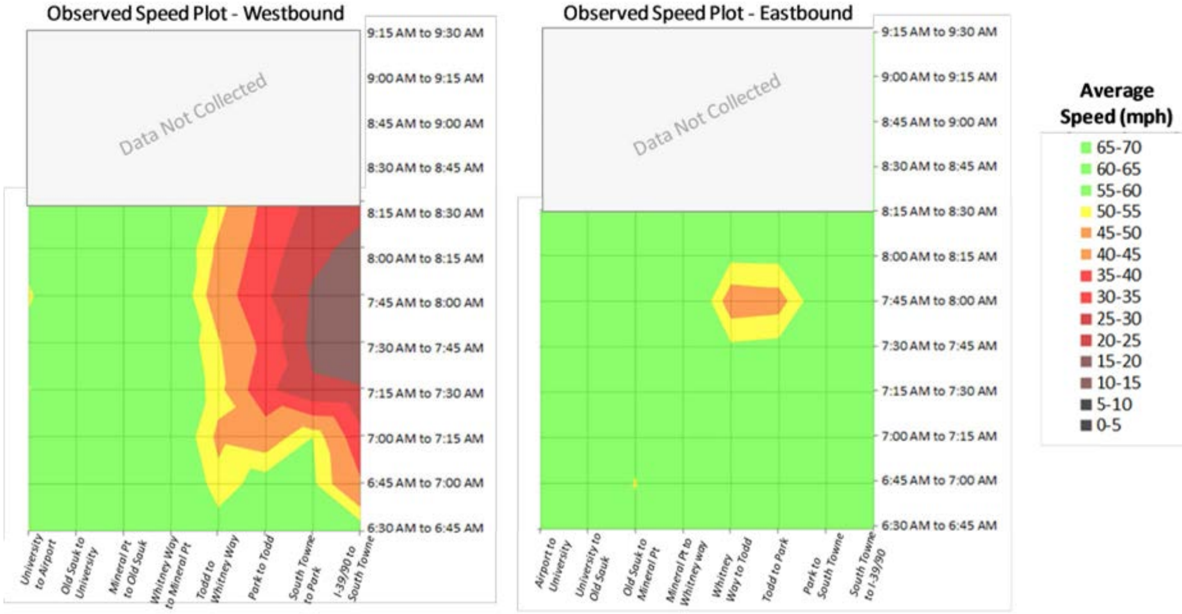


Figure 4.03-3 AM September 2012 Observed Beltline Speeds

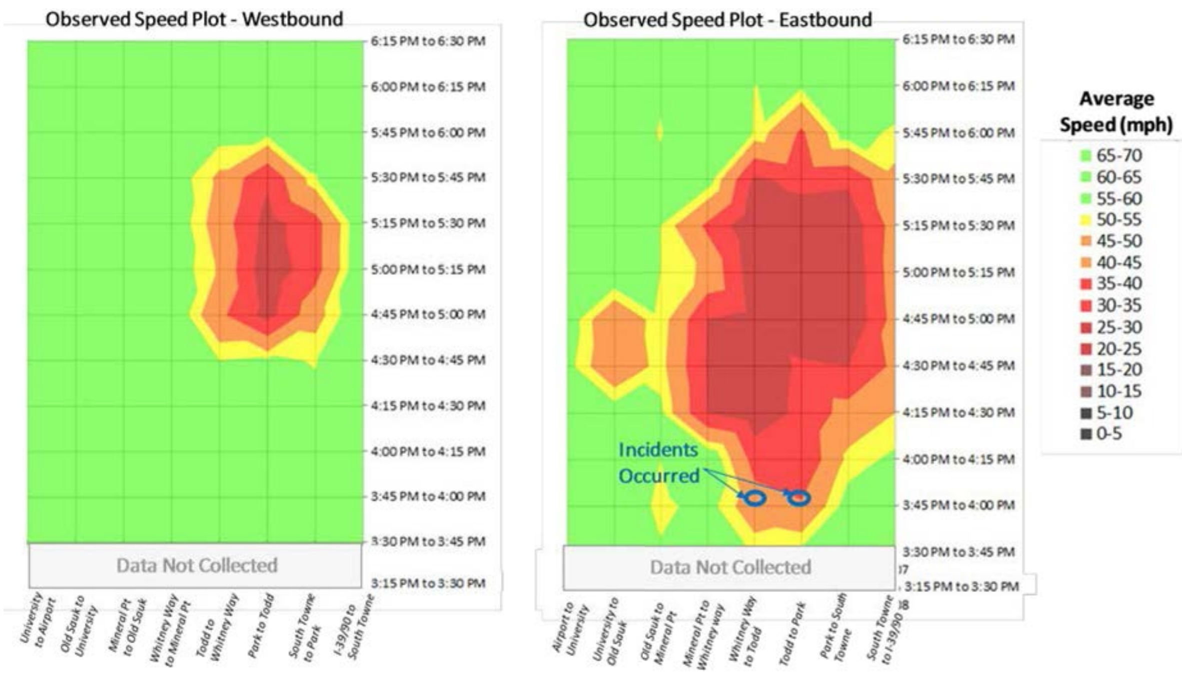


Figure 4.03-4 PM September 2012 Observed Beltline Speeds

The maximum travel time in the AM westbound on September 11, 2012, was about 35 minutes with speeds ranging from 20 to 67 mph (average of 33 mph) and eastbound was about 17 minutes with speeds ranging from 52 to 66 mph (average of 60 mph). Maximum travel time on September 11, 2012 in the PM westbound was about 20 minutes with speeds ranging from 40 to 65 mph (average of 51 mph) and eastbound was about 30 minutes with speeds ranging from 25 to 61 mph (average of 37 mph).

There were two incidents that occurred on September 11, 2012 during the PM eastbound direction. These incidents included a rear-end accident at Whitney Way where the vehicles pulled off into the inside shoulder and a semi-truck parked immediately downstream of the Todd Drive off-ramp gore. None of these incidents blocked travel lanes on the Beltline. Comparing the eastbound PM TLAP data from September 11, 2012 to that collected on September 12, 2012 shows a noticeable difference in mainline speeds in the eastbound direction during the PM peak period. There were no apparent incidents eastbound during the September 12, 2012 PM peak period and the traffic volumes were about 10 percent higher than those observed on September 11, 2012. Figure 4.03-5 below compares the eastbound PM September 11 and September 12, 2012 observed speeds. Because of the differing conditions between the 11th and 12th (September 12 had higher volumes but no incidents, September 11 had lower traffic volumes but two incidents) it is unknown to what degree the two incidents on the 11th may have impacted operations and speeds.

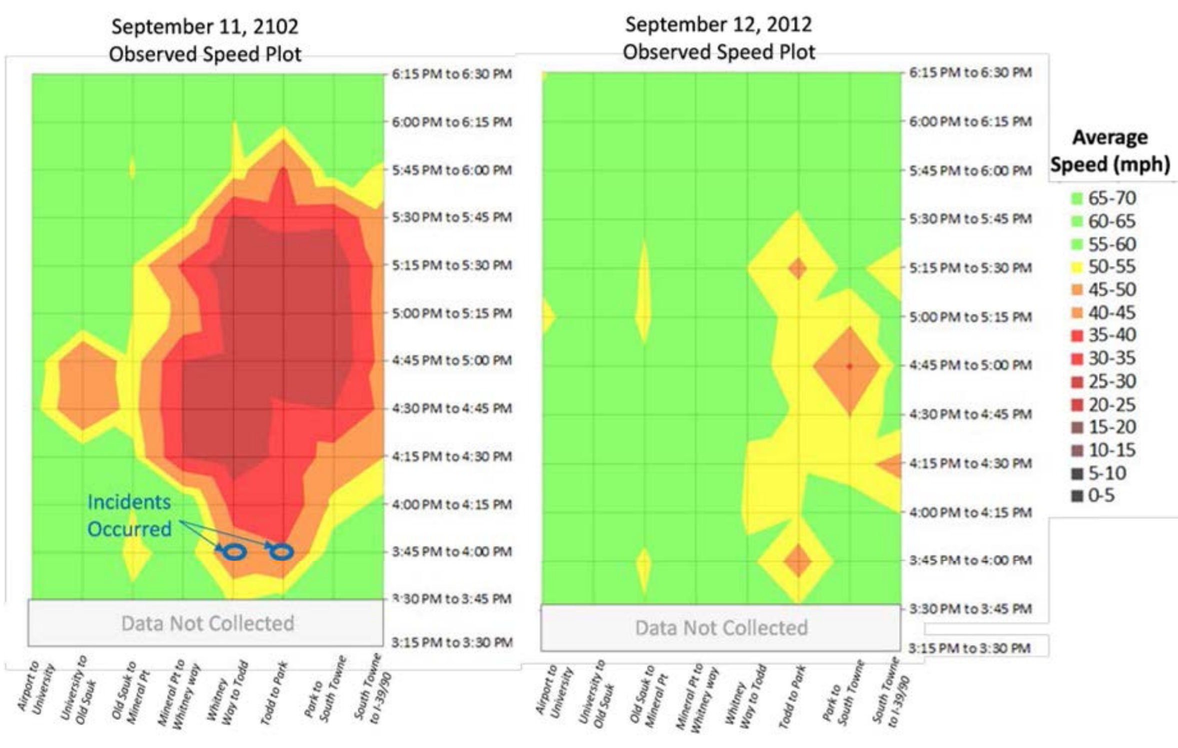


Figure 4.03-5 PM September 2012 Observed Beltline Speeds

In addition to the travel times on the September 2012 TLAP day, travel times for the remaining weekdays in September 2012 were reviewed on the Beltline between US 18/151 (Verona Road) and I-39/90 to help understand the variability of travel times from day to day and how the September 2012 TLAP travel times compared to the rest of the month. Figures 4.03-6 through 4.03-7 provide a travel time summary for each weekday during September 2012.

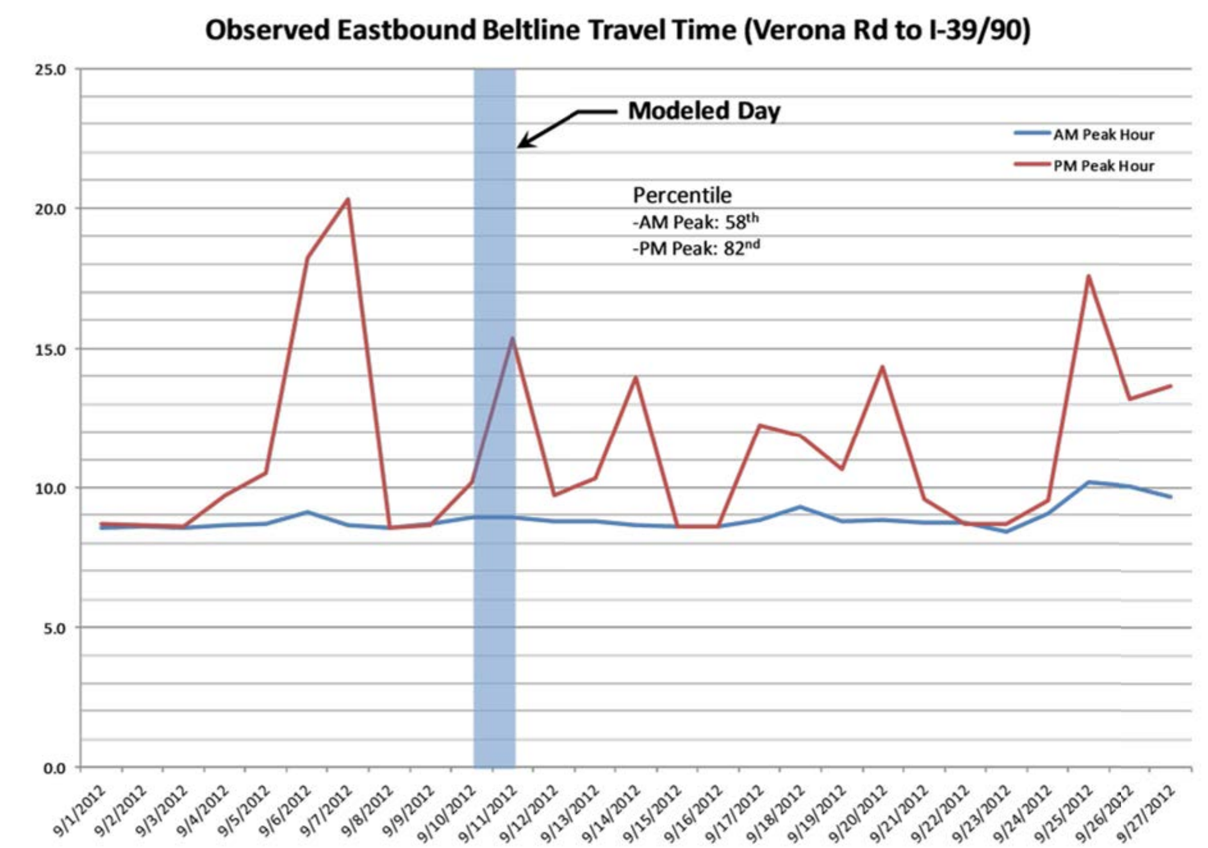


Figure 4.03-6 AM and PM September 2012 Observed Eastbound Beltline Travel Times

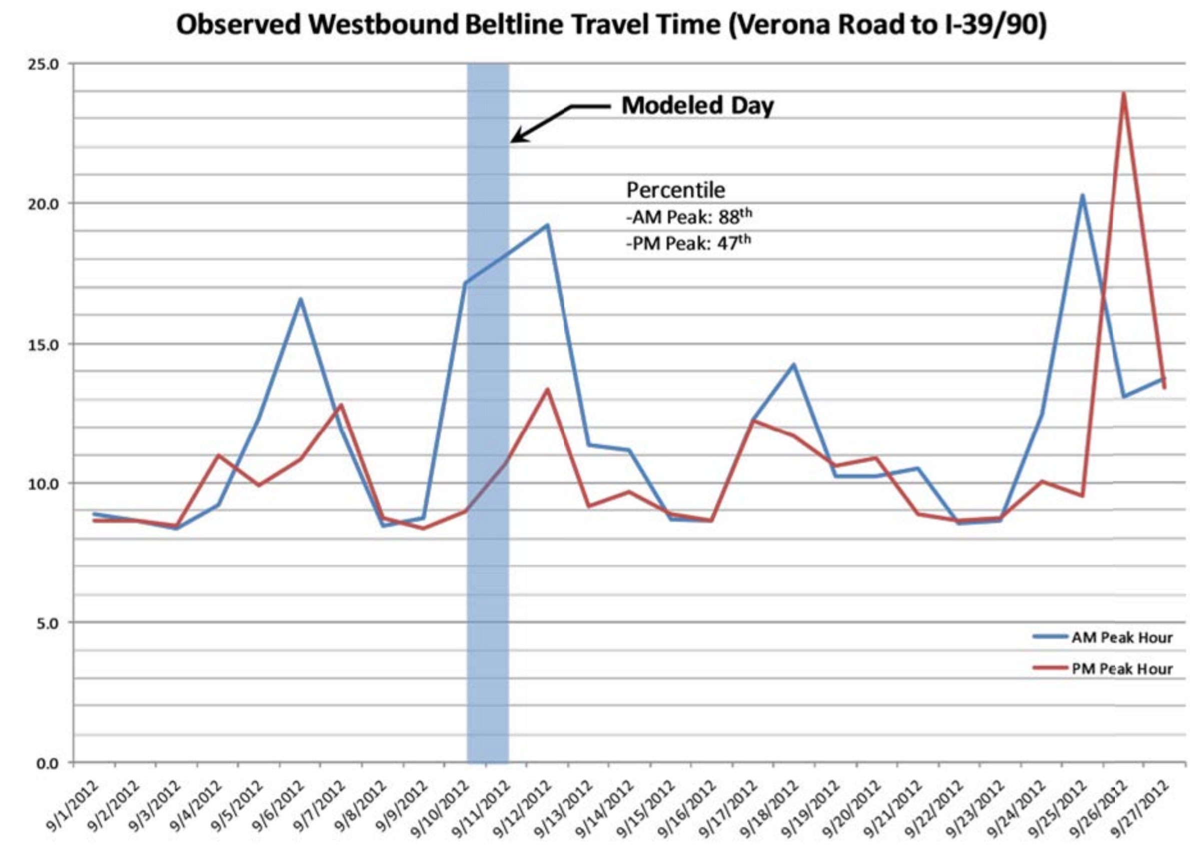


Figure 4.03-7 AM and PM September 2012 Observed Westbound Beltline Travel Times

When reviewing travel time for the full month of September, the September 2012 TLAP day data falls in the 58th percentile for eastbound AM travel times, 82nd percentile for eastbound PM, 88th percentile for westbound AM, and 47th percentile for westbound PM travel times when compared to the other weekdays in September of 2012. For example, a 50th percentile would indicate that 50 percent of the work days in the month of September experience less travel times/greater speeds (less congestion) and 50 percent of other days in September experience higher travel times/less speed (greater congestion).

A. Travel Time Reliability

Travel Time Reliability (TTR) is defined by the FHWA as the consistency or dependability in travel times, as measured from day to day and/or across different times of the day. Because the Beltline is a congested corridor and experiences unstable traffic flow (LOS F), TTR can vary greatly from day to day because a relatively minor fluctuation in traffic or a minor incident can have significant impacts on an already congested corridor.

As part of the Verona Road reconstruction project, TranSmart Technologies, Inc (TranSmart) deployed and used Bluetooth detectors at various locations along the Beltline to collect travel time and speed data.

This travel time data was used to analyze TTR along the Beltline as well. The locations of these Bluetooth detectors are shown in Appendix B. The following describes several measures of TTR:

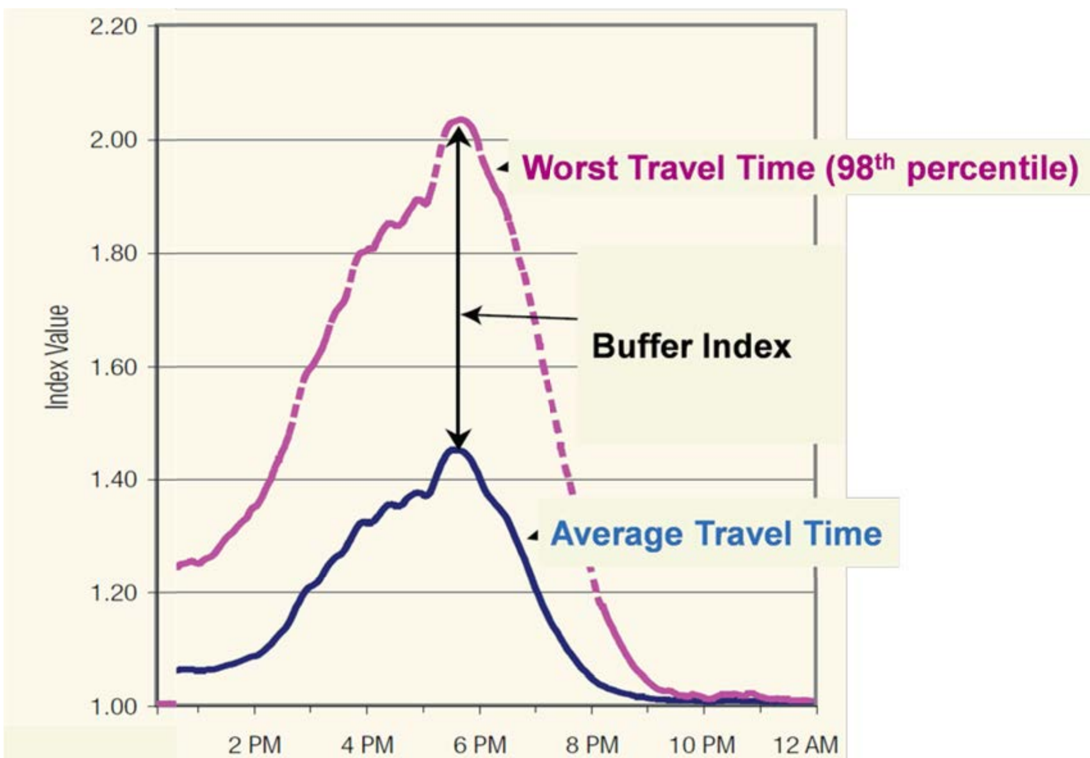
1. Planning Time: a measure of longest travel delay for a section of roadway (calculated for the roadway section to be the 98th percentile travel time).

2. Buffer Time: the extra time required to ensure on time arrival (calculated as the difference between the 98th percentile travel time and the average travel time).

3. Planning Time Index: the total travel time that should be planned when an adequate buffer time is included (calculated as the ratio of the 98th percentile to the ideal, or free-flow, travel time).

4. Buffer Index: the time cushion travelers add to their average travel time to ensure on-time arrival (calculated as the 98th percentile minus the average, divided by the average). This time cushion varies depending on the time of day and the day of the week.

A representation of the Planning Time Index and Buffer Time Index is shown in Figure 4.03-8.



Source: FHWA

Figure 4.03-8 Example Travel Time Reliability and Variables

The Bluetooth data collection period was from June 2012 through November 2012 (6 months), covering the modeled conditions of September 2012 for the Beltline PEL. The five aspects of TTR discussed above were measured for three time periods covering 16 hours of the day based on the following segments:

- West Beltline: US 14/University Avenue to Verona Road
- Center Beltline: Verona Road to South Towne Drive
- East Beltline: South Towne Drive to I-39/90

Tables 4.03-1 and 4.03-2 show the Planning Time Index and Buffer Time Index for the Beltline segments during the AM (5 to 10 A.M.) and PM (3 to 9 P.M.) time periods, respectively.

Beltline Segment	Direction of Travel	Planning Time Index	Buffer Time Index
West (University Avenue to Verona Road)	Eastbound	1.18	6%
Center (Verona Road to South Towne Drive)	Eastbound	1.19	9%
East (South Towne Drive to I-39/90)	Eastbound	1.22	8%
Combined (University Avenue to I-39/90)	Eastbound	1.19	8%
East (I-39/90 to South Towne Drive)	Westbound	2.31	118%
Center (South Towne Drive to Verona Road)	Westbound	2.15	78%
West (Verona Road to University Avenue)	Westbound	1.36	17%
Combined (I-39/90 to University Avenue)	Westbound	2.0	74%

Table 4.03-1 Beltline AM Period Planning Time Index and Buffer Time Index

Beltline Segment	Direction of Travel	Planning Time Index	Buffer Time Index
West (University Avenue to Verona Road)	Eastbound	1.72	52%
Center (Verona Road to South Towne Drive)	Eastbound	3.42	156%
East (South Towne Drive to I-39/90)	Eastbound	1.64	48%
Combined (University Avenue to I-39/90)	Eastbound	2.45	98%
East (I-39/90 to South Towne Drive)	Westbound	1.04	7%
Center (South Towne Drive to Verona Road)	Westbound	2.27	85%
West (Verona Road to University Avenue)	Westbound	1.42	22%
Combined (I-39/90 to University Avenue)	Westbound	1.67	48%

Table 4.03-2 Beltline PM Period Planning Time Index and Buffer Time Index

As expected and shown by congestion observed from the TLAP on September 11, 2012, similar areas and time periods of congestion are shown in the TTR analysis. The westbound direction of travel in the AM period between I-39/90 and Verona Road experiences the highest planning time and buffer time. These periods of congestion have a planning time index and buffer time index of 2.31 and 118 percent for the East Beltline and 2.15 and 78 percent for the Center Beltline, respectively.

The eastbound and westbound directions of travel for the Center Beltline are shown to have the highest congestion during the PM period. These results are also similar to the congestion observed from the TLAP. The Center Beltline section has a planning time index and buffer time index of 3.42 and 156 percent for the eastbound direction of travel and 2.27 and 85 percent for the westbound direction of travel, respectively.

A buffer time index over 100 percent means drivers need to double the average travel time for their regular commute. The Beltline shows a buffer time index of over 100 percent for the westbound direction of travel on the East Beltline segment in the AM period and in the eastbound direction of travel on the Center Beltline segment in the PM period.

The Beltline segments and their respective TTR Planning Time and Buffer Time Indexes are shown in Figure 4.03-9.

Direction and Time	West Beltline (University Ave to Verona Road)	Center Beltline (Verona Road to South Towne Drive)	East Beltline (South Towne Drive to I-39/90)
WB AM	1.36 *(17%)*	2.15 *(78%)*	2.31 *(118%)*
WB PM	1.42 *(22%)*	2.27 *(85%)*	1.04 *(7%)*
EB AM	1.18 *(6%)*	1.19 *(9%)*	1.22 *(8%)*
EB PM	1.72 *(52%)*	3.42 *(156%)*	1.64 *(48%)*

Values shown above = Planning Time Index (*Buffer Time Index*). Higher index = Higher unreliability in travel times.

$$Planning\ Time\ Index = \frac{98th\ Percentile\ TT}{Freeflow\ TT} \qquad Buffer\ Time\ Index = \frac{98th\ Pecentile\ TT - Average\ TT}{Average\ TT} \times 100\%$$

Figure 4.03-9 Travel Time Reliability Indexes for Beltline

4.04 INTERSECTION OPERATIONS

The existing conditions of the intersections located along the study corridor as well as within the area of influence of ramp terminals at interchanges along the Beltline were modeled using Paramics software. This report includes results from the Fall 2014 draft Base Paramics models. The intersection count data was collected using TLAP. For intersections that were outside of the viewable area of the flight pictures, field turning-movement count data was used. The count data was balanced along the Beltline and then along each of the individual intersecting roadways. Appendix C contains the balanced volume information.

At an intersection, the LOS is determined by the average delay, in seconds, of all vehicles entering the intersection. The average delay is based on the peak 15-minute period of the peak hour being analyzed. Since this delay is an average value, some vehicles will experience greater delay and some will experience less delay. Intersections with short average delays have high LOS such as LOS A; conversely, intersections with long average delays have low LOS. WisDOT considers LOS D the limit of acceptable delay with LOS E accepted under certain circumstances. LOS F for the total intersection is considered an indication of the need for improvement. WisDOT establishes a delay of up to 35 seconds for unsignalized intersections and 55 seconds for signalized intersections, corresponding to LOS D.

LOS characteristics are different for signalized and unsignalized intersections. Drivers anticipate longer delays at signalized intersections that carry large amounts of traffic. However, drivers generally feel unsignalized intersections should have less delay. Additionally, several driver behavior considerations combine to make delays at unsignalized intersections less desirable than at signalized intersections. For example, drivers at signalized intersections are able to relax during the red interval, whereas drivers on the minor approaches to unsignalized intersections must remain attentive to identify acceptable gaps for entry. Typically, LOS is only calculated for the legs of an unsignalized intersection that have to yield to other movements (stop control or left turns). Table 4.04-1 shows the LOS thresholds for signalized and unsignalized intersections.

Level of Service	Signalized Intersections (average delay, seconds)	Unsignalized Intersections (average delay, seconds)
A	≤ 10	≤ 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

Table 4.04-1 Intersection LOS Thresholds

Paramics microsimulation modeling was used to determine LOS for the project intersections. Operations at the intersections in the Paramics model were calibrated using observed queues from TLAP or field observation where TLAP was not available.

Figures 4.04-1 through 4.04-3 summarize the overall intersection operations for the 2012 base conditions. For the morning and evening peak hours, tables summarizing the intersection operations for the base conditions are located in Appendix D.

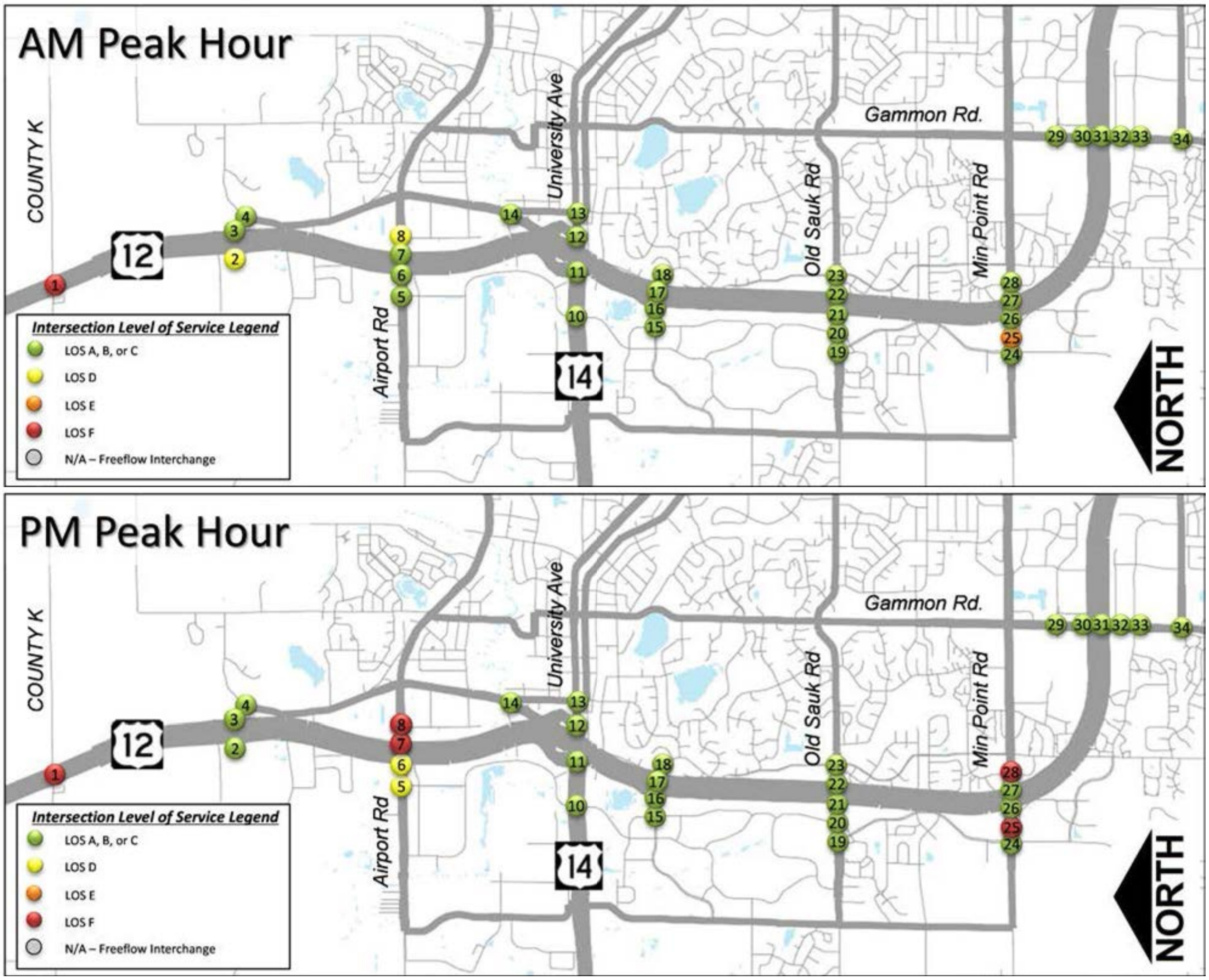


Figure 4.04-1 2012 Existing Conditions Intersection Operations Summary County K to Gammon Road

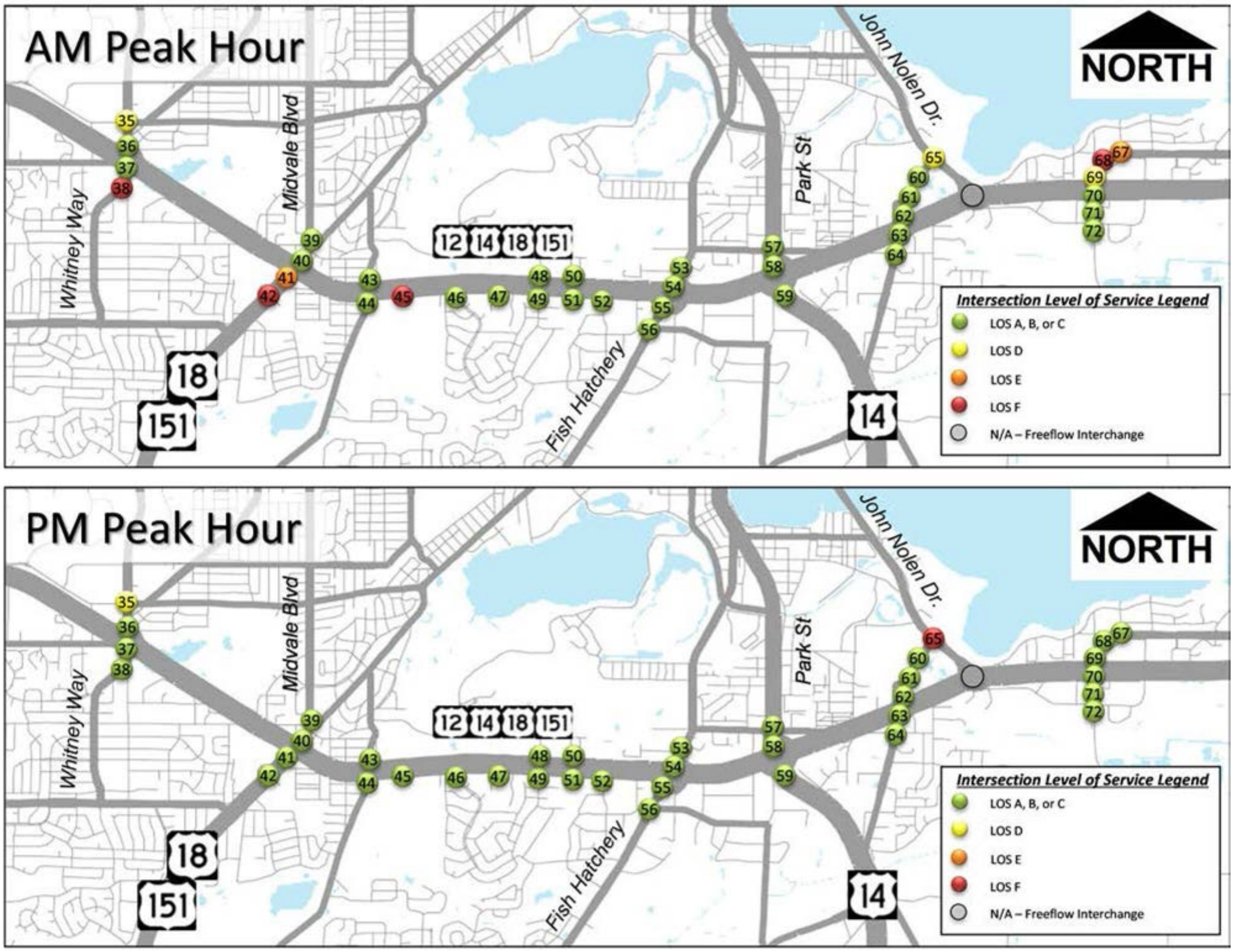


Figure 4.04-2 2012 Existing Conditions Intersection Operations Summary Whitney Way to Broadway/South Towne

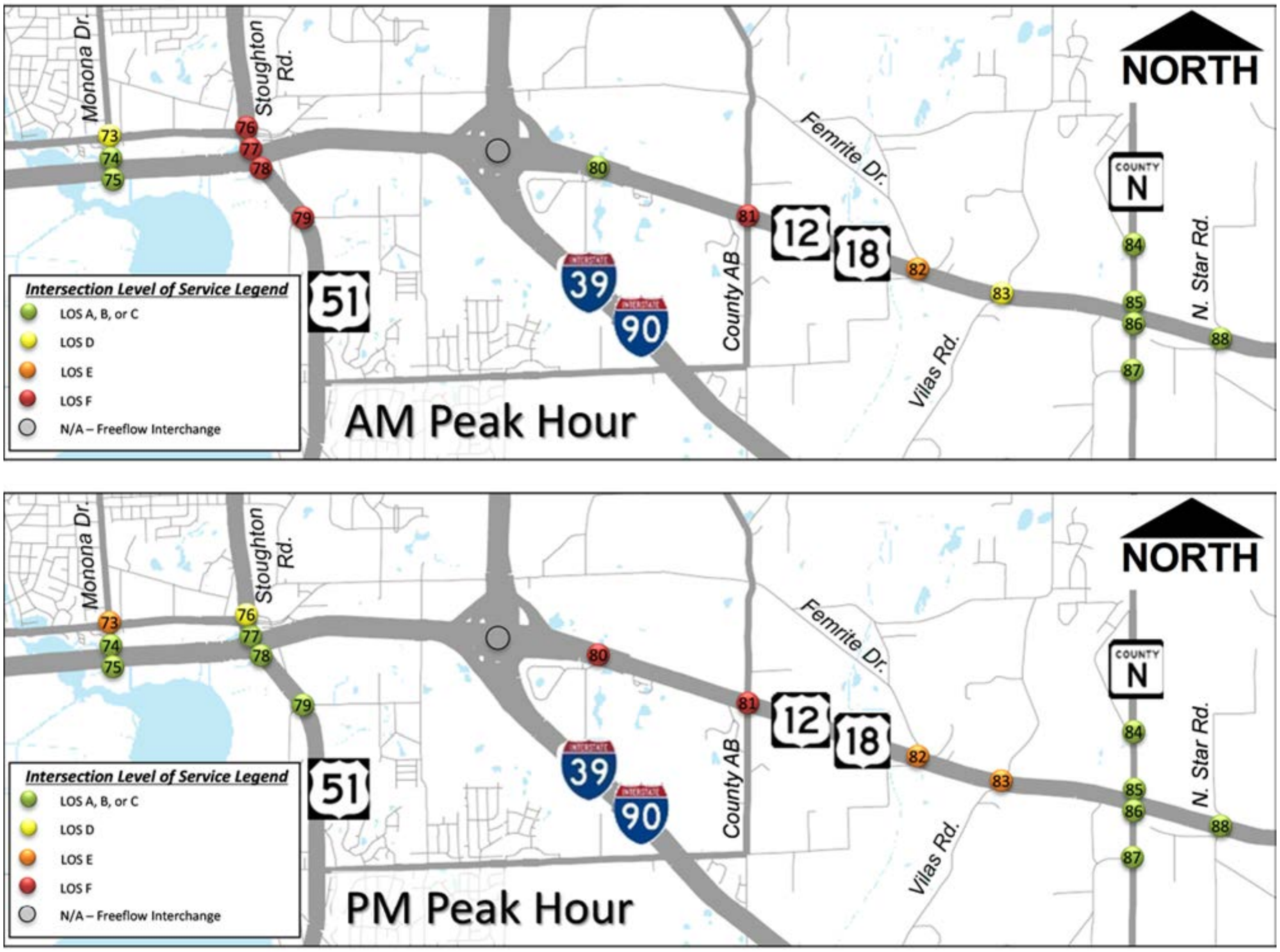


Figure 4.04-3 2012 Existing Conditions Intersection Operations Summary Monona Drive to Star Road

The existing configurations and LOS of intersection movements adjacent to or along the Beltline are included in the detailed summaries that follow. The Paramics operations model only reports delay for links within the model. Because of this, the majority of intersection movement delays are reported by approach rather than by movement. Intersections that have separate links for left-turn lanes, right-turn lanes, or both delays specific to a movement are reported. Specific approach/movement LOS is shown below.

LOS and average delays provided in this section are for the controlling 15-minute period of the peak hour for the particular movement.

A. <u>Beltline and County K</u>

The Intersection of the Beltline and County K is an at-grade signal-controlled intersection. Figure 4.04-4 shows the existing lane configuration along with the modeled existing LOS from the Fall 2014 Paramics models for both the AM and PM peak hours.

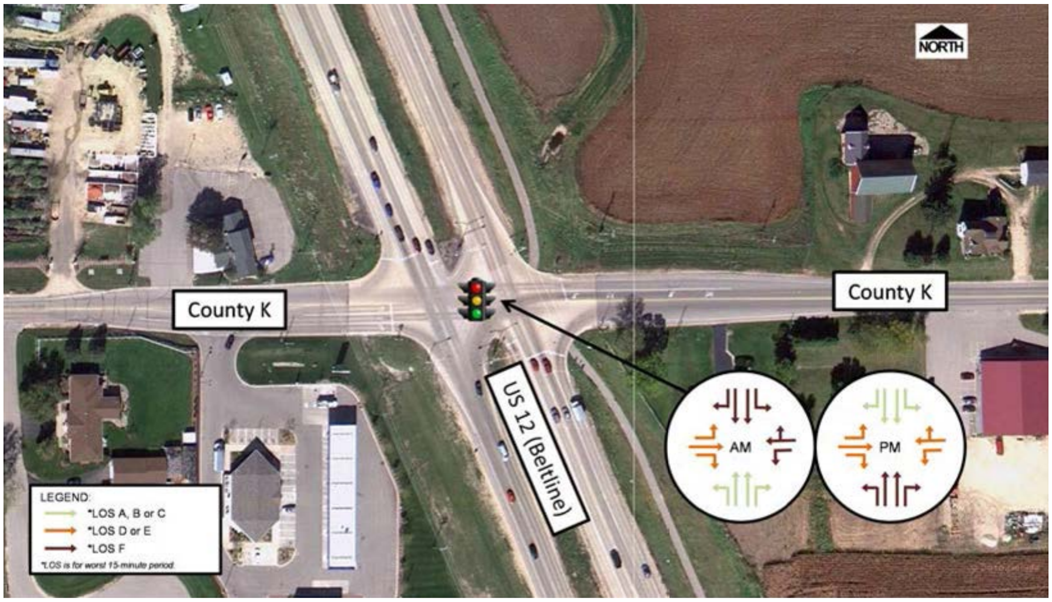


Figure 4.04-4 Beltline and County K Intersection

1. AM Peak Hour

The intersection operates at LOS F in the AM with an overall modeled average delay over 300 seconds. Modeled southbound queuing along the Beltline and westbound queuing along County K in the AM both exceed 2,000 feet. These long queues have been confirmed with field observations. The southbound and westbound approaches both fail during the AM peak hour. The southbound approach has an overall modeled average delay over 300 seconds, and the westbound approach has a modeled average delay exceeding 300 seconds.

2. PM Peak Hour

The intersection operates at LOS F in the PM with an overall modeled average delay of 90 seconds. The northbound approach fails during the PM peak hour with an overall modeled average delay of 120 seconds, with queues approaching 2,000 feet. These queues have been confirmed with field observations.

B. Beltline and Parmenter Street

The interchange of the Beltline and Parmenter Street is a diamond interchange with stop-controlled ramp terminals. In proximity to the Parmenter Street interchange is the stop-controlled intersection of Greenbriar Road to the east. Figure 4.04-5 shows the existing lane configurations along with the modeled existing LOS from Paramics for both the AM and PM peak hours for the Parmenter Street interchange area.

Figure 4.04-5 Beltline and Parmenter Street Interchange

1. AM Peak Hour

There are no LOS F movements/intersections and the majority of movements are LOS C or better.

2. PM Peak Hour

There are no LOS F movements/intersections and all movements are LOS C or better.

C. Beltline and Airport Road/County M (Century Avenue)

The interchange of the Beltline and Airport Road/County M (Century Avenue) is a diamond interchange with signal-controlled ramp terminals. Adjacent to the Airport Road interchange are the stop-controlled intersections of Nursery Drive/Harvard Square to the west and Tribeca Drive/Laura Lane to the east. Figure 4.04-6 shows the existing lane configurations along with the modeled existing LOS from Paramics for both the AM and PM peak hours for the Airport Road interchange area.

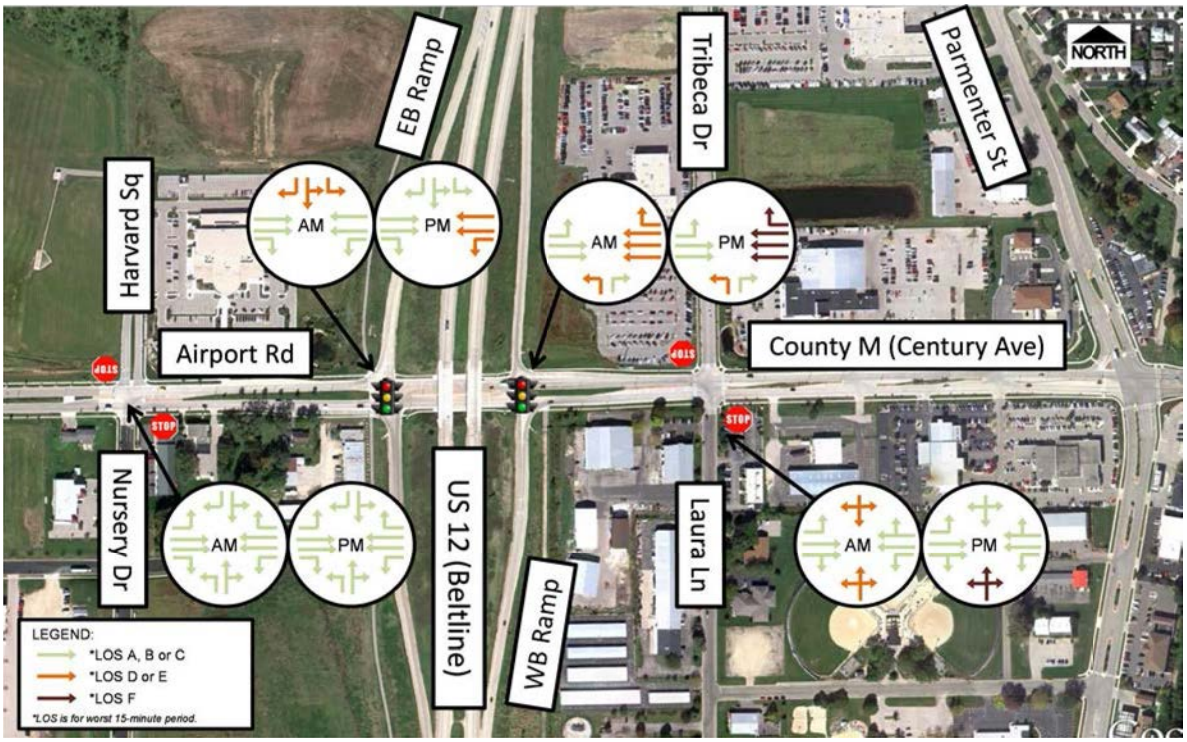


Figure 4.04-6 - Beltline and Airport Road Interchange

1. AM Peak Hour

There are no LOS F movements/intersections and the majority of movements are LOS C or better. About a third of intersection approaches experience LOS D or E operations.

2. PM Peak Hour

Both the westbound approach of the westbound ramp terminal intersection and the northbound approach to the Laura Lane/Tribeca Drive intersection operate at LOS F in the PM with overall modeled average delays of 95 and 90 seconds, respectively. Modeled westbound queuing along Century Avenue in the PM exceeds 400 feet.

D. Beltline and US 14/University Avenue

The interchange of the Beltline and US 14/University Avenue is a partial cloverleaf interchange with signal-controlled ramp terminals. Adjacent the US 14/University Avenue interchange are the signal-controlled intersections of Deming Way to the west and Parmenter Street to the east. Also near the interchange is the Discovery Drive and Parmenter Street roundabout to the northeast. Figure 4.04-7 shows the existing lane configurations along with the modeled existing LOS from Paramics for both the AM and PM peak hours for the US 14/University Avenue interchange area.

After the data collection effort for the existing conditions was completed, the southbound approach of the Deming Way intersection was reconstructed to provide dual-left turn lanes. This configuration has not been modeled by the study team under existing traffic conditions; however, it will be included and evaluated in the future conditions.

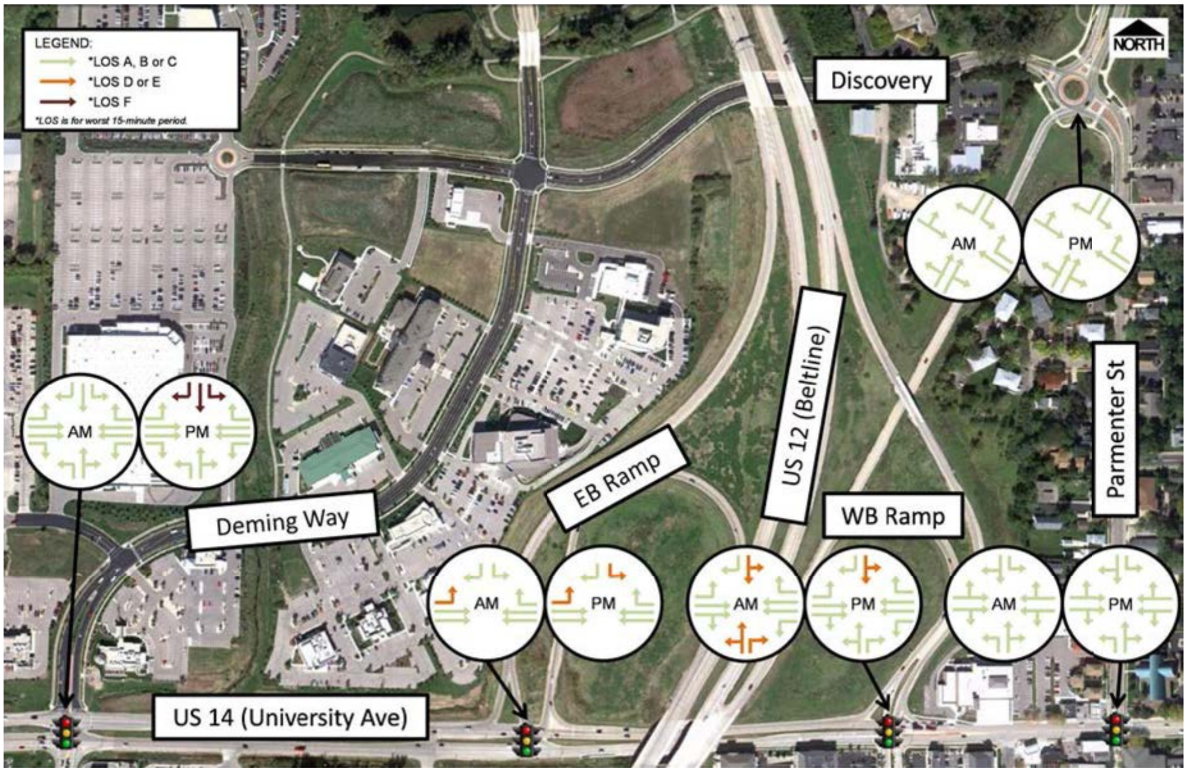


Figure 4.04-7 Beltline and US 14 /University Avenue Interchange

1. AM Peak Hour

There are no LOS F movements/intersections, and the majority of movements are LOS C or better. There are three movements/approaches at the ramp terminal intersections with LOS D or E operations.

2. PM Peak Hour

The southbound approach of the Deming Way intersection operates at LOS F in the PM with an overall modeled average delay of 150 seconds; however, as mentioned, this approach has since been reconstructed to include a dual-left-turn lane to mitigate the LOS F operations. The modeled queue length for the southbound left-turn ranges from 360 to 730 feet during the PM peak hour. There are no other failing movements/intersections in the PM and the majority of movements are LOS C or better.

E. Beltline and Greenway Boulevard

The interchange of the Beltline and Greenway Boulevard is a diamond interchange with signal-controlled ramp terminals. Adjacent to the Greenway Boulevard interchange is the signal-controlled intersection of John Q Hammons Drive to the west and the stop-controlled intersection of High Point Road to the east. Figure 4.04-8 shows the existing lane configurations along with the modeled existing LOS from Paramics for the AM and PM peak hours for the Greenway Boulevard interchange area.

Figure 4.04-8 Beltline and Greenway Boulevard Interchange

1. AM Peak Hour

There are no LOS F movements/intersections, and the majority of movements are LOS C or better.

2. PM Peak Hour

There are no LOS F movements/intersections, and the majority of movements are LOS C or better.

F. Beltline and Old Sauk Road

The interchange of the Beltline and Old Sauk Road is a diamond interchange with signal-controlled ramp terminals. Adjacent to the Old Sauk Road interchange are the signal-controlled intersections of Junction Road and Excelsior Drive to the west and High Point Road to the east. Figure 4.04-9 shows the existing lane configurations along with the modeled existing LOS from Paramics for the AM and PM peak hours for the Old Sauk Road interchange area.

Figure 4.04-9 Beltline and Old Sauk Road Interchange

1. AM Peak Hour

There are no LOS F movements/intersections, and the majority of movements are LOS C or better.

2. PM Peak Hour

There are no LOS F movements/intersections, and the majority of movements are LOS C or better.

G. Beltline and County S (Mineral Point Road)

The interchange of the Beltline and County S (Mineral Point Road) is a diamond interchange with signal-controlled ramp terminals. Near the County S (Mineral Point Road) interchange is the signal-controlled intersection of County M/Junction Road and the stop-controlled intersection of Commerce Drive to the west and the stop-controlled intersection of Tree Lane/Big Sky Drive to the east. Figure 4.04-10 shows the existing lane configurations along with the modeled existing LOS from Paramics for the AM and PM peak hours for the County S (Mineral Point Road) interchange area.

After the data collection effort for the existing conditions was completed, the city of Madison began the reconstruction of the Mineral Point Road and Junction Road intersection as a grade-separated jug-handle intersection. The reconstruction added a jug-handle in the southwest quadrant of the intersection, and grade-separated the southbound Junction Road. The construction is anticipated to be completed in late 2014. This configuration has not been modeled by the study team under existing traffic conditions, but, it will be included and evaluated in the future conditions.

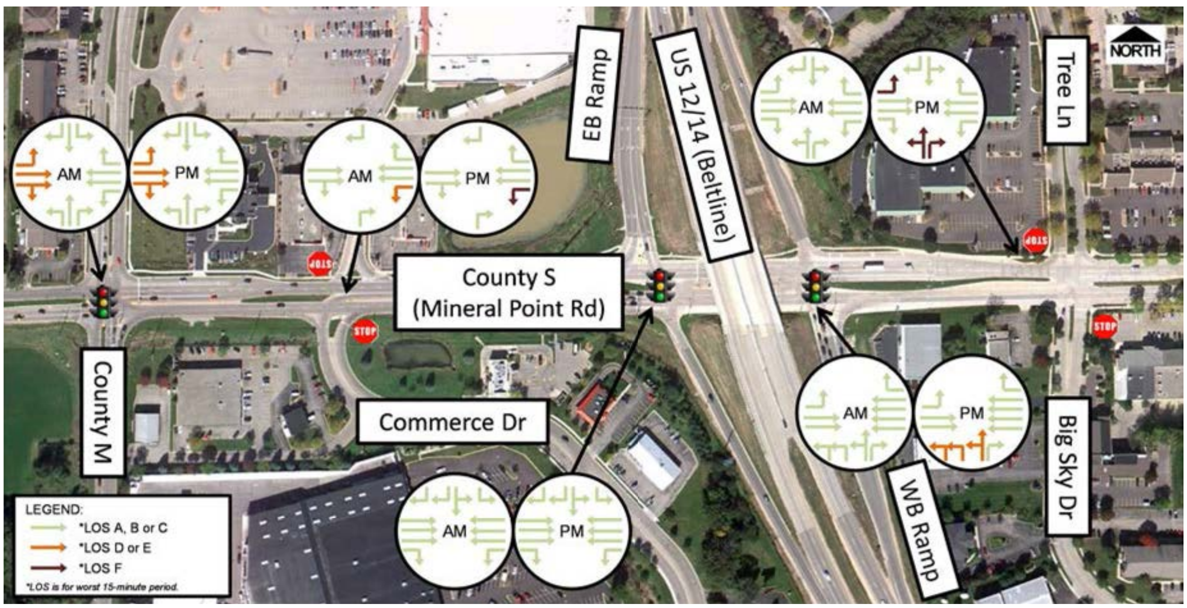


Figure 4.04-10 Beltline and County S (Mineral Point Road) Interchange

1. AM Peak Hour

There are no LOS F movements/intersections, and the majority of movements are LOS C or better with two approaches/movements having LOS D or E operations.

2. PM Peak Hour

The westbound left of the Commerce Drive intersection operates at LOS F in the PM with an overall modeled average delay of 50 seconds. In addition, the eastbound left and northbound approach of the Tree Lane/Big Sky Drive intersection operates at LOS F with overall modeled average delays of 70 and 240 seconds, respectively.

H. <u>Beltline and Gammon Road</u>

The interchange of the Beltline and Gammon Road is a diamond interchange with signal-controlled ramp terminals. Adjacent to the Gammon Road interchange are the signal-controlled intersections of Seybold Road and Watts Road to the south and Odana Road to the north. Figure 4.04-11 shows the existing lane configurations along with the modeled existing LOS from Paramics for the AM and PM peak hours for the Gammon Road interchange area.

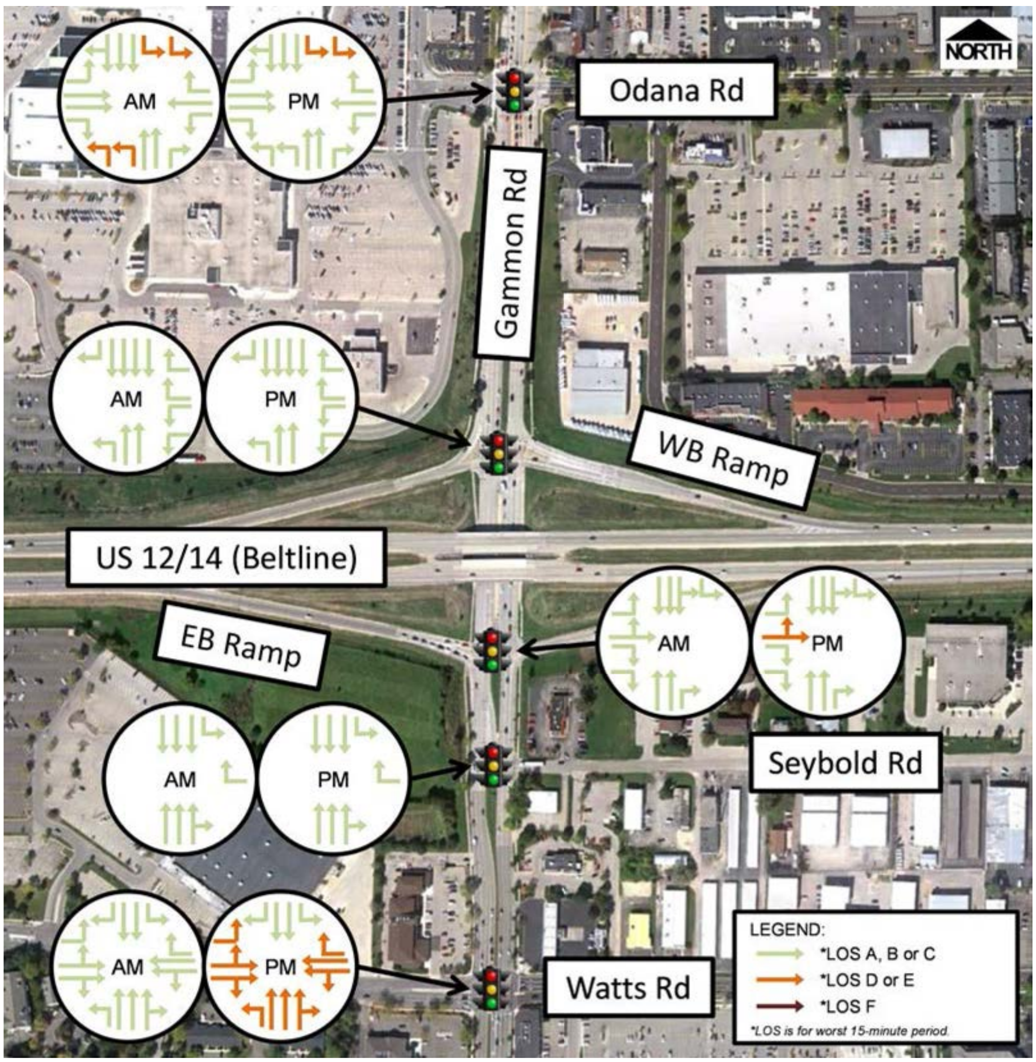


Figure 4.04-11 Beltline and Gammon Road Interchange

1. AM Peak Hour

There are no LOS F movements/intersections, and the majority of movements are LOS C or better with two movements having LOS D or E operations.

2. PM Peak Hour

There are no LOS F movements/intersections, and the majority of movements are LOS C or better. The majority of LOS D and E movements occur at the Watts Road intersection. The modeled southbound approach queues reach up to 320 feet during the PM peak hour, which is approximately halfway to the eastbound ramp terminal intersection.

I. Beltline and Whitney Way

The interchange of the Beltline and Whitney Way is a diamond interchange with signal-controlled ramp terminals. Adjacent to the Whitney Way interchange is the stop-controlled intersection of Gilbert Road to the south and the signal-controlled intersection of Odana Road to the north. The eastbound off-ramp intersects Schroeder Road to the west of Whitney Way as a stop-controlled intersection. Figure 4.04-12 shows the existing lane configurations along with the modeled existing LOS from Paramics for the AM and PM peak hours for the Whitney Way interchange area.

Figure 4.04-12 Beltline and Whitney Way Interchange

1. AM Peak Hour

The southbound left of the Gilbert Road intersection operates at LOS F in the AM with an overall modeled average delay of 110 seconds. There are also several LOS D and E movements primarily along Whitney Way at the ramp terminal intersections and Odana Road. For northbound traffic south of the Beltline interchange, modeled queue lengths at the eastbound ramp terminal intersection range from 880 to 1,040 feet, which extends into the Gilbert Road intersection approximately 550 feet away. For northbound traffic north of the interchange, modeled queue lengths at the Odana Road intersection are less than 500 feet, which is approximately halfway to the westbound ramp terminal intersection.

2. PM Peak Hour

There are no LOS F movements/intersections, and the majority of movements are LOS C or better. The majority of LOS D and E movements that are present occur at the Odana Road intersection.

J. Beltline and US 18/151 (Verona Road)/Midvale Boulevard

For the Beltline PEL 2012 existing conditions the interchange of the Beltline and US 18/151 (Verona Road)/Midvale Boulevard was a diamond interchange with signal-controlled ramp terminals. Adjacent to the US 18/151 (Verona Road)/Midvale Boulevard interchange was the signal-controlled intersection of Atticus Way to the south and Nakoma Road to the north. Figure 4.04-13 shows the 2012 existing lane configurations along with the modeled LOS from Paramics for the AM and PM peak hours for the US 18/151 (Verona Road)/Midvale Boulevard interchange area.

After the data collection effort for the existing conditions was completed, WisDOT began the reconstruction of the Verona Road interchange. Improvements being constructed include Verona Road to the south of the Beltline, Midvale Boulevard north of the Beltline, and the Beltline from Todd Drive to Gammon Road. Construction includes replacing the existing diamond interchange at Verona Road and the Beltline with a Single-Point Urban Interchange, replacement of the existing at-grade signalized Summit Avenue/Atticus Way and Verona Road intersection with a grade-separated jug-handle intersection, extension of a third westbound Beltline travel lane to Gammon Road, extension of a third eastbound Beltline travel lane to Whitney Way, and several other geometric improvements to help address the long-term needs of the Verona Road corridor. The construction began in late 2013 and is anticipated to be completed in 2016. These improvements have not been modeled by the study team under existing traffic conditions, but they will be included and evaluated in the future conditions.

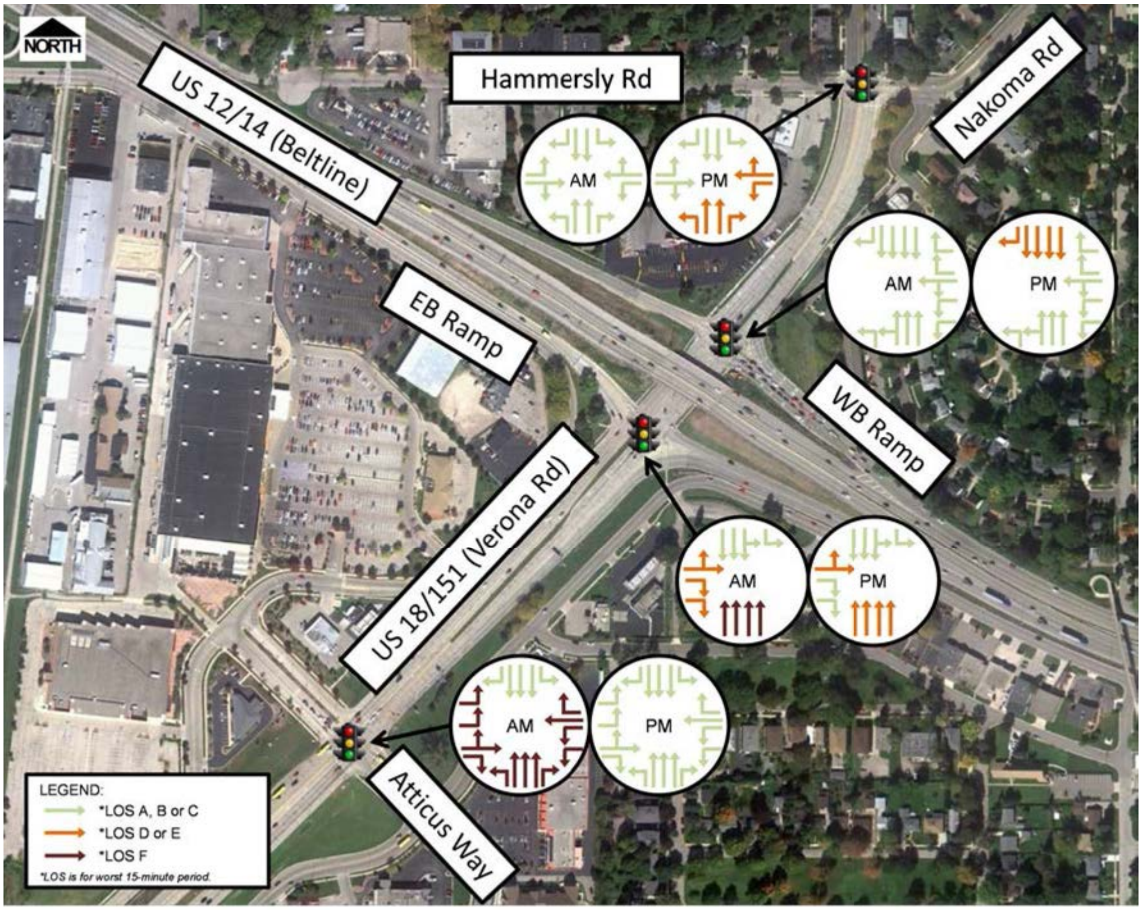


Figure 4.04-13 Beltline and US 18/151 (Verona Road)/Midvale Boulevard Interchange

1. AM Peak Hour

The westbound, eastbound, and northbound approaches of the Atticus Way intersection operate at LOS F in the AM with overall modeled average delays of 145, 80, and 225 seconds, respectively. In addition, the northbound approach of the eastbound ramp terminal intersection operates at LOS F with overall modeled average delay of 170 seconds and queues exceeding 1,000 feet and extending south into the Atticus Way intersection.

2. PM Peak Hour

There are no LOS F movements/intersections, and the majority of movements are LOS C or better. Approximately a third of the intersection approaches experience LOS D and E operations.

K. Beltline and Seminole Hwy

The interchange of the Beltline and Seminole Highway is a half-diamond interchange with signal-controlled ramp terminals. Adjacent to the Seminole Highway interchange is the stop-controlled, braided intersection of the West Beltline Frontage Road and the eastbound Seminole Highway on-ramp and the stop-controlled intersection of Grandview Boulevard and the West Beltline Frontage Road farther to the east. Figure 4.04-14 shows the existing lane configurations along with the modeled existing LOS from Paramics for the AM and PM peak hours for the Seminole Highway interchange area.

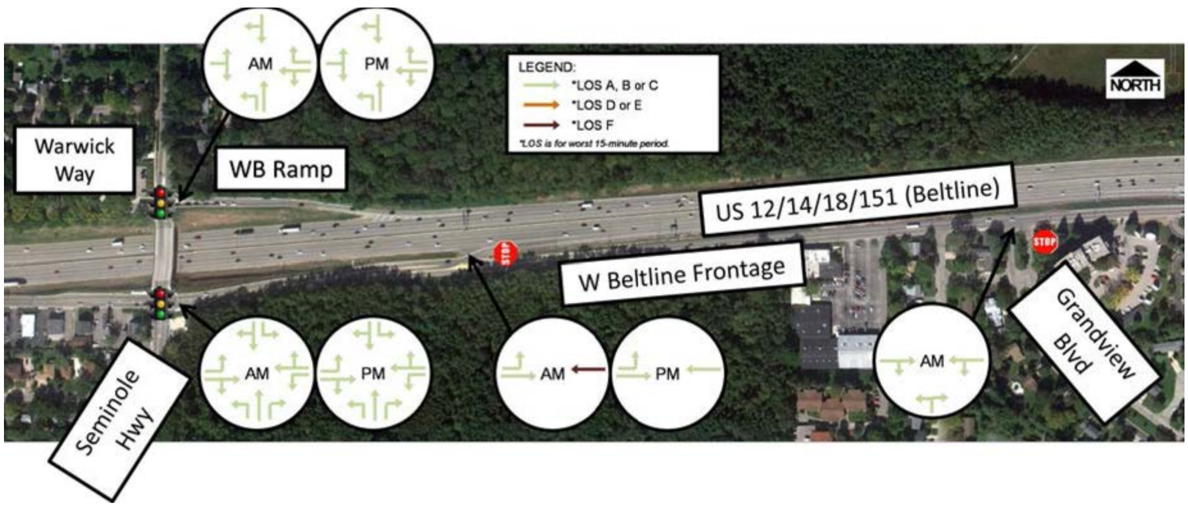


Figure 4.04-14 Beltline and Seminole Highway Interchange

1. AM Peak Hour

The westbound approach of the eastbound on-ramp and West Beltline Frontage Road braided intersection operates at LOS F in the AM with an overall modeled average delay of 50 seconds. The modeled queue length for the stop-controlled westbound through movement at the braided intersection is up to 215’ during the AM peak hour. The remaining movements/intersections are LOS C or better.

2. PM Peak Hour

There are no LOS F movements/intersections, and all movements are LOS C or better.

L. Beltline and Todd Drive

The interchange of the Beltline and Todd Drive is a split-diamond interchange with stop-controlled braided intersections at the frontage roads for three of the four ramps. The frontage road/ramp terminal intersections at Todd Drive are signal-controlled. Also in proximity to the Todd Drive interchange is the stop-controlled intersection of the West Beltline Frontage Road with Coho Street to the east. Figure 4.04-15 shows the existing lane configurations along with the modeled existing LOS from Paramics for the AM and PM peak hours for the Todd Drive interchange area.

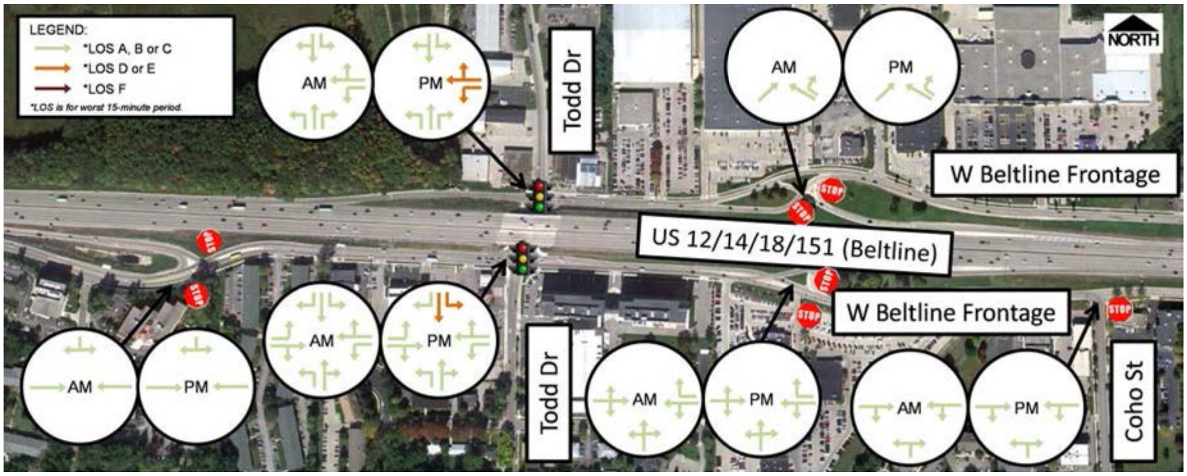


Figure 4.04-15 Beltline and Todd Drive Interchange

1. AM Peak Hour

There are no LOS F movements/intersections, and all movements are LOS C or better.

2. PM Peak Hour

There are no LOS F movements/intersections, and the majority of movements are LOS C or better.

M. Beltline and County D (Fish Hatchery Road)

The interchange of the Beltline and County D (Fish Hatchery Road) is a diamond interchange with one loop ramp that has signal-controlled ramp terminals. Adjacent to the County D (Fish Hatchery Road) interchange is the signal-controlled intersection of Greenway Crossing to the south and Emil Street to the north. Figure 4.04-16 shows the existing lane configurations along with the modeled existing LOS from Paramics for the AM and PM peak hours for the County D (Fish Hatchery Road) interchange area.

Approximately 1 mile north of the Beltline, Fish Hatchery Road and Park Street intersect. This intersection and the close spacing of their respective interchanges on the Beltline cause them to act as alternate routes for each other. If Park Street is experiencing long delays, the volume on Fish Hatchery Road will increase and vice versa.

During the data collection effort for the existing conditions, WisDOT was in the process of reconstructing the Fish Hatchery Road interchange. Primary improvements being constructed include turn lane additions on Fish Hatchery Road and modification of the existing interchange to remove the northbound-to-westbound loop ramp. The construction began in 2012 and was completed in 2013. These improvements have been modeled by the study team as existing traffic conditions.

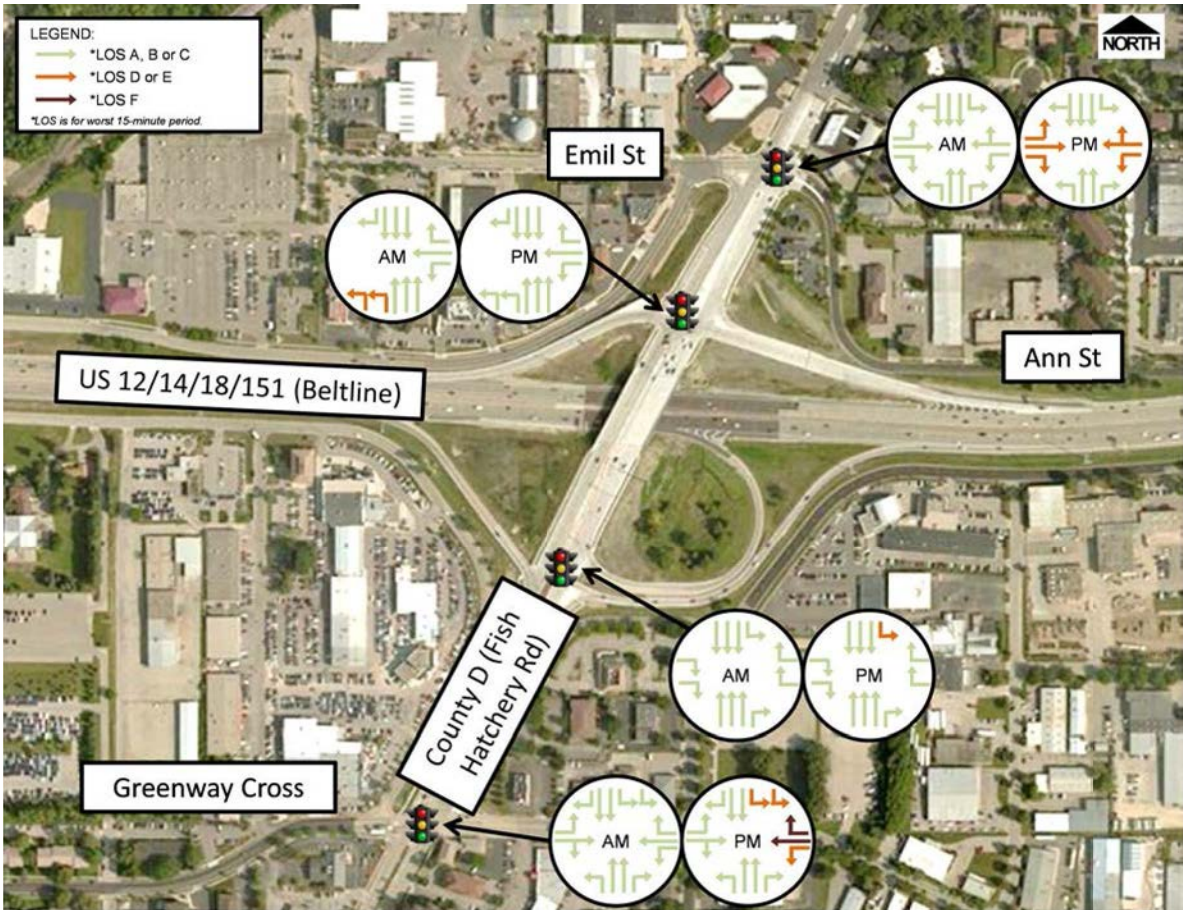


Figure 4.04-16 Beltline and County D (Fish Hatchery Road) Interchange

1. AM Peak Hour

There are no LOS F movements/intersections, and the majority of movements are LOS C or better.

2. PM Peak Hour

The westbound right and through movement of the Greenway Crossing intersection operates at LOS F in the PM with an overall modeled average delay of 90 seconds. The modeled queue length for the southbound through movement is up to 370 feet during the PM peak hour, which is approximately halfway to the eastbound ramp terminal intersection. The majority of the remaining movements are LOS C or better.

N. Beltline and US 151 (Park Street)/US 14

The interchange of the Beltline and US 151 (Park Street)/US 14 is a partial cloverleaf interchange with signal-controlled ramp terminals. Adjacent to the US 151 (Park Street)/US 14 interchange is the signal-controlled intersection of Badger Road to the north. Figure 4.04-17 shows the existing lane configurations along with the modeled existing LOS from Paramics for the AM and PM peak hours for the US 151 (Park Street)/US 14 interchange area.

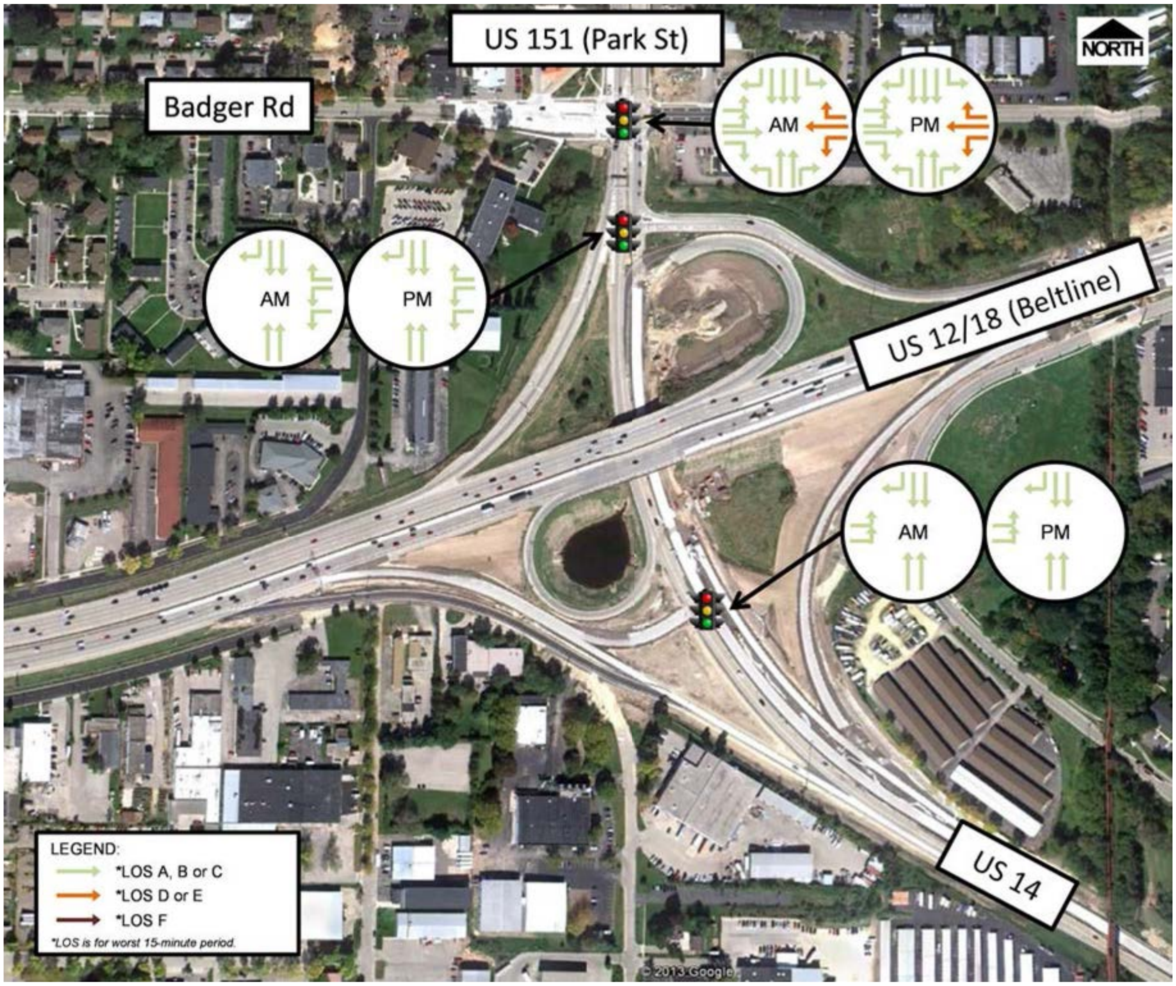


Figure 4.04-17 Beltline and US 151 (Park Street)/US 14 Interchange

1. AM Peak Hour

There are no LOS F movements/intersections, and the majority of movements are LOS C or better.

2. PM Peak Hour

There are no LOS F movements/intersections, and the majority of movements are LOS C or better.

O. Beltline and County MM (Rimrock Road)

The interchange of the Beltline and County MM (Rimrock Road) is a diamond interchange with signal-controlled ramp terminals. Adjacent to the County MM (Rimrock Road) interchange are the signal-controlled intersections of Badger Road to the south and Rusk Road, Alliant Energy Center Way, and John Nolen Drive to the north. Figure 4.04-18 shows the existing lane configurations along with the modeled existing LOS from Paramics for the AM and PM peak hours for the County MM (Rimrock Road) interchange area.

The intersection of Rimrock Road and John Nolen Drive is directly north of the Beltline. This leads the interchanges of Rimrock Road and John Nolen Drive to be alternate routes for one another. This also leads to tendencies for Rimrock Road to carry more traffic destined to the west and John Nolen Drive to carry more traffic destined to the east.

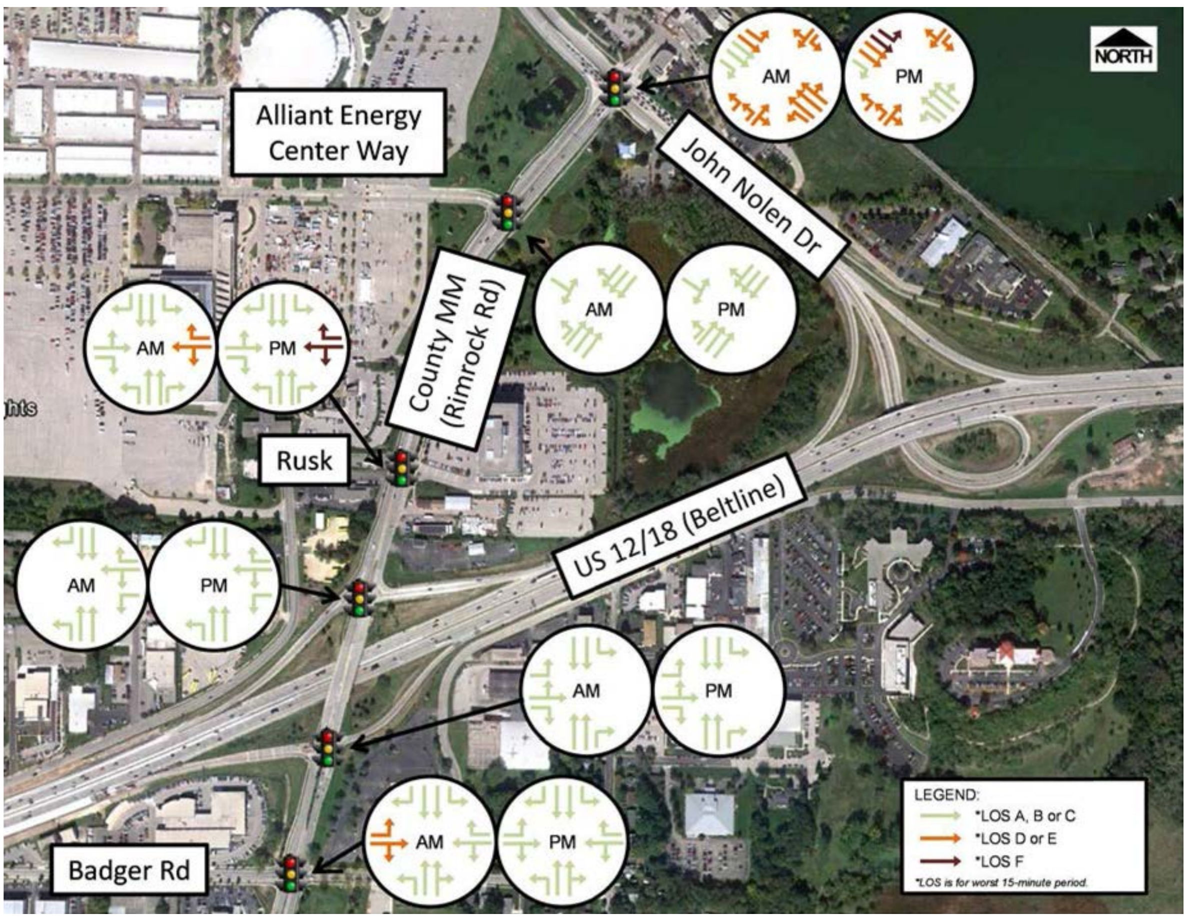


Figure 4.04-18 Beltline and County MM (Rimrock Road) Interchange

1. AM Peak Hour

There are no LOS F movements/intersections, and the majority of movements are LOS C or better. The majority of LOS D and E movements that are present occur at the John Nolen Drive and Rimrock Road intersection. Queuing northbound on John Nolen Drive is consistently around 600 feet during the AM peak hour, which is approximately halfway to the Beltline ramps.

2. PM Peak Hour

The westbound approach of the Rusk Road intersection and the southbound left and through lanes at the John Nolen Drive intersection operate at LOS F in the PM with overall modeled average delays of 105 and 255 seconds, respectively. Queuing southbound on John Nolen Drive ranges from 1,600 to 3,600 feet during the PM peak hour, which is generally through the Olin Avenue intersection (approximately 1,900 feet away) and near the Lakeside Street intersection (approximately 4,000 feet away).

The majority of the remaining movements are LOS C or better, and the majority of LOS D and E movements that are present occur at the John Nolen Drive intersection.

P. <u>Beltline and John Nolen Drive</u>

The interchange of the Beltline and John Nolen Drive is a trumpet-style interchange with free-flow ramps and has no stop or intersection control present. Figure 4.04-18 above shows interchange configuration for the John Nolen Drive interchange.

The intersection of John Nolen Drive and Rimrock Road experiences significant congestion during the peak hours. These queues are described in the Rimrock Road interchange section above.

Q. <u>Beltline and South Towne Drive/County BW (Broadway)</u>

The interchange of the Beltline and South Towne Drive/County BW (Broadway) is a diamond interchange with signal-controlled ramp terminals. Adjacent to the South Towne Drive/County BW (Broadway) interchange is the stop-controlled intersection of Royal Avenue and the roundabout intersection of Industrial Drive to the south and the stop-controlled intersection of Raywood Avenue and the signal-controlled intersection of Frazier Avenue to the north. Figure 4.04-19 shows the existing lane configurations along with the modeled existing LOS from Paramics for the AM and PM peak hours for the South Towne Drive/County BW (Broadway) interchange area.

The South Towne Drive interchange is used as an alternate to the Monona Drive interchange because of the congestion that is present on the Beltline. Traffic destined to or originating from Monona Drive will use Broadway and the South Towne Drive interchange instead of using the Monona Drive interchange and then traveling on the congested Beltline This additional traffic contributes to the poor southbound operations during the AM peak hour.

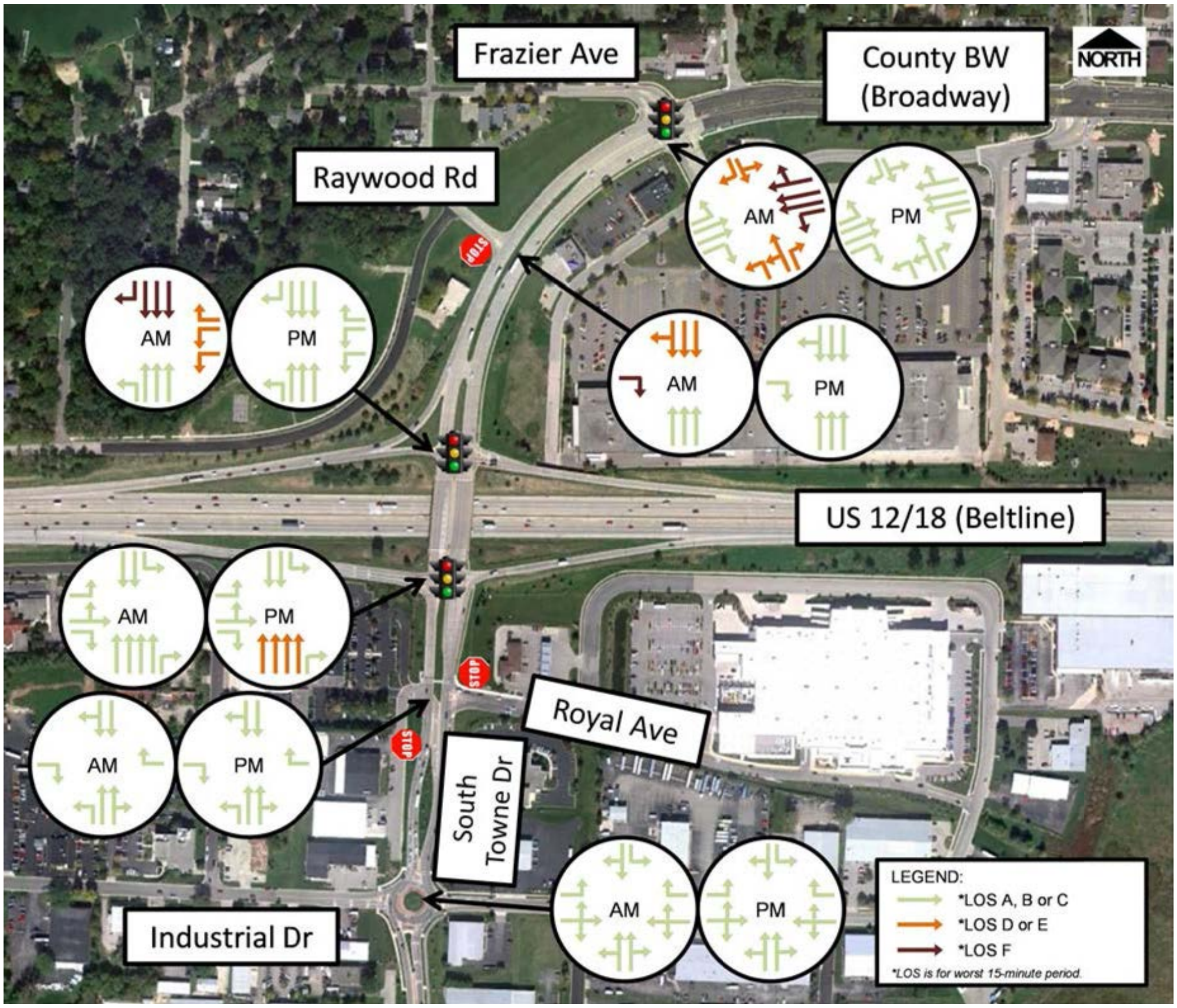


Figure 4.04-19 Beltline and County BW (Broadway)/South Towne Drive Interchange

1. AM Peak Hour

The southbound approach of the westbound ramp terminal intersection, the eastbound (side street) right turn at the Raywood Avenue intersection, and the westbound (Broadway) approach at the Frazier Avenue intersection operate at LOS F in the AM with overall modeled average delays of 100, over 300 and 95 seconds, respectively. It appears a primary cause of these delays is severe congestion on the westbound Beltline and westbound on-ramp. Queuing southbound on Broadway at the westbound ramp terminal intersection exceeds 1,100 feet measured from the end of the channelized right turn, which extends to just west of the Frazier Avenue intersection.

The majority of the remaining movements are LOS C or better, and the majority of LOS D and E movements that are present occur at the Frazier Avenue intersection.

2. PM Peak Hour

There are no LOS F movements/intersections, and the majority of movements are LOS C or better.

R. Beltline and County BB (Monona Drive)

The interchange of the Beltline and County BB (Monona Drive) is a diamond interchange with a signal-controlled eastbound ramp terminal and a stop-controlled westbound ramp terminal. In proximity to the County BB (Monona Drive) interchange is the signal-controlled intersection of County BW (Broadway) to the north. Figure 4.04-20 shows the existing lane configurations along with the modeled existing LOS from Paramics for the AM and PM peak hours for the County BB (Monona Drive) interchange area.

Figure 4.04-20 Beltline and County BB (Monona Drive) Interchange

1. AM Peak Hour

There are no LOS F movements/intersections, and the majority of movements are LOS C or better. The LOS D and E movements that are present occur at the Broadway intersection. Westbound queues at the Broadway intersection extend up to 750 feet during the AM peak hour.

2. PM Peak Hour

The westbound approach at the Broadway intersection operates at LOS F in the PM with an overall modeled average delay of 100 seconds. The majority of the remaining movements and intersection operations are LOS C or better, and the LOS D and E movements that are present occur at the Broadway intersection. Eastbound queues at the Broadway intersection extend up to 575 feet during the PM peak hour.

S. Beltline and US 51 (Stoughton Road)

The interchange of the Beltline and US 51 (Stoughton Road) is a diamond interchange with signal-controlled ramp terminals. Adjacent to the US 51 (Stoughton Road) interchange is the signal-controlled intersection of Terminal Drive/Voges Road to the south and County BW (Broadway)/Dutch Mill Road to the north. Figure 4.04-21 shows the existing lane configurations along with the modeled existing LOS from Paramics for the AM and PM peak hours for the US 51 (Stoughton Road) interchange area.

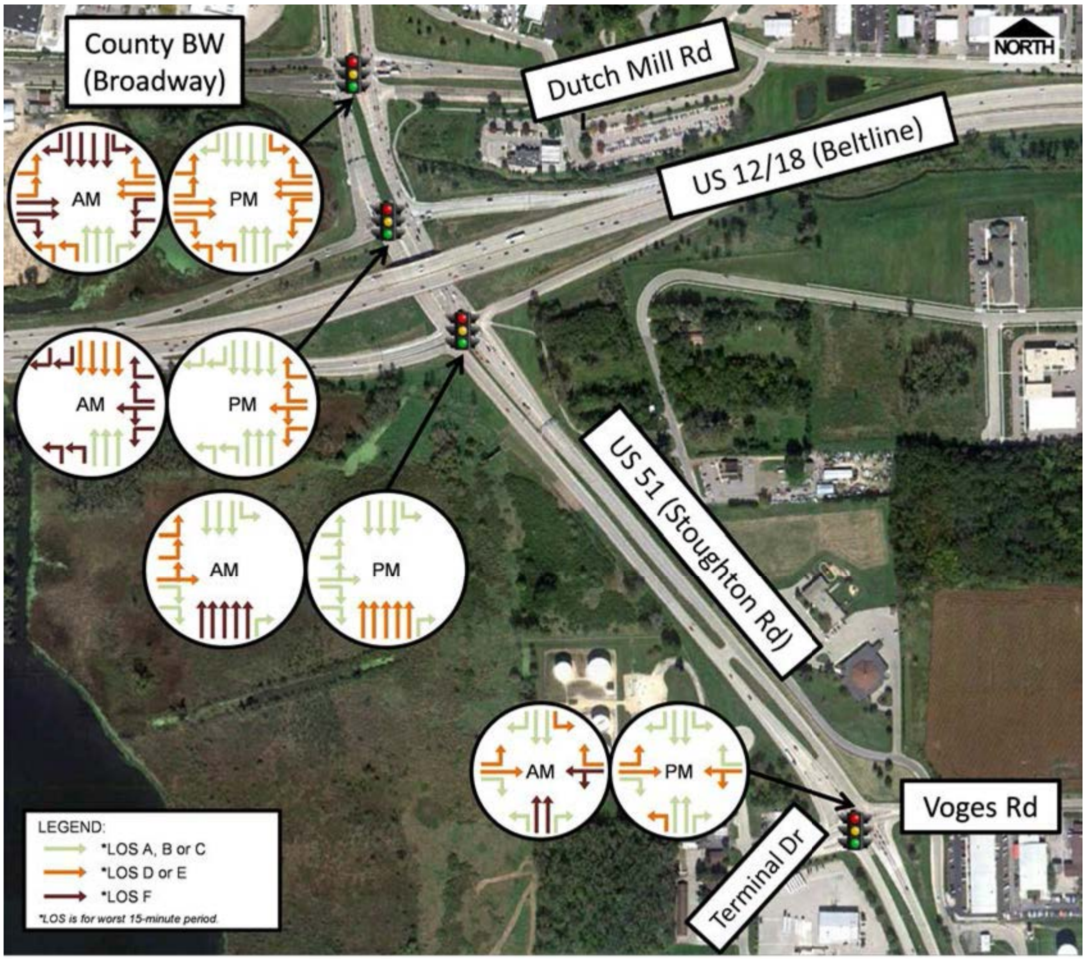


Figure 4.04-21 Beltline and US 51 (Stoughton Road) Interchange

1. AM Peak Hour

There are several movements/approaches during the AM peak hour that experience LOS F operations and are summarized below:

a. County BW (Broadway)/Dutch Mill Road Intersection LOS F Locations.
   (1) Eastbound through and right: 210 seconds of modeled average delay.
   (2) Westbound left: 215 seconds of modeled average delay.
   (3) Southbound left and through: greater than 300 seconds of modeled average delay.
   (4) Southbound right: 130 seconds of modeled average delay.
b. Westbound Ramp Terminal Intersection LOS F Locations.
   (1) Southbound right: 205 seconds of modeled average delay with queuing extending into the southbound through lanes (appears to be primarily caused by severe congestion on the westbound on-ramp).
   (2) Northbound left: 150 seconds of modeled average delay with queuing exceeding 300 feet (appears to be primarily caused by severe congestion on the westbound on-ramp, which is causing cycle failure at the ramp terminal intersections).
   (3) Westbound approach: 190 seconds of modeled average delay with queuing extending for the length of the westbound off-ramp.
c. Eastbound Ramp Terminal Intersection LOS F Locations.
   (1) Northbound approach: greater than 300 seconds of modeled average delay with queuing exceeding 300 feet (appears to be primarily caused by severe congestion on the westbound on-ramp, which is causing cycle failure at the ramp terminal intersections).
d. Terminal Drive/Voges Road Intersection LOS F Locations.
   (1) Northbound through: 280 seconds of modeled average delay.
   (2) Westbound left and through: 115 seconds of modeled average delay.

There are two major contributing factors to the congestion experienced at the US 51/Stoughton Road interchange. First, queues from the westbound merge to the Beltline extend back into the westbound ramp terminal intersection in both the observed and modeled conditions. Second, the queues from the northbound left-turn movement at the Broadway intersection, which is likely overcapacity because drivers use Broadway to avoid the congested Beltline, extend back into the westbound ramp terminal intersection. The congestion within the Stoughton Road interchange caused by these two locations leads to a disruption in the normal coordinated interchange timing and a loss of usable green time for Stoughton Road traffic.

The congestion within the westbound ramp terminal intersection leads to extended queues on the westbound exit ramp to Stoughton Road and along Stoughton Road northbound. The westbound exit ramp modeled queues are up to 3,200 feet during the AM peak hour, which are verified and less than the TLAP queues of approximately 4,700 feet. In both the modeled and observed conditions, the westbound exit ramp queues are well beyond the 1,200-foot length of the ramp and spill back onto the Beltline mainline. The northbound queues along Stoughton Road are modeled to be 2,000 feet at the eastbound ramp terminal intersection. These queues are verified by the TLAP conditions.

2. PM Peak Hour

There are no LOS F movements/intersections; however, several movements are LOS D or E.

T. Beltline and I-39/90

The interchange of the Beltline and I-39/90 is an all-direction interchange with free-flow ramps and therefore has no intersection control present.

U. Beltline and Millpond Road/Long Drive

The intersection of the Beltline and Millpond Road/Long Drive is an at-grade stop-controlled intersection. Figure 4.04-22 shows the existing lane configuration along with the modeled existing LOS from Paramics for the AM and PM peak hours.

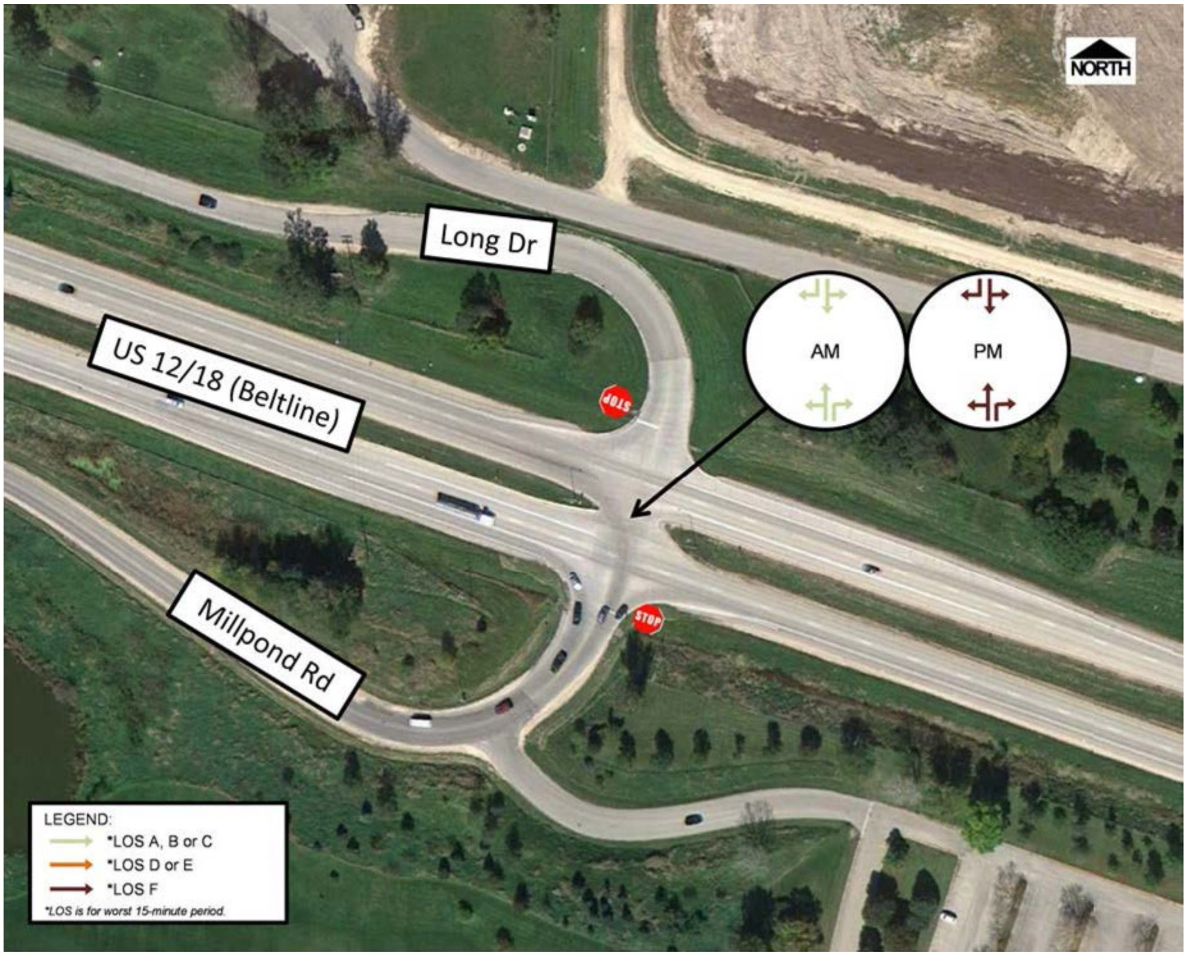


Figure 4.04-22 Beltline and Millpond Road/Long Drive

1. AM Peak Hour

There are no LOS F movements/intersections, and all the movements are LOS C or better.

2. PM Peak Hour

The intersection's worst movements operate at LOS F in the PM with a modeled average delay greater than 300 seconds. The Millpond Road and Long Drive approaches have overall modeled average delays greater than 300 seconds. Modeled queuing along Millpond Road in the PM exceeds 1,000 feet and is about 100 feet along Long Drive.

V. <u>Beltline and County AB</u>

The Intersection of the Beltline and County AB is an at-grade stop-controlled intersection. Figure 4.04-23 shows the existing lane configuration along with the modeled existing LOS from Paramics for the AM and PM peak hours.

Figure 4.04-23 Beltline and County AB

1 AM Peak Hour

The intersection's worst movements operate at LOS F in the AM with a modeled delay of 125 seconds. The northbound approach has an overall modeled average delay of 125 seconds. Modeled queuing along the northbound approach in the AM exceeds 300 feet. The southbound approach has an overall modeled average delay of XX seconds with queues exceeding XX feet.

2. PM Peak Hour

The intersection's worst movements operate at LOS F in the PM with a modeled average delay greater than 300 seconds. The northbound approach has an overall modeled average delay of 110 seconds with queues of about 200 feet. The southbound approach has an overall modeled average delay greater than 300 seconds with queues exceeding 1,500 feet. The modeled queues are higher than the observed queues of less than 100 feet for the southbound approach due to inaccurate usage of the median opening for two-stage left-turns, which is common in Microsimulation modeling. Stop-controlled intersections such as this one will be further discussed with WisDOT when it comes to needs identification and alternatives evaluation.

W. Beltline and Femrite Drive/Siggelkow Road

The intersection of the Beltline and Femrite Drive/Siggelkow Road is an at-grade stop-controlled intersection. Figure 4.04-24 shows the existing lane configuration along with the modeled existing LOS from Paramics for the AM and PM peak hours.

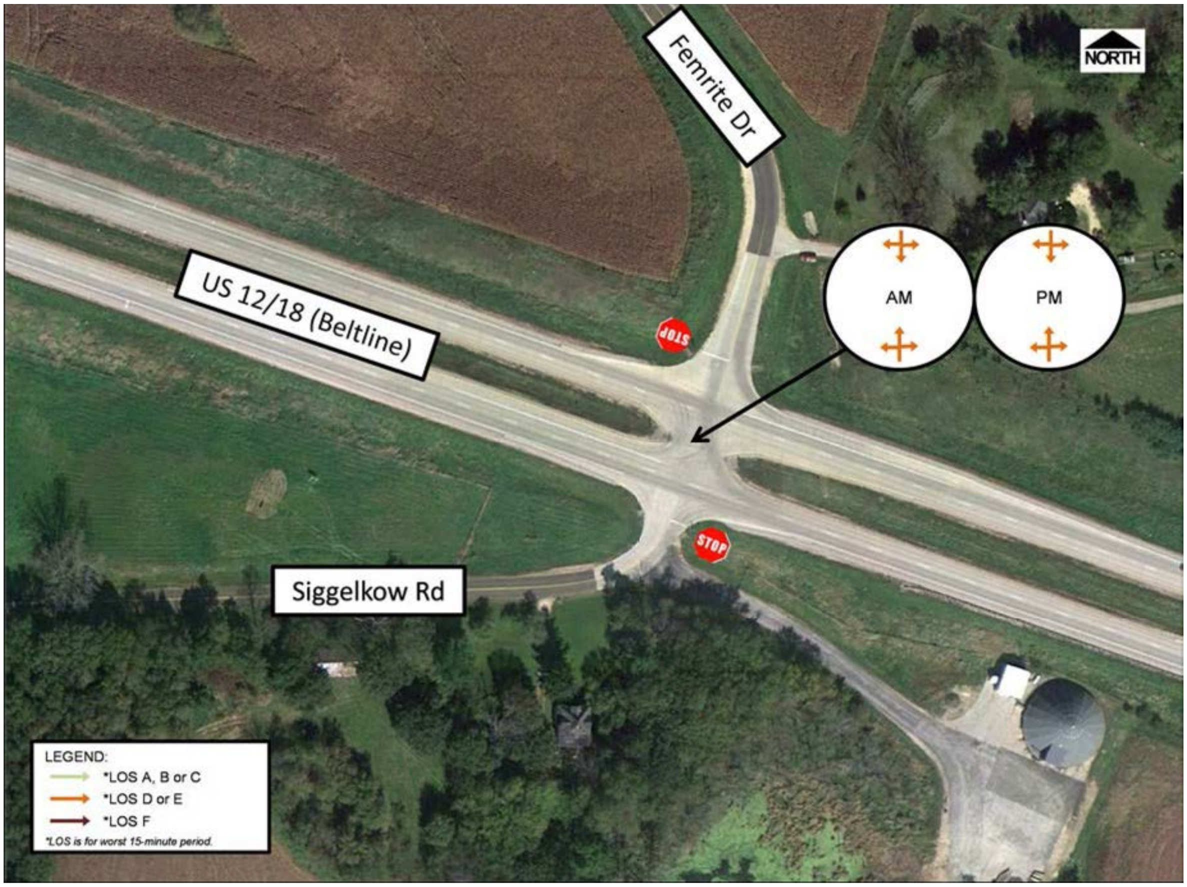


Figure 4.04-24 Beltline and Femrite Drive/Siggelkow Road

1. AM Peak Hour

There are no LOS F movements; however, the southbound approach is at LOS D and the northbound approach is at LOS E. Queuing on the northbound and southbound approaches is less than 60 feet during the AM peak hour.

2. PM Peak Hour

There are no LOS F movements; however, the southbound approach is at LOS D and the northbound approach is at LOS E. Queuing on the northbound and southbound approaches is less than 125 feet during the PM peak hour.

X. Beltline and Vilas Road

The Intersection of the Beltline and Vilas Road is an at-grade stop-controlled intersection. Figure 4.04-25 shows the existing lane configuration along with the modeled existing LOS from Paramics for the AM and PM peak hours.

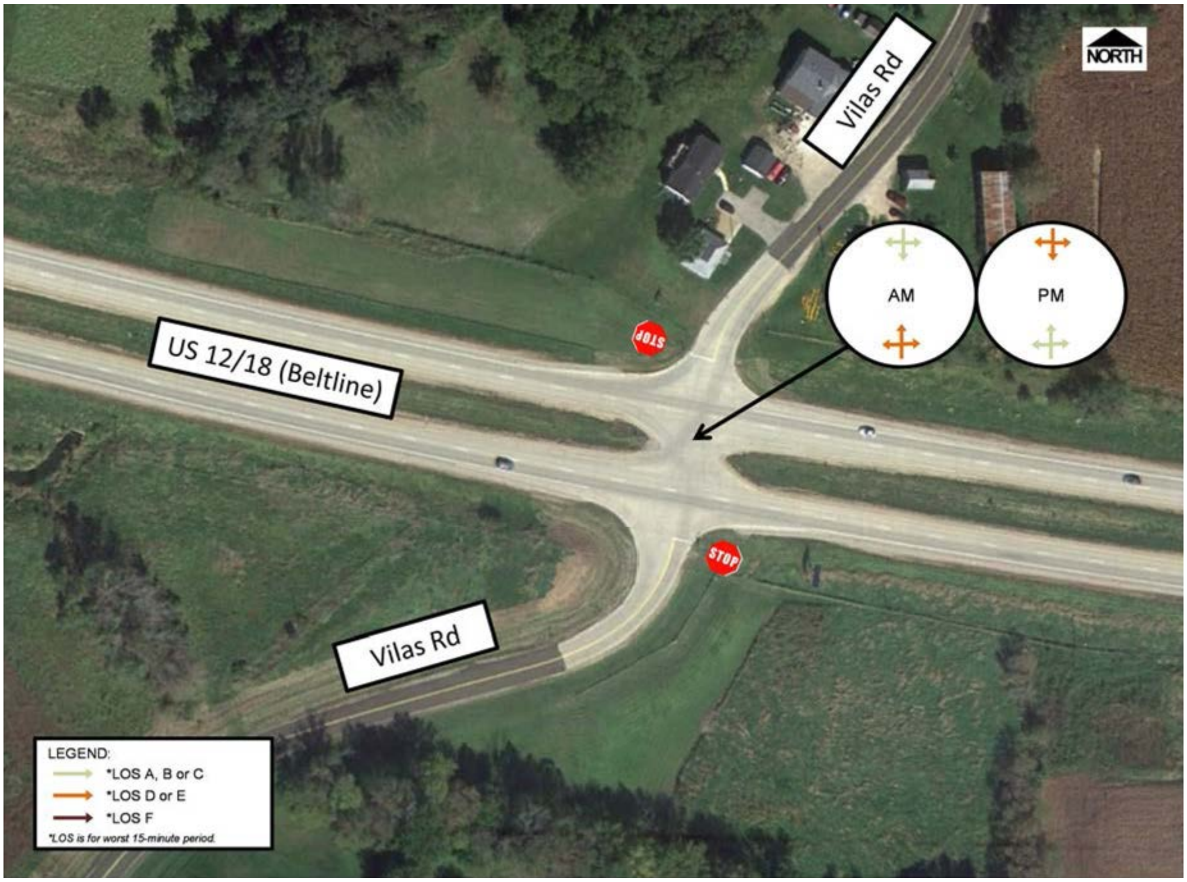


Figure 4.04-25 Beltline and Vilas Road

1. AM Peak Hour:

There are no LOS F movements; however, the northbound approach is at LOS D. Queuing on the northbound approach is less than 60 feet during the AM peak hour.

2. PM Peak Hour

There are no LOS F movements; however, the southbound approach is at LOS E. Queuing on the southbound approach is less than 140 feet during the PM peak hour.

Y. <u>Beltline and County N</u>

The interchange of the Beltline and County N is a diamond interchange with stop-controlled ramp terminals. Adjacent to the County N interchange are the stop-controlled intersections of County MN to the south and Natvig Road to the north. Figure 4.04-26 shows the existing lane configurations along with the modeled existing LOS from Paramics for the AM and PM peak hours for the County N interchange area.

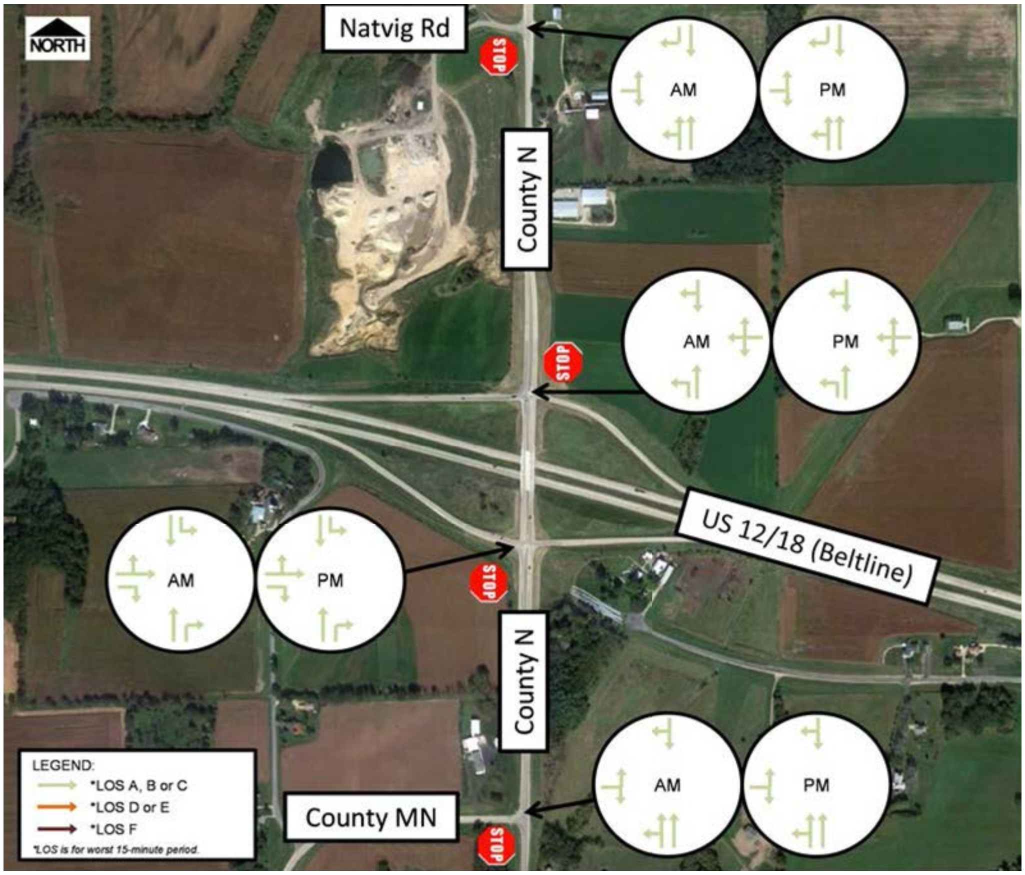


Figure 4.04-26 Beltline and County N Interchange

1. AM Peak Hour

There are no LOS F movements/intersections, and all movements are LOS C or better.

2. PM Peak Hour

There are no LOS F movements/intersections, and all movements are LOS C or better.

Z. <u>Beltline and North Star Road</u>

The intersection of the Beltline and North Star Road is an at-grade stop-controlled intersection. Figure 4.04-27 shows the existing lane configuration along with the modeled existing LOS from Paramics for the AM and PM peak hours.

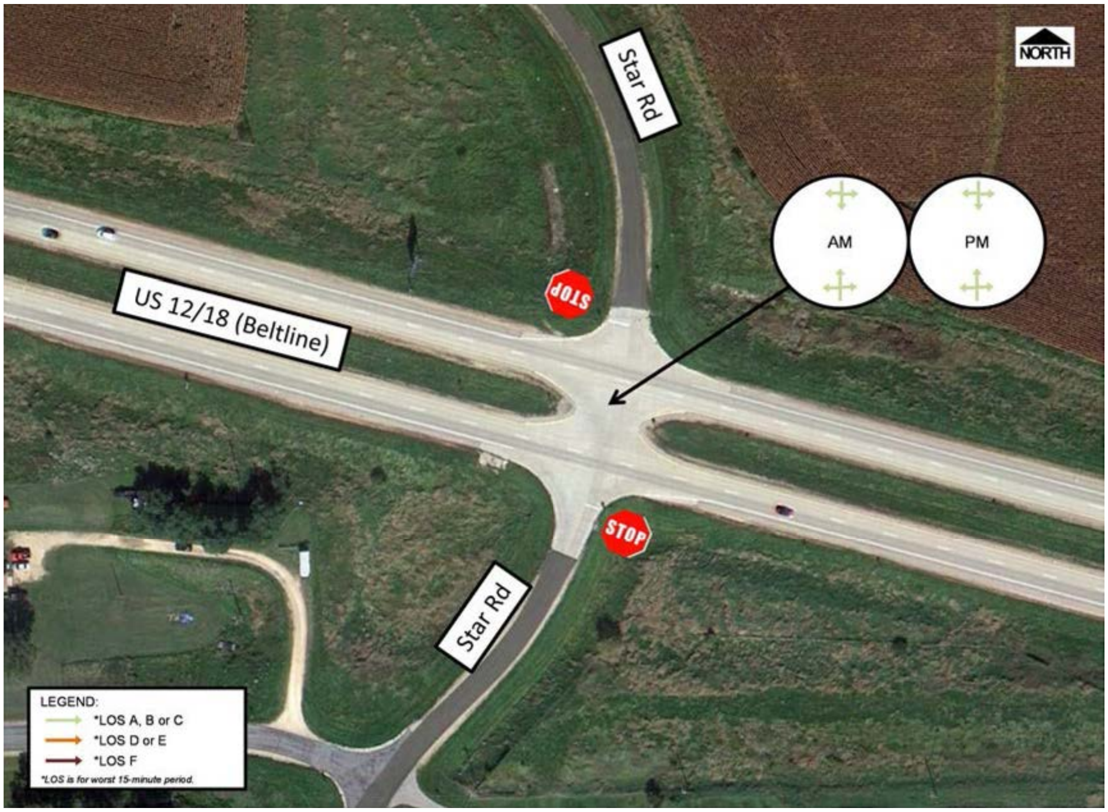


Figure 4.04-27 Beltline and North Star Road

1. AM Peak Hour

There are no LOS F movements, and all movements are LOS C or better.

2. PM Peak Hour

There are no LOS F movements, and all movements are LOS C or better.

4.05 CONCLUSION

Motor vehicles currently experience poor operations on the Beltline during weekday AM and PM peak periods. These poor operations are characterized by unstable traffic flows, severe congestion, and unpredictable travel during. Quantitative measures demonstrating the existing poor operations on the Beltline have been evaluated using aerial photography for mainline densities, and the Fall 2014 draft Base Paramics models for average intersection delay. A summary follows:

Beltline Freeway Operations: In 2012 a third of the segments evaluated along the Beltline experienced LOS F operations and half experienced LOS E or worse operations. The Beltline section from Verona Road to I-39 is particularly poor, with most segments experiencing LOS E or F during the morning or evening rush hours, and some during both peaks. During the AM peak hour, four sections of the Beltline saw motor vehicle densities that were more than double the LOS F threshold: I-39/90 to Stoughton Road; Stoughton Road to Monona Drive; South Towne Drive to John Nolen Drive; and Rimrock Road to Park Street.

Contributing to the poor Beltline mainline LOS are heavy volumes of merging and weaving traffic present at interchanges along the corridor. The combination of high mainline traffic volumes and high merging/weaving volumes is a primary factor in the unstable flow and creates platoons of congestion that propagate along the Beltline during the AM and PM peak hours. Average speeds along the Beltline frequently drop below freeflow conditions due to high traffic volumes and significant weaving between interchanges.

Travel Time: The Travel Time Reliability (TTR) along the Beltline varies greatly from day to day because of the unstable traffic flow. Travelers do not have a consistent time they can allocate for their trip, because Beltline conditions vary from day to day. Relatively minor fluctuations in traffic or a minor incident can result in significant impacts to an already congested corridor. This results in poor TTR, particularly westbound in the AM peak period and eastbound in the PM peak period.

Intersection Operations: Many of the ramp terminals and adjacent intersections operate poorly today. During the 2012 AM peak hour 13 of the 88 intersections evaluated (15%) operated at LOS E or LOS F overall. During the 2012 PM peak hour 6 of the 88 intersections evaluated (7%) operated at LOS E or LOS F overall. The highest levels of congestion existed at County K, along Airport Road, along Mineral Point Road (likely improved with the project at Junction Road and along Mineral Point Road), along Verona Road (improvements currently in design and construction), along John Nolen Drive, along West Broadway, along Stoughton Road.

The at-grade intersections on US 12 east of the Beltline Interchange with I-39/90 struggled in 2012. Millpond Road and at County AB operated at LOS F. As traffic volumes grow and delays get more severe these at-grade intersections may begin to experience crash issues. This section of US 12 is currently under study for freeway conversion.

Motor vehicle operations on the Beltline and at the ramp terminals and most nearby intersections are expected to deteriorate as population and employment in the greater Madison area continues to grow and traffic volumes increase as a result. Preliminary Beltline traffic forecasts show a daily increase in traffic ranging from about 10,000 to 35,000 vehicles per day on the Beltline by 2050 even if no capacity is added. While this is represent smaller growth than the Beltline has experienced in the past 30 years, a volume increase of this magnitude would substantially increase Beltline and side road congestion. Demand modeling indicates an additional 7,000 to 13,000 vehicles per day currently desire to use the most heavily traveled portions of the Beltline but cannot because of capacity constraints. This unserved demand could grow to 25,000 to 35,000 vehicles per day by 2050.

There is little to no capacity available during peak travel times to handle the anticipated traffic increases and unstable operations and bottlenecks are anticipated to become more frequent and widespread. As travel demand grows, locations that did not experience significant delay during the 2012 AM or PM peak hours may do so in the future. Locations that were already congested during the 2012 AM and/or PM peak hours will likely experience much longer periods of congestion extending “rush hour” to a larger portion of the typical day.