FINAL
ADDENDUM TO YEAR 2035 BUILD TRAFFIC OPERATIONS TECHNICAL MEMORANDUM

MONROE CONNECTOR / BYPASS
STIP NUMBER R-3329 / R-2559
UNION AND MECKLENBURG COUNTIES

Prepared For:

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1 INTRODUCTION

The purpose of this addendum is to present the revised traffic operations analysis and queuing results for the year 2035 Build scenario Traffic Alternative 3A at the Monroe Connector/Bypass / US 74 Frontage Road interchange, Monroe Connector/Bypass / Unionville Indian Trail Road interchange, and Monroe Connector/Bypass / Austin Chaney Road interchange. The report will present the appropriate forms and arrangement of lanes for all freeway segments, interchanges and surface street at-grade intersections within the reevaluation project area.

An Addendum is required to the *Traffic Operations Technical Memorandum*, dated April 2009, in order to re-evaluate, from a traffic operations standpoint, the Monroe Connector/Bypass / US 74 Frontage Road interchange, Monroe Connector/Bypass / Unionville Indian Trail Road interchange, and Monroe Connector/Bypass / Austin Chaney Road interchange under Detailed Study Alternative (DSA) D, Traffic Alternative 3A.

Since the original *Traffic Operations Technical Memorandum* was completed, a revised toll collection plan was developed for the Monroe Connector/Bypass / US 74 Frontage Road interchange. The new toll collection plan altered the traffic patterns within this area requiring a new traffic forecast to be developed. The new traffic forecast is the basis for the traffic operations re-evaluation of the Monroe Connector/Bypass / US 74 Frontage Road interchange.

Based on input from the public meetings held after the completion of the *Traffic Operations Technical Memorandum*, the Monroe Connector/Bypass / Unionville Indian Trail Road interchange design was revised to eliminate the need to realign Secrest Shortcut Road and allow for a reduced interchange footprint. The proposed interchange form remains a diamond but the spacing between the ramp terminal intersections was reduced to 350 feet and the interchange was shifted slightly to the north. The revised Monroe Connector/Bypass / Unionville Indian Trail Road interchange design is the basis for the traffic operations re-evaluation of the interchange.

Additional input from the public meetings led to redesign of the Monroe Connector/Bypass / Austin Chaney Road interchange to avoid having to terminate McIntyre Road at the Monroe Connector/Bypass and severing the connection it provides between Austin Chaney Road and Monroe Ansonville Road. The interchange form would change from a Parclo-A (2 quad – northeast and southwest) to a Parclo-AB (2 quad – northwest and southwest). The revised interchange design also reduces the amount of impact to the surrounding wetlands. The revised Monroe Connector/Bypass / Austin Chaney Road interchange design is the basis for the traffic operations re-evaluation of the interchange.

2 TRAFFIC VOLUMES

Year 2035 is designated as the design year of the Build scenario analysis. The Monroe Connector/Bypass/ US 74 Frontage Road interchange morning and evening peak hour turning movement traffic volumes for the year 2035 Build scenario conditions of the DSA D, Traffic Alternative 3A were provided by HNTB and are located in **Appendix A-A**. The provided peak hour traffic volumes were balanced using engineering judgment and also located in **Appendix A-A**.

The traffic volumes from the April 2009 *Traffic Operations Technical Memorandum* were used in the reevaluation of the Unionville Indian Trail Road and Austin Chaney Road interchanges.

3 ANALYSIS METHODOLOGY

Level of service (LOS) analyses were performed following the NCDOT Congestion Management Section's *Capacity Analysis Guidelines for TIP Project Traffic Analyses*. The roadway design criteria established for the Monroe Connector/Bypass were also followed in setting up analysis parameters. All of the assumptions employed in the analysis are documented in the first section of **Appendix A-B**.

Traffic operations analysis for individual freeway elements (basic freeway segments, ramp merge/diverge areas, and weave sections) were conducted using Highway Capacity Software 2000 (HCS 2000, Version 4.1f), which is based on the methodologies of the *2000 Highway Capacity Manual*. Additionally, based on the methodologies of the *2000 Highway Capacity Manual*, major merge/diverge locations were analyzed by checking the capacity of each of the entering and exiting legs. The LOS and density of the worst performing entering or exiting segment was reported.

All signalized intersections were analyzed using the Synchro software package, Version 7, Build 761. Stop-controlled intersections were analyzed using HCS 2000, Version 4.1f. The intersection LOS and volume-to-capacity ratios were determined by taking the values from the worst operation of all the stop-controlled movements.

A SimTraffic arterial analysis was performed for the Eastbound and Westbound US 74 Frontage Roads. The SimTraffic simulation analysis was also used to determine the queue lengths of the signalized Frontage Road intersections. Ten simulation runs were recorded for each scenario and the 95th percentile queue lengths were averaged. For the stop-controlled intersections, the 95th percentile queue length from HCS 2000 report was utilized.

4 ANALYSIS RESULTS

4.1 Monroe Connector/Bypass / US 74 Frontage Road Interchange

The Monroe Connector/Bypass / US 74 Frontage Road interchange will only be provided under Traffic Alternatives 3A to 3D as these alternatives will start the Monroe Connector/Bypass along US 74, west of Stallings Road. Under this alternative, the section of US 74 between McKee and Stallings Roads will be reconfigured to form a split diamond interchange with the US 74 Frontage Road (Business 74). East of this interchange, US 74 will split to provide a direct connection between the Monroe Connector/Bypass and the US 74 traffic to and from the west. For the US 74 traffic to and from the east, access to the Monroe Connector/Bypass will be via Indian Trail Road which will lead to an interchange with the Monroe Connector/Bypass.

The Monroe Connector/Bypass / US 74 Frontage Road interchange form and lane geometry are shown in **Figure A-1**, along with the Year 2035 Build traffic volumes and the LOS and queue length results from the analysis. The LOS analysis printouts are located in **Appendix A-B**.

The LOS results are summarized in **Table 4-1** for the analysis of freeway elements and **Table 4-2** for the analysis of intersections. When LOS results are worse than the desirable LOS D level, the LOS results are highlighted in orange. The results indicate that this interchange will operate at desirable LOS except for the US 74 eastbound and westbound weave sections between the US 74 frontage road interchange and the I-485 interchange. The four ramp terminal intersections of the split diamond interchange formed by McKee Road, Stallings Road, and the US 74 frontage road will all operate at desirable LOS.

Table 4-1: Monroe Connector/Bypass / US 74 Frontage Road Interchange LOS Analysis Results

Interchange Element	2035 Build AM(PM) Alt 3A	
	density	LOS
US 74 EB, between I-485 and off-ramp to McKee Rd (weave) (Site 474)	33.0 (43.0)	D (E)
US 74 EB, from McKee Rd to split to Monroe Connector/Bypass (mainline) (Site 463)	24.1 (32.3)	C (D)
US 74 EB, diverge to Monroe Connector/Bypass (diverge) (Sites 457, 463, 472)	24.1 (32.3)	C (D)
Monroe Connector/Bypass EB, before on-ramp from US 74 EB frontage road (mainline) (Site 472)	21.2 (30.5)	C (D)
Monroe Connector/Bypass EB, on-ramp from US 74 EB frontage road (merge) (Site 455)	17.4 (25.7)	B (C)
Monroe Connector/Bypass EB, east of interchange (mainline) (Site 483)	18.9 (27.4)	C (D)
Monroe Connector/Bypass WB, east of interchange (mainline) (Site 482)	27.4 (18.9)	D (C)
Monroe Connector/Bypass WB, off-ramp to US 74 WB frontage road (diverge) (Site 454)	30.7 (21.5)	D (C)
Monroe Connector/Bypass WB, before on-ramp from Business US 74 WB (mainline) (Site 458)	31.7 (22.1)	D (C)
Monroe Connector/Bypass WB, on-ramp from Business US 74 WB (merge) (Sites 458, 459, 464)	31.7 (22.1)	D (C)
US 74 WB, after merge of Monroe Connector/Bypass WB and Business US 74 WB (mainline) (Site 471)	32.6 (24.9)	D (C)
US 74 WB, between on-ramp from US 74 WB frontage road and I-485 (weave) (Site 473)	41.0 (31.9)	E (D)
Business US 74 EB, on-ramp from US 74 EB frontage road (merge) (Sites 457, 468, 469)	20.5 (22.9)	C (C)
Business US 74 EB, east of interchange (mainline) (Site 469)	16.6 (19.4)	B (C)
Business US 74 WB, east of interchange (mainline) (Site 470)	29.8 (25.5)	D (C)
Business US 74 WB, off-ramp to US 74 WB frontage road (diverge) (Site 460)	26.0 (21.9)	C (C)
Business US 74 WB, before merge with Monroe Connector/Bypass WB (mainline) (Site 464)	18.5 (16.3)	C (B)

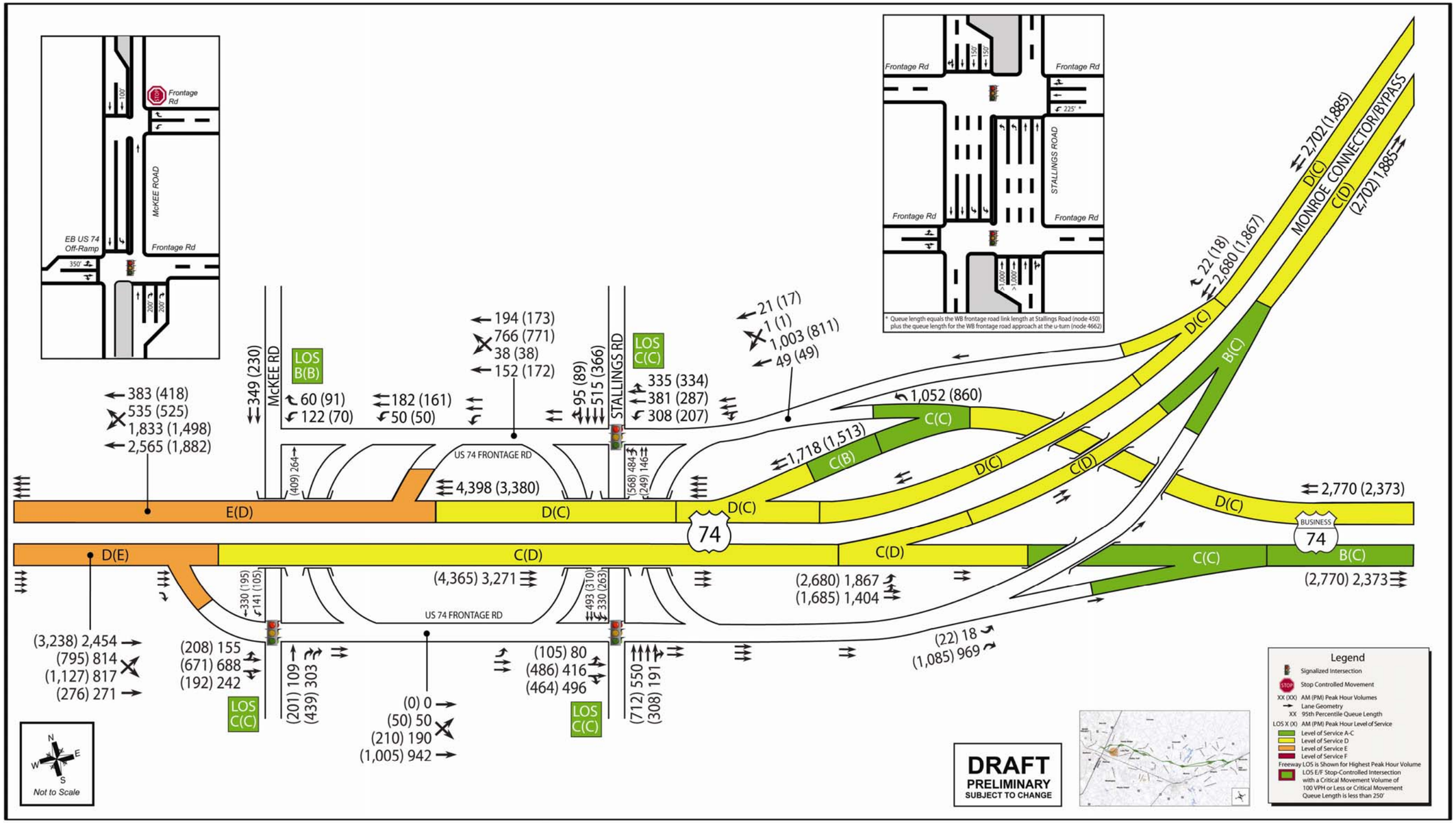
Table 4-2: Monroe Connector / US 74 Frontage Road Interchange Ramp Terminal Intersections LOS Analysis Results

Intersection	2035 Build AM(PM) Alt 3A	
	V/C	LOS
McKee Road, south intersection with US 74 EB off-ramp/Frontage Road (Site 481)	0.79 (0.77)	C (C)
McKee Road, north intersection with US 74 WB Frontage Road (unsignalized) (Site 480)	0.24 (0.17)	B (B)
Stallings Road, south intersection with US 74 EB Frontage Road (Site 451)	0.88 (0.90)	C (C)
Stallings Road, north intersection with US 74 WB Frontage Road (Site 450)	0.88 (0.90)	C (C)

To determine the operating conditions of the US 74 Frontage Roads an arterial analysis was performed using SimTraffic. The results of the simulation showed no significant delay along with acceptable travel times and arterial speeds on both the Eastbound and Westbound US 74 Frontage Roads during the AM and PM peak hours. The arterial analysis results are summarized in **Table 4-3**.

Table 4-3: US 74 Frontage Road Arterial Analysis Results

Cross Street	Site	2035 Build AM(PM) Alt 3A			
		Delay (sec/veh)	Travel Time (sec)	Distance (mi)	Arterial Speed (mph)
US 74 WB Frontage Road					
U-Turn to EB Frontage Road	4662	8.1 (5.9)	26.0 (23.9)	0.2 (0.2)	21 (23)
Stallings Road	450	17.1 (16.9)	19.0 (18.8)	0.0 (0.0)	5 (5)
U-Turn from EB Frontage Road	4751	2.2 (2.1)	5.4 (5.3)	0.0 (0.0)	18 (18)
Ramp to WB US 74	4752	1.0 (0.9)	12.3 (12.3)	0.1 (0.1)	30 (30)
U-Turn to EB Frontage Road	477	2.0 (1.7)	22.0 (21.9)	0.2 (0.2)	32 (32)
McKee Road	480	14.3 (10.3)	18.2 (14.2)	0.0 (0.0)	4 (6)
Total	**-**	**44.6 (37.7)**	**103.0 (96.4)**	**0.5 (0.5)**	**18 (20)**
US 74 EB Frontage Road					
McKee Road	481	27.0 (30.8)	47.3 (51.1)	0.2 (0.2)	17 (16)
U-Turn from WB Frontage Road	4761	1.7 (1.7)	3.9 (3.9)	0.0 (0.0)	20 (20)
U-Turn to WB Frontage Road	4762	31.4 (26.6)	63.0 (58.3)	0.3 (0.3)	17 (18)
Stallings Road	451	17.0 (16.5)	18.8 (18.4)	0.0 (0.0)	5 (5)
U-Turn from WB Frontage Road	484	2.2 (2.3)	5.7 (5.7)	0.0 (0.0)	18 (18)
U-Turn from WB Frontage Road Lane Drop	9999	0.7 (0.7)	12.0 (11.9)	0.1 (0.1)	31 (31)
Split to EB Monroe Connector / Bypass and EB US 74 Business	456	3.2 (3.4)	37.6 (37.8)	0.3 (0.3)	32 (32)
Total	**-**	**83.1 (82.0)**	**188.2 (187.1)**	**1.0 (1.0)**	**20 (20)**



NORTH CAROLINA Turnpike Authority

MONROE CONNECTOR / BYPASS
TIP Project Numbers R-3329 & R-2559
Mecklenburg and Union Counties

Year 2035 Build Alternative 3A - Monroe Connector / US 74 Frontage Road Interchange Conditions

Figure A-1

4.2 Monroe Connector/Bypass / Unionville Indian Trail Road Interchange

The Monroe Connector/Bypass / Unionville-Indian Trail Road interchange will be provided under all of the alternatives. The selected interchange form is a compressed diamond. The Monroe Connector/Bypass / Unionville-Indian Trail Road interchange form and lane geometry are shown in **Figure A-2**, along with the Year 2035 Build traffic volumes and the LOS and queue length results from the analysis. The LOS analysis printouts are located in **Appendix A-B**.

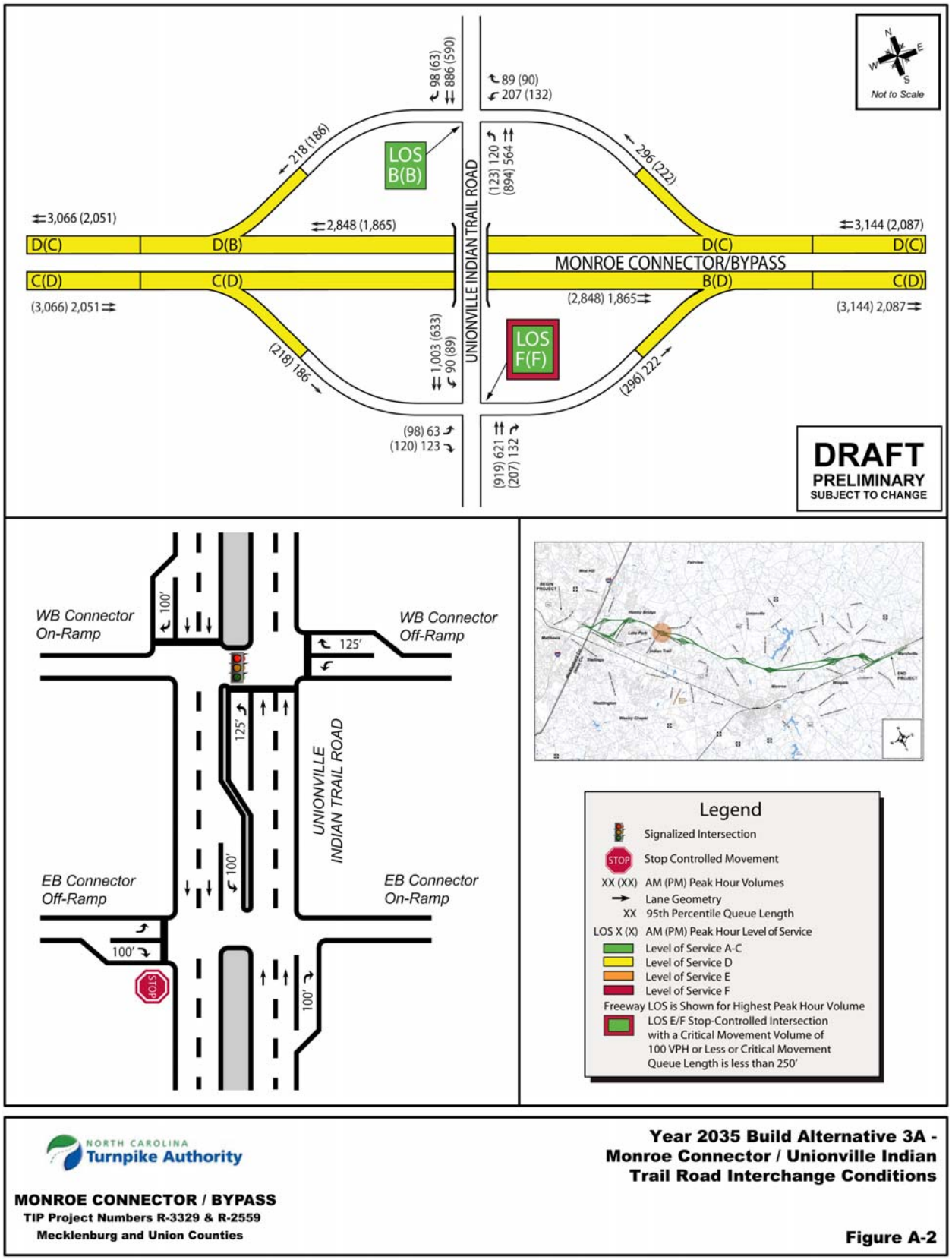
The LOS results are summarized in **Table 4-4** for the analysis of freeway elements and **Table 4-5** for the analysis of intersections. When LOS results are worse than the desirable LOS D level, the LOS results are highlighted in orange. The results indicate that this interchange will operate at desirable LOS, except for an unsignalized intersection. The south ramp terminal intersection on Unionville Indian Trail Road will be unlikely to meet signal warrants under Alternatives 3A; and will operate at undesirable LOS with a stop sign control. The north ramp terminal intersection will likely meet signal warrants and will operate at desirable LOS with signal control.

Table 4-4: Monroe Connector/Bypass / Unionville Indian Trail Road Interchange LOS Analysis Results

Interchange Element	2035 Build AM(PM)	
	density	LOS
Monroe Connector/Bypass EB, west of interchange (mainline) (Site 504)	20.5 (32.6)	C (D)
Monroe Connector/Bypass EB, off-ramp to Unionville-Indian Trail Road (diverge) (Site 550)	21.3 (32.7)	C (D)
Monroe Connector/Bypass EB, on-ramp from Unionville-Indian Trail Road (merge) (Site 552)	19.5 (30.1)	B (D)
Monroe Connector/Bypass EB, east of interchange (mainline) (Site 554)	20.9 (34.0)	C (D)
Monroe Connector/Bypass WB, east of interchange (mainline) (Site 555)	34.0 (20.9)	D (C)
Monroe Connector/Bypass WB, off-ramp to Unionville-Indian Trail Road (diverge) (Site 553)	33.2 (21.3)	D (C)
Monroe Connector/Bypass WB, on-ramp from Unionville-Indian Trail Road (merge) (Site 551)	28.6 (18.3)	D (B)
Monroe Connector/Bypass WB, west of interchange (mainline) (Site 505)	32.6 (20.5)	D (C)

Table 4-5: Monroe Connector/Bypass / Unionville Indian Trail Road Interchange Ramp Terminal Intersections LOS Analysis Results

Intersection	2035 Build AM(PM)	
	V/C	LOS
Unionville-Indian Trail Road, south intersection with Monroe Connector/Bypass EB ramps (unsignalized) (Site 560)	0.56 (0.75)	F (F)
Unionville-Indian Trail Road, north intersection with Monroe Connector/Bypass WB ramps (Site 561)	0.65 (0.50)	B (B)


Not to Scale
98 (63)
886 (590)
89 (90)
207 (132)
218 (186)
LOS B(B)
(123) 120
(894) 564
296 (222)
3,066 (2,051)
2,848 (1,865)
3,144 (2,087)
D(C)
D(B)
D(C)
D(C)
MONROE CONNECTOR/BYPASS
C(D)
C(D)
B(D)
C(D)
(3,066) 2,051
(2,848) 1,865
(3,144) 2,087
UNIONVILLE INDIAN TRAIL ROAD
1,003 (633)
90 (89)
LOS F(F)
(218) 186
(296) 222
(98) 63
(120) 123
(919) 621
(207) 132
DRAFT
PRELIMINARY
SUBJECT TO CHANGE
WB Connector On-Ramp
100'
WB Connector Off-Ramp
125'
125'
UNIONVILLE INDIAN TRAIL ROAD
100'
EB Connector Off-Ramp
EB Connector On-Ramp
100'
STOP
100'
Legend
Signalized Intersection
Stop Controlled Movement
XX (XX) AM (PM) Peak Hour Volumes
Lane Geometry
XX 95th Percentile Queue Length
LOS X (X) AM (PM) Peak Hour Level of Service
Level of Service A-C
Level of Service D
Level of Service E
Level of Service F
Freeway LOS is Shown for Highest Peak Hour Volume
LOS E/F Stop-Controlled Intersection with a Critical Movement Volume of 100 VPH or Less or Critical Movement Queue Length is less than 250'
NORTH CAROLINA Turnpike Authority
MONROE CONNECTOR / BYPASS
TIP Project Numbers R-3329 & R-2559
Mecklenburg and Union Counties
Year 2035 Build Alternative 3A - Monroe Connector / Unionville Indian Trail Road Interchange Conditions
Figure A-2

4.3 Monroe Connector/Bypass / Austin Chaney Road Interchange

The Monroe Connector/Bypass / Austin Chaney Road interchange will be provided under all of the alternatives. The selected interchange form is a Parclo-AB with ramps in the northwest and southwest quadrants. The Monroe Connector/Bypass / Austin Chaney Road interchange form and lane geometry are shown in **Figure A-3**, along with the Year 2035 Build traffic volumes and the LOS and queue length results from the analysis. The LOS analysis printouts are located in **Appendix A-B**.

The LOS results are summarized in **Table 4-6** for the analysis of freeway elements and **Table 4-7** for the analysis of intersections. When LOS results are worse than the desirable LOS D level, the LOS results are highlighted in orange. The results indicate that this interchange will operate at desirable LOS, except for an unsignalized intersection. The south ramp terminal intersection on Austin Chaney Road will not likely meet signal warrants under Alternative 3A; and will operate at undesirable LOS with a stop sign control. The north ramp terminal intersection will likely meet signal warrants and will operate at desirable LOS with signal control.

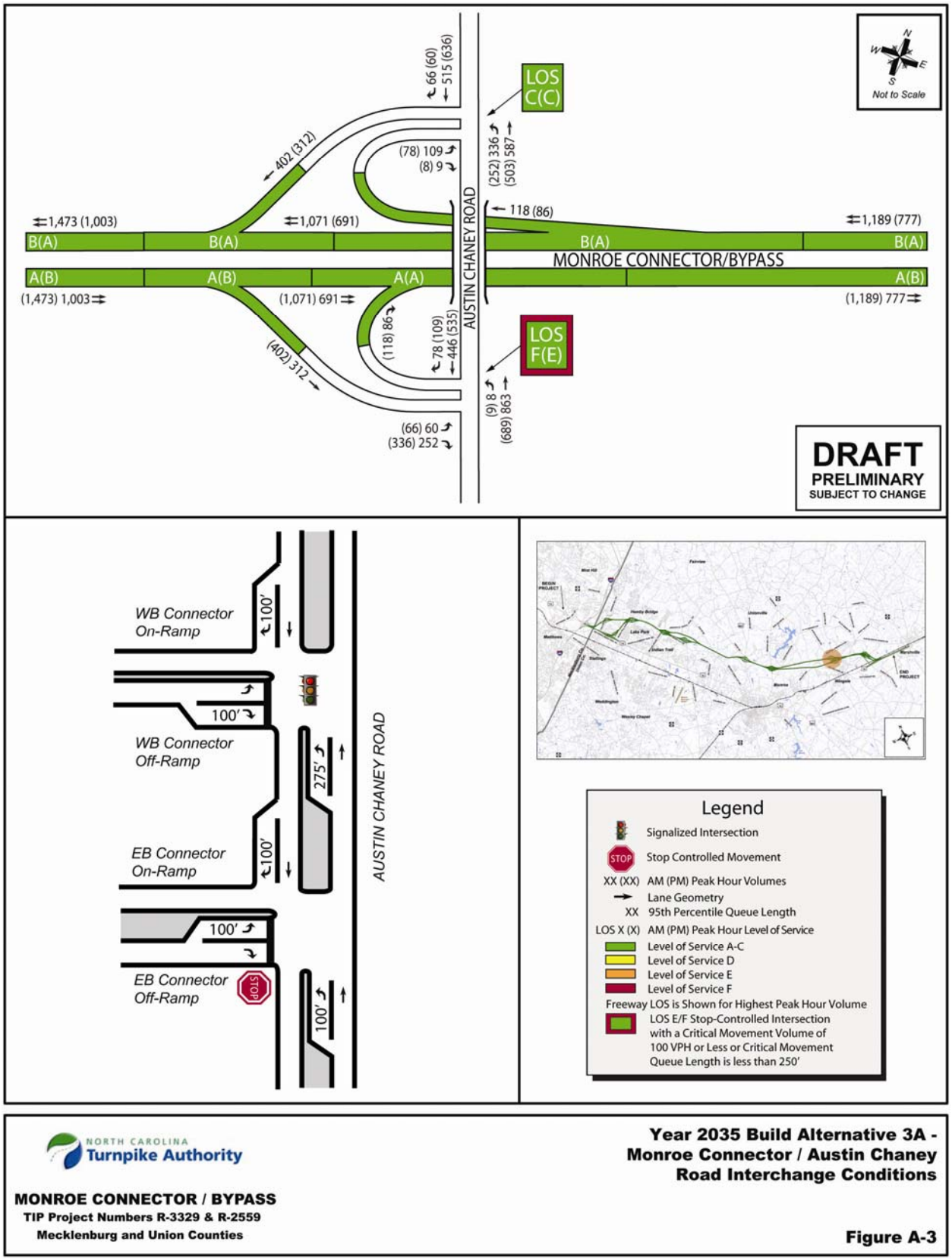
Table 4-6: Monroe Connector/Bypass / Austin Chaney Road Interchange LOS Analysis Results

Interchange Element	2035 Build AM(PM)	
	density	LOS
Monroe Connector/Bypass EB, west of interchange (mainline) (Site 704)	10.0 (14.7)	A (B)
Monroe Connector/Bypass EB, off-ramp to Austin Chaney Road (diverge) (Site 750)	9.7 (15.0)	A (B)
Monroe Connector/Bypass EB, on-ramp from Austin Chaney Road (merge) (Site 751)	2.9 (7.1)	A (A)
Monroe Connector/Bypass EB, east of interchange (mainline) (Site 754)	7.8 (11.9)	A (B)
Monroe Connector/Bypass WB, east of interchange (mainline) (Site 755)	11.9 (7.8)	B (A)
Monroe Connector/Bypass WB, off-ramp to Austin Chaney Road (diverge) (Site 753)	10.8 (6.1)	B (A)
Monroe Connector/Bypass WB, on-ramp from Austin Chaney Road (merge) (Site 752)	14.2 (9.5)	B (A)
Monroe Connector/Bypass WB, west of interchange (mainline) (Site 705)	14.7 (10.0)	B (A)

Table 4-7: Monroe Connector/Bypass / Austin Chaney Road Interchange Ramp Terminal Intersections LOS Analysis Results

Intersection	2035 Build AM(PM)	
	V/C	LOS
Austin Chaney Road, south intersection with Monroe Connector/Bypass EB ramps (unsignalized) (Site 760)	0.50 (0.77)[1]	F (E)[1]
Austin Chaney Road, north intersection with Monroe Connector/Bypass WB ramps (Site 761)	0.75 (0.80)	C (C)

[1] LOS is for the left-turn lane while the V/C ratio is for the right-turn lane


Not to Scale
LOS C(C)
LOS F(E)
AUSTIN CHANEY ROAD
MONROE CONNECTOR/BYPASS
1,473 (1,003)
1,071 (691)
1,189 (777)
(1,473) 1,003
(1,071) 691
(1,189) 777
B(A)
A(B)
A(A)
66 (60)
515 (636)
402 (312)
(78) 109
(8) 9
(252) 336
(503) 587
118 (86)
(118) 86
78 (109)
446 (535)
(402) 312
(9) 8
(689) 863
(66) 60
(336) 252
DRAFT
PRELIMINARY
SUBJECT TO CHANGE
WB Connector On-Ramp
WB Connector Off-Ramp
EB Connector On-Ramp
EB Connector Off-Ramp
100'
275'
STOP
Legend
Signalized Intersection
Stop Controlled Movement
XX (XX) AM (PM) Peak Hour Volumes
Lane Geometry
XX 95th Percentile Queue Length
LOS X (X) AM (PM) Peak Hour Level of Service
Level of Service A-C
Level of Service D
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Freeway LOS is Shown for Highest Peak Hour Volume
LOS E/F Stop-Controlled Intersection with a Critical Movement Volume of 100 VPH or Less or Critical Movement Queue Length is less than 250'
NORTH CAROLINA Turnpike Authority
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Mecklenburg and Union Counties
Year 2035 Build Alternative 3A - Monroe Connector / Austin Chaney Road Interchange Conditions
Figure A-3

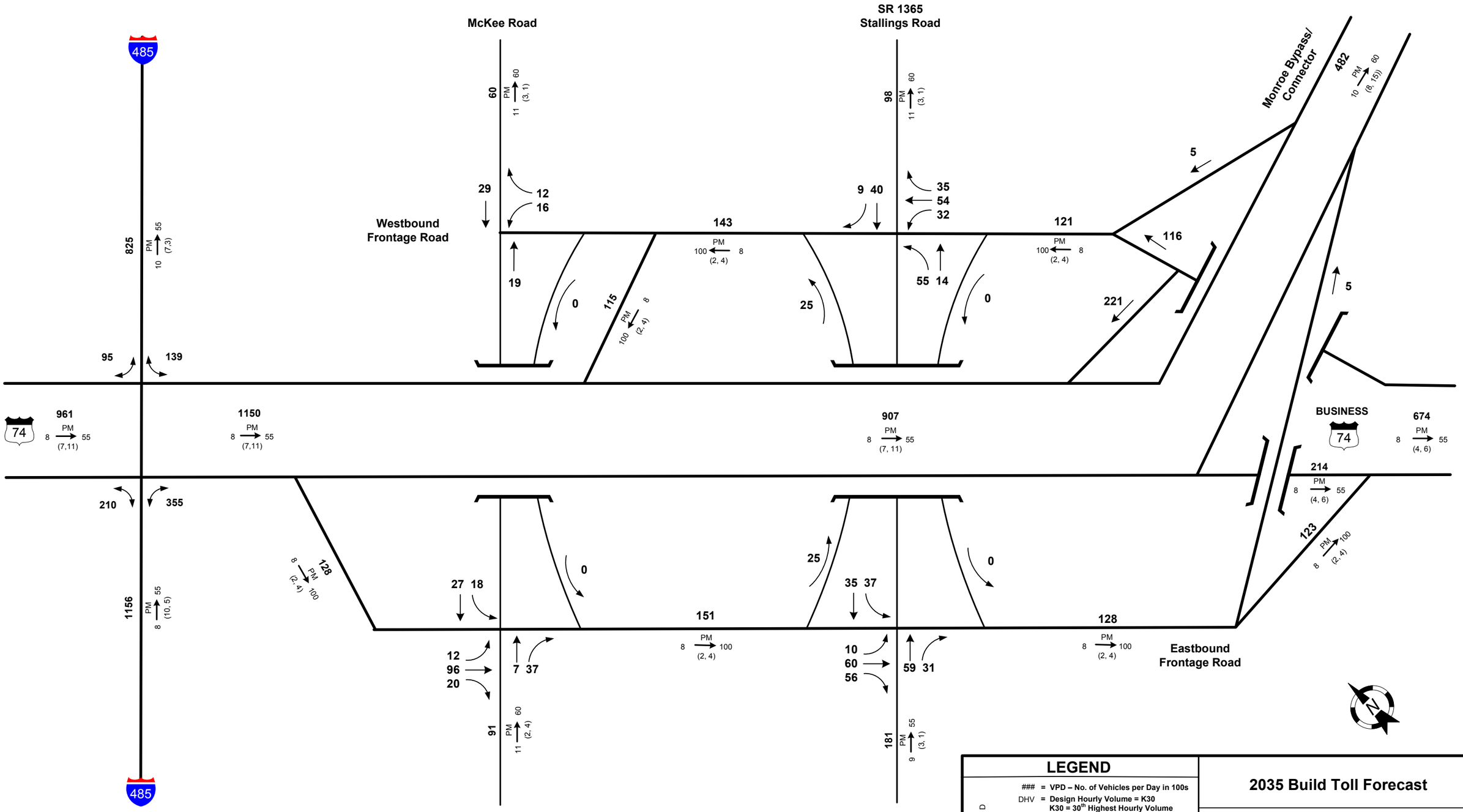
5 CONCLUSIONS

The DSA 3A Build scenario traffic operations analysis indicates that all of the Monroe Connector/Bypass / US 74 Frontage Road interchange elements, Monroe Connector/Bypass / Unionville Indian Trail Road interchange elements, and Monroe Connector/Bypass / Austin Chaney Road interchange elements will operate at a desirable LOS in the design year of 2035 except:

- US 74 EB weave between I-485 and off-ramp to McKee Rd
- US 74 WB weave between on-ramp from McKee Rd and I-485
- Unionville Indian Trail Road unsignalized intersection with Monroe Connector/Bypass EB ramps (unlikely to meet signal warrants).
- Austin Chaney Road unsignalized intersection with Monroe Connector/Bypass EB ramps (unlikely to meet signal warrants).

APPENDIX A-A

Year 2035 Build Peak Hour Traffic Volumes



LEGEND

###	= VPD – No. of Vehicles per Day in 100s
DHV	= Design Hourly Volume = K30 K30 = 30th Highest Hourly Volume
PM	= PM Peak Period
D	= Directional Split (%)
→	= Indicates Direction of D Reverse Flow for AM Peak
(d,t)	= Duals, TT-ST's (%)
↑	= Daily Turn Movements

N.T.S.

2035 Build Toll Forecast

Segment 2 (Alternative 3A)

DATE: July 2009

FIGURE 1

NORTH CAROLINA Turnpike Authority

HNTB

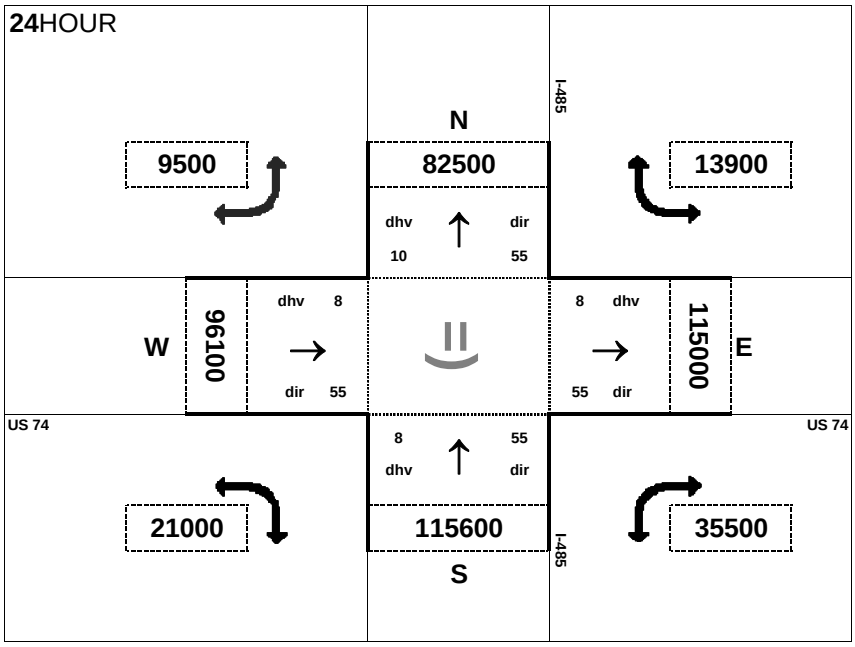
HNTB, North Carolina, PC
343 East Six Forks Rd Suite 200
Raleigh, North Carolina 27609

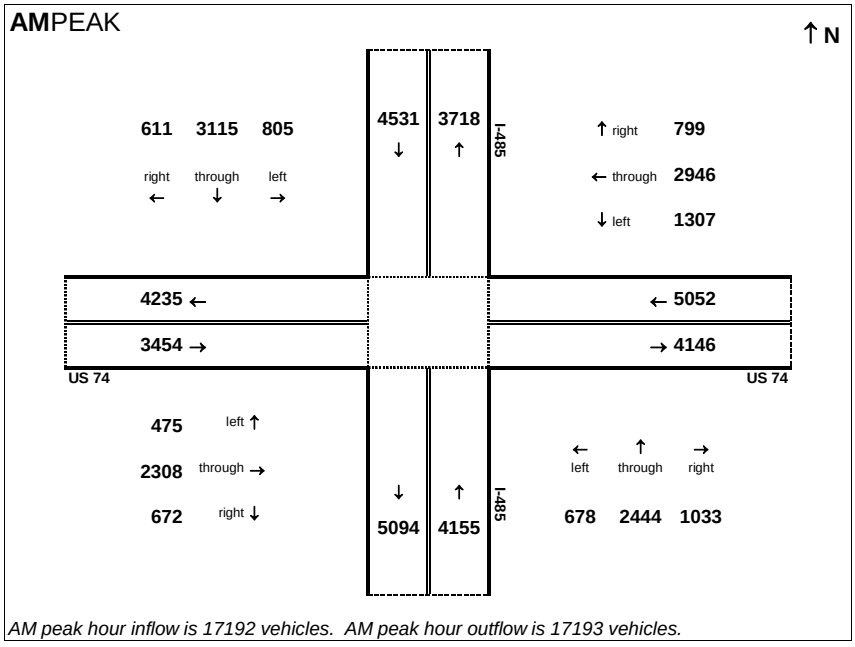
Peak Hour Volume Breakouts Report:
US 74 & I-485

Traffic Forecast Release Date:
July-09

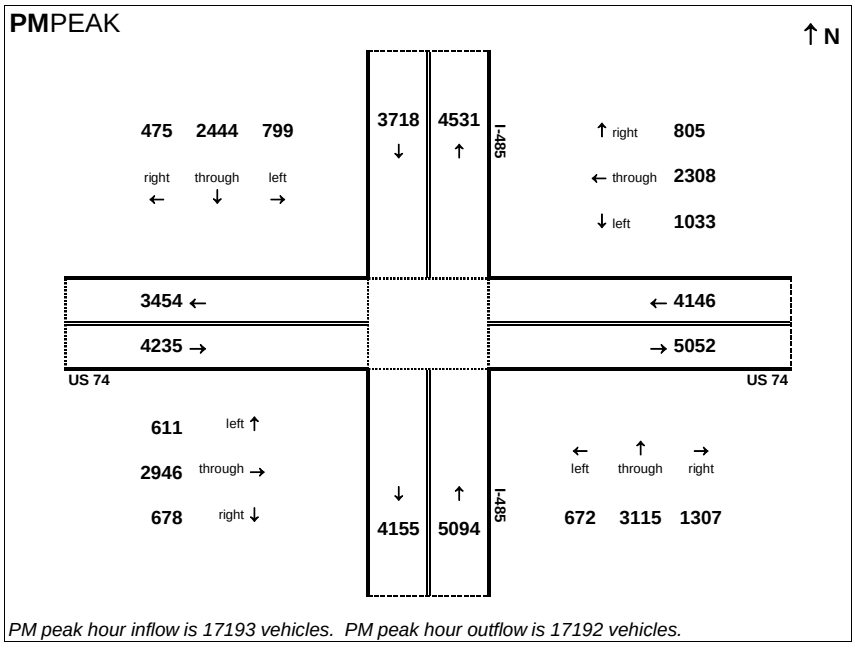
Traffic Data Year:
2035

Project:
Alt 3A Segment 2

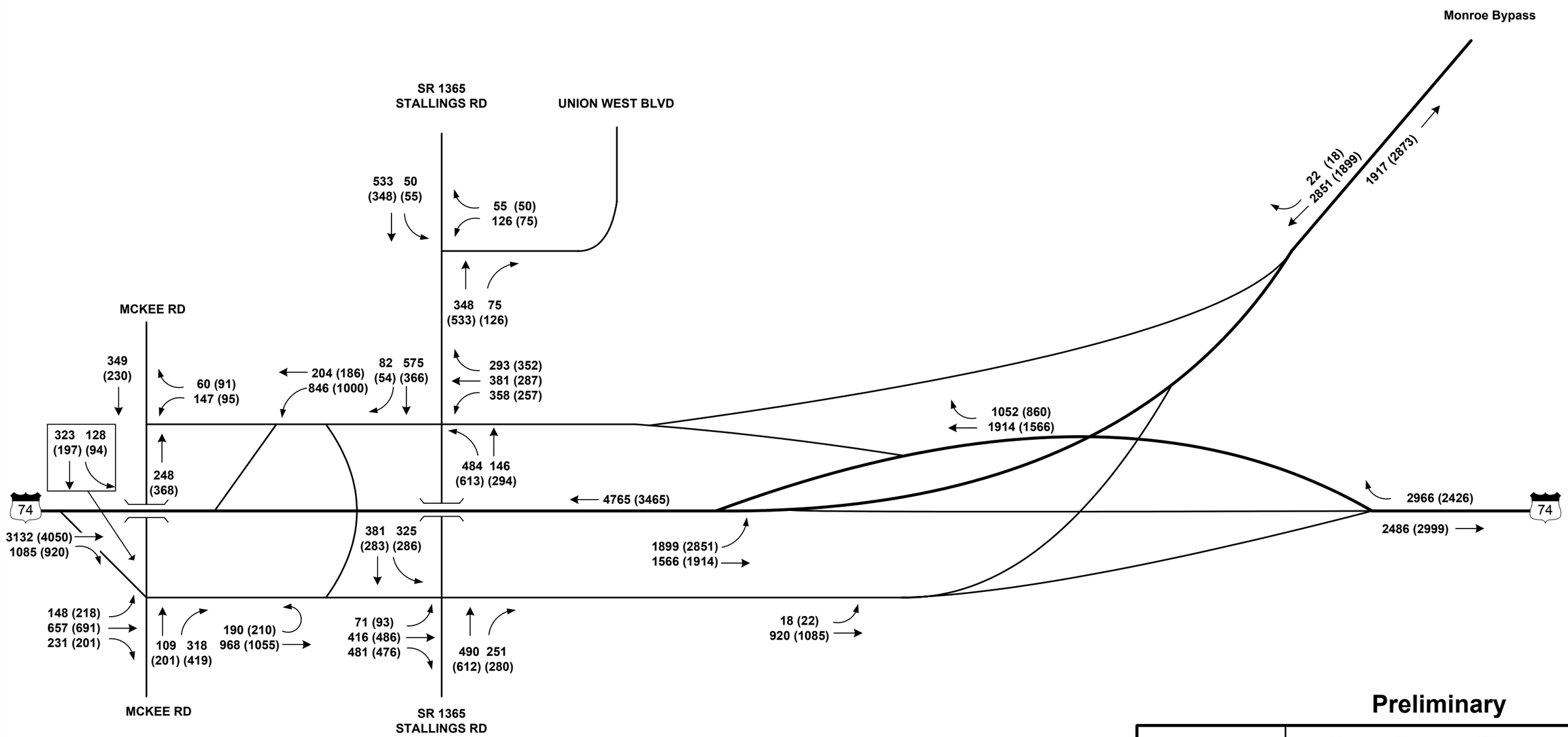




AM peak hour inflow is 17192 vehicles. AM peak hour outflow is 17193 vehicles.



PM peak hour inflow is 17193 vehicles. PM peak hour outflow is 17192 vehicles.



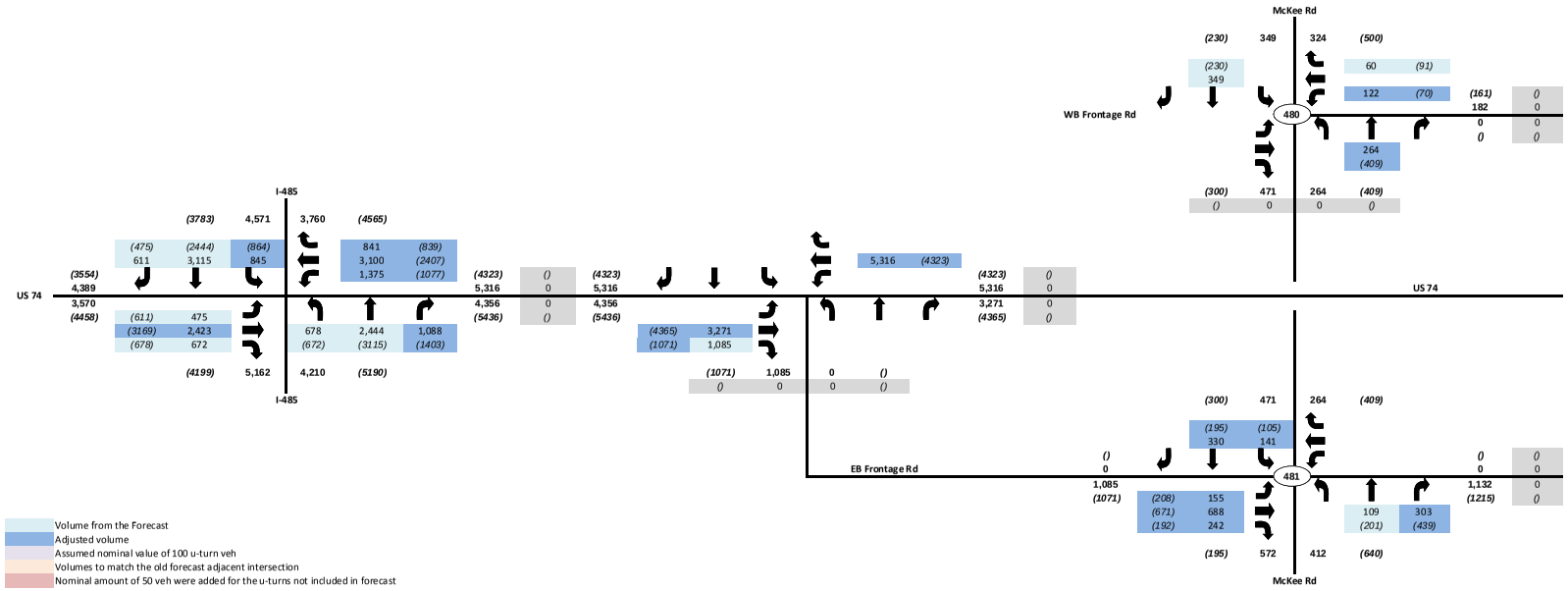
Preliminary

LEGEND	Monroe Connector/Bypass Alternative 3A
XXX = AM Peak (XXX) = PM Peak	2035 Peak Hour Traffic Build Toll Scenario
NOT TO SCALE	HNTB Proj # 46816 DATE: July 2009
	FIGURE 1A

HNTB

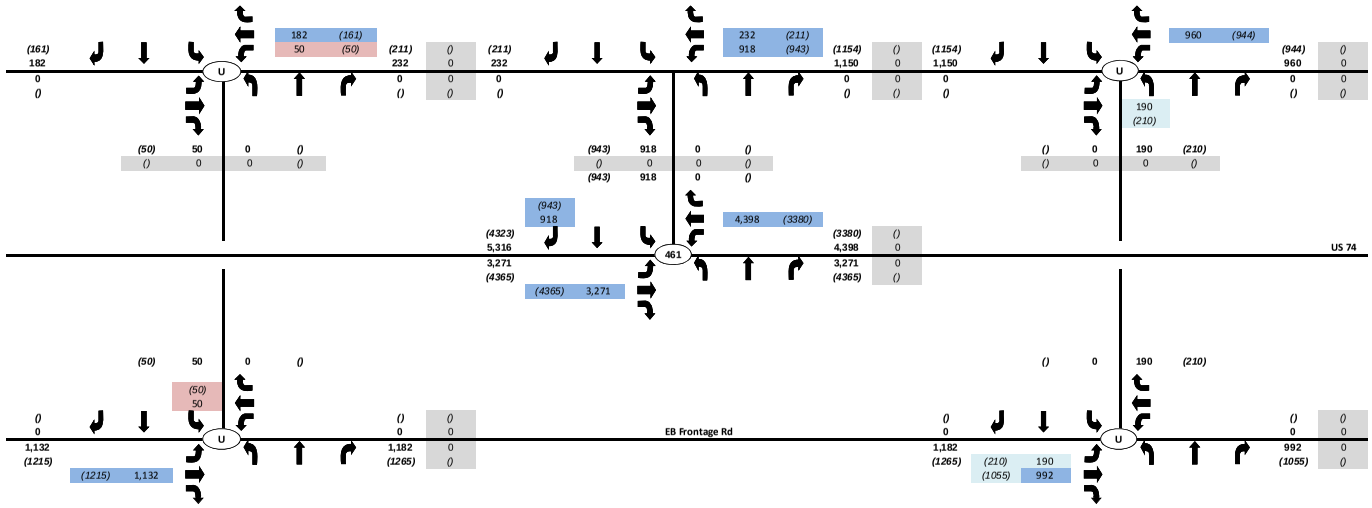
HNTB, North Carolina, PC
343 East Six Forks Rd Suite 200
Raleigh, North Carolina 27609

NORTH CAROLINA Turnpike Authority



Year 2035 Alt 3A - Segment 2

Balanced Peak Hour Volumes from HNTB Forecast



Year 2035 Alt 3A - Segment 2

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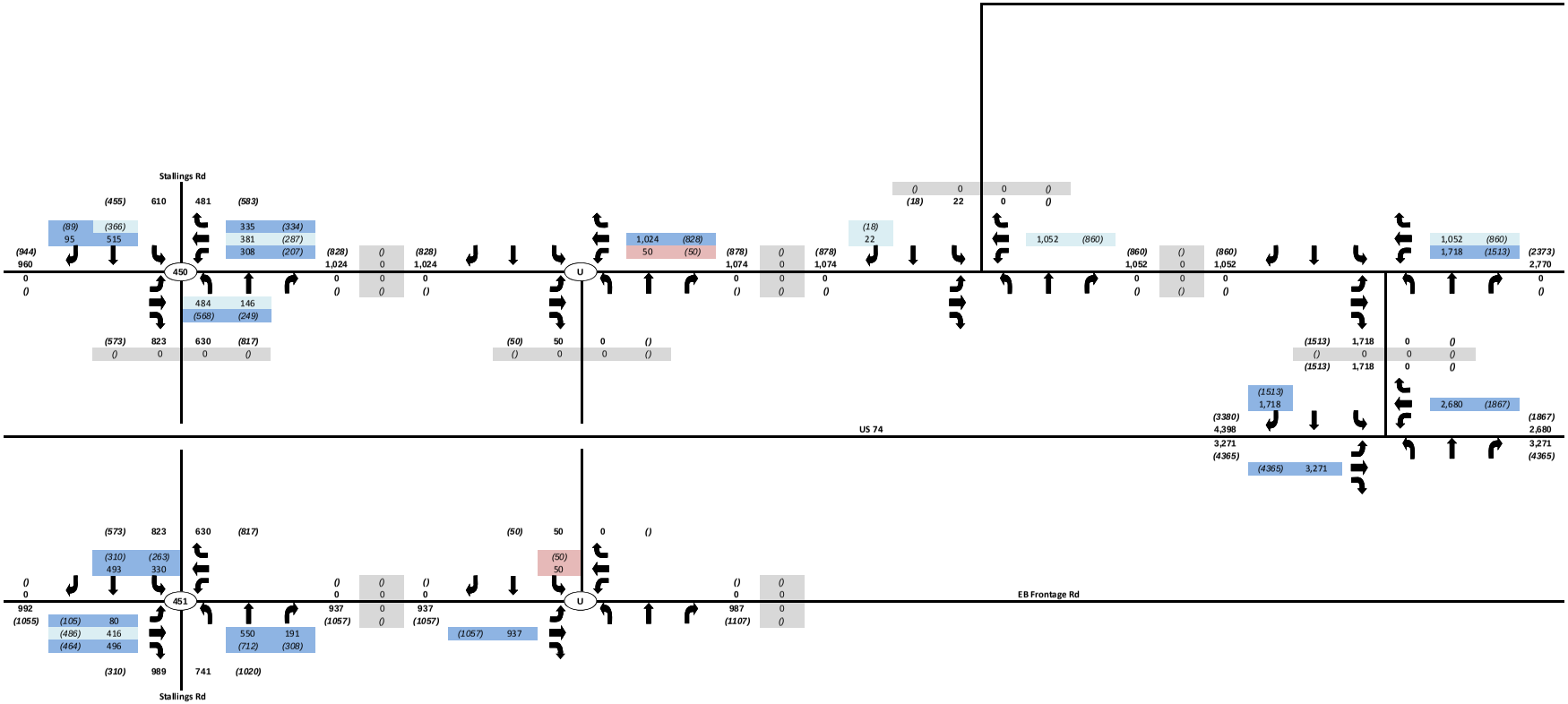

Year 2035 Alt 3A - Segment 2

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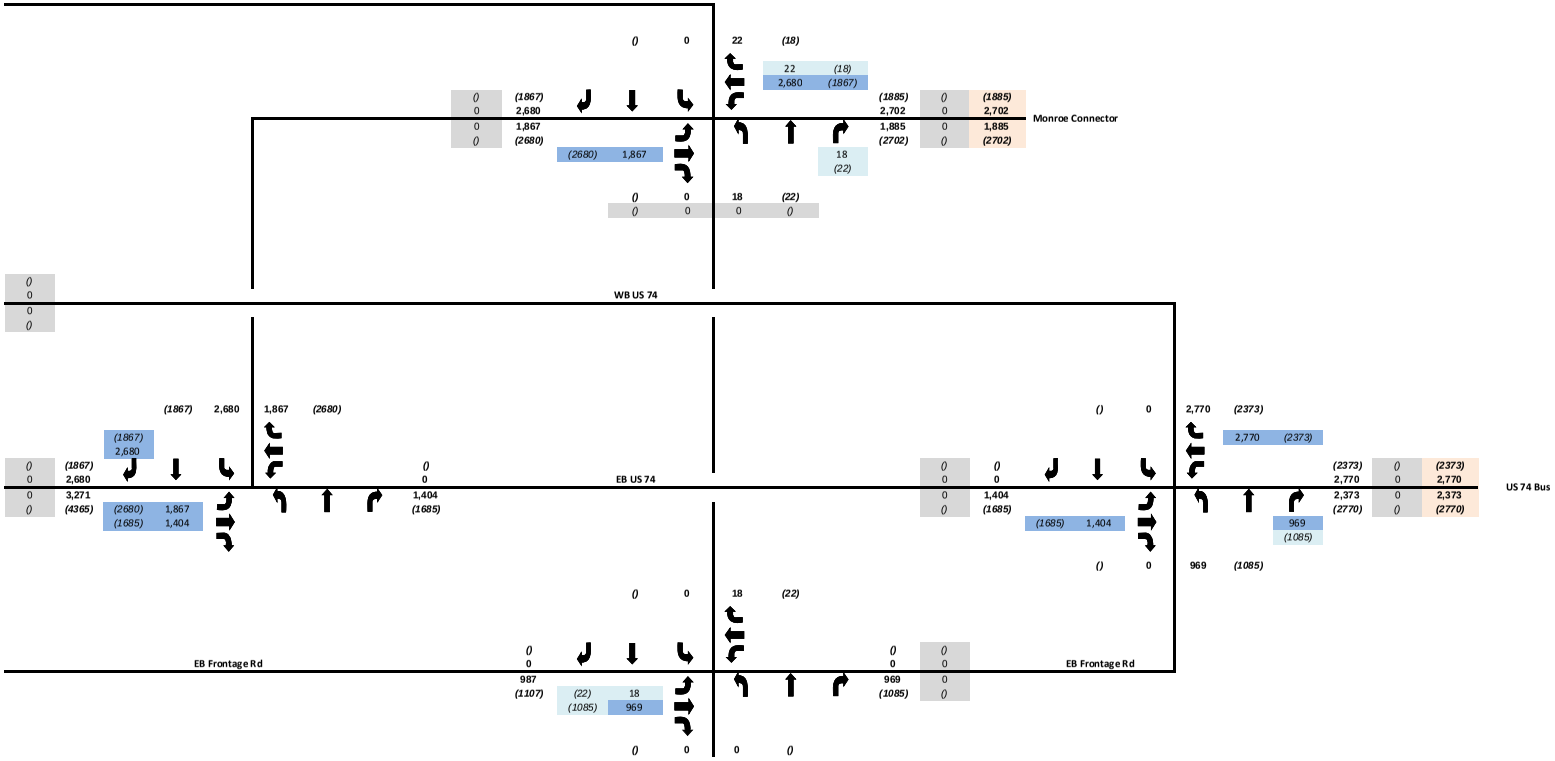

Year 2035 Alt 3A - Segment 2

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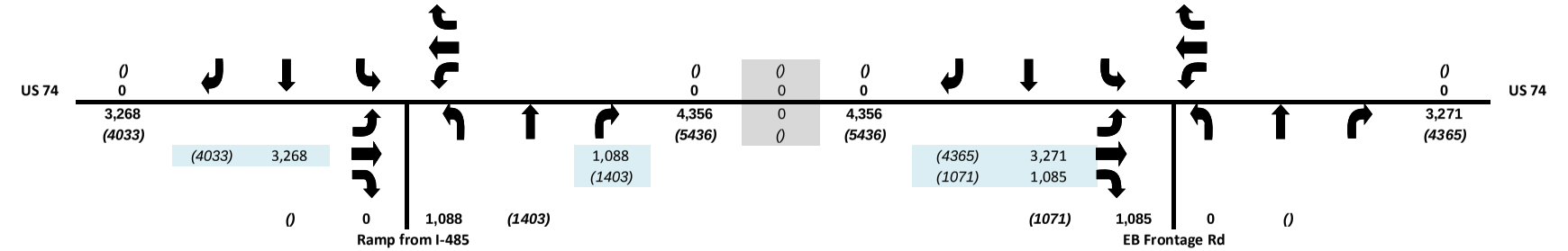
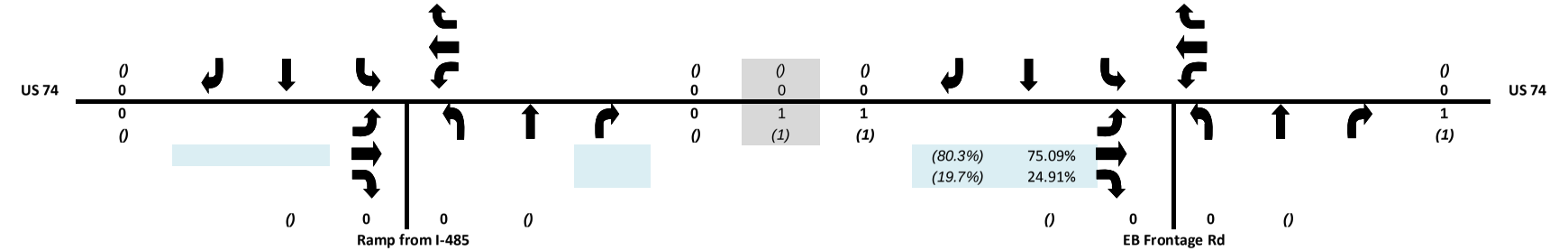
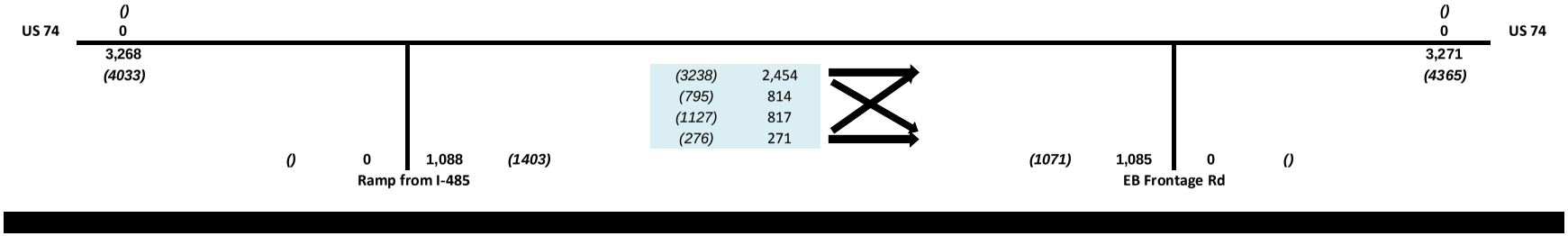
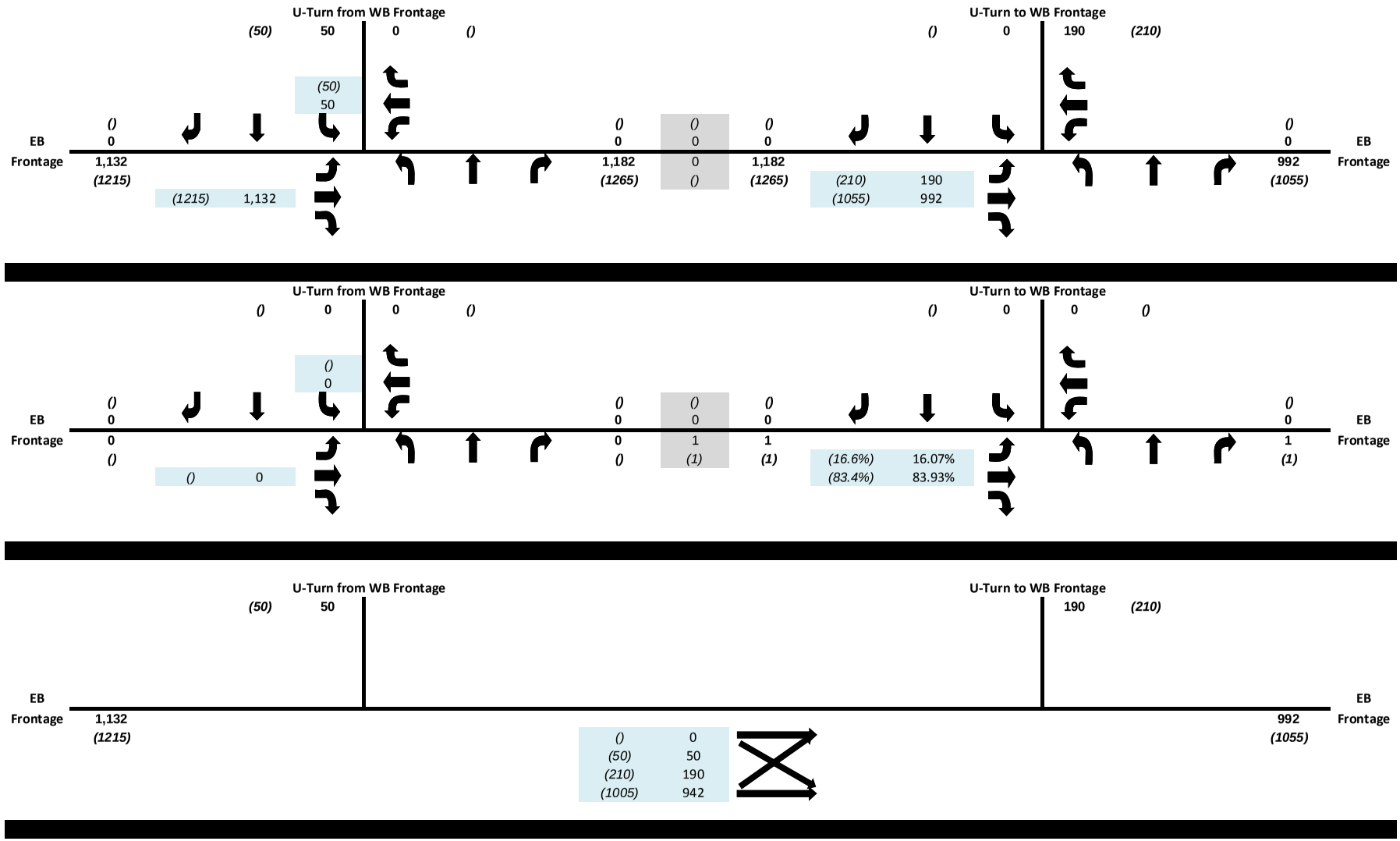






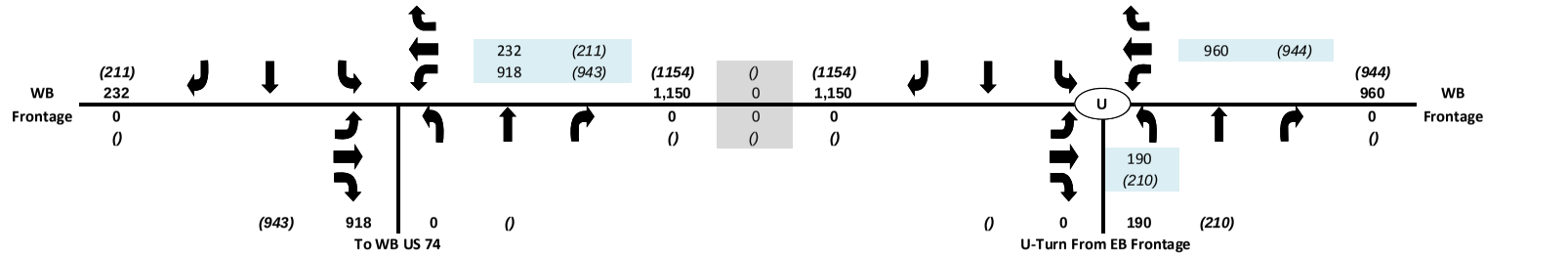
Year 2035 Alt 3A - Segment 2

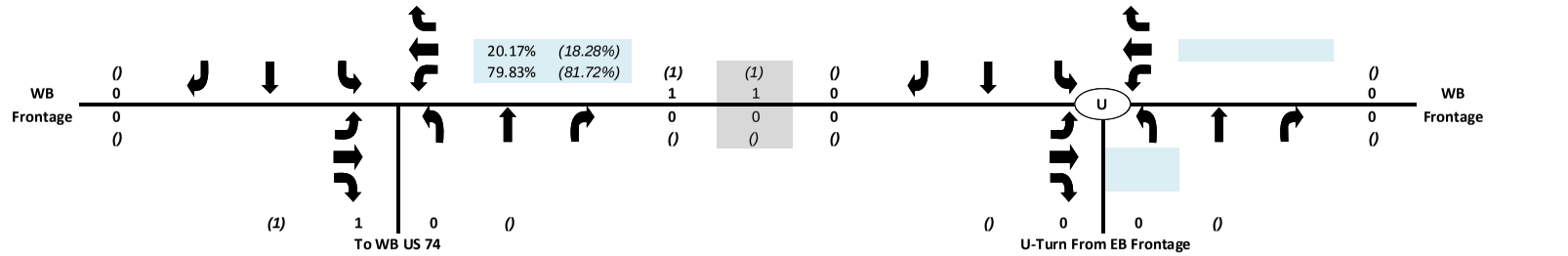
EB US 74 Weave between I-485 and off-ramp to Mckee Rd (Site474)

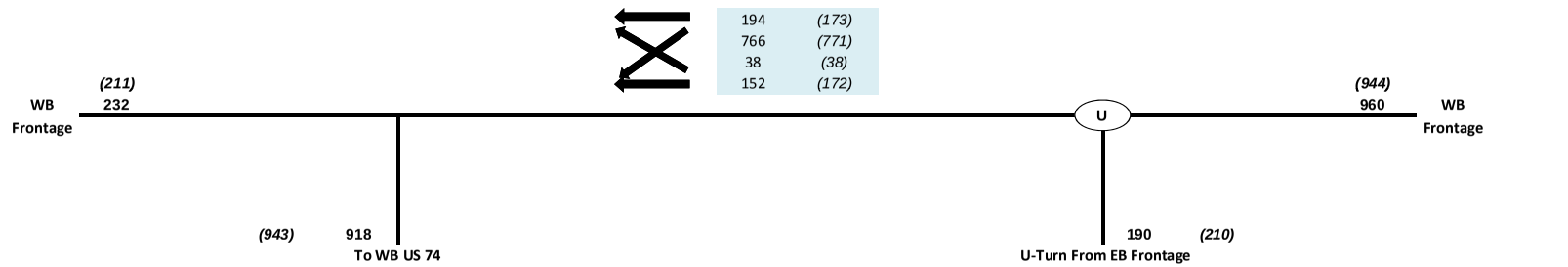


Year 2035 Alt 3A - Segment 2

EB Frontage Rd Weave between U-turn from/to WB Frontage Rd (Site476)

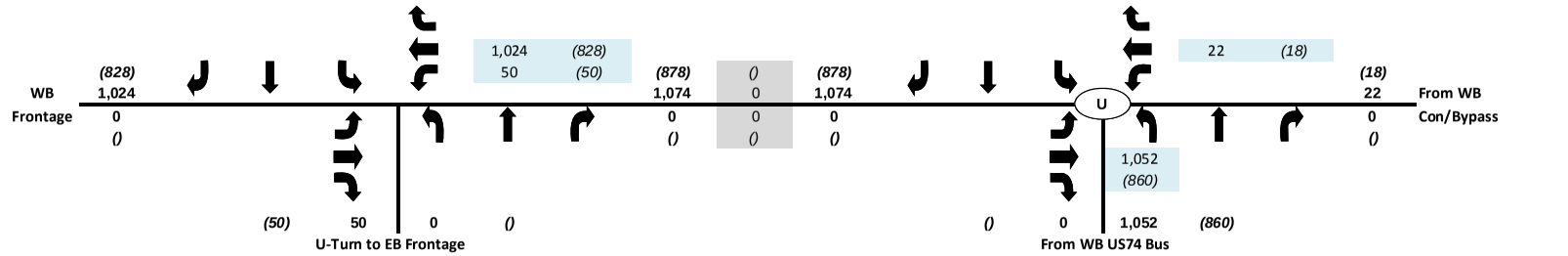


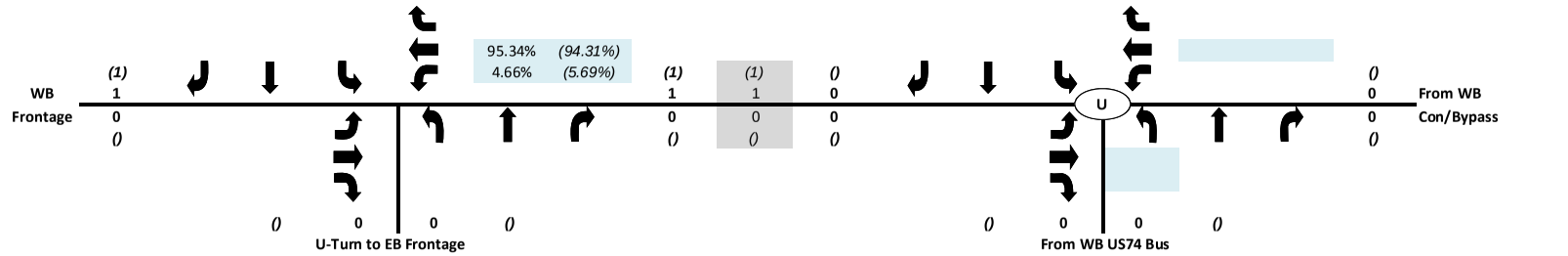


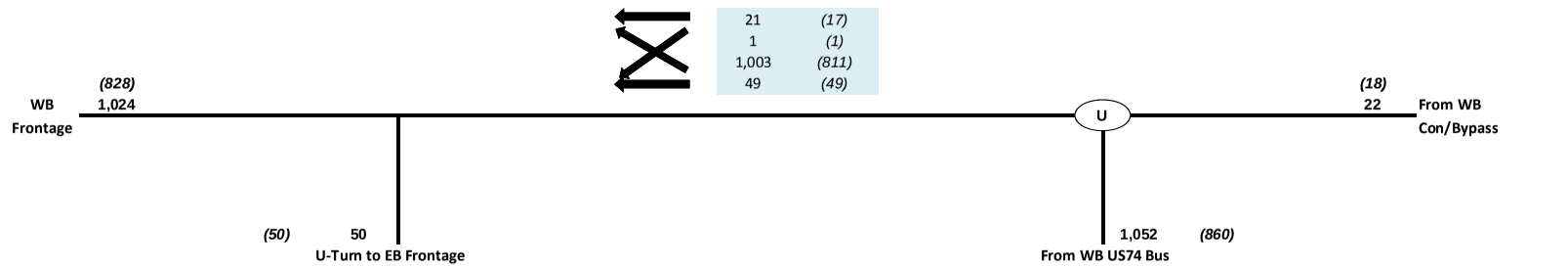


Year 2035 Alt 3A - Segment 2

WB Frontage Rd Weave between u-turn from EB Frontage and ramp to WB US 74 (Site475)

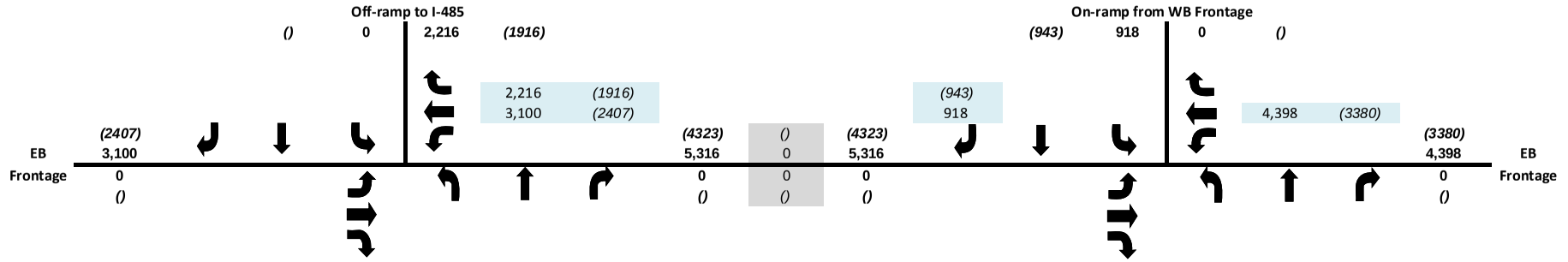


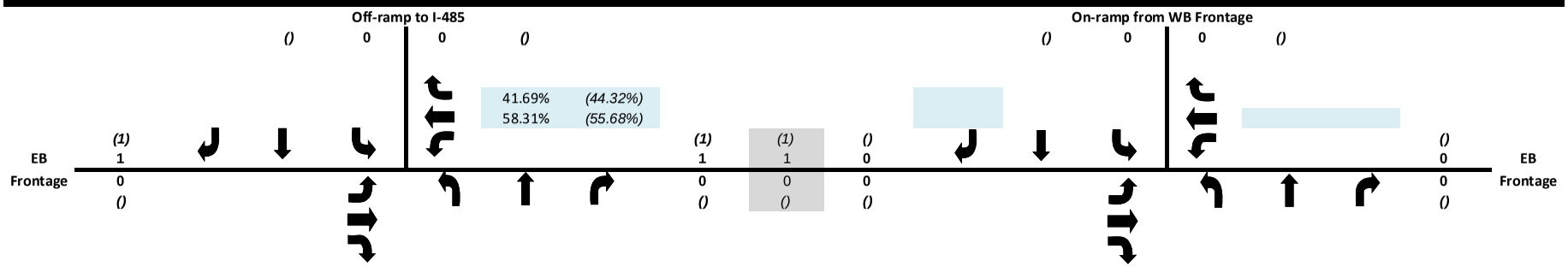


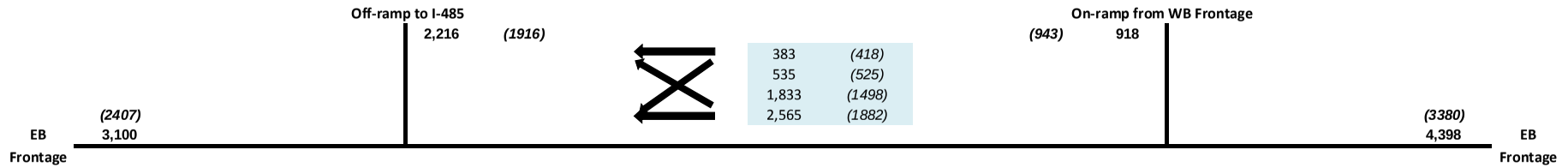


Year 2035 Alt 3A - Segment 2

WB Frontage Rd Weave between u-turn from EB Frontage and ramp to WB US 74 (Site475)







Year 2035 Alt 3A - Segment 2

WB US 74 Weave between on-ramp from WB Frontage Rd and I-485 (Site473)

APPENDIX A-B

Level of Service Analysis Printouts

APPENDIX A-B

Level of Service Analysis Printouts

Analysis Assumptions

ANALYSIS ASSUMPTIONS

Levels of service (LOS) analysis were performed following the NCDOT Congestion Management Section's *Capacity Guidelines for TIP Project Traffic Analysis*. In addition, the following documents/procedures were also followed in the LOS analysis:

- Roadway Design Criteria established for the Monroe Connector / Bypass

  The analysis parameters, such as free flow speeds, were set in accordance with the roadway design criteria. A copy of the roadway design criteria is included herein.

  Base Free Flow speeds were used for mainline segments and Measured Free Flow speeds were used for ramp segments that would normally be analyzed with a lower speed.

- Interchange Density

  An interchange density of 0.5 was used in the HCS analysis. The length of the Monroe Connector/Bypass is approximately 19 miles from I-485 to the eastern end at US 74. The Monroe Connector/Bypass will consist of seven (7) to ten (10) interchanges, depending on alternatives. So the interchange density ranges from 0.5 to 0.4, depending on alternatives.

- Storage Bay Length

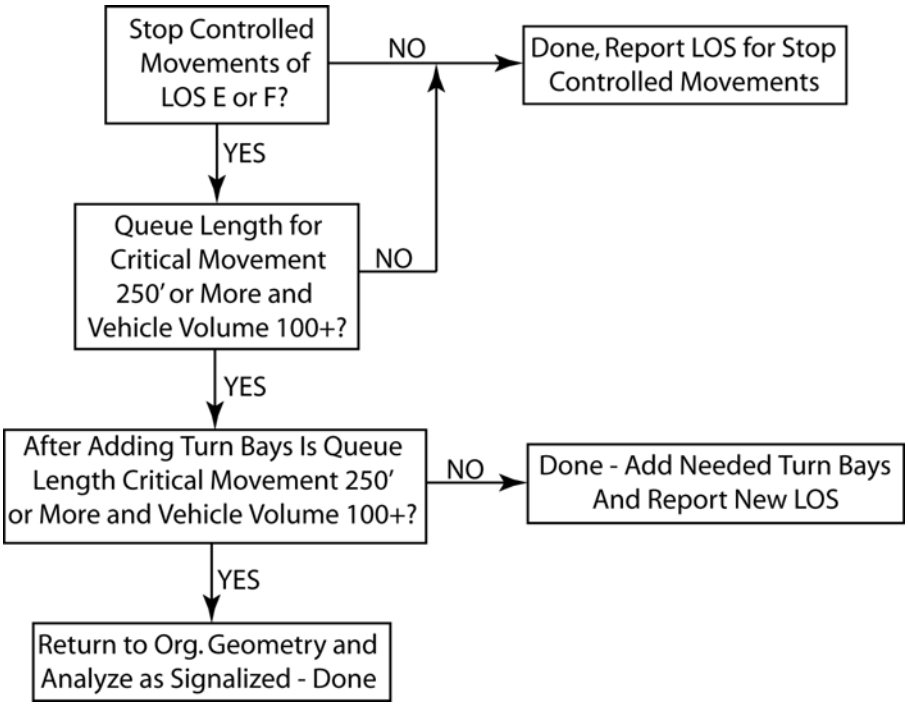
  The storage bay lengths were taken from the SimTraffic analysis just like the No-Build analysis, which has been reviewed and approved by the NCDOT and NCTA.

- Right Turn Overlap Phasing

  Right turn overlap phasing was used when the opportunity existed per the guidance from HNTB.

- Unsignalization to Signalization Flow Chart

  To determine if unsignalized intersections needed to be analyzed as signalized, the following flow chart was followed. The flow chart also helped identify what improvements to recommend. This flow chart has been used by PBS&J for numerous NCDOT and NCTA traffic operations projects. The parameters in this flow chart were developed by PBS&J and the NCDOT Congestion Management section for the planning level determination of intersection control


Stop Controlled Movements of LOS E or F?
NO
Done, Report LOS for Stop Controlled Movements
YES
Queue Length for Critical Movement 250' or More and Vehicle Volume 100+?
NO
YES
After Adding Turn Bays Is Queue Length Critical Movement 250' or More and Vehicle Volume 100+?
NO
Done - Add Needed Turn Bays And Report New LOS
YES
Return to Org. Geometry and Analyze as Signalized - Done

PROPOSED DESIGN CRITERIA

TIP: R-3329 / R-2559

STATE PROJECT:
F. A. PROJECT:
COUNTY: Mecklenburg/Union **DIVISION:** 10
PROJECT DESCRIPTION: Monroe Connector/Bypass between I-485 west of Charlotte in Mecklenburg County to US 74 near Marshville in Union County
(Traffic Alternative 1A)
PREPARED BY: PBS&J

PAGE: 1 of 4
DATE: March 17, 2008

ROUTE LINE	Monroe Conn/Bypass -L-	I-485	US 74 (West End)	US 74 (East End)	Union West
TRAFFIC DATA					Seg. 2
ADT LET YR = 2013					
ADT DESIGN YR = 2035	51,500	115,900	79,600	37,100	1,000
TTST	5%	5%	5%	5%	1%
DUALS	8%	10%	8%	8%	3%
DHV	10%	8%	8%	8%	9%
DIR	60%	55%	55%	55%	55%
CLASSIFICATION	Freeway	Interstate	Rural Arterial	Rural Arterial	Rural Local
TERRAIN TYPE	Rolling	Rolling	Rolling	Rolling	Rolling
DESIGN SPEED km/hr or mph	70 mph	70 mph	60 mph	60 mph	50 mph
POSTED SPEED km/hr or mph	65 mph	65 mph	55 mph	55 mph	45 mph
PROP. R/W WIDTH m or ft	300 ft	300 ft	150 ft	150 ft	80 ft
CONTROL OF ACCESS	Full	Full	Partial	Partial	N
RUMBLE STRIPS (Y/N)	Y	Y	N	N	N
TYPICAL SECTION TYPE	4-lane divided	4-lane divided	4-lane divided	4-lane divided	2-lane shld
LANE WIDTH m or ft	12 ft	12 ft	12 ft	12 ft	12 ft
SIDEWALKS (Y/N)	N	N	N	N	N
BICYCLE LANES (Y/N)	N	N	N	N	N
MEDIAN WIDTH m or ft	70 ft	70 ft	30 ft	46 ft	N/A
MED. PROTECT. (GR/BARRIER)	Guiderail	Guiderail	N/A	N/A	N/A
SHOULDER WIDTH (total)					
MEDIAN m or ft	12 ft	12 ft	6 ft	6 ft	N/A
OUTSIDE w/o GR m or ft	14 ft	14 ft	12 ft	10 ft	6 ft
OUTSIDE w/ GR m or ft	17 ft	17 ft	15 ft	13 ft	9 ft
PAVED SHOULDER					
OUTSIDE TOTAL/FDPS m or ft	12 ft/ 12 ft	12 ft/ 12 ft	10 ft / 4 ft	10 ft / 4 ft	TURF
MEDIAN TOTAL/FDPS m or ft	4 ft/ 4 ft	4 ft/ 4 ft	4 ft/ 4 ft	4 ft/ 4 ft	N/A
GRADE					
MAX.	4%	4%	4%	4%	8%
MIN.	0.3%	0.3%	0.3%	0.3%	0.3%
K VALUE					
SAG	181	181	136	136	96
CREST	247	247	151	151	84
HORIZ. ALIGN.					
MAX. SUPER.	8%	10%	8%	8%	6%
MIN. RADIUS m or ft	1,810	1,630	1,200	1,200	833
SPIRAL (Y/N)	Y	Y	Y	Y	N
CROSS SLOPES					
PAVEMENT	2%	2%	2%	2%	2%
PAVED SHOULDER	2%Median/4%Outside	2%Median/4%Outside	2% / 4%	2% / 4%	N/A
TURF SHOULDER	8%Median/4%Outside	8%Median/4%Outside	8%Median/4%Outside	8%Median/4%Outside	8%
MEDIAN DITCH	8:1	8:1	5:1	6:1	N/A
DITCH TYPICAL (A,B,C)	A	A	A	A	C
CLEAR ZONE m or ft					
TYPICAL SECTION NO.					

General Note: Accommodate for future loops at all diamond interchanges

Note 3: The median outside the ramp terminals will transition out in the future to the desirable 23' raised median

PROPOSED DESIGN CRITERIA

TIP: R-3329 / R-2559

ROUTE LINE	SR 1365 Stallings Road	SR 1520 Indian Trail Fairview	SR 1367 Unionville-Indian Trail	SR 1514 Rocky River Road	US 601 Concord Highway
TRAFFIC DATA	Seg. 1, 18A	Seg. 2, 18A	Seg. 22A, 30	Seg. 22A, 30	Seg. 31
ADT LET YR = 2013					
ADT DESIGN YR = 2035	11,500	22,700	20,200	17,000	53,900
TTST	1%	1%	1%	1%	7%
DUALS	3%	8%	3%	3%	8%
DHV	11%	9%	9%	9%	8%
DIR	60%	65%	60%	60%	55%
CLASSIFICATION	Rural Collector	Rural Collector	Rural Collector	Rural Collector	Rural Arterial
TERRAIN TYPE	Rolling	Rolling	Rolling	Rolling	Rolling
DESIGN SPEED km/hr or mph	50 mph	50 mph	50 mph	50 mph	50 mph
POSTED SPEED km/hr or mph	45 mph	45 mph	45 mph	45 mph	45 mph
PROP. R/W WIDTH m or ft	80 ft	110 ft	110 ft	110 ft	120 ft
CONTROL OF ACCESS	N	N	N	N	Partial
RUMBLE STRIPS (Y/N)	N	N	N	N	N
TYPICAL SECTION TYPE	2-lane shld	4-lane divided	4-lane divided	4-lane divided	4-lane divided
LANE WIDTH m or ft	12 ft	12 ft	12 ft	12 ft	12 ft
SIDEWALKS (Y/N)	N	N	N	N	N
BICYCLE LANES (Y/N)	N	N	N	N	N
MEDIAN WIDTH m or ft	N/A	23 ft	23 ft	23 ft	17.5 ft
MED. PROTECT. (GR/BARRIER)	N/A	N/A	N/A	N/A	N/A
SHOULDER WIDTH (total)					
MEDIAN m or ft	N/A	1'-6" C&G	1'-6" C & G	1'-6" C & G	1'-6" C & G
OUTSIDE w/o GR m or ft	8 ft	8 ft	8 ft	8 ft	10 ft
OUTSIDE w/ GR m or ft	11 ft	11 ft	11 ft	11 ft	13 ft
PAVED SHOULDER					
OUTSIDE TOTAL/FDPS m or ft	4 ft/ 4 ft	4 ft/ 4 ft	4 ft/ 4 ft	4 ft/ 4 ft	10 ft / 4 ft
MEDIAN TOTAL/FDPS m or ft	N/A	1'-6" C&G	1'-6" C & G	1'-6" C & G	1'-6" C & G
GRADE					
MAX.	7%	7%	7%	7%	4%
MIN.	0.3%	0.3%	0.3%	0.3%	0.3%
K VALUE					
SAG	96	96	96	96	136
CREST	84	84	84	84	151
HORIZ. ALIGN.					
MAX. SUPER.	8%	8%	8%	8%	8%
MIN. RADIUS m or ft	758	758	758	758	1,200
SPIRAL (Y/N)	N	N	N	N	Y
CROSS SLOPES					
PAVEMENT	2%	2%	2%	2%	2%
PAVED SHOULDER	2%	2%	2%	2%	2% / 4%
TURF SHOULDER	8%	8%	8%	8%	4%
MEDIAN DITCH	N/A	N/A	N/A	N/A	N/A
DITCH TYPICAL (A,B,C)	B	B	B	B	A
CLEAR ZONE m or ft					
TYPICAL SECTION NO.					

General Note: Accommodate for future loops at all diamond interchanges
Note 1: 2004 AASHTO page 220 exhibit 3-51case II vehicle A; 26 ft for two-lane loops (13 ft lanes)
Note 2: R = 230 ft per NCDOT Roadway Design Manual. R = 213 ft per 2004 Green Book
Note 3: The median outside the ramp terminals will transition out in the future to the desirable 23' raised median

PROPOSED DESIGN CRITERIA

TIP: R-3329 / R-2559

ROUTE LINE	NC 200 Morgan Mill Road	SR 1758 Austin Chaney Road	SR 1754 Forest Hills School	Loops	Ramps
TRAFFIC DATA	Seg. 34, 36	Seg. 34, 36	Seg. 40, 41		
ADT LET YR = 2013					
ADT DESIGN YR = 2035	20,700	17,400	1,700		
TTST	3%	1%	1%		
DUALS	10%	3%	3%		
DHV	8%	9%	9%	10%	10%
DIR	60%	55%	55%	60%	60%
CLASSIFICATION	Rural Arterial	Rural Collector	Rural Local		
TERRAIN TYPE	Rolling	Rolling	Rolling	Rolling	Rolling
DESIGN SPEED km/hr or mph	60 mph	50 mph	50 mph	30 mph	60 mph
POSTED SPEED km/hr or mph	55 mph	45 mph	45 mph	N/A	N/A
PROP. R/W WIDTH m or ft	150 ft	150 ft	80 ft	100 ft	100 ft
CONTROL OF ACCESS	Partial	N	N	Full	Full
RUMBLE STRIPS (Y/N)	N	N	N	N	N
TYPICAL SECTION TYPE	4-lane divided	4-lane divide	2-lane shld	1-lane	1-lane shld
LANE WIDTH m or ft	12 ft	12 ft	12 ft	18 ft (note 1)	16 ft
SIDEWALKS (Y/N)	N	N	N	N	N
BICYCLE LANES (Y/N)	N	N	N	N	N
MEDIAN WIDTH m or ft	23 ft	23 ft	N/A	N/A	N/A
MED. PROTECT. (GR/BARRIER)	N/A	N/A	N/A	N/A	N/A
SHOULDER WIDTH (total)					
MEDIAN m or ft	1'-6" C & G	1'-6" C & G	N/A	14 ft BERM	12 ft
OUTSIDE w/o GR m or ft	8 ft	8 ft	6 ft	12 ft	14 ft
OUTSIDE w/ GR m or ft	11 ft	11 ft	9 ft	N/A	17 ft
PAVED SHOULDER					
OUTSIDE TOTAL/FDPS m or ft	4 ft/ 4 ft	4 ft/ 4 ft	TURF	4 ft/ 4 ft	4 ft/ 4 ft
MEDIAN TOTAL/FDPS m or ft	1'-6" C & G	1'-6" C & G	N/A	2'-6" C & G	4 ft/ 4 ft
GRADE					
MAX.	4%	7%	8%	10%	4%
MIN.	0.3%	0.3%	0.3%	0.3%	0.3%
K VALUE					
SAG	136	96	96	37	136
CREST	151	84	84	19	151
HORIZ. ALIGN.					
MAX. SUPER.	8%	8%	6%	8%	8%
MIN. RADIUS m or ft	1,200	758	833	230 ft (note 2)	1,200 ft
SPIRAL (Y/N)	Y	N	N	Y	Y
CROSS SLOPES					
PAVEMENT	2%	2%	2%	2%	2%
PAVED SHOULDER	2%	2%	N/A	2%	2%
TURF SHOULDER	8%	8%	8%	8%	8%
MEDIAN DITCH	N/A	N/A	N/A	N/A	N/A
DITCH TYPICAL (A,B,C)	B	B	C	A	A
CLEAR ZONE m or ft					
TYPICAL SECTION NO.					

General Note: Accommodate for future loops at all diamond interchanges
Note 1: 2004 AASHTO page 220 exhibit 3-51 case II vehicle C; 22 ft for one-lane loop minus paved shoulder (18 ft lane)
Note 2: R = 230 ft per NCDOT Roadway Design Manual. R = 213 ft per 2004 Green Book
Note 3: The median outside the ramp terminals will transition out in the future to the desirable 23' raised median

PROPOSED DESIGN CRITERIA

TIP: R-3329 / R-2559

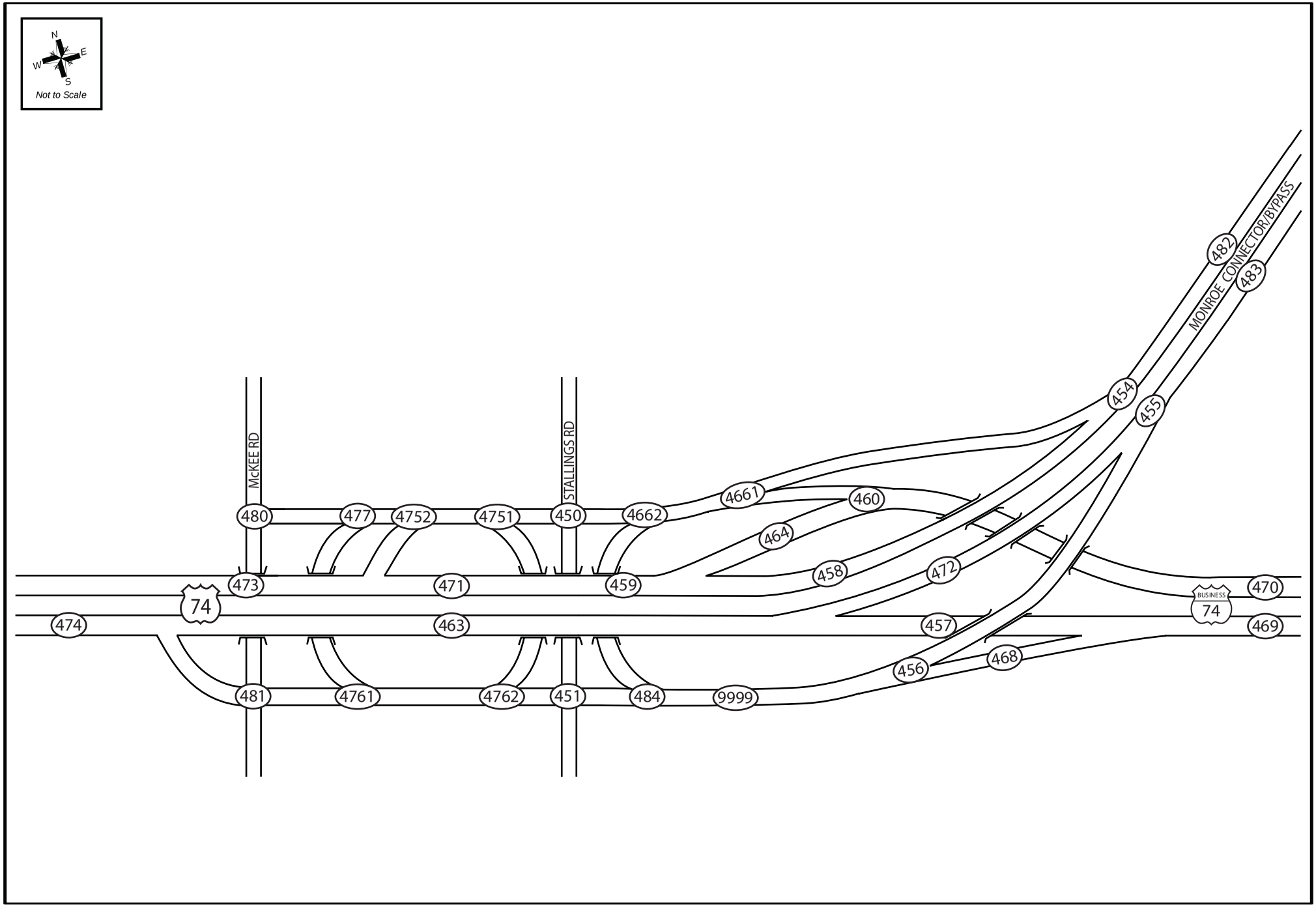
ROUTE LINE	Misc. Collector Rds	Misc. Local Rds			
TRAFFIC DATA					
ADT LET YR = 2013					
ADT DESIGN YR = 2035					
TTST					
DUALS					
DHV					
DIR					
CLASSIFICATION	**Collector**	**Local**			
TERRAIN TYPE	**Rolling**	**Rolling**			
DESIGN SPEED km/hr or mph	**50 to 60 mph**	**30 to 60 mph**			
POSTED SPEED km/hr or mph	**45 to 55 mph**	**25 to 55 mph**			
PROP. R/W WIDTH m or ft					
CONTROL OF ACCESS	**N**	**N**			
RUMBLE STRIPS (Y/N)	**N**	**N**			
TYPICAL SECTION TYPE	**2-lane shld**	**2-lane shld**			
LANE WIDTH m or ft	**9-12 ft**	**9-12 ft**			
SIDEWALKS (Y/N)	**N**	**N**			
BICYCLE LANES (Y/N)	**N**	**N**			
MEDIAN WIDTH m or ft	**N/A**	**N/A**			
MED. PROTECT. (GR/BARRIER)	**N/A**	**N/A**			
SHOULDER WIDTH (total)					
MEDIAN m or ft	**N/A**	**N/A**			
OUTSIDE w/o GR m or ft	**2-8 ft**	**2-8 ft**			
OUTSIDE w/ GR m or ft	**7-11 ft**	**7-11 ft**			
PAVED SHOULDER					
OUTSIDE TOTAL/FDPS m or ft	**0' - 4 ft/ 4 ft**	**0' - 4 ft/ 4 ft**			
MEDIAN TOTAL/FDPS m or ft	**N/A**	**N/A**			
GRADE					
MAX.	**6-10%**	**6-10%**			
MIN.	**0.3%**	**0.3%**			
K VALUE					
SAG	**96 to 136**	**37 to 136**			
CREST	**84 to 151**	**19 to 151**			
HORIZ. ALIGN.					
MAX. SUPER.	**8%**	**6%**			
MIN. RADIUS m or ft	**758 to 1,200**	**231 to 1,330**			
SPIRAL (Y/N)	**N**	**N**			
CROSS SLOPES					
PAVEMENT	**2%**	**2%**			
PAVED SHOULDER	**2%**	**2%**			
TURF SHOULDER	**8%**	**8%**			
MEDIAN DITCH	**N/A**	**N/A**			
DITCH TYPICAL (A,B,C)	**B**	**C**			
CLEAR ZONE m or ft					
TYPICAL SECTION NO.					

General Note: Dimensions will vary on miscellenous Collector and Local routes depending on design year ADT.

APPENDIX A-B

Level of Service Analysis Printouts

Monroe Connector / US 74 Frontage Road Interchange



NORTH CAROLINA Turnpike Authority

MONROE CONNECTOR / BYPASS
TIP Project Numbers R-3329 & R-2559
Mecklenburg and Union Counties

Monroe Connector / Bypass Corridor
US 74 Alt 3
Key Sheet

Appendix A-B

KeySheetConnectorAlltnts.ai

Lanes, Volumes, Timings
450: WB US 74 Frontage Road & Stallings Road

11/9/2009

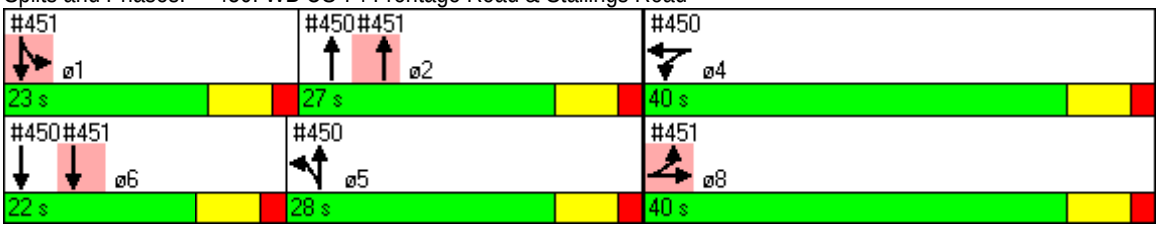
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	308	381	335	484	146	0	0	515	95
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		0	0		900	0		0	500		0
Storage Lanes	0		0	1		0	2		0	2		0
Taper Length (ft)	25		25	25		25	25		25	25		25
Lane Util. Factor	1.00	1.00	1.00	1.00	0.95	0.95	0.97	0.95	1.00	1.00	0.86	0.86
Frt					0.930						0.977	
Flt Protected				0.950			0.950					
Satd. Flow (prot)	0	0	0	1752	3260	0	3433	3539	0	0	6260	0
Flt Permitted				0.950			0.950					
Satd. Flow (perm)	0	0	0	1752	3260	0	3433	3539	0	0	6260	0
Right Turn on Red			No			No			No			No
Satd. Flow (RTOR)												
Link Speed (mph)		35			35			45			45	
Link Distance (ft)		140			140			181			1197	
Travel Time (s)		2.7			2.7			2.7			18.1	
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Heavy Vehicles (%)	0%	0%	0%	3%	3%	3%	2%	2%	0%	0%	2%	2%
Adj. Flow (vph)	0	0	0	342	423	372	538	162	0	0	572	106
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	0	0	342	795	0	538	162	0	0	678	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)		12			12			24			24	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			16			16			16	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors				1	2		1	2			2	
Detector Template				Left	Thru		Left	Thru			Thru	
Leading Detector (ft)				20	100		20	100			100	
Trailing Detector (ft)				0	0		0	0			0	
Detector 1 Position(ft)				0	0		0	0			0	
Detector 1 Size(ft)				20	6		20	6			6	
Detector 1 Type				Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex			Cl+Ex	
Detector 1 Channel												
Detector 1 Extend (s)				0.0	0.0		0.0	0.0			0.0	
Detector 1 Queue (s)				0.0	0.0		0.0	0.0			0.0	
Detector 1 Delay (s)				0.0	0.0		0.0	0.0			0.0	
Detector 2 Position(ft)					94			94			94	
Detector 2 Size(ft)					6			6			6	
Detector 2 Type					Cl+Ex			Cl+Ex			Cl+Ex	
Detector 2 Channel												
Detector 2 Extend (s)					0.0			0.0			0.0	
Turn Type				custom			Prot					
Protected Phases				4	4		5	5 2			6	
Permitted Phases				4								

Lane Group	ø1	ø2	ø8
Lane Configurations			
Volume (vph)			
Ideal Flow (vphpl)			
Storage Length (ft)			
Storage Lanes			
Taper Length (ft)			
Lane Util. Factor			
Frt			
Flt Protected			
Satd. Flow (prot)			
Flt Permitted			
Satd. Flow (perm)			
Right Turn on Red			
Satd. Flow (RTOR)			
Link Speed (mph)			
Link Distance (ft)			
Travel Time (s)			
Peak Hour Factor			
Heavy Vehicles (%)			
Adj. Flow (vph)			
Shared Lane Traffic (%)			
Lane Group Flow (vph)			
Enter Blocked Intersection			
Lane Alignment			
Median Width(ft)			
Link Offset(ft)			
Crosswalk Width(ft)			
Two way Left Turn Lane			
Headway Factor			
Turning Speed (mph)			
Number of Detectors			
Detector Template			
Leading Detector (ft)			
Trailing Detector (ft)			
Detector 1 Position(ft)			
Detector 1 Size(ft)			
Detector 1 Type			
Detector 1 Channel			
Detector 1 Extend (s)			
Detector 1 Queue (s)			
Detector 1 Delay (s)			
Detector 2 Position(ft)			
Detector 2 Size(ft)			
Detector 2 Type			
Detector 2 Channel			
Detector 2 Extend (s)			
Turn Type			
Protected Phases	1	2	8
Permitted Phases			

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Detector Phase				4	4		5	5 2			6	
Switch Phase												
Minimum Initial (s)				7.0	7.0		7.0				12.0	
Minimum Split (s)				14.0	14.0		14.0				19.0	
Total Split (s)	0.0	0.0	0.0	40.0	40.0	0.0	28.0	55.0	0.0	0.0	22.0	0.0
Total Split (%)	0.0%	0.0%	0.0%	44.4%	44.4%	0.0%	31.1%	61.1%	0.0%	0.0%	24.4%	0.0%
Maximum Green (s)				33.0	33.0		21.0				15.0	
Yellow Time (s)				5.0	5.0		5.0				5.0	
All-Red Time (s)				2.0	2.0		2.0				2.0	
Lost Time Adjust (s)	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0
Total Lost Time (s)	2.0	2.0	2.0	5.0	5.0	2.0	5.0	5.0	2.0	2.0	5.0	2.0
Lead/Lag							Lag				Lead	
Lead-Lag Optimize?												
Vehicle Extension (s)				3.0	3.0		3.0				3.0	
Recall Mode				None	None		None				C-Min	
Act Effct Green (s)				35.1	35.1		21.6	23.1			18.4	
Actuated g/C Ratio				0.39	0.39		0.24	0.26			0.20	
v/c Ratio				0.50	0.63		0.65	0.18			0.53	
Control Delay				23.9	24.8		7.0	25.2			34.2	
Queue Delay				0.5	0.0		0.0	0.4			0.3	
Total Delay				24.4	24.8		7.0	25.7			34.5	
LOS				C	C		A	C			C	
Approach Delay					24.7			11.4			34.5	
Approach LOS					C			B			C	
Queue Length 50th (ft)				144	187		11	29			102	
Queue Length 95th (ft)				226	251		23	m40			134	
Internal Link Dist (ft)		60			60			101			1117	
Turn Bay Length (ft)												
Base Capacity (vph)				692	1288		877	965			1278	
Starvation Cap Reductn				0	0		0	478			0	
Spillback Cap Reductn				98	0		0	0			188	
Storage Cap Reductn				0	0		0	0			0	
Reduced v/c Ratio				0.58	0.62		0.61	0.33			0.62	

Intersection Summary	
Area Type:	Other
Cycle Length: 90	
Actuated Cycle Length: 90	
Offset: 0 (0%), Referenced to phase 6:SBT, Start of Green	
Natural Cycle: 65	
Control Type: Actuated-Coordinated	
Maximum v/c Ratio: 0.88	
Intersection Signal Delay: 23.6	Intersection LOS: C
Intersection Capacity Utilization 84.4%	ICU Level of Service E
Analysis Period (min) 15	
m Volume for 95th percentile queue is metered by upstream signal.	

Splits and Phases: 450: WB US 74 Frontage Road & Stallings Road



Lane Group	ø1	ø2	ø8
Detector Phase			
Switch Phase			
Minimum Initial (s)	7.0	12.0	7.0
Minimum Split (s)	14.0	19.0	14.0
Total Split (s)	23.0	27.0	40.0
Total Split (%)	26%	30%	44%
Maximum Green (s)	16.0	20.0	33.0
Yellow Time (s)	5.0	5.0	5.0
All-Red Time (s)	2.0	2.0	2.0
Lost Time Adjust (s)			
Total Lost Time (s)			
Lead/Lag	Lead	Lag	
Lead-Lag Optimize?		Yes	
Vehicle Extension (s)	3.0	3.0	3.0
Recall Mode	None	Min	None
Act Effct Green (s)			
Actuated g/C Ratio			
v/c Ratio			
Control Delay			
Queue Delay			
Total Delay			
LOS			
Approach Delay			
Approach LOS			
Queue Length 50th (ft)			
Queue Length 95th (ft)			
Internal Link Dist (ft)			
Turn Bay Length (ft)			
Base Capacity (vph)			
Starvation Cap Reductn			
Spillback Cap Reductn			
Storage Cap Reductn			
Reduced v/c Ratio			

Intersection Summary

Lanes, Volumes, Timings
450: WB US 74 Frontage Road & Stallings Road

11/9/2009

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	207	287	334	568	249	0	0	366	89
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		0	0		900	0		0	500		0
Storage Lanes	0		0	1		0	2		0	2		0
Taper Length (ft)	25		25	25		25	25		25	25		25
Lane Util. Factor	1.00	1.00	1.00	1.00	0.95	0.95	0.97	0.95	1.00	1.00	0.86	0.86
Frt					0.919						0.971	
Flt Protected				0.950			0.950					
Satd. Flow (prot)	0	0	0	1752	3221	0	3433	3539	0	0	6222	0
Flt Permitted				0.950			0.950					
Satd. Flow (perm)	0	0	0	1752	3221	0	3433	3539	0	0	6222	0
Right Turn on Red			No			No			No			No
Satd. Flow (RTOR)												
Link Speed (mph)		35			35			45			45	
Link Distance (ft)		140			140			181			1197	
Travel Time (s)		2.7			2.7			2.7			18.1	
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Heavy Vehicles (%)	0%	0%	0%	3%	3%	3%	2%	2%	0%	0%	2%	2%
Adj. Flow (vph)	0	0	0	230	319	371	631	277	0	0	407	99
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	0	0	230	690	0	631	277	0	0	506	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)		12			12			24			24	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			16			16			16	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors				1	2		1	2			2	
Detector Template				Left	Thru		Left	Thru			Thru	
Leading Detector (ft)				20	100		20	100			100	
Trailing Detector (ft)				0	0		0	0			0	
Detector 1 Position(ft)				0	0		0	0			0	
Detector 1 Size(ft)				20	6		20	6			6	
Detector 1 Type				Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex			Cl+Ex	
Detector 1 Channel												
Detector 1 Extend (s)				0.0	0.0		0.0	0.0			0.0	
Detector 1 Queue (s)				0.0	0.0		0.0	0.0			0.0	
Detector 1 Delay (s)				0.0	0.0		0.0	0.0			0.0	
Detector 2 Position(ft)					94			94			94	
Detector 2 Size(ft)					6			6			6	
Detector 2 Type					Cl+Ex			Cl+Ex			Cl+Ex	
Detector 2 Channel												
Detector 2 Extend (s)					0.0			0.0			0.0	
Turn Type				custom			Prot					
Protected Phases				4	4		5	5 2			6	
Permitted Phases				4								

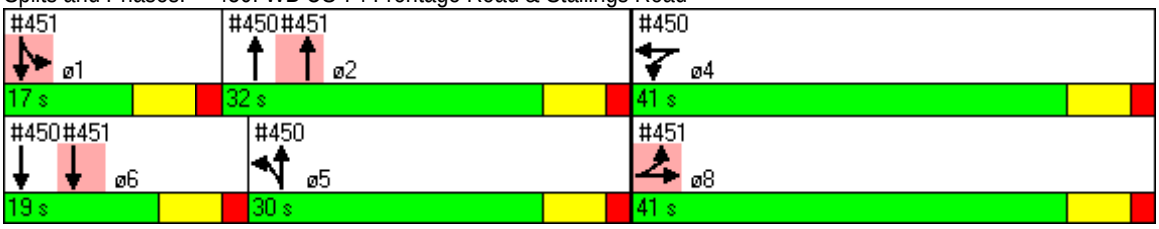
Lane Group	ø1	ø2	ø8
Lane Configurations			
Volume (vph)			
Ideal Flow (vphpl)			
Storage Length (ft)			
Storage Lanes			
Taper Length (ft)			
Lane Util. Factor			
Frt			
Flt Protected			
Satd. Flow (prot)			
Flt Permitted			
Satd. Flow (perm)			
Right Turn on Red			
Satd. Flow (RTOR)			
Link Speed (mph)			
Link Distance (ft)			
Travel Time (s)			
Peak Hour Factor			
Heavy Vehicles (%)			
Adj. Flow (vph)			
Shared Lane Traffic (%)			
Lane Group Flow (vph)			
Enter Blocked Intersection			
Lane Alignment			
Median Width(ft)			
Link Offset(ft)			
Crosswalk Width(ft)			
Two way Left Turn Lane			
Headway Factor			
Turning Speed (mph)			
Number of Detectors			
Detector Template			
Leading Detector (ft)			
Trailing Detector (ft)			
Detector 1 Position(ft)			
Detector 1 Size(ft)			
Detector 1 Type			
Detector 1 Channel			
Detector 1 Extend (s)			
Detector 1 Queue (s)			
Detector 1 Delay (s)			
Detector 2 Position(ft)			
Detector 2 Size(ft)			
Detector 2 Type			
Detector 2 Channel			
Detector 2 Extend (s)			
Turn Type			
Protected Phases	1	2	8
Permitted Phases			

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Detector Phase				4	4		5	5 2			6	
Switch Phase												
Minimum Initial (s)				7.0	7.0		7.0				12.0	
Minimum Split (s)				14.0	14.0		14.0				19.0	
Total Split (s)	0.0	0.0	0.0	41.0	41.0	0.0	30.0	62.0	0.0	0.0	19.0	0.0
Total Split (%)	0.0%	0.0%	0.0%	45.6%	45.6%	0.0%	33.3%	68.9%	0.0%	0.0%	21.1%	0.0%
Maximum Green (s)				34.0	34.0		23.0				12.0	
Yellow Time (s)				5.0	5.0		5.0				5.0	
All-Red Time (s)				2.0	2.0		2.0				2.0	
Lost Time Adjust (s)	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0
Total Lost Time (s)	2.0	2.0	2.0	5.0	5.0	2.0	5.0	5.0	2.0	2.0	5.0	2.0
Lead/Lag							Lag				Lead	
Lead-Lag Optimize?												
Vehicle Extension (s)				3.0	3.0		3.0				3.0	
Recall Mode				None	None		None				C-Min	
Act Effct Green (s)				35.9	35.9		23.7	27.2			15.4	
Actuated g/C Ratio				0.40	0.40		0.26	0.30			0.17	
v/c Ratio				0.33	0.54		0.70	0.26			0.48	
Control Delay				20.3	22.5		6.4	18.3			35.9	
Queue Delay				0.0	0.0		0.0	0.7			0.1	
Total Delay				20.3	22.5		6.5	19.0			36.0	
LOS				C	C		A	B			D	
Approach Delay					22.0			10.3			36.0	
Approach LOS					C			B			D	
Queue Length 50th (ft)				88	154		6	39			77	
Queue Length 95th (ft)				145	207		7	m52			105	
Internal Link Dist (ft)		60			60			101			1117	
Turn Bay Length (ft)												
Base Capacity (vph)				704	1294		954	1121			1065	
Starvation Cap Reductn				0	0		2	547			0	
Spillback Cap Reductn				13	0		0	0			62	
Storage Cap Reductn				0	0		0	0			0	
Reduced v/c Ratio				0.33	0.53		0.66	0.48			0.50	

Intersection Summary

Area Type: Other
Cycle Length: 90
Actuated Cycle Length: 90
Offset: 0 (0%), Referenced to phase 6:SBT, Start of Green
Natural Cycle: 70
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.90
Intersection Signal Delay: 20.5 Intersection LOS: C
Intersection Capacity Utilization 87.7% ICU Level of Service E
Analysis Period (min) 15
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 450: WB US 74 Frontage Road & Stallings Road



Lane Group	ø1	ø2	ø8
Detector Phase			
Switch Phase			
Minimum Initial (s)	7.0	12.0	7.0
Minimum Split (s)	14.0	19.0	14.0
Total Split (s)	17.0	32.0	41.0
Total Split (%)	19%	36%	46%
Maximum Green (s)	10.0	25.0	34.0
Yellow Time (s)	5.0	5.0	5.0
All-Red Time (s)	2.0	2.0	2.0
Lost Time Adjust (s)			
Total Lost Time (s)			
Lead/Lag	Lead	Lag	
Lead-Lag Optimize?		Yes	
Vehicle Extension (s)	3.0	3.0	3.0
Recall Mode	None	Min	None
Act Effct Green (s)			
Actuated g/C Ratio			
v/c Ratio			
Control Delay			
Queue Delay			
Total Delay			
LOS			
Approach Delay			
Approach LOS			
Queue Length 50th (ft)			
Queue Length 95th (ft)			
Internal Link Dist (ft)			
Turn Bay Length (ft)			
Base Capacity (vph)			
Starvation Cap Reductn			
Spillback Cap Reductn			
Storage Cap Reductn			
Reduced v/c Ratio			

Intersection Summary

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	80	416	496	0	0	0	0	550	191	330	493	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	900		900	0		0	1000		0	0		0
Storage Lanes	0		0	0		0	2		0	2		0
Taper Length (ft)	25		25	25		25	25		25	25		25
Lane Util. Factor	0.95	0.95	0.95	1.00	1.00	1.00	1.00	0.86	0.86	0.97	0.95	1.00
Frt		0.925						0.961				
Flt Protected		0.996								0.950		
Satd. Flow (prot)	0	3229	0	0	0	0	0	6158	0	3433	3539	0
Flt Permitted		0.996								0.950		
Satd. Flow (perm)	0	3229	0	0	0	0	0	6158	0	3433	3539	0
Right Turn on Red			No			No			No			No
Satd. Flow (RTOR)												
Link Speed (mph)		35			35			45			45	
Link Distance (ft)		132			150			1723			181	
Travel Time (s)		2.6			2.9			26.1			2.7	
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Heavy Vehicles (%)	3%	3%	3%	0%	0%	0%	0%	2%	2%	2%	2%	0%
Adj. Flow (vph)	89	462	551	0	0	0	0	611	212	367	548	0
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	1102	0	0	0	0	0	823	0	367	548	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)		0			0			24			24	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			16			16			16	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors	1	2						2		1	2	
Detector Template	Left	Thru						Thru		Left	Thru	
Leading Detector (ft)	20	100						100		20	100	
Trailing Detector (ft)	0	0						0		0	0	
Detector 1 Position(ft)	0	0						0		0	0	
Detector 1 Size(ft)	20	6						6		20	6	
Detector 1 Type	Cl+Ex	Cl+Ex						Cl+Ex		Cl+Ex	Cl+Ex	
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0						0.0		0.0	0.0	
Detector 1 Queue (s)	0.0	0.0						0.0		0.0	0.0	
Detector 1 Delay (s)	0.0	0.0						0.0		0.0	0.0	
Detector 2 Position(ft)		94						94			94	
Detector 2 Size(ft)		6						6			6	
Detector 2 Type		Cl+Ex						Cl+Ex			Cl+Ex	
Detector 2 Channel												
Detector 2 Extend (s)		0.0						0.0			0.0	
Turn Type	custom									Prot		
Protected Phases	8	8						2		1	1 6	
Permitted Phases	8											

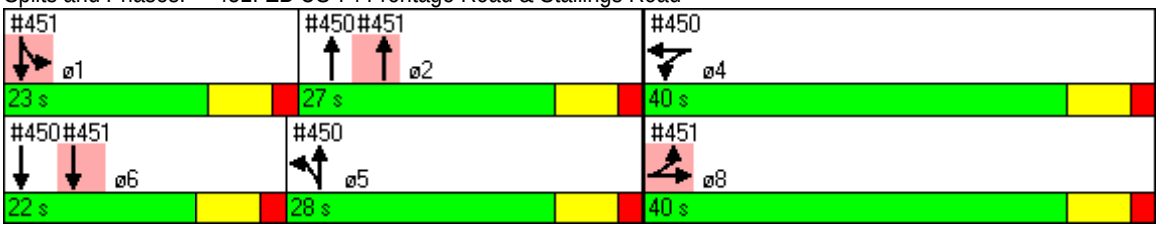
Lane Group	ø4	ø5	ø6
Lane Configurations			
Volume (vph)			
Ideal Flow (vphpl)			
Storage Length (ft)			
Storage Lanes			
Taper Length (ft)			
Lane Util. Factor			
Frt			
Flt Protected			
Satd. Flow (prot)			
Flt Permitted			
Satd. Flow (perm)			
Right Turn on Red			
Satd. Flow (RTOR)			
Link Speed (mph)			
Link Distance (ft)			
Travel Time (s)			
Peak Hour Factor			
Heavy Vehicles (%)			
Adj. Flow (vph)			
Shared Lane Traffic (%)			
Lane Group Flow (vph)			
Enter Blocked Intersection			
Lane Alignment			
Median Width(ft)			
Link Offset(ft)			
Crosswalk Width(ft)			
Two way Left Turn Lane			
Headway Factor			
Turning Speed (mph)			
Number of Detectors			
Detector Template			
Leading Detector (ft)			
Trailing Detector (ft)			
Detector 1 Position(ft)			
Detector 1 Size(ft)			
Detector 1 Type			
Detector 1 Channel			
Detector 1 Extend (s)			
Detector 1 Queue (s)			
Detector 1 Delay (s)			
Detector 2 Position(ft)			
Detector 2 Size(ft)			
Detector 2 Type			
Detector 2 Channel			
Detector 2 Extend (s)			
Turn Type			
Protected Phases	4	5	6
Permitted Phases			

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Detector Phase	8	8						2		1	1 6	
Switch Phase												
Minimum Initial (s)	7.0	7.0						12.0		7.0		
Minimum Split (s)	14.0	14.0						19.0		14.0		
Total Split (s)	40.0	40.0	0.0	0.0	0.0	0.0	0.0	27.0	0.0	23.0	45.0	0.0
Total Split (%)	44.4%	44.4%	0.0%	0.0%	0.0%	0.0%	0.0%	30.0%	0.0%	25.6%	50.0%	0.0%
Maximum Green (s)	33.0	33.0						20.0		16.0		
Yellow Time (s)	5.0	5.0						5.0		5.0		
All-Red Time (s)	2.0	2.0						2.0		2.0		
Lost Time Adjust (s)	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0
Total Lost Time (s)	5.0	5.0	2.0	2.0	2.0	2.0	2.0	5.0	2.0	5.0	5.0	2.0
Lead/Lag								Lag		Lead		
Lead-Lag Optimize?								Yes				
Vehicle Extension (s)	3.0	3.0						3.0		3.0		
Recall Mode	None	None						Min		None		
Act Effct Green (s)		35.1						22.3		17.6	19.2	
Actuated g/C Ratio		0.39						0.25		0.20	0.21	
v/c Ratio		0.88						0.54		0.55	0.73	
Control Delay		35.4						31.1		5.0	26.8	
Queue Delay		0.0						0.0		0.0	9.8	
Total Delay		35.4						31.1		5.0	36.6	
LOS		D						C		A	D	
Approach Delay		35.4						31.1			24.0	
Approach LOS		D						C			C	
Queue Length 50th (ft)		302						119		2	114	
Queue Length 95th (ft)		#428						151		4	#188	
Internal Link Dist (ft)		52			70			1643			101	
Turn Bay Length (ft)												
Base Capacity (vph)		1276						1565		687	754	
Starvation Cap Reductn		0						0		3	177	
Spillback Cap Reductn		0						0		0	0	
Storage Cap Reductn		0						0		0	0	
Reduced v/c Ratio		0.86						0.53		0.54	0.95	

Intersection Summary

Area Type: Other
Cycle Length: 90
Actuated Cycle Length: 90
Offset: 0 (0%), Referenced to phase 6:SBT, Start of Green
Natural Cycle: 65
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.88
Intersection Signal Delay: 30.5 Intersection LOS: C
Intersection Capacity Utilization 84.4% ICU Level of Service E
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 451: EB US 74 Frontage Road & Stallings Road



Lane Group	ø4	ø5	ø6
Detector Phase			
Switch Phase			
Minimum Initial (s)	7.0	7.0	12.0
Minimum Split (s)	14.0	14.0	19.0
Total Split (s)	40.0	28.0	22.0
Total Split (%)	44%	31%	24%
Maximum Green (s)	33.0	21.0	15.0
Yellow Time (s)	5.0	5.0	5.0
All-Red Time (s)	2.0	2.0	2.0
Lost Time Adjust (s)			
Total Lost Time (s)			
Lead/Lag		Lag	Lead
Lead-Lag Optimize?			
Vehicle Extension (s)	3.0	3.0	3.0
Recall Mode	None	None	C-Min
Act Effct Green (s)			
Actuated g/C Ratio			
v/c Ratio			
Control Delay			
Queue Delay			
Total Delay			
LOS			
Approach Delay			
Approach LOS			
Queue Length 50th (ft)			
Queue Length 95th (ft)			
Internal Link Dist (ft)			
Turn Bay Length (ft)			
Base Capacity (vph)			
Starvation Cap Reductn			
Spillback Cap Reductn			
Storage Cap Reductn			
Reduced v/c Ratio			

Intersection Summary

Lanes, Volumes, Timings
451: EB US 74 Frontage Road & Stallings Road

11/9/2009

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	105	486	464	0	0	0	0	712	308	263	310	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	900		900	0		0	1000		0	0		0
Storage Lanes	0		0	0		0	2		0	2		0
Taper Length (ft)	25		25	25		25	25		25	25		25
Lane Util. Factor	0.95	0.95	0.95	1.00	1.00	1.00	1.00	0.86	0.86	0.97	0.95	1.00
Frt		0.934						0.955				
Flt Protected		0.995								0.950		
Satd. Flow (prot)	0	3257	0	0	0	0	0	6119	0	3433	3539	0
Flt Permitted		0.995								0.950		
Satd. Flow (perm)	0	3257	0	0	0	0	0	6119	0	3433	3539	0
Right Turn on Red			No			No			No			No
Satd. Flow (RTOR)												
Link Speed (mph)		35			35			45			45	
Link Distance (ft)		132			150			1723			181	
Travel Time (s)		2.6			2.9			26.1			2.7	
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Heavy Vehicles (%)	3%	3%	3%	0%	0%	0%	0%	2%	2%	2%	2%	0%
Adj. Flow (vph)	117	540	516	0	0	0	0	791	342	292	344	0
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	1173	0	0	0	0	0	1133	0	292	344	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)		0			0			24			24	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			16			16			16	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors	1	2						2		1	2	
Detector Template	Left	Thru						Thru		Left	Thru	
Leading Detector (ft)	20	100						100		20	100	
Trailing Detector (ft)	0	0						0		0	0	
Detector 1 Position(ft)	0	0						0		0	0	
Detector 1 Size(ft)	20	6						6		20	6	
Detector 1 Type	Cl+Ex	Cl+Ex						Cl+Ex		Cl+Ex	Cl+Ex	
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0						0.0		0.0	0.0	
Detector 1 Queue (s)	0.0	0.0						0.0		0.0	0.0	
Detector 1 Delay (s)	0.0	0.0						0.0		0.0	0.0	
Detector 2 Position(ft)		94						94			94	
Detector 2 Size(ft)		6						6			6	
Detector 2 Type		Cl+Ex						Cl+Ex			Cl+Ex	
Detector 2 Channel												
Detector 2 Extend (s)		0.0						0.0			0.0	
Turn Type	custom									Prot		
Protected Phases	8	8						2		1	1 6	
Permitted Phases	8											

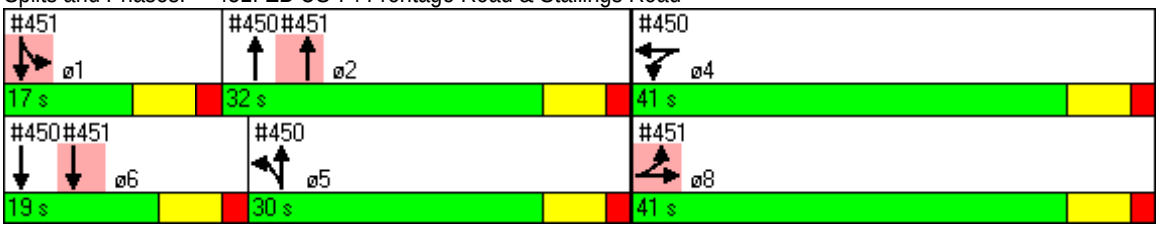
Lane Group	ø4	ø5	ø6
Lane Configurations			
Volume (vph)			
Ideal Flow (vphpl)			
Storage Length (ft)			
Storage Lanes			
Taper Length (ft)			
Lane Util. Factor			
Frt			
Flt Protected			
Satd. Flow (prot)			
Flt Permitted			
Satd. Flow (perm)			
Right Turn on Red			
Satd. Flow (RTOR)			
Link Speed (mph)			
Link Distance (ft)			
Travel Time (s)			
Peak Hour Factor			
Heavy Vehicles (%)			
Adj. Flow (vph)			
Shared Lane Traffic (%)			
Lane Group Flow (vph)			
Enter Blocked Intersection			
Lane Alignment			
Median Width(ft)			
Link Offset(ft)			
Crosswalk Width(ft)			
Two way Left Turn Lane			
Headway Factor			
Turning Speed (mph)			
Number of Detectors			
Detector Template			
Leading Detector (ft)			
Trailing Detector (ft)			
Detector 1 Position(ft)			
Detector 1 Size(ft)			
Detector 1 Type			
Detector 1 Channel			
Detector 1 Extend (s)			
Detector 1 Queue (s)			
Detector 1 Delay (s)			
Detector 2 Position(ft)			
Detector 2 Size(ft)			
Detector 2 Type			
Detector 2 Channel			
Detector 2 Extend (s)			
Turn Type			
Protected Phases	4	5	6
Permitted Phases			

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Detector Phase	8	8						2		1	1 6	
Switch Phase												
Minimum Initial (s)	7.0	7.0						12.0		7.0		
Minimum Split (s)	14.0	14.0						19.0		14.0		
Total Split (s)	41.0	41.0	0.0	0.0	0.0	0.0	0.0	32.0	0.0	17.0	36.0	0.0
Total Split (%)	45.6%	45.6%	0.0%	0.0%	0.0%	0.0%	0.0%	35.6%	0.0%	18.9%	40.0%	0.0%
Maximum Green (s)	34.0	34.0						25.0		10.0		
Yellow Time (s)	5.0	5.0						5.0		5.0		
All-Red Time (s)	2.0	2.0						2.0		2.0		
Lost Time Adjust (s)	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0
Total Lost Time (s)	5.0	5.0	2.0	2.0	2.0	2.0	2.0	5.0	2.0	5.0	5.0	2.0
Lead/Lag								Lag		Lead		
Lead-Lag Optimize?								Yes				
Vehicle Extension (s)	3.0	3.0						3.0		3.0		
Recall Mode	None	None						Min		None		
Act Effct Green (s)		35.9						27.2		11.9	15.4	
Actuated g/C Ratio		0.40						0.30		0.13	0.17	
v/c Ratio		0.90						0.61		0.64	0.57	
Control Delay		37.1						28.7		13.8	25.9	
Queue Delay		0.0						0.0		0.0	1.9	
Total Delay		37.1						28.7		13.8	27.8	
LOS		D						C		B	C	
Approach Delay		37.1						28.7			21.4	
Approach LOS		D						C			C	
Queue Length 50th (ft)		325						160		4	76	
Queue Length 95th (ft)		#460						196		20	108	
Internal Link Dist (ft)		52			70			1643			101	
Turn Bay Length (ft)												
Base Capacity (vph)		1309						1858		458	606	
Starvation Cap Reductn		0						0		0	137	
Spillback Cap Reductn		0						0		0	0	
Storage Cap Reductn		0						0		0	0	
Reduced v/c Ratio		0.90						0.61		0.64	0.73	

Intersection Summary

Area Type: Other
Cycle Length: 90
Actuated Cycle Length: 90
Offset: 0 (0%), Referenced to phase 6:SBT, Start of Green
Natural Cycle: 70
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.90
Intersection Signal Delay: 30.5 Intersection LOS: C
Intersection Capacity Utilization 87.7% ICU Level of Service E
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 451: EB US 74 Frontage Road & Stallings Road



Lane Group	ø4	ø5	ø6
Detector Phase			
Switch Phase			
Minimum Initial (s)	7.0	7.0	12.0
Minimum Split (s)	14.0	14.0	19.0
Total Split (s)	41.0	30.0	19.0
Total Split (%)	46%	33%	21%
Maximum Green (s)	34.0	23.0	12.0
Yellow Time (s)	5.0	5.0	5.0
All-Red Time (s)	2.0	2.0	2.0
Lost Time Adjust (s)			
Total Lost Time (s)			
Lead/Lag		Lag	Lead
Lead-Lag Optimize?			
Vehicle Extension (s)	3.0	3.0	3.0
Recall Mode	None	None	C-Min
Act Effct Green (s)			
Actuated g/C Ratio			
v/c Ratio			
Control Delay			
Queue Delay			
Total Delay			
LOS			
Approach Delay			
Approach LOS			
Queue Length 50th (ft)			
Queue Length 95th (ft)			
Internal Link Dist (ft)			
Turn Bay Length (ft)			
Base Capacity (vph)			
Starvation Cap Reductn			
Spillback Cap Reductn			
Storage Cap Reductn			
Reduced v/c Ratio			

Intersection Summary

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	TDK
Agency/Co.:	PBS&J
Date performed:	8/21/09
Analysis time period:	AM Peak
Freeway/Dir of Travel:	Monroe Connector/Bypass WB
Junction:	454
Jurisdiction:	
Analysis Year:	2035 Build Toll Alternative 3A
Description:	Monroe Connector/Bypass

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	2702	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	45.0	mph
Volume on ramp	22	vph
Length of first accel/decel lane	450	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent ramp		vph
Position of adjacent ramp		
Type of adjacent ramp		
Distance to adjacent ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	2702		22			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	751		6			v
Trucks and buses	12		12			%
Recreational vehicles	0		0			%
Terrain type:	Rolling		Rolling			
Grade	0.00	%	0.00	%		%
Length	0.00	mi	0.00	mi		mi
Trucks and buses PCE, ET	2.5		2.5			
Recreational vehicle PCE, ER	2.0		2.0			

Heavy vehicle adjustment, fHV	0.847	0.847	
Driver population factor, fP	1.00	1.00	
Flow rate, vp	3543	29	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 3543 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	3543	4800	No
v_{12}	3543	4400	No
$v_{FO} = v_F - v_R$	3514	4800	No
v_R	29	2100	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 30.7 pc/mi/ln

Level of service for ramp-freeway junction areas of influence D

Speed Estimation

Intermediate speed variable,	D_S = 0.301	
Space mean speed in ramp influence area,	S_R = 61.6	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 61.6	mph

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	TDK
Agency/Co.:	PBS&J
Date performed:	8/21/09
Analysis time period:	PM Peak
Freeway/Dir of Travel:	Monroe Connector/Bypass WB
Junction:	454
Jurisdiction:	
Analysis Year:	2035 Build Toll Alternative 3A
Description:	Monroe Connector/Bypass

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1885	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	45.0	mph
Volume on ramp	18	vph
Length of first accel/decel lane	450	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent ramp		vph
Position of adjacent ramp		
Type of adjacent ramp		
Distance to adjacent ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	1885		18			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	524		5			v
Trucks and buses	12		12			%
Recreational vehicles	0		0			%
Terrain type:	Rolling		Rolling			
Grade	0.00	%	0.00	%		%
Length	0.00	mi	0.00	mi		mi
Trucks and buses PCE, ET	2.5		2.5			
Recreational vehicle PCE, ER	2.0		2.0			

Heavy vehicle adjustment, fHV	0.847	0.847	
Driver population factor, fP	1.00	1.00	
Flow rate, vp	2471	24	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 2471 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	2471	4800	No
v_{12}	2471	4400	No
$v_{FO} = v_F - v_R$	2447	4800	No
v_R	24	2100	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 21.5 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable,	D_S = 0.300	
Space mean speed in ramp influence area,	S_R = 61.6	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 61.6	mph

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	TDK
Agency/Co.:	PBS&J
Date performed:	8/21/09
Analysis time period:	AM Peak
Freeway/Dir of Travel:	Monroe Connector/Bypass EB
Junction:	455
Jurisdiction:	
Analysis Year:	2035 Build Toll Alternative 3A
Description:	Monroe Connector/Bypass

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1867	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	45.0	mph
Volume on ramp	18	vph
Length of first accel/decel lane	1175	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent Ramp		vph
Position of adjacent Ramp		
Type of adjacent Ramp		
Distance to adjacent Ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1867	18		vph
Peak-hour factor, PHF	0.90	0.90		
Peak 15-min volume, v15	519	5		v
Trucks and buses	12	3		%
Recreational vehicles	0	0		%
Terrain type:	Rolling	Rolling		
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	2.5	2.5		
Recreational vehicle PCE, ER	2.0	2.0		

Heavy vehicle adjustment, fHV	0.847	0.957	
Driver population factor, fP	1.00	1.00	
Flow rate, vp	2448	21	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 2448 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	2469	4800	No
v_{R12}	2469	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 17.4 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable,	M_S = 0.261	
Space mean speed in ramp influence area,	S_R = 62.7	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 62.7	mph

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	TDK
Agency/Co.:	PBS&J
Date performed:	8/21/09
Analysis time period:	PM Peak
Freeway/Dir of Travel:	Monroe Connector/Bypass EB
Junction:	455
Jurisdiction:	
Analysis Year:	2035 Build Toll Alternative 3A
Description:	Monroe Connector/Bypass

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	2680	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	45.0	mph
Volume on ramp	22	vph
Length of first accel/decel lane	1175	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent Ramp		vph
Position of adjacent Ramp		
Type of adjacent Ramp		
Distance to adjacent Ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	2680	22		vph
Peak-hour factor, PHF	0.90	0.90		
Peak 15-min volume, v15	744	6		v
Trucks and buses	12	3		%
Recreational vehicles	0	0		%
Terrain type:	Rolling	Rolling		
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	2.5	2.5		
Recreational vehicle PCE, ER	2.0	2.0		

Heavy vehicle adjustment, fHV	0.847	0.957	
Driver population factor, fP	1.00	1.00	
Flow rate, vp	3514	26	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 3514 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	3540	4800	No
v_{R12}	3540	4600	No

Level of Service Determination (if not F)

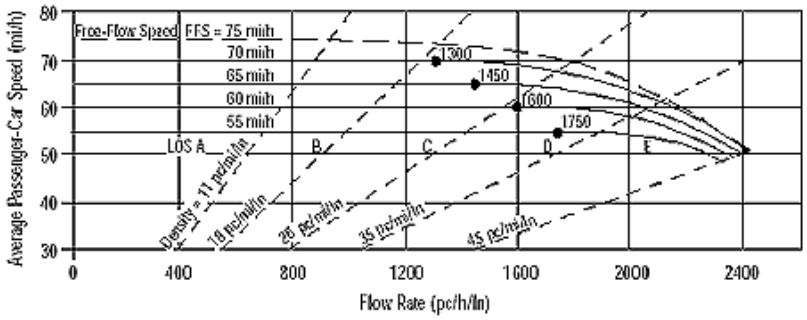
Density, $D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 25.7 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable,	M_S = 0.350	
Space mean speed in ramp influence area,	S_R = 60.2	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 60.2	mph

BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	TDK
Agency or Company	PBS&J
Date Performed	10/22/09
Analysis Time Period	AM Peak

Site Information

Highway/Direction of Travel	Monroe Connector/Bypass EB
From/To	East of Stallings Road
Jurisdiction	457
Analysis Year	2035 Build Toll Alternative 3A

Project Description Monroe Connector/Bypass

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	1404 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	9
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Rolling
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	2.0
E_T	2.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.881

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	2	
FFS (measured)		mi/h
Base free-flow Speed, BFFS	60.0	mi/h

Calc Speed Adj and FFS

f_{LW}	0.0	mi/h
f_{LC}	0.0	mi/h
f_{ID}	0.0	mi/h
f_N	4.5	mi/h
FFS	55.5	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	885	pc/h/ln
S	55.5	mi/h
D = v_p / S	15.9	pc/mi/ln
LOS	B	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
f_p - Page 23-12	f_N - Exhibit 23-6
LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7

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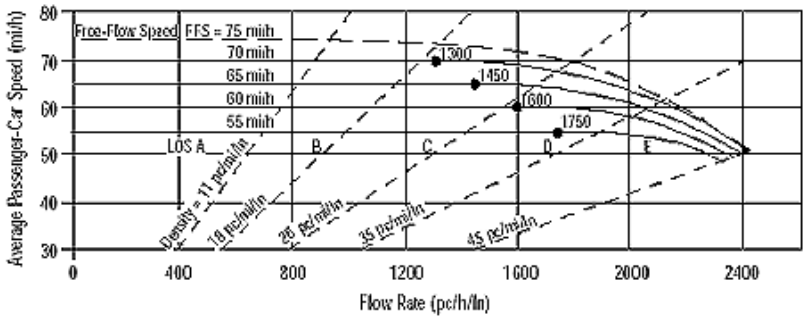
BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	TDK
Agency or Company	PBS&J
Date Performed	8/21/09
Analysis Time Period	PM Peak

Site Information

Highway/Direction of Travel	Monroe Connector/Bypass EB
From/To	East of Stallings Road
Jurisdiction	457
Analysis Year	2035 Build Toll Alternative 3A

Project Description Monroe Connector/Bypass

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	1685 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	9
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Rolling
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	2.0
E_T	2.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.881

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	2	
FFS (measured)		mi/h
Base free-flow Speed, BFFS	60.0	mi/h

Calc Speed Adj and FFS

f_{LW}	0.0	mi/h
f_{LC}	0.0	mi/h
f_{ID}	0.0	mi/h
f_N	4.5	mi/h
FFS	55.5	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1062	pc/h/ln
S	55.5	mi/h
D = v_p / S	19.1	pc/mi/ln
LOS	C	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
f_p - Page 23-12	f_N - Exhibit 23-6
LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7

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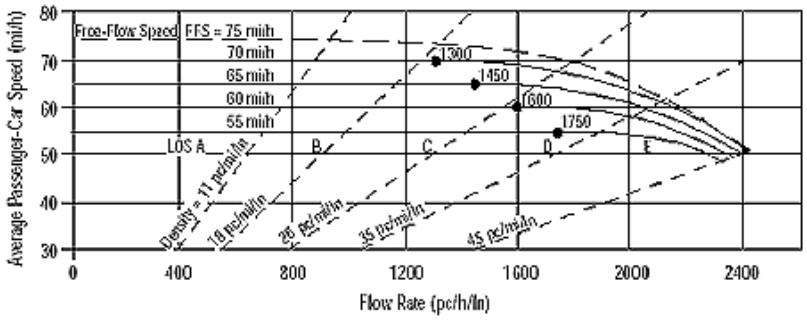

Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	TDK
Agency or Company	PBS&J
Date Performed	8/21/09
Analysis Time Period	AM Peak

Site Information

Highway/Direction of Travel	Monroe Connector/Bypass WB
From/To	East of Stallings Road
Jurisdiction	458
Analysis Year	2035 Build Toll Alternative 3A

Project Description Monroe Connector/Bypass

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	2680 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	12
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Rolling
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	2.0
E_T	2.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.847

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	2	
FFS (measured)		mi/h
Base free-flow Speed, BFFS	60.0	mi/h

Calc Speed Adj and FFS

f_{LW}	0.0	mi/h
f_{LC}	0.0	mi/h
f_{ID}	0.0	mi/h
f_N	4.5	mi/h
FFS	55.5	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1757	pc/h/ln
S	55.5	mi/h
D = v_p / S	31.7	pc/mi/ln
LOS	D	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
f_p - Page 23-12	f_N - Exhibit 23-6
LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7

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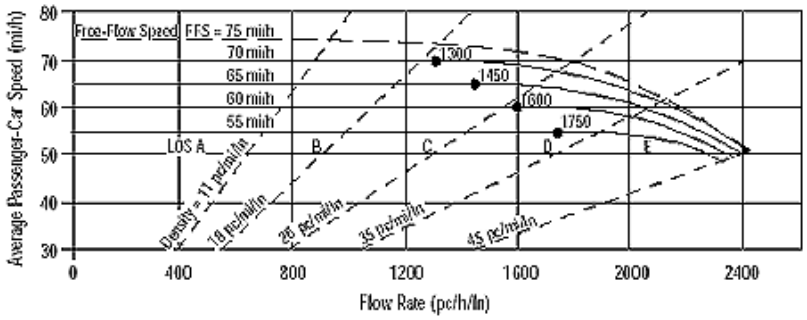

Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	TDK
Agency or Company	PBS&J
Date Performed	8/21/09
Analysis Time Period	PM Peak

Site Information

Highway/Direction of Travel	Monroe Connector/Bypass WB
From/To	West of Stallings Road
Jurisdiction	458
Analysis Year	2035 Build Toll Alternative 3A

Project Description Monroe Connector/Bypass

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	1867 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	12
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Rolling
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	2.0
E_T	2.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.847

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	2	
FFS (measured)		mi/h
Base free-flow Speed, BFFS	60.0	mi/h

Calc Speed Adj and FFS

f_{LW}	0.0	mi/h
f_{LC}	0.0	mi/h
f_{ID}	0.0	mi/h
f_N	4.5	mi/h
FFS	55.5	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1224	pc/h/ln
S	55.5	mi/h
D = v_p / S	22.1	pc/mi/ln
LOS	C	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
f_p - Page 23-12	f_N - Exhibit 23-6
LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7

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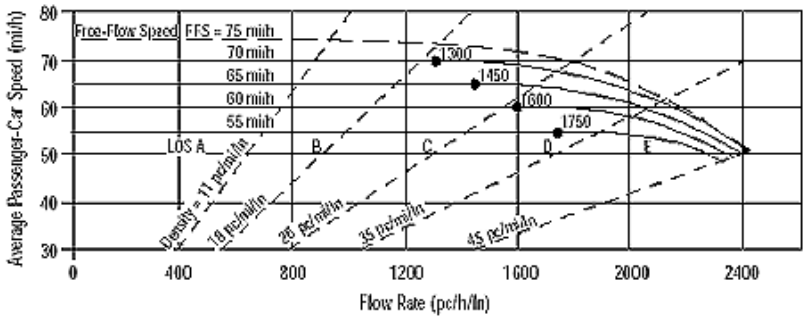

Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	TDK
Agency or Company	PBS&J
Date Performed	8/21/09
Analysis Time Period	AM Peak

Site Information

Highway/Direction of Travel	Monroe Connector/Bypass WB
From/To	East of Indian Trail Rd
Jurisdiction	459
Analysis Year	2035 Build Toll Alternative 3A

Project Description Monroe Connector/Bypass

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	4398 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	9
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Rolling
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	2.0
E_T	2.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.881

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	4	
FFS (measured)		mi/h
Base free-flow Speed, BFFS	60.0	mi/h

Calc Speed Adj and FFS

f_{LW}	0.0	mi/h
f_{LC}	0.0	mi/h
f_{ID}	0.0	mi/h
f_N	1.5	mi/h
FFS	58.5	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1387	pc/h/ln
S	58.5	mi/h
D = v_p / S	23.7	pc/mi/ln
LOS	C	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
f_p - Page 23-12	f_N - Exhibit 23-6
LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7

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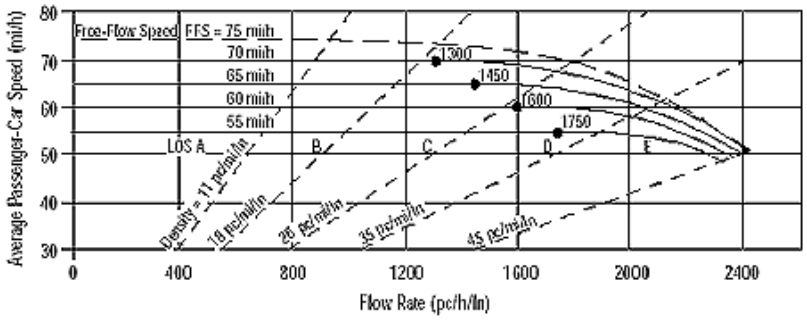

Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	TDK
Agency or Company	PBS&J
Date Performed	8/21/09
Analysis Time Period	PM Peak

Site Information

Highway/Direction of Travel	Monroe Connector/Bypass WB
From/To	East of Stallings Road
Jurisdiction	459
Analysis Year	2035 Build Toll Alternative 3A

Project Description Monroe Connector/Bypass

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	3380 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	9
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Rolling
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	2.0
E_T	2.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.881

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	4	
FFS (measured)		mi/h
Base free-flow Speed, BFFS	60.0	mi/h

Calc Speed Adj and FFS

f_{LW}	0.0	mi/h
f_{LC}	0.0	mi/h
f_{ID}	0.0	mi/h
f_N	1.5	mi/h
FFS	58.5	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1066	pc/h/ln
S	58.5	mi/h
D = v_p / S	18.2	pc/mi/ln
LOS	C	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
f_p - Page 23-12	f_N - Exhibit 23-6
LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7

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Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	TDK
Agency/Co.:	PBS&J
Date performed:	8/21/09
Analysis time period:	AM Peak
Freeway/Dir of Travel:	US 74 WB
Junction:	460
Jurisdiction:	
Analysis Year:	2035 Build Toll Alternative 3A
Description:	Monroe Connector/Bypass

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	60.0	mph
Volume on freeway	2770	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	45.0	mph
Volume on ramp	1052	vph
Length of first accel/decel lane	750	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent ramp		vph
Position of adjacent ramp		
Type of adjacent ramp		
Distance to adjacent ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	2770		1052			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	769		292			v
Trucks and buses	5		5			%
Recreational vehicles	0		0			%
Terrain type:	Rolling		Rolling			
Grade	0.00	%	0.00	%		%
Length	0.00	mi	0.00	mi		mi
Trucks and buses PCE, ET	2.5		2.5			
Recreational vehicle PCE, ER	2.0		2.0			

Heavy vehicle adjustment, fHV	0.930	0.930	
Driver population factor, fP	1.00	1.00	
Flow rate, vp	3309	1257	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 3309 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	3309	4600	No
v_{12}	3309	4400	No
$v_{FO} = v_F - v_R$	2052	4600	No
v_R	1257	2100	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 26.0 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable, D_S = 0.411

Space mean speed in ramp influence area, S_R = 52.6 mph

Space mean speed in outer lanes, S_0 = N/A mph

Space mean speed for all vehicles, S = 52.6 mph

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	TDK
Agency/Co.:	PBS&J
Date performed:	8/21/09
Analysis time period:	PM Peak
Freeway/Dir of Travel:	US 74 WB
Junction:	460
Jurisdiction:	
Analysis Year:	2035 Build Toll Alternative 3A
Description:	Monroe Connector/Bypass

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	60.0	mph
Volume on freeway	2373	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	45.0	mph
Volume on ramp	860	vph
Length of first accel/decel lane	750	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent ramp		vph
Position of adjacent ramp		
Type of adjacent ramp		
Distance to adjacent ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	2373		860			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	659		239			v
Trucks and buses	5		5			%
Recreational vehicles	0		0			%
Terrain type:	Rolling		Rolling			
Grade	0.00	%	0.00	%		%
Length	0.00	mi	0.00	mi		mi
Trucks and buses PCE, ET	2.5		2.5			
Recreational vehicle PCE, ER	2.0		2.0			

Heavy vehicle adjustment, fHV	0.930	0.930	
Driver population factor, fP	1.00	1.00	
Flow rate, vp	2834	1027	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 2834 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	2834	4600	No
v_{12}	2834	4400	No
$v_{FO} = v_F - v_R$	1807	4600	No
v_R	1027	2100	No

Level of Service Determination (if not F)

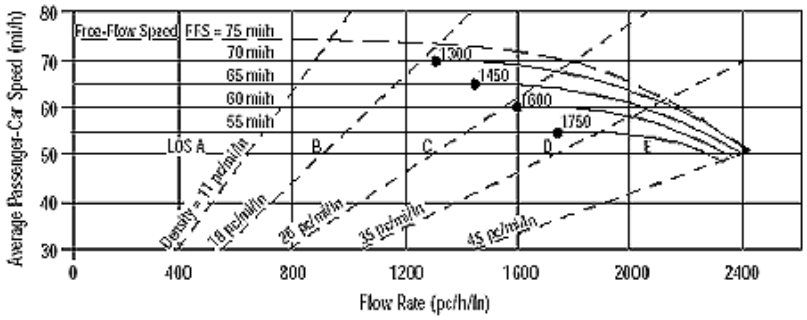
Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 21.9 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable,	D_S = 0.390	
Space mean speed in ramp influence area,	S_R = 53.0	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 53.0	mph

BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	TDK
Agency or Company	PBS&J
Date Performed	10/23/09
Analysis Time Period	AM Peak

Site Information

Highway/Direction of Travel	Monroe Connector/Bypass EB
From/To	West of Stallingsl Rd
Jurisdiction	463
Analysis Year	2035 Build Toll Alternative 3A

Project Description Monroe Connector/Bypass

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	3271 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	9
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Rolling
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	2.0
E_T	2.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.881

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	3	
FFS (measured)		mi/h
Base free-flow Speed, BFFS	60.0	mi/h

Calc Speed Adj and FFS

f_{LW}	0.0	mi/h
f_{LC}	0.0	mi/h
f_{ID}	0.0	mi/h
f_N	3.0	mi/h
FFS	57.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1375	pc/h/ln
S	57.0	mi/h
D = v_p / S	24.1	pc/mi/ln
LOS	C	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
f_p - Page 23-12	f_N - Exhibit 23-6
LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7

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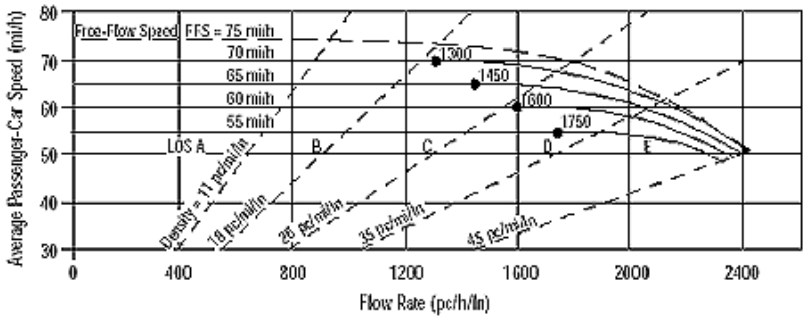

Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	TDK
Agency or Company	PBS&J
Date Performed	8/21/09
Analysis Time Period	PM Peak

Site Information

Highway/Direction of Travel	Monroe Connector/Bypass EB
From/To	West of Stallings Road
Jurisdiction	463
Analysis Year	2035 Build Toll Alternative 3A

Project Description Monroe Connector/Bypass

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	4365 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	9
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Rolling
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	2.0
E_T	2.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.881

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	3	
FFS (measured)		mi/h
Base free-flow Speed, BFFS	60.0	mi/h

Calc Speed Adj and FFS

f_{LW}	0.0	mi/h
f_{LC}	0.0	mi/h
f_{ID}	0.0	mi/h
f_N	3.0	mi/h
FFS	57.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1835	pc/h/ln
S	56.8	mi/h
D = v_p / S	32.3	pc/mi/ln
LOS	D	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits23-8, 23-10
E_T - Exhibits 23-8, 23-10, 23-11
f_p - Page 23-12
LOS, S, FFS, v_p - Exhibits 23-2, 23-3
f_{LW} - Exhibit 23-4
f_{LC} - Exhibit 23-5
f_N - Exhibit 23-6
f_{ID} - Exhibit 23-7

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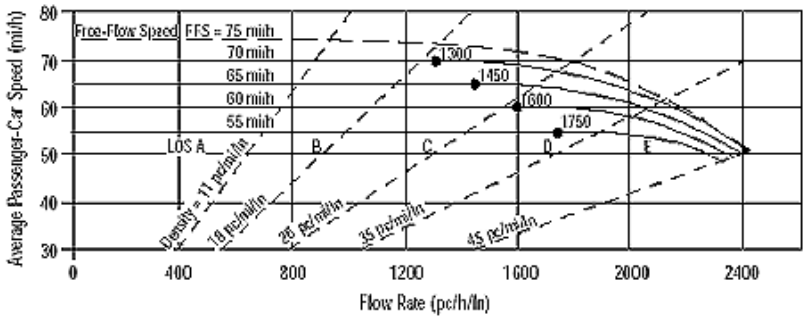

Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information / Site Information

General Information		Site Information	
Analyst	TDK	Highway/Direction of Travel	Monroe Connector/Bypass WB
Agency or Company	PBS&J	From/To	East of Stallings Road
Date Performed	8/21/09	Jurisdiction	464
Analysis Time Period	AM Peak	Analysis Year	2035 Build Toll Alternative 3A

Project Description Monroe Connector/Bypass

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	1718 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	5
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Rolling
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	2.0
E_T	2.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.930

Speed Inputs / Calc Speed Adj and FFS

Speed Inputs			Calc Speed Adj and FFS		
Lane Width	12.0	ft	f_{LW}	0.0	mi/h
Rt-Shoulder Lat. Clearance	6.0	ft	f_{LC}	0.0	mi/h
Interchange Density	0.50	I/mi	f_{ID}	0.0	mi/h
Number of Lanes, N	2		f_N	4.5	mi/h
FFS (measured)		mi/h	FFS	55.5	mi/h
Base free-flow Speed, BFFS	60.0	mi/h			

LOS and Performance Measures / Design (N)

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1026	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	55.5	mi/h	S	mi/h
D = v_p / S	18.5	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	C		Required Number of Lanes, N	

Glossary / Factor Location

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
V - Hourly volume	D - Density	E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 23-12	f_N - Exhibit 23-6
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7
DDHV - Directional design hour volume			

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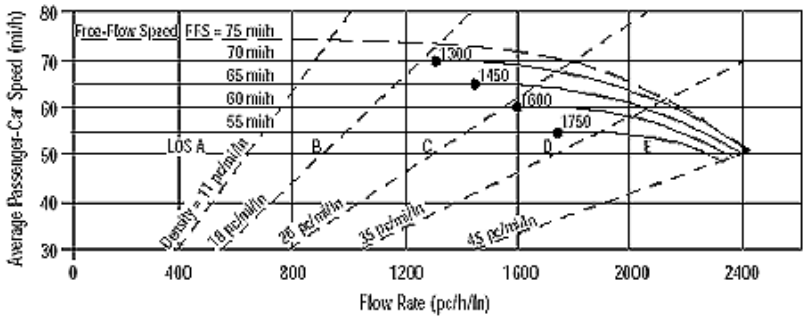

Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	TDK
Agency or Company	PBS&J
Date Performed	8/21/09
Analysis Time Period	PM Peak

Site Information

Highway/Direction of Travel	Monroe Connector/Bypass WB
From/To	East of Stallings Road
Jurisdiction	464
Analysis Year	2035 Build Toll Alternative 3A

Project Description Monroe Connector/Bypass

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	1513 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	5
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Rolling
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	2.0
E_T	2.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.930

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	2	
FFS (measured)		mi/h
Base free-flow Speed, BFFS	60.0	mi/h

Calc Speed Adj and FFS

f_{LW}	0.0	mi/h
f_{LC}	0.0	mi/h
f_{ID}	0.0	mi/h
f_N	4.5	mi/h
FFS	55.5	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	904	pc/h/ln
S	55.5	mi/h
D = v_p / S	16.3	pc/mi/ln
LOS	B	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
f_p - Page 23-12	f_N - Exhibit 23-6
LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7

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SINGLE LANE
BASIC FREEWAY SEGMENT WORKSHEET

General Information

Analyst:	TDK
Agency or Company:	PBSJ
Date Performed:	10/23/2009
Analysis Time Period:	AM Peak

Site Information

Highway/Dir of Travel	US 74 Frontage Road EB On Ramp
From/To	
Jurisdiction	468
Analysis Year	2035 Build Toll Alternative 3A

Flow Inputs

Volume, V	969	veh/h	Peak Hour Factor, PHF	0.90
Driver Population, f_P	1		%Trucks and Buses, P_T	3%
General Terrain	Rolling		%RVs, P_R	0%

LOS and Performance Measures

$$f_{HV} = \frac{1}{1+ P_T(E_T-1)+P_R(E_R-1)} = 0.9569378$$

$$V_P = \frac{V}{PHF*N*f_{HV}*f_P} = 1125.12$$

LOS	V_P (pc/h/ln)	Minimum Speed
A	600	55
B	990	55
C	1430	55
D	1910	54.7
E	2250	50

DENSITY: **20.5**

LOS: **C**

* From Exhibit 23-2 of the 2000 HCM - Maximum Service Flow Rate for a BFS with a FFS of 55mph.

SINGLE LANE
BASIC FREEWAY SEGMENT WORKSHEET

General Information

Analyst:	TDK
Agency or Company:	PBSJ
Date Performed:	8/21/2009
Analysis Time Period:	PM Peak

Site Information

Highway/Dir of Travel	US 74 Frontage Road EB On Ramp
From/To	
Jurisdiction	468
Analysis Year	2035 Build Toll Alternative 3A

Flow Inputs

Volume, V	1085	veh/h	Peak Hour Factor, PHF	0.90
Driver Population, f_P	1		%Trucks and Buses, P_T	3%
General Terrain	Rolling		%RVs, P_R	0%

LOS and Performance Measures

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)} = 0.9569378$$

$$V_P = \frac{V}{PHF*N*f_{HV}*f_P} = 1259.81$$

LOS	V_P (pc/h/ln)	Minimum Speed
A	600	55
B	990	55
C	1430	55
D	1910	54.7
E	2250	50

DENSITY: **22.9**

LOS: **C**

* From Exhibit 23-2 of the 2000 HCM - Maximum Service Flow Rate for a BFS with a FFS of 55mph.

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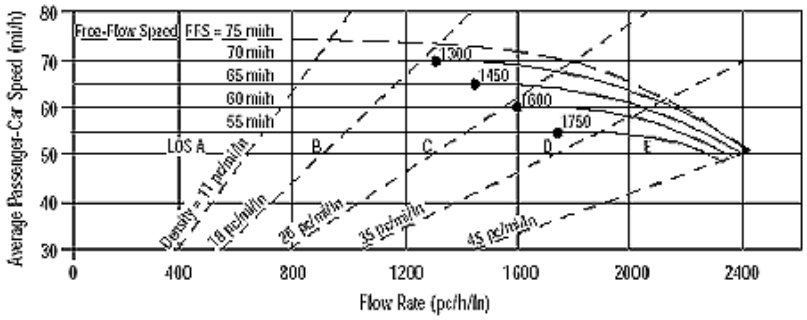

Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information		***Site Information***	
Analyst	OSR	Highway/Direction of Travel	Monroe Connector/Bypass EB
Agency or Company	PBS&J	From/To	East of Stallings Road
Date Performed	6/25/2008	Jurisdiction	469
Analysis Time Period	AM Peak	Analysis Year	2035 Build Toll Alternative 3A

Project Description Monroe Connector/Bypass

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs			
Volume, V	2373 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	5
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Rolling
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments			
f_p	1.00	E_R	2.0
E_T	2.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.930

Speed Inputs			**Calc Speed Adj and FFS**		
Lane Width	12.0	ft	f_{LW}	0.0	mi/h
Rt-Shoulder Lat. Clearance	6.0	ft	f_{LC}	0.0	mi/h
Interchange Density	0.50	I/mi	f_{ID}	0.0	mi/h
Number of Lanes, N	3		f_N	3.0	mi/h
FFS (measured)		mi/h	FFS	57.0	mi/h
Base free-flow Speed, BFFS	60.0	mi/h			

LOS and Performance Measures			**Design (N)**	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	945	pc/h/ln	Design LOS	
S	57.0	mi/h	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
D = v_p / S	16.6	pc/mi/ln	S	mi/h
LOS	B		D = v_p / S	pc/mi/ln
			Required Number of Lanes, N	

Glossary		**Factor Location**	
N - Number of lanes	S - Speed	E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
V - Hourly volume	D - Density	E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 23-12	f_N - Exhibit 23-6
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7
DDHV - Directional design hour volume			

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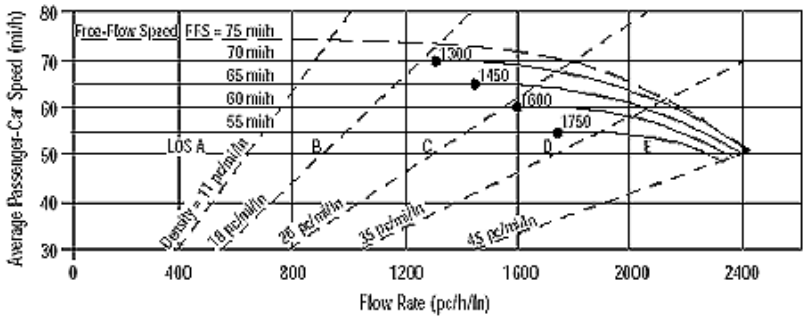
BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	OSR
Agency or Company	PBS&J
Date Performed	6/25/2008
Analysis Time Period	PM Peak

Site Information

Highway/Direction of Travel	Monroe Connector/Bypass EB
From/To	East of Indian Trail Rd
Jurisdiction	469
Analysis Year	2035 Build Toll Alternative 3A

Project Description Monroe Connector/Bypass

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	2770 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	5
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Rolling
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	2.0
E_T	2.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.930

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	3	
FFS (measured)		mi/h
Base free-flow Speed, BFFS	60.0	mi/h

Calc Speed Adj and FFS

f_{LW}	0.0	mi/h
f_{LC}	0.0	mi/h
f_{ID}	0.0	mi/h
f_N	3.0	mi/h
FFS	57.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1103	pc/h/ln
S	57.0	mi/h
D = v_p / S	19.4	pc/mi/ln
LOS	C	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
f_p - Page 23-12	f_N - Exhibit 23-6
LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7

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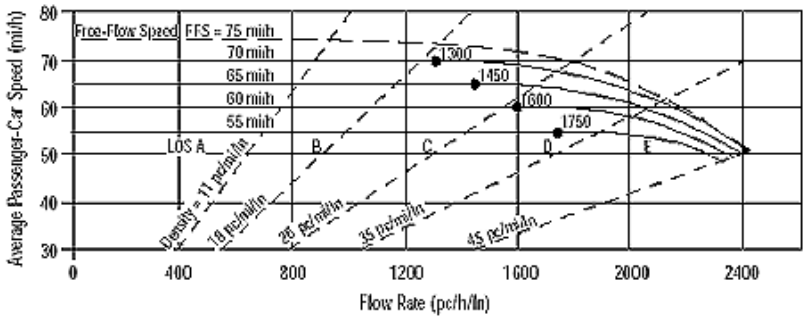
BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information / Site Information

General Information		Site Information	
Analyst	OSR	Highway/Direction of Travel	Monroe Connector/Bypass WB
Agency or Company	PBS&J	From/To	East of Stallings Road
Date Performed	6/25/2008	Jurisdiction	470
Analysis Time Period	AM Peak	Analysis Year	2035 Build Toll Alternative 3A

Project Description Monroe Connector/Bypass

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	2770 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	5
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Rolling
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	2.0
E_T	2.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.930

Speed Inputs / Calc Speed Adj and FFS

Speed Inputs			Calc Speed Adj and FFS		
Lane Width	12.0	ft	f_{LW}	0.0	mi/h
Rt-Shoulder Lat. Clearance	6.0	ft	f_{LC}	0.0	mi/h
Interchange Density	0.50	I/mi	f_{ID}	0.0	mi/h
Number of Lanes, N	2		f_N	4.5	mi/h
FFS (measured)		mi/h	FFS	55.5	mi/h
Base free-flow Speed, BFFS	60.0	mi/h			

LOS and Performance Measures / Design (N)

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1654	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	55.5	mi/h	S	mi/h
D = v_p / S	29.8	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	D		Required Number of Lanes, N	

Glossary / Factor Location

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
V - Hourly volume	D - Density	E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 23-12	f_N - Exhibit 23-6
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7
DDHV - Directional design hour volume			

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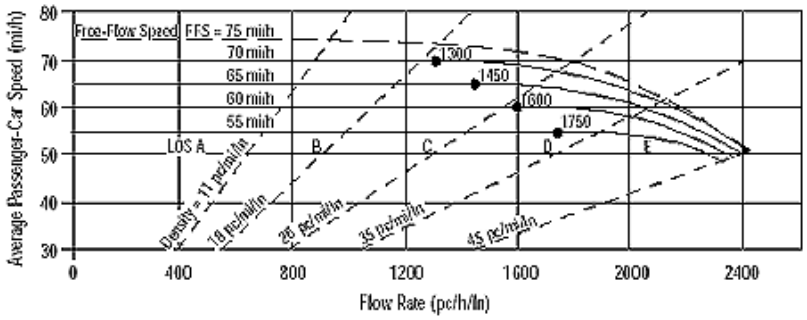
BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	OSR
Agency or Company	PBS&J
Date Performed	6/25/2008
Analysis Time Period	PM Peak

Site Information

Highway/Direction of Travel	Monroe Connector/Bypass WB
From/To	East of Stallings Road
Jurisdiction	470
Analysis Year	2035 Build Toll Alternative 3A

Project Description Monroe Connector/Bypass

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	2373 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	5
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Rolling
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	2.0
E_T	2.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.930

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	2	
FFS (measured)		mi/h
Base free-flow Speed, BFFS	60.0	mi/h

Calc Speed Adj and FFS

f_{LW}	0.0	mi/h
f_{LC}	0.0	mi/h
f_{ID}	0.0	mi/h
f_N	4.5	mi/h
FFS	55.5	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1417	pc/h/ln
S	55.5	mi/h
D = v_p / S	25.5	pc/mi/ln
LOS	C	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
f_p - Page 23-12	f_N - Exhibit 23-6
LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7

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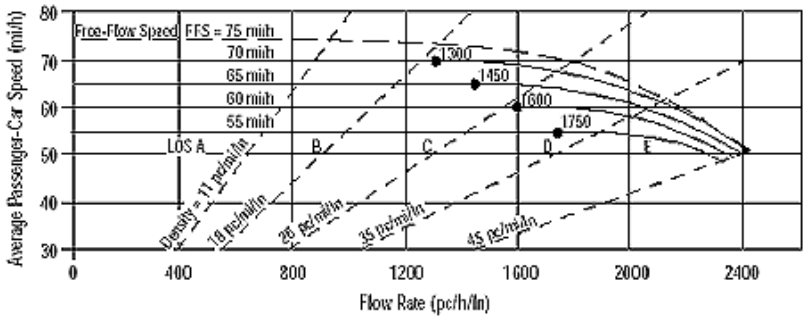

Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information / Site Information

General Information		Site Information	
Analyst	TDK	Highway/Direction of Travel	Monroe Connector/Bypass WB
Agency or Company	PBS&J	From/To	West of Stallings Road
Date Performed	8/21/09	Jurisdiction	471
Analysis Time Period	AM Peak	Analysis Year	2035 Build Toll Alternative 3A

Project Description Monroe Connector/Bypass

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	4398 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	9
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Rolling
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	2.0
E_T	2.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.881

Speed Inputs / Calc Speed Adj and FFS

Speed Inputs			Calc Speed Adj and FFS		
Lane Width	12.0	ft	f_{LW}	0.0	mi/h
Rt-Shoulder Lat. Clearance	6.0	ft	f_{LC}	0.0	mi/h
Interchange Density	0.50	I/mi	f_{ID}	0.0	mi/h
Number of Lanes, N	3		f_N	3.0	mi/h
FFS (measured)		mi/h	FFS	57.0	mi/h
Base free-flow Speed, BFFS	60.0	mi/h			

LOS and Performance Measures / Design (N)

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1849	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	56.8	mi/h	S	mi/h
D = v_p / S	32.6	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	D		Required Number of Lanes, N	

Glossary / Factor Location

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
V - Hourly volume	D - Density	E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 23-12	f_N - Exhibit 23-6
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7
DDHV - Directional design hour volume			

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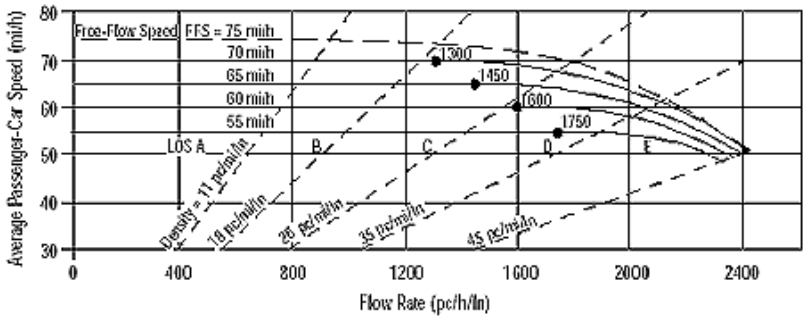

Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information / Site Information

General Information		Site Information	
Analyst	TDK	Highway/Direction of Travel	Monroe Connector/Bypass WB
Agency or Company	PBS&J	From/To	West of Stallings Road
Date Performed	8/21/09	Jurisdiction	471
Analysis Time Period	PM Peak	Analysis Year	2035 Build Toll Alternative 3A

Project Description Monroe Connector/Bypass

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	3380 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	9
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Rolling
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	2.0
E_T	2.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.881

Speed Inputs / Calc Speed Adj and FFS

Speed Inputs			Calc Speed Adj and FFS		
Lane Width	12.0	ft	f_{LW}	0.0	mi/h
Rt-Shoulder Lat. Clearance	6.0	ft	f_{LC}	0.0	mi/h
Interchange Density	0.50	I/mi	f_{ID}	0.0	mi/h
Number of Lanes, N	3		f_N	3.0	mi/h
FFS (measured)		mi/h	FFS	57.0	mi/h
Base free-flow Speed, BFFS	60.0	mi/h			

LOS and Performance Measures / Design (N)

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1421	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	57.0	mi/h	S	mi/h
D = v_p / S	24.9	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	C		Required Number of Lanes, N	

Glossary / Factor Location

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
V - Hourly volume	D - Density	E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 23-12	f_N - Exhibit 23-6
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7
DDHV - Directional design hour volume			

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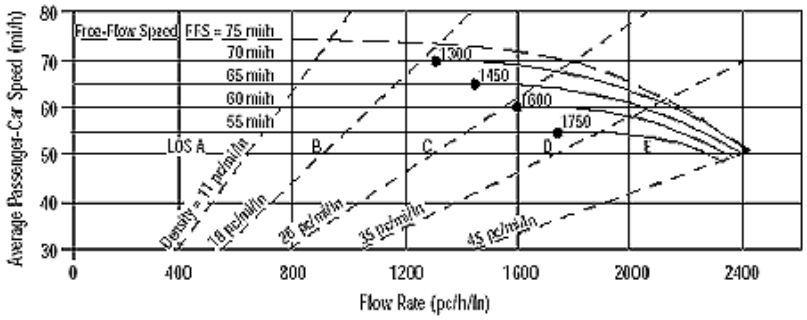

Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	TDK
Agency or Company	PBS&J
Date Performed	8/21/09
Analysis Time Period	AM Peak

Site Information

Highway/Direction of Travel	Monroe Connector/Bypass EB
From/To	Eastst of Stallings Road
Jurisdiction	472
Analysis Year	2035 Build Toll Alternative 3A

Project Description Monroe Connector/Bypass

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	1867 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	9
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Rolling
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	2.0
E_T	2.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.881

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	2	
FFS (measured)		mi/h
Base free-flow Speed, BFFS	60.0	mi/h

Calc Speed Adj and FFS

f_{LW}	0.0	mi/h
f_{LC}	0.0	mi/h
f_{ID}	0.0	mi/h
f_N	4.5	mi/h
FFS	55.5	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1177	pc/h/ln
S	55.5	mi/h
D = v_p / S	21.2	pc/mi/ln
LOS	C	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
f_p - Page 23-12	f_N - Exhibit 23-6
LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7

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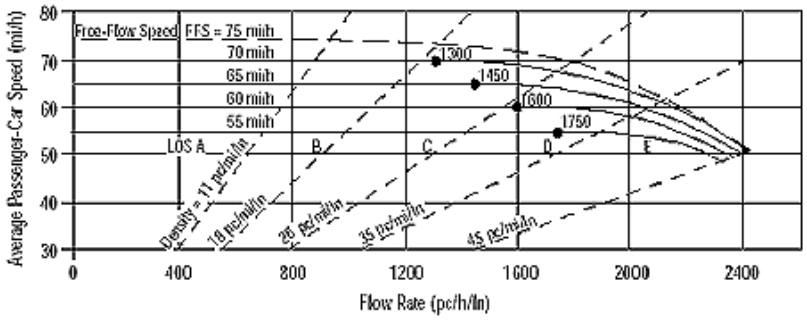

Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	TDK
Agency or Company	PBS&J
Date Performed	8/21/09
Analysis Time Period	PM Peak

Site Information

Highway/Direction of Travel	Monroe Connector/Bypass EB
From/To	East of Stallings Road
Jurisdiction	472
Analysis Year	2035 Build Toll Alternative 3A

Project Description Monroe Connector/Bypass

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	2680 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	9
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Rolling
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	2.0
E_T	2.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.881

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	2	
FFS (measured)		mi/h
Base free-flow Speed, BFFS	60.0	mi/h

Calc Speed Adj and FFS

f_{LW}	0.0	mi/h
f_{LC}	0.0	mi/h
f_{ID}	0.0	mi/h
f_N	4.5	mi/h
FFS	55.5	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1690	pc/h/ln
S	55.5	mi/h
D = v_p / S	30.5	pc/mi/ln
LOS	D	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
f_p - Page 23-12	f_N - Exhibit 23-6
LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7

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FREEWAY WEAVING WORKSHEET

General Information

Analyst	TDK
Agency/Company	PBSJ
Date Performed	8/21/09
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	US 74 WB
Weaving Seg Location	473
Jurisdiction	
Analysis Year	2035 Build Toll Alternative 3A

Inputs

Freeway free-flow speed, SFF (mi/h)	60
Weaving number of lanes, N	4
Weaving seg length, L (ft)	2500
Terrain	Rolling

Weaving type	A
Volume ratio, VR	0.44
Weaving ratio, R	0.21

Conversions to pc/h Under Base Conditions

(pc/h)	V	PHF	Truck %	RV %	E_T	E_R	f_{HV}	f_p	v
Vo1	383	0.90	3	0	2.5	2.0	0.957	1.00	444
Vo2	2565	0.90	9	0	2.5	2.0	0.881	1.00	3234
Vw1	535	0.90	3	0	2.5	2.0	0.957	1.00	621
Vw2	1833	0.90	9	0	2.5	2.0	0.881	1.00	2311
Vw				2932	Vnw				3678
V									6610

Weaving and Non-Weaving Speeds

	Unconstrained		Constrained	
	Weaving (i = w)	Non-Weaving (i = nw)	Weaving (i = w)	Non-Weaving (= nw)
a (Exhibit 24-6)			0.15	0.00
b (Exhibit 24-6)			4.00	4.00
c (Exhibit 24-6)			0.97	1.30
d (Exhibit 24-6)			0.80	0.75
Weaving intensity factor, Wi			1.99	0.37
Weaving and non-weaving speeds, Si (mi/h)			31.74	51.37

Number of lanes required for unconstrained operation, Nw 2.26
Maximum number of lanes, Nw (max) 1.40

☐ If Nw < Nw(max) unconstrained operation ☑ if Nw > Nw (max) constrained operation

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment speed, S (mi/h)	40.31
Weaving segment density, D (pc/mi/ln)	40.99
Level of service, LOS	E
Capacity of base condition, c_b (pc/h)	7400
Capacity as a 15-minute flow rate, c (veh/h)	7081
Capacity as a full-hour volume, c_h (veh/h)	6373

Notes

a. Weaving segments longer than 2500 ft. are treated as isolated merge and diverge areas using the procedures of Chapter 25, "Ramps and Ramp Junctions".
b. Capacity constrained by basic freeway capacity.
c. Capacity occurs under constrained operating conditions.
d. Three-lane Type A segments do not operate well at volume ratios greater than 0.45. Poor operations and some local queuing are expected in such cases.
e. Four-lane Type A segments do not operate well at volume ratios greater than 0.35. Poor operations and some local queuing are expected in such cases.
f. Capacity constrained by maximum allowable weaving flow rate: 2,800 pc/h (Type A), 4,000 (Type B), 3,500 (Type C).
g. Five-lane Type A segments do not operate well at volume ratios greater than 0.20. Poor operations and some local queuing are expected in such cases.
h. Type B weaving segments do not operate well at volume ratios greater than 0.80. Poor operations and some local queuing are expected in such cases.
i. Type C weaving segments do not operate well at volume ratios greater than 0.50. Poor operations and some local queuing are expected in such cases.

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FREEWAY WEAVING WORKSHEET

General Information

Analyst	TDK
Agency/Company	PBSJ
Date Performed	8/21/09
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	US 74 WB
Weaving Seg Location	473
Jurisdiction	
Analysis Year	2035 Build Toll Alternative 3A

Inputs

Freeway free-flow speed, SFF (mi/h)	60	Weaving type	A
Weaving number of lanes, N	4	Volume ratio, VR	0.47
Weaving seg length, L (ft)	2500	Weaving ratio, R	0.24
Terrain	Rolling		

Conversions to pc/h Under Base Conditions

(pc/h)	V	PHF	Truck %	RV %	E_T	E_R	f_{HV}	f_p	v
Vo1	418	0.90	3	0	2.5	2.0	0.957	1.00	485
Vo2	1882	0.90	9	0	2.5	2.0	0.881	1.00	2373
Vw1	525	0.90	3	0	2.5	2.0	0.957	1.00	609
Vw2	1498	0.90	9	0	2.5	2.0	0.881	1.00	1889
Vw				2498	Vnw				2858
V									5356

Weaving and Non-Weaving Speeds

	Unconstrained		Constrained	
	Weaving (i = w)	Non-Weaving (i = nw)	Weaving (i = w)	Non-Weaving (= nw)
a (Exhibit 24-6)			0.15	0.00
b (Exhibit 24-6)			4.00	4.00
c (Exhibit 24-6)			0.97	1.30
d (Exhibit 24-6)			0.80	0.75
Weaving intensity factor, Wi			1.68	0.30
Weaving and non-weaving speeds, Si (mi/h)			33.68	53.35

Number of lanes required for unconstrained operation, Nw 2.28
Maximum number of lanes, Nw (max) 1.40

☐ If Nw < Nw(max) unconstrained operation ☑ if Nw > Nw (max) constrained operation

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment speed, S (mi/h)	41.93
Weaving segment density, D (pc/mi/ln)	31.93
Level of service, LOS	D
Capacity of base condition, c_b (pc/h)	7400
Capacity as a 15-minute flow rate, c (veh/h)	7081
Capacity as a full-hour volume, c_h (veh/h)	6373

Notes

a. Weaving segments longer than 2500 ft. are treated as isolated merge and diverge areas using the procedures of Chapter 25, "Ramps and Ramp Junctions".
b. Capacity constrained by basic freeway capacity.
c. Capacity occurs under constrained operating conditions.
d. Three-lane Type A segments do not operate well at volume ratios greater than 0.45. Poor operations and some local queuing are expected in such cases.
e. Four-lane Type A segments do not operate well at volume ratios greater than 0.35. Poor operations and some local queuing are expected in such cases.
f. Capacity constrained by maximum allowable weaving flow rate: 2,800 pc/h (Type A), 4,000 (Type B), 3,500 (Type C).
g. Five-lane Type A segments do not operate well at volume ratios greater than 0.20. Poor operations and some local queuing are expected in such cases.
h. Type B weaving segments do not operate well at volume ratios greater than 0.80. Poor operations and some local queuing are expected in such cases.
i. Type C weaving segments do not operate well at volume ratios greater than 0.50. Poor operations and some local queuing are expected in such cases.

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FREEWAY WEAVING WORKSHEET

General Information

Analyst	TDK
Agency/Company	PBSJ
Date Performed	10/27/09
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	US 74 EB
Weaving Seg Location	474
Jurisdiction	
Analysis Year	2035 Build Toll Alternative 3A

Inputs

Freeway free-flow speed, SFF (mi/h)	60	Weaving type	A
Weaving number of lanes, N	4	Volume ratio, VR	0.37
Weaving seg length, L (ft)	1550	Weaving ratio, R	0.50
Terrain	Rolling		

Conversions to pc/h Under Base Conditions

(pc/h)	V	PHF	Truck %	RV %	E_T	E_R	f_{HV}	f_p	v
Vo1	2454	0.90	9	0	2.5	2.0	0.881	1.00	3094
Vo2	271	0.90	8	0	2.5	2.0	0.893	1.00	337
Vw1	814	0.90	9	0	2.5	2.0	0.881	1.00	1026
Vw2	817	0.90	8	0	2.5	2.0	0.893	1.00	1016
Vw				2042	Vnw				3431
V									5473

Weaving and Non-Weaving Speeds

	Unconstrained		Constrained	
	Weaving (i = w)	Non-Weaving (i = nw)	Weaving (i = w)	Non-Weaving (= nw)
a (Exhibit 24-6)			0.15	0.00
b (Exhibit 24-6)			4.00	4.00
c (Exhibit 24-6)			0.97	1.30
d (Exhibit 24-6)			0.80	0.75
Weaving intensity factor, Wi			2.17	0.34
Weaving and non-weaving speeds, Si (mi/h)			30.76	52.21

Number of lanes required for unconstrained operation, Nw 1.85
Maximum number of lanes, Nw (max) 1.40

☐ If Nw < Nw(max) unconstrained operation ☑ if Nw > Nw (max) constrained operation

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment speed, S (mi/h)	41.43
Weaving segment density, D (pc/mi/ln)	33.02
Level of service, LOS	D
Capacity of base condition, c_b (pc/h)	6843
Capacity as a 15-minute flow rate, c (veh/h)	6029
Capacity as a full-hour volume, c_h (veh/h)	5426

Notes

a. Weaving segments longer than 2500 ft. are treated as isolated merge and diverge areas using the procedures of Chapter 25, "Ramps and Ramp Junctions".
b. Capacity constrained by basic freeway capacity.
c. Capacity occurs under constrained operating conditions.
d. Three-lane Type A segments do not operate well at volume ratios greater than 0.45. Poor operations and some local queuing are expected in such cases.
e. Four-lane Type A segments do not operate well at volume ratios greater than 0.35. Poor operations and some local queuing are expected in such cases.
f. Capacity constrained by maximum allowable weaving flow rate: 2,800 pc/h (Type A), 4,000 (Type B), 3,500 (Type C).
g. Five-lane Type A segments do not operate well at volume ratios greater than 0.20. Poor operations and some local queuing are expected in such cases.
h. Type B weaving segments do not operate well at volume ratios greater than 0.80. Poor operations and some local queuing are expected in such cases.
i. Type C weaving segments do not operate well at volume ratios greater than 0.50. Poor operations and some local queuing are expected in such cases.

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FREEWAY WEAVING WORKSHEET

General Information

Analyst	TDK
Agency/Company	PBSJ
Date Performed	10/27/09
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	US 74 EB
Weaving Seg Location	474
Jurisdiction	
Analysis Year	2035 Build Toll Alternative 3A

Inputs

Freeway free-flow speed, SFF (mi/h)	60	Weaving type	A
Weaving number of lanes, N	4	Volume ratio, VR	0.35
Weaving seg length, L (ft)	1550	Weaving ratio, R	0.42
Terrain	Rolling		

Conversions to pc/h Under Base Conditions

(pc/h)	V	PHF	Truck %	RV %	E_T	E_R	f_{HV}	f_p	v
Vo1	3238	0.90	9	0	2.5	2.0	0.881	1.00	4083
Vo2	276	0.90	8	0	2.5	2.0	0.893	1.00	343
Vw1	795	0.90	9	0	2.5	2.0	0.881	1.00	1002
Vw2	1127	0.90	8	0	2.5	2.0	0.893	1.00	1402
Vw				2404	Vnw				4426
V									6830

Weaving and Non-Weaving Speeds

	Unconstrained		Constrained	
	Weaving (i = w)	Non-Weaving (i = nw)	Weaving (i = w)	Non-Weaving (= nw)
a (Exhibit 24-6)			0.15	0.00
b (Exhibit 24-6)			4.00	4.00
c (Exhibit 24-6)			0.97	1.30
d (Exhibit 24-6)			0.80	0.75
Weaving intensity factor, Wi			2.60	0.43
Weaving and non-weaving speeds, Si (mi/h)			28.88	49.95

Number of lanes required for unconstrained operation, Nw 1.84
Maximum number of lanes, Nw (max) 1.40

☐ If Nw < Nw(max) unconstrained operation ☑ if Nw > Nw (max) constrained operation

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment speed, S (mi/h)	39.74
Weaving segment density, D (pc/mi/ln)	42.96
Level of service, LOS	E
Capacity of base condition, c_b (pc/h)	6843
Capacity as a 15-minute flow rate, c (veh/h)	6029
Capacity as a full-hour volume, c_h (veh/h)	5426

Notes

a. Weaving segments longer than 2500 ft. are treated as isolated merge and diverge areas using the procedures of Chapter 25, "Ramps and Ramp Junctions".
b. Capacity constrained by basic freeway capacity.
c. Capacity occurs under constrained operating conditions.
d. Three-lane Type A segments do not operate well at volume ratios greater than 0.45. Poor operations and some local queuing are expected in such cases.
e. Four-lane Type A segments do not operate well at volume ratios greater than 0.35. Poor operations and some local queuing are expected in such cases.
f. Capacity constrained by maximum allowable weaving flow rate: 2,800 pc/h (Type A), 4,000 (Type B), 3,500 (Type C).
g. Five-lane Type A segments do not operate well at volume ratios greater than 0.20. Poor operations and some local queuing are expected in such cases.
h. Type B weaving segments do not operate well at volume ratios greater than 0.80. Poor operations and some local queuing are expected in such cases.
i. Type C weaving segments do not operate well at volume ratios greater than 0.50. Poor operations and some local queuing are expected in such cases.

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TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	*TDK*	Intersection	*480*
Agency/Co.	*PBS&J*	Jurisdiction	
Date Performed	*10/26/09*	Analysis Year	*Year 2035 Build Toll Alt 3A*
Analysis Time Period	*AM Peak*		
Project Description	*Monroe Connector / Bypass*		
East/West Street:	*WB Frontage Rd*	North/South Street:	*McKee Rd*
Intersection Orientation:	*North-South*	Study Period (hrs):	*0.25*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	*0*	*264*	*0*	*0*	*349*	*0*
Peak-Hour Factor, PHF	*1.00*	*0.90*	*0.90*	*0.90*	*0.90*	*1.00*
Hourly Flow Rate, HFR	*0*	*293*	*0*	*0*	*387*	*0*
Percent Heavy Vehicles	*0*	--	--	*0*	--	--
Median Type	*Undivided*					
RT Channelized			*0*			*0*
Lanes	*0*	*1*	*0*	*0*	*2*	*0*
Configuration		*T*			*T*	
Upstream Signal		*1*			*0*	

Minor Street	Westbound			Eastbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	*122*	*0*	*60*	*0*	*0*	*0*
Peak-Hour Factor, PHF	*0.90*	*1.00*	*0.90*	*1.00*	*1.00*	*1.00*
Hourly Flow Rate, HFR	*135*	*0*	*66*	*0*	*0*	*0*
Percent Heavy Vehicles	*3*	*0*	*3*	*0*	*0*	*0*
Percent Grade (%)		*0*			*0*	
Flared Approach		*N*			*N*	
Storage		*0*			*0*	
RT Channelized			*0*			*0*
Lanes	*1*	*0*	*1*	*0*	*0*	*0*
Configuration	*L*		*R*			

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration			*L*		*R*			
v (vph)			*135*		*66*			
C (m) (vph)			*557*		*734*			
v/c			*0.24*		*0.09*			
95% queue length			*0.94*		*0.30*			
Control Delay			*13.5*		*10.4*			
LOS			*B*		*B*			
Approach Delay	--	--	*12.5*					
Approach LOS	--	--	*B*					

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TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	*TDK*	Intersection	*480*
Agency/Co.	*PBS&J*	Jurisdiction	
Date Performed	*10/26/09*	Analysis Year	*Year 2035 Build Toll Alt 3A*
Analysis Time Period	*PM Peak*		
Project Description	*Monroe Connector / Bypass*		
East/West Street:	*WB Frontage Rd*	North/South Street:	*McKee Rd*
Intersection Orientation:	*North-South*	Study Period (hrs):	*0.25*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	*0*	*409*	*0*	*0*	*230*	*0*
Peak-Hour Factor, PHF	*1.00*	*0.90*	*0.90*	*0.90*	*0.90*	*1.00*
Hourly Flow Rate, HFR	*0*	*454*	*0*	*0*	*255*	*0*
Percent Heavy Vehicles	*0*	--	--	*0*	--	--
Median Type	*Undivided*					
RT Channelized			*0*			*0*
Lanes	*0*	*1*	*0*	*0*	*2*	*0*
Configuration		*T*			*T*	
Upstream Signal		*1*			*0*	

Minor Street	Westbound			Eastbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	*70*	*0*	*91*	*0*	*0*	*0*
Peak-Hour Factor, PHF	*0.90*	*1.00*	*0.90*	*1.00*	*1.00*	*1.00*
Hourly Flow Rate, HFR	*77*	*0*	*101*	*0*	*0*	*0*
Percent Heavy Vehicles	*3*	*0*	*3*	*0*	*0*	*0*
Percent Grade (%)	*0*			*0*		
Flared Approach		*N*			*N*	
Storage		*0*			*0*	
RT Channelized			*0*			*0*
Lanes	*1*	*0*	*1*	*0*	*0*	*0*
Configuration	*L*		*R*			

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration			*L*		*R*			
v (vph)			*77*		*101*			
C (m) (vph)			*525*		*591*			
v/c			*0.15*		*0.17*			
95% queue length			*0.51*		*0.61*			
Control Delay			*13.0*		*12.3*			
LOS			*B*		*B*			
Approach Delay	--	--	*12.6*					
Approach LOS	--	--	*B*					

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Lanes, Volumes, Timings
481: EB US 74 Frontage Road & McKee Road

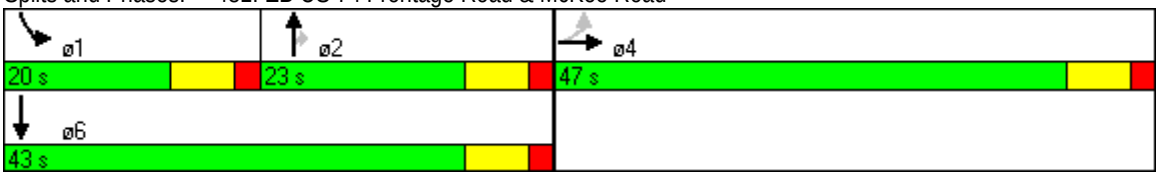
11/9/2009

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	155	688	242	0	0	0	0	109	303	141	330	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	900		900	0		0	0		900	0		0
Storage Lanes	1		0	0		0	0		2	1		0
Taper Length (ft)	25		25	25		25	25		25	25		25
Lane Util. Factor	0.95	0.95	0.95	1.00	1.00	1.00	1.00	1.00	0.88	1.00	1.00	1.00
Frt		0.967							0.850			
Flt Protected		0.993								0.950		
Satd. Flow (prot)	0	3365	0	0	0	0	0	1845	2760	1770	1863	0
Flt Permitted		0.993								0.950		
Satd. Flow (perm)	0	3365	0	0	0	0	0	1845	2760	1770	1863	0
Right Turn on Red			No			No			No			No
Satd. Flow (RTOR)												
Link Speed (mph)		35			35			45			45	
Link Distance (ft)		1058			114			828			186	
Travel Time (s)		20.6			2.2			12.5			2.8	
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Heavy Vehicles (%)	3%	3%	3%	0%	0%	0%	0%	3%	3%	2%	2%	0%
Adj. Flow (vph)	172	764	269	0	0	0	0	121	337	157	367	0
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	1205	0	0	0	0	0	121	337	157	367	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)		0			0			12			12	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			16			16			16	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors	1	2						2	1	1	2	
Detector Template	Left	Thru						Thru	Right	Left	Thru	
Leading Detector (ft)	20	100						100	20	20	100	
Trailing Detector (ft)	0	0						0	0	0	0	
Detector 1 Position(ft)	0	0						0	0	0	0	
Detector 1 Size(ft)	20	6						6	20	20	6	
Detector 1 Type	Cl+Ex	Cl+Ex						Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0						0.0	0.0	0.0	0.0	
Detector 1 Queue (s)	0.0	0.0						0.0	0.0	0.0	0.0	
Detector 1 Delay (s)	0.0	0.0						0.0	0.0	0.0	0.0	
Detector 2 Position(ft)		94						94			94	
Detector 2 Size(ft)		6						6			6	
Detector 2 Type		Cl+Ex						Cl+Ex			Cl+Ex	
Detector 2 Channel												
Detector 2 Extend (s)		0.0						0.0			0.0	
Turn Type	Perm								Perm	Prot		
Protected Phases		4						2		1	6	
Permitted Phases	4								2			

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Detector Phase	4	4						2	2	1	6	
Switch Phase												
Minimum Initial (s)	7.0	7.0						12.0	12.0	7.0	12.0	
Minimum Split (s)	14.0	14.0						19.0	19.0	14.0	19.0	
Total Split (s)	47.0	47.0	0.0	0.0	0.0	0.0	0.0	23.0	23.0	20.0	43.0	0.0
Total Split (%)	52.2%	52.2%	0.0%	0.0%	0.0%	0.0%	0.0%	25.6%	25.6%	22.2%	47.8%	0.0%
Maximum Green (s)	40.0	40.0						16.0	16.0	13.0	36.0	
Yellow Time (s)	5.0	5.0						5.0	5.0	5.0	5.0	
All-Red Time (s)	2.0	2.0						2.0	2.0	2.0	2.0	
Lost Time Adjust (s)	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0
Total Lost Time (s)	5.0	5.0	2.0	2.0	2.0	2.0	2.0	5.0	5.0	5.0	5.0	2.0
Lead/Lag								Lag	Lag	Lead		
Lead-Lag Optimize?												
Vehicle Extension (s)	3.0	3.0						3.0	3.0	3.0	3.0	
Recall Mode	None	None						Min	Min	None	Min	
Act Effct Green (s)		37.5						16.7	16.7	13.3	35.1	
Actuated g/C Ratio		0.45						0.20	0.20	0.16	0.42	
v/c Ratio		0.79						0.33	0.61	0.55	0.46	
Control Delay		24.0						33.0	36.6	41.6	20.3	
Queue Delay		0.0						0.0	0.0	0.0	0.0	
Total Delay		24.0						33.0	36.6	41.6	20.3	
LOS		C						C	D	D	C	
Approach Delay		24.0						35.7			26.7	
Approach LOS		C						D			C	
Queue Length 50th (ft)		288						59	100	83	146	
Queue Length 95th (ft)		372						110	149	145	224	
Internal Link Dist (ft)		978			34			748			106	
Turn Bay Length (ft)									900			
Base Capacity (vph)		1735						408	610	326	869	
Starvation Cap Reductn		0						0	0	0	0	
Spillback Cap Reductn		0						0	0	0	0	
Storage Cap Reductn		0						0	0	0	0	
Reduced v/c Ratio		0.69						0.30	0.55	0.48	0.42	

Intersection Summary	
Area Type:	Other
Cycle Length: 90	
Actuated Cycle Length: 82.8	
Natural Cycle: 60	
Control Type: Actuated-Uncoordinated	
Maximum v/c Ratio: 0.79	
Intersection Signal Delay: 27.1	Intersection LOS: C
Intersection Capacity Utilization 68.6%	ICU Level of Service C
Analysis Period (min) 15	

Splits and Phases: 481: EB US 74 Frontage Road & McKee Road



Lanes, Volumes, Timings
481: EB US 74 Frontage Road & McKee Road

11/9/2009

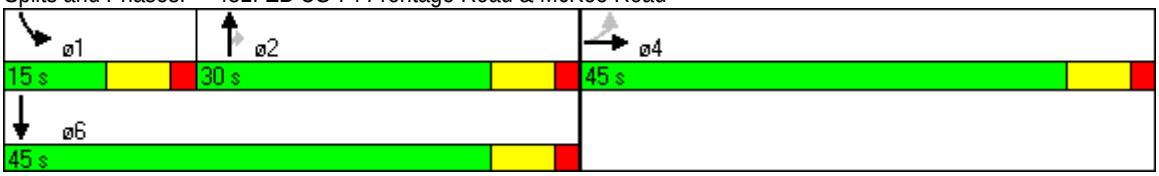
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	208	671	192	0	0	0	0	201	439	105	195	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	900		900	0		0	0		900	0		0
Storage Lanes	1		0	0		0	0		2	1		0
Taper Length (ft)	25		25	25		25	25		25	25		25
Lane Util. Factor	0.95	0.95	0.95	1.00	1.00	1.00	1.00	1.00	0.88	1.00	1.00	1.00
Frt		0.973							0.850			
Flt Protected		0.990								0.950		
Satd. Flow (prot)	0	3376	0	0	0	0	0	1845	2760	1770	1863	0
Flt Permitted		0.990								0.950		
Satd. Flow (perm)	0	3376	0	0	0	0	0	1845	2760	1770	1863	0
Right Turn on Red			No			No			No			No
Satd. Flow (RTOR)												
Link Speed (mph)		35			35			45			45	
Link Distance (ft)		1058			114			828			186	
Travel Time (s)		20.6			2.2			12.5			2.8	
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Heavy Vehicles (%)	3%	3%	3%	0%	0%	0%	0%	3%	3%	2%	2%	0%
Adj. Flow (vph)	231	746	213	0	0	0	0	223	488	117	217	0
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	1190	0	0	0	0	0	223	488	117	217	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)		0			0			12			12	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			16			16			16	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors	1	2						2	1	1	2	
Detector Template	Left	Thru						Thru	Right	Left	Thru	
Leading Detector (ft)	20	100						100	20	20	100	
Trailing Detector (ft)	0	0						0	0	0	0	
Detector 1 Position(ft)	0	0						0	0	0	0	
Detector 1 Size(ft)	20	6						6	20	20	6	
Detector 1 Type	Cl+Ex	Cl+Ex						Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0						0.0	0.0	0.0	0.0	
Detector 1 Queue (s)	0.0	0.0						0.0	0.0	0.0	0.0	
Detector 1 Delay (s)	0.0	0.0						0.0	0.0	0.0	0.0	
Detector 2 Position(ft)		94						94			94	
Detector 2 Size(ft)		6						6			6	
Detector 2 Type		Cl+Ex						Cl+Ex			Cl+Ex	
Detector 2 Channel												
Detector 2 Extend (s)		0.0						0.0			0.0	
Turn Type	Perm								Perm	Prot		
Protected Phases		4						2		1	6	
Permitted Phases	4								2			

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Detector Phase	4	4						2	2	1	6	
Switch Phase												
Minimum Initial (s)	7.0	7.0						12.0	12.0	7.0	12.0	
Minimum Split (s)	14.0	14.0						19.0	19.0	14.0	19.0	
Total Split (s)	45.0	45.0	0.0	0.0	0.0	0.0	0.0	30.0	30.0	15.0	45.0	0.0
Total Split (%)	50.0%	50.0%	0.0%	0.0%	0.0%	0.0%	0.0%	33.3%	33.3%	16.7%	50.0%	0.0%
Maximum Green (s)	38.0	38.0						23.0	23.0	8.0	38.0	
Yellow Time (s)	5.0	5.0						5.0	5.0	5.0	5.0	
All-Red Time (s)	2.0	2.0						2.0	2.0	2.0	2.0	
Lost Time Adjust (s)	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0
Total Lost Time (s)	5.0	5.0	2.0	2.0	2.0	2.0	2.0	5.0	5.0	5.0	5.0	2.0
Lead/Lag								Lag	Lag	Lead		
Lead-Lag Optimize?												
Vehicle Extension (s)	3.0	3.0						3.0	3.0	3.0	3.0	
Recall Mode	None	None						Min	Min	None	Min	
Act Effct Green (s)		36.8						21.8	21.8	10.2	32.8	
Actuated g/C Ratio		0.46						0.27	0.27	0.13	0.41	
v/c Ratio		0.77						0.44	0.65	0.52	0.28	
Control Delay		23.6						29.4	32.0	46.6	16.8	
Queue Delay		0.0						0.0	0.0	0.0	0.0	
Total Delay		23.6						29.4	32.0	46.6	16.8	
LOS		C						C	C	D	B	
Approach Delay		23.6						31.2			27.2	
Approach LOS		C						C			C	
Queue Length 50th (ft)		284						104	138	63	75	
Queue Length 95th (ft)		382						171	196	#130	124	
Internal Link Dist (ft)		978			34			748			106	
Turn Bay Length (ft)									900			
Base Capacity (vph)		1764						603	902	231	974	
Starvation Cap Reductn		0						0	0	0	0	
Spillback Cap Reductn		0						0	0	0	0	
Storage Cap Reductn		0						0	0	0	0	
Reduced v/c Ratio		0.67						0.37	0.54	0.51	0.22	

Intersection Summary

Area Type: Other
Cycle Length: 90
Actuated Cycle Length: 80.1
Natural Cycle: 60
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.77
Intersection Signal Delay: 26.5 Intersection LOS: C
Intersection Capacity Utilization 68.4% ICU Level of Service C
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 481: EB US 74 Frontage Road & McKee Road



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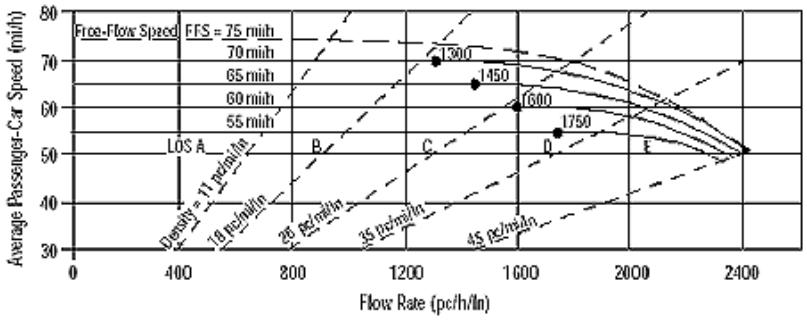

Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	OSR
Agency or Company	PBS&J
Date Performed	6/26/2008
Analysis Time Period	AM Peak

Site Information

Highway/Direction of Travel	Monroe Connector/Bypass WB
From/To	East of Stallings Road
Jurisdiction	482
Analysis Year	2035 Build Toll Alternative 3A

Project Description Monroe Connector/Bypass

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	2702 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	12
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Rolling
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	2.0
E_T	2.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.847

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	2	
FFS (measured)		mi/h
Base free-flow Speed, BFFS	70.0	mi/h

Calc Speed Adj and FFS

f_{LW}	0.0	mi/h
f_{LC}	0.0	mi/h
f_{ID}	0.0	mi/h
f_N	4.5	mi/h
FFS	65.5	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1771	pc/h/ln
S	64.5	mi/h
D = v_p / S	27.4	pc/mi/ln
LOS	D	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
f_p - Page 23-12	f_N - Exhibit 23-6
LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7

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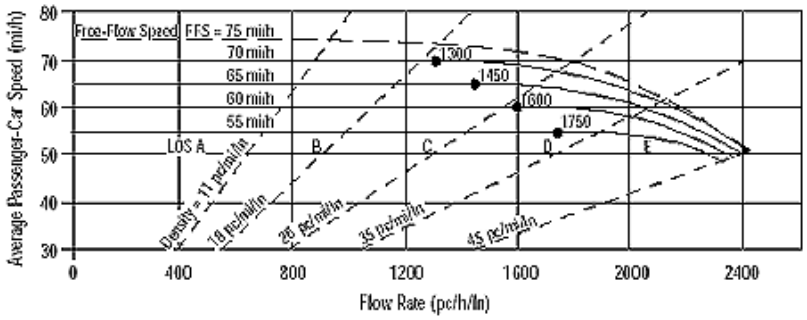

Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	OSR
Agency or Company	PBS&J
Date Performed	6/26/2008
Analysis Time Period	PM Peak

Site Information

Highway/Direction of Travel	Monroe Connector/Bypass WB
From/To	East of Stallings Road
Jurisdiction	482
Analysis Year	2035 Build Toll Alternative 3A

Project Description Monroe Connector/Bypass

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	1885 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	12
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Rolling
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	2.0
E_T	2.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.847

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	2	
FFS (measured)		mi/h
Base free-flow Speed, BFFS	70.0	mi/h

Calc Speed Adj and FFS

f_{LW}	0.0	mi/h
f_{LC}	0.0	mi/h
f_{ID}	0.0	mi/h
f_N	4.5	mi/h
FFS	65.5	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1236	pc/h/ln
S	65.5	mi/h
D = v_p / S	18.9	pc/mi/ln
LOS	C	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
f_p - Page 23-12	f_N - Exhibit 23-6
LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7

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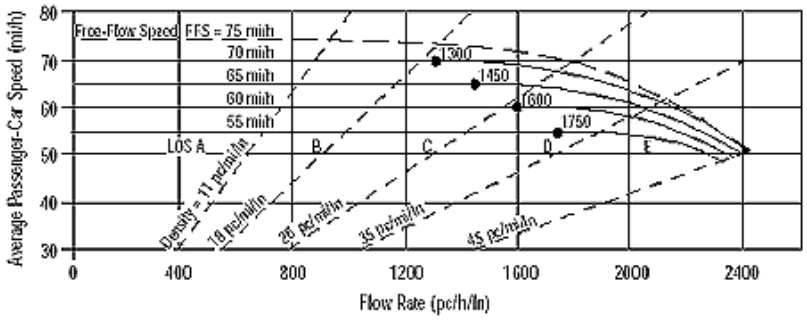

Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	OSR
Agency or Company	PBS&J
Date Performed	6/26/2008
Analysis Time Period	AM Peak

Site Information

Highway/Direction of Travel	Monroe Connector/Bypass EB
From/To	East of Stallings Road
Jurisdiction	483
Analysis Year	2035 Build Toll Alternative 3A

Project Description Monroe Connector/Bypass

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	1885 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	12
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Rolling
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	2.0
E_T	2.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.847

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	2	
FFS (measured)		mi/h
Base free-flow Speed, BFFS	70.0	mi/h

Calc Speed Adj and FFS

f_{LW}	0.0	mi/h
f_{LC}	0.0	mi/h
f_{ID}	0.0	mi/h
f_N	4.5	mi/h
FFS	65.5	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1236	pc/h/ln
S	65.5	mi/h
D = v_p / S	18.9	pc/mi/ln
LOS	C	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
f_p - Page 23-12	f_N - Exhibit 23-6
LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7

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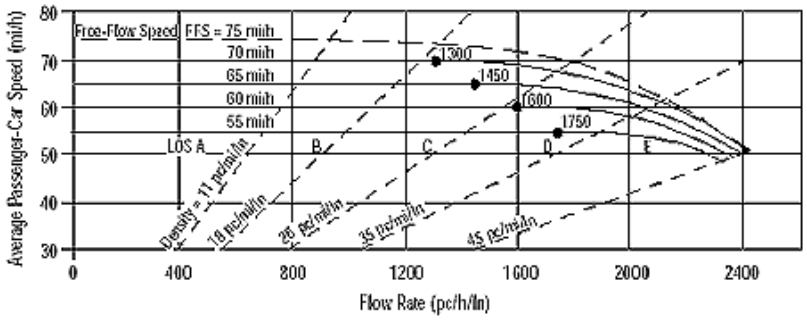

Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	OSR
Agency or Company	PBS&J
Date Performed	6/26/2008
Analysis Time Period	PM Peak

Site Information

Highway/Direction of Travel	Monroe Connector/Bypass EB
From/To	East of Stallings Road
Jurisdiction	483
Analysis Year	2035 Build Toll Alternative 3A

Project Description Monroe Connector/Bypass

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	2702 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	12
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Rolling
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	2.0
E_T	2.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.847

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	2	
FFS (measured)		mi/h
Base free-flow Speed, BFFS	70.0	mi/h

Calc Speed Adj and FFS

f_{LW}	0.0	mi/h
f_{LC}	0.0	mi/h
f_{ID}	0.0	mi/h
f_N	4.5	mi/h
FFS	65.5	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1771	pc/h/ln
S	64.5	mi/h
D = v_p / S	27.4	pc/mi/ln
LOS	D	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
f_p - Page 23-12	f_N - Exhibit 23-6
LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7

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Arterial Level of Service: WB WB US 74 Frontage Road

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
WB Stallings U-Turn	4662	8.1	26.0	0.2	21
Stallings Road	450	17.1	19.0	0.0	5
EB Stallings U-Turn	4751	2.2	5.4	0.0	18
Ramp to WB US 74	4752	1.0	12.3	0.1	30
WB McKee U-Turn	477	2.0	22.0	0.2	32
McKee Road	480	14.3	18.2	0.0	4
Total		44.6	103.0	0.5	18

Arterial Level of Service: EB EB US 74 Frontage Road

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
McKee Road	481	27.0	47.3	0.2	17
WB McKee U-Turn	4761	1.7	3.9	0.0	20
EB Stallings U-Turn	4762	31.4	63.0	0.3	17
Stallings Road	451	17.0	18.8	0.0	5
WB Stallings U-Turn	484	2.2	5.7	0.0	18
Lane Drop	9999	0.7	12.0	0.1	31
Ramp to EB Connector	456	3.2	37.6	0.3	32
Total		83.1	188.2	1.0	20

Arterial Level of Service: WB WB US 74 Frontage Road

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
WB Stallings U-Turn	4662	5.9	23.9	0.2	23
Stallings Road	450	16.9	18.8	0.0	5
EB Stallings U-Turn	4751	2.1	5.3	0.0	18
Ramp to WB US 74	4752	0.9	12.3	0.1	30
WB McKee U-Turn	477	1.7	21.9	0.2	32
McKee Road	480	10.3	14.2	0.0	6
Total		37.7	96.4	0.5	20

Arterial Level of Service: EB EB US 74 Frontage Road

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
McKee Road	481	30.8	51.1	0.2	16
WB McKee U-Turn	4761	1.7	3.9	0.0	20
EB Stallings U-Turn	4762	26.6	58.3	0.3	18
Stallings Road	451	16.5	18.4	0.0	5
WB Stallings U-Turn	484	2.3	5.7	0.0	18
Lane Drop	9999	0.7	11.9	0.1	31
Ramp to EB Connector	456	3.4	37.8	0.3	32
Total		82.0	187.1	1.0	20

Intersection: 450: WB US 74 Frontage Road & Stallings Road

Movement	WB	WB	WB	NB	NB	NB	NB	SB	SB	SB	SB
Directions Served	L	T	TR	L	L	T	T	T	T	T	TR
Maximum Queue (ft)	129	127	130	139	81	87	76	134	155	153	195
Average Queue (ft)	97	102	107	109	8	41	28	72	88	53	97
95th Queue (ft)	131	137	132	132	39	72	64	119	134	114	166
Link Distance (ft)	36	36	36	141	141	141	141			1141	1141
Upstream Blk Time (%)	42	40	45	1	0						
Queuing Penalty (veh)	143	138	155	1	0						
Storage Bay Dist (ft)								500	500		
Storage Blk Time (%)											
Queuing Penalty (veh)											

Intersection: 451: EB US 74 Frontage Road & Stallings Road

Movement	EB	EB	NB	NB	NB	NB	SB	SB	SB	SB
Directions Served	LT	TR	T	T	T	TR	L	L	T	T
Maximum Queue (ft)	127	130	978	966	1304	958	67	79	173	172
Average Queue (ft)	104	108	784	643	569	173	25	34	127	117
95th Queue (ft)	120	118	1169	1282	1709	623	59	68	179	170
Link Distance (ft)	43	43			1675	1675	141	141	141	141
Upstream Blk Time (%)	45	62			6	0			7	3
Queuing Penalty (veh)	226	306			0	0			14	6
Storage Bay Dist (ft)			1000	1000						
Storage Blk Time (%)			16	20	0					
Queuing Penalty (veh)			21	27	0					

Intersection: 456: EB US 74 Frontage Road & Ramp to EB Connector/Bypass

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 477: WB US 74 Frontage Road & WB McKee U-Turn

Movement	WB
Directions Served	T
Maximum Queue (ft)	22
Average Queue (ft)	1
95th Queue (ft)	13
Link Distance (ft)	981
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 480: WB US 74 Frontage Road & McKee Road

Movement	WB	WB	SB	SB
Directions Served	L	R	T	T
Maximum Queue (ft)	123	73	40	80
Average Queue (ft)	54	31	2	11
95th Queue (ft)	96	58	18	46
Link Distance (ft)	56	56		876
Upstream Blk Time (%)	12	0		
Queuing Penalty (veh)	11	0		
Storage Bay Dist (ft)			250	
Storage Blk Time (%)				
Queuing Penalty (veh)				

Intersection: 481: EB US 74 Frontage Road & McKee Road

Movement	EB	EB	NB	NB	NB	SB	SB
Directions Served	LT	TR	T	R	R	L	T
Maximum Queue (ft)	350	380	127	158	166	158	162
Average Queue (ft)	203	236	59	81	86	87	122
95th Queue (ft)	303	342	110	134	136	145	185
Link Distance (ft)		1024	788			147	147
Upstream Blk Time (%)						2	5
Queuing Penalty (veh)						4	11
Storage Bay Dist (ft)	900			900	900		
Storage Blk Time (%)							
Queuing Penalty (veh)							

Intersection: 484: EB US 74 Frontage Road & WB Stallings U-Turn

Movement	SE
Directions Served	L
Maximum Queue (ft)	65
Average Queue (ft)	3
95th Queue (ft)	45
Link Distance (ft)	125
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 4661: WB US 74 Frontage Road & Ramp from WB Connector/Bypass

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 4662: WB US 74 Frontage Road & WB Stallings U-Turn

Movement	WB	WB	WB
Directions Served	LT	T	T
Maximum Queue (ft)	233	208	206
Average Queue (ft)	66	64	77
95th Queue (ft)	173	165	173
Link Distance (ft)		753	753
Upstream Blk Time (%)			
Queuing Penalty (veh)			
Storage Bay Dist (ft)	500		
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 4751: WB US 74 Frontage Road & EB Stallings U-Turn

Movement	WB	NW
Directions Served	T	L
Maximum Queue (ft)	73	25
Average Queue (ft)	6	1
95th Queue (ft)	35	10
Link Distance (ft)	34	154
Upstream Blk Time (%)	0	
Queuing Penalty (veh)	1	
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 4752: WB US 74 Frontage Road & Ramp to WB US 74

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 4761: EB US 74 Frontage Road & WB McKee U-Turn

Movement	EB	EB
Directions Served	T	T
Maximum Queue (ft)	11	52
Average Queue (ft)	1	3
95th Queue (ft)	10	24
Link Distance (ft)	15	15
Upstream Blk Time (%)	0	0
Queuing Penalty (veh)	0	0
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 4762: EB US 74 Frontage Road & EB Stallings U-Turn

Movement	EB	EB	EB
Directions Served	L	T	T
Maximum Queue (ft)	70	526	574
Average Queue (ft)	14	189	314
95th Queue (ft)	166	461	557
Link Distance (ft)	1520	1520	1520
Upstream Blk Time (%)			
Queuing Penalty (veh)			
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 9999: EB US 74 Frontage Road & Lane Drop

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Network Summary

Network wide Queuing Penalty: 1065

Intersection: 450: WB US 74 Frontage Road & Stallings Road

Movement	WB	WB	WB	NB	NB	NB	NB	SB	SB	SB	SB
Directions Served	L	T	TR	L	L	T	T	T	T	T	TR
Maximum Queue (ft)	116	123	131	159	50	109	108	126	144	92	162
Average Queue (ft)	74	91	107	128	11	51	38	57	74	30	74
95th Queue (ft)	121	132	134	164	38	89	81	104	120	70	133
Link Distance (ft)	36	36	36	141	141	141	141			1141	1141
Upstream Blk Time (%)	29	33	45	2		0	0				
Queuing Penalty (veh)	80	91	124	4		0	0				
Storage Bay Dist (ft)								500	500		
Storage Blk Time (%)											
Queuing Penalty (veh)											

Intersection: 451: EB US 74 Frontage Road & Stallings Road

Movement	EB	EB	NB	NB	NB	NB	SB	SB	SB	SB
Directions Served	LT	TR	T	T	T	TR	L	L	T	T
Maximum Queue (ft)	120	130	1008	1016	1567	1434	116	129	152	138
Average Queue (ft)	104	107	861	781	826	333	51	59	88	77
95th Queue (ft)	121	116	1199	1341	2056	966	98	102	140	131
Link Distance (ft)	43	43			1675	1675	141	141	141	141
Upstream Blk Time (%)	47	60			10	0	0	0	1	0
Queuing Penalty (veh)	247	314			0	0	0	0	1	0
Storage Bay Dist (ft)			1000	1000						
Storage Blk Time (%)			23	27	0					
Queuing Penalty (veh)			40	48	0					

Intersection: 456: EB US 74 Frontage Road & Ramp to EB Connector/Bypass

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 477: WB US 74 Frontage Road & WB McKee U-Turn

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 480: WB US 74 Frontage Road & McKee Road

Movement	WB	WB	SB	SB
Directions Served	L	R	T	T
Maximum Queue (ft)	88	80	7	12
Average Queue (ft)	37	38	0	1
95th Queue (ft)	68	67	5	7
Link Distance (ft)	56	56		876
Upstream Blk Time (%)	3	2		
Queuing Penalty (veh)	2	2		
Storage Bay Dist (ft)			250	
Storage Blk Time (%)				
Queuing Penalty (veh)				

Intersection: 481: EB US 74 Frontage Road & McKee Road

Movement	EB	EB	NB	NB	NB	SB	SB
Directions Served	LT	TR	T	R	R	L	T
Maximum Queue (ft)	385	385	195	194	205	150	149
Average Queue (ft)	218	229	92	109	111	74	79
95th Queue (ft)	336	345	163	172	178	130	136
Link Distance (ft)		1024	788			147	147
Upstream Blk Time (%)						1	0
Queuing Penalty (veh)						1	1
Storage Bay Dist (ft)	900			900	900		
Storage Blk Time (%)							
Queuing Penalty (veh)							

Intersection: 484: EB US 74 Frontage Road & WB Stallings U-Turn

Movement	EB	SE
Directions Served	T	L
Maximum Queue (ft)	13	43
Average Queue (ft)	0	2
95th Queue (ft)	9	32
Link Distance (ft)	47	125
Upstream Blk Time (%)	0	
Queuing Penalty (veh)	0	
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 4661: WB US 74 Frontage Road & Ramp from WB Connector/Bypass

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 4662: WB US 74 Frontage Road & WB Stallings U-Turn

Movement	WB	WB	WB
Directions Served	LT	T	T
Maximum Queue (ft)	118	165	211
Average Queue (ft)	16	29	74
95th Queue (ft)	73	99	171
Link Distance (ft)		753	753
Upstream Blk Time (%)			
Queuing Penalty (veh)			
Storage Bay Dist (ft)	500		
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 4751: WB US 74 Frontage Road & EB Stallings U-Turn

Movement	WB	WB	NW
Directions Served	T	T	L
Maximum Queue (ft)	60	10	23
Average Queue (ft)	5	1	1
95th Queue (ft)	31	9	12
Link Distance (ft)	34	34	154
Upstream Blk Time (%)	0	0	
Queuing Penalty (veh)	1	0	
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 4752: WB US 74 Frontage Road & Ramp to WB US 74

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 4761: EB US 74 Frontage Road & WB McKee U-Turn

Movement	EB	EB
Directions Served	T	T
Maximum Queue (ft)	21	50
Average Queue (ft)	1	4
95th Queue (ft)	12	27
Link Distance (ft)	15	15
Upstream Blk Time (%)	0	0
Queuing Penalty (veh)	0	0
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 4762: EB US 74 Frontage Road & EB Stallings U-Turn

Movement	EB	EB	EB
Directions Served	L	T	T
Maximum Queue (ft)	71	459	520
Average Queue (ft)	6	197	285
95th Queue (ft)	104	419	493
Link Distance (ft)	1520	1520	1520
Upstream Blk Time (%)			
Queuing Penalty (veh)			
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 9999: EB US 74 Frontage Road & Lane Drop

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

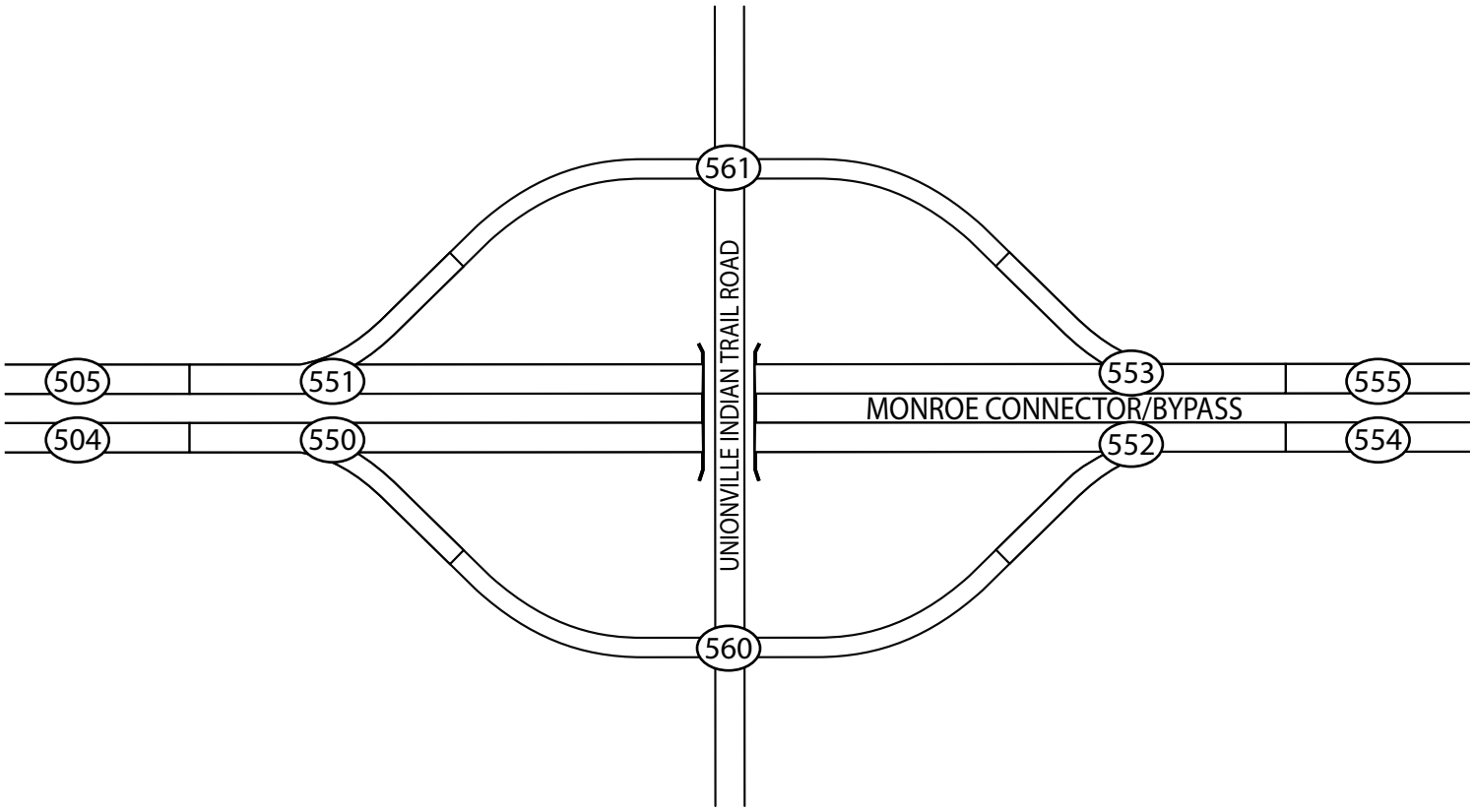
Network Summary

Network wide Queuing Penalty: 959

APPENDIX A-B

Level of Service Analysis Printouts

Monroe Connector / Unionville Indian Trail Road Interchange



NORTH CAROLINA Turnpike Authority

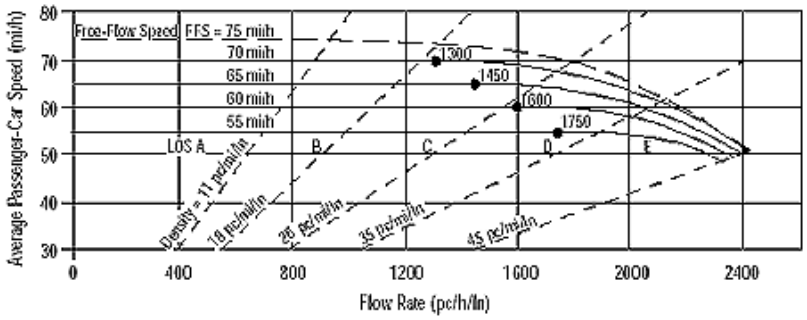
MONROE CONNECTOR / BYPASS
TIP Project Numbers R-3329 & R-2559
Mecklenburg and Union Counties

Monroe Connector / Bypass Corridor
Unionville Indian Trail
Key Sheet

Appendix A-B

KeySheetConnectorAllInts.ai 07-18-08

BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	TDK
Agency or Company	PBS&J
Date Performed	11/10/09
Analysis Time Period	AM Peak

Site Information

Highway/Direction of Travel	Monroe Connector/Bypass EB
From/To	Indian Trail Rd & Unionville
Jurisdiction	504
Analysis Year	2035 Build Toll Alternative 3A

Project Description Monroe Connector/Bypass

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	2051 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	12
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Rolling
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	2.0
E_T	2.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.847

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	2	
FFS (measured)		mi/h
Base free-flow Speed, BFFS	70.0	mi/h

Calc Speed Adj and FFS

f_{LW}	0.0	mi/h
f_{LC}	0.0	mi/h
f_{ID}	0.0	mi/h
f_N	4.5	mi/h
FFS	65.5	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1345	pc/h/ln
S	65.5	mi/h
D = v_p / S	20.5	pc/mi/ln
LOS	C	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
f_p - Page 23-12	f_N - Exhibit 23-6
LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7

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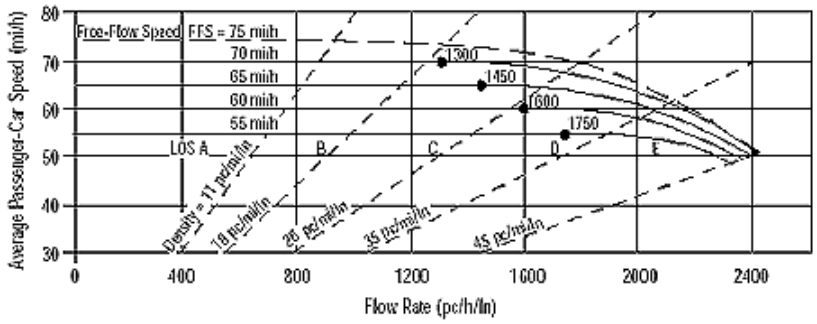
BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information / Site Information

General Information		Site Information	
Analyst	OSR	Highway/Direction of Travel	Monroe Connector/Bypass EB
Agency or Company	PBS&J	From/To	Indian Trail Rd & Unionville
Date Performed	3/19/2008	Jurisdiction	504
Analysis Time Period	PM Peak	Analysis Year	2035 Build Toll Alternative 3A

Project Description Monroe Connector/Bypass

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	3066 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	12
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Rolling
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	2.0
E_T	2.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.847

Speed Inputs / Calc Speed Adj and FFS

Speed Inputs			Calc Speed Adj and FFS		
Lane Width	12.0	ft	f_{LW}	0.0	mi/h
Rt-Shoulder Lat. Clearance	6.0	ft	f_{LC}	0.0	mi/h
Interchange Density	0.50	I/mi	f_{ID}	0.0	mi/h
Number of Lanes, N	2		f_N	4.5	mi/h
FFS (measured)		mi/h	FFS	65.5	mi/h
Base free-flow Speed, BFFS	70.0	mi/h			

LOS and Performance Measures / Design (N)

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2010	pc/h/ln	Design LOS	
S	61.6	mi/h	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
D = v_p / S	32.6	pc/mi/ln	S	mi/h
LOS	D		D = v_p / S	pc/mi/ln
			Required Number of Lanes, N	

Glossary / Factor Location

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
V - Hourly volume	D - Density	E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 23-12	f_N - Exhibit 23-6
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7
DDHV - Directional design hour volume			

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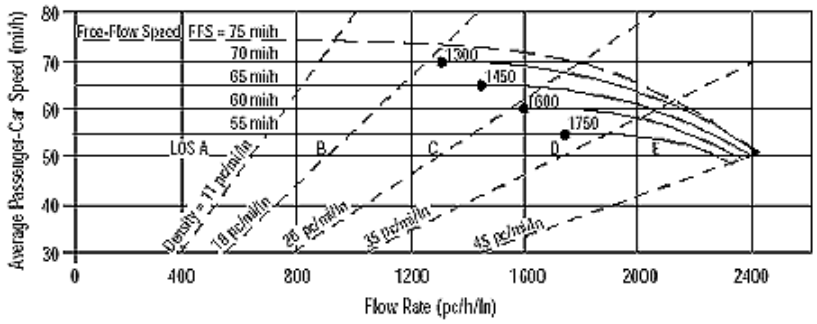
BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	OSR
Agency or Company	PBS&J
Date Performed	3/19/2008
Analysis Time Period	AM Peak

Site Information

Highway/Direction of Travel	Monroe Connector/Bypass WB
From/To	Unionville & Indian Trail Rd
Jurisdiction	505
Analysis Year	2035 Build Toll Alternative 3A

Project Description Monroe Connector/Bypass

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	3066 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	12
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Rolling
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	2.0
E_T	2.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.847

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	2	
FFS (measured)		mi/h
Base free-flow Speed, BFFS	70.0	mi/h

Calc Speed Adj and FFS

f_{LW}	0.0	mi/h
f_{LC}	0.0	mi/h
f_{ID}	0.0	mi/h
f_N	4.5	mi/h
FFS	65.5	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2010	pc/h/ln
S	61.6	mi/h
D = v_p / S	32.6	pc/mi/ln
LOS	D	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
f_p - Page 23-12	f_N - Exhibit 23-6
LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7

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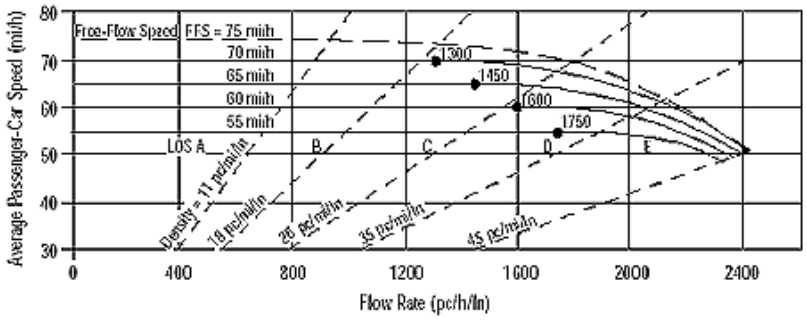
BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information / Site Information

General Information		Site Information	
Analyst	TDK	Highway/Direction of Travel	Monroe Connector/Bypass WB
Agency or Company	PBS&J	From/To	Unionville & Indian Trail Rd
Date Performed	11/10/09	Jurisdiction	505
Analysis Time Period	PM Peak	Analysis Year	2035 Build Toll Alternative 3A

Project Description Monroe Connector/Bypass

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	2051 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	12
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Rolling
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	2.0
E_T	2.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.847

Speed Inputs / Calc Speed Adj and FFS

Speed Inputs			Calc Speed Adj and FFS		
Lane Width	12.0	ft	f_{LW}	0.0	mi/h
Rt-Shoulder Lat. Clearance	6.0	ft	f_{LC}	0.0	mi/h
Interchange Density	0.50	I/mi	f_{ID}	0.0	mi/h
Number of Lanes, N	2		f_N	4.5	mi/h
FFS (measured)		mi/h	FFS	65.5	mi/h
Base free-flow Speed, BFFS	70.0	mi/h			

LOS and Performance Measures / Design (N)

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1345	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	65.5	mi/h	S	mi/h
D = v_p / S	20.5	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	C		Required Number of Lanes, N	

Glossary / Factor Location

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits23-8, 23-10
E_T - Exhibits 23-8, 23-10, 23-11
f_p - Page 23-12
LOS, S, FFS, v_p - Exhibits 23-2, 23-3
f_{LW} - Exhibit 23-4
f_{LC} - Exhibit 23-5
f_N - Exhibit 23-6
f_{ID} - Exhibit 23-7

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Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	TDK
Agency/Co.:	PBS&J
Date performed:	7/31/09
Analysis time period:	AM Peak
Freeway/Dir of Travel:	Monroe Connector/Bypass EB
Junction:	Off Ramp to Unionville Indian
Jurisdiction:	550
Analysis Year:	2035 Build Toll Alternative 3A
Description:	Monroe Connector/Bypass

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	2051	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	60.0	mph
Volume on ramp	186	vph
Length of first accel/decel lane	675	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent ramp		vph
Position of adjacent ramp		
Type of adjacent ramp		
Distance to adjacent ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	2051		186			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	570		52			v
Trucks and buses	12		12			%
Recreational vehicles	0		0			%
Terrain type:	Rolling		Rolling			
Grade	0.00	%	0.00	%		%
Length	0.00	mi	0.00	mi		mi
Trucks and buses PCE, ET	2.5		2.5			
Recreational vehicle PCE, ER	2.0		2.0			

Heavy vehicle adjustment, fHV	0.847	0.847	
Driver population factor, fP	1.00	1.00	
Flow rate, vp	2689	244	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 2689 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	2689	4800	No
v_{12}	2689	4400	No
$v_{FO} = v_F - v_R$	2445	4800	No
v_R	244	2200	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 21.3 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable,	D_S = 0.125	
Space mean speed in ramp influence area,	S_R = 66.5	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 66.5	mph

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	TDK
Agency/Co.:	PBS&J
Date performed:	7/31/09
Analysis time period:	PM Peak
Freeway/Dir of Travel:	Monroe Connector/Bypass EB
Junction:	Off Ramp to Unionville Indian
Jurisdiction:	550
Analysis Year:	2035 Build Toll Alternative 3A
Description:	Monroe Connector/Bypass

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	3066	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	60.0	mph
Volume on ramp	218	vph
Length of first accel/decel lane	675	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent ramp		vph
Position of adjacent ramp		
Type of adjacent ramp		
Distance to adjacent ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	3066		218			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	852		61			v
Trucks and buses	12		12			%
Recreational vehicles	0		0			%
Terrain type:	Rolling		Rolling			
Grade	0.00	%	0.00	%		%
Length	0.00	mi	0.00	mi		mi
Trucks and buses PCE, ET	2.5		2.5			
Recreational vehicle PCE, ER	2.0		2.0			

Heavy vehicle adjustment, fHV	0.847	0.847	
Driver population factor, fP	1.00	1.00	
Flow rate, vp	4020	286	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 4020 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	4020	4800	No
v_{12}	4020	4400	No
$v_{FO} = v_F - v_R$	3734	4800	No
v_R	286	2200	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 32.7 pc/mi/ln

Level of service for ramp-freeway junction areas of influence D

Speed Estimation

Intermediate speed variable, D_S = 0.129

Space mean speed in ramp influence area, S_R = 66.4 mph

Space mean speed in outer lanes, S_0 = N/A mph

Space mean speed for all vehicles, S = 66.4 mph

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	TDK
Agency/Co.:	PBS&J
Date performed:	7/31/09
Analysis time period:	AM Peak
Freeway/Dir of Travel:	Monroe Connector/Bypass WB
Junction:	On Ramp from Unionville Indian
Jurisdiction:	551
Analysis Year:	2035 Build Toll Alternative 3A
Description:	Monroe Connector/Bypass

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	2848	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	60.0	mph
Volume on ramp	218	vph
Length of first accel/decel lane	1250	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	296	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	3524	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	2848	218	296	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	791	61	82	v
Trucks and buses	12	2	12	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

Heavy vehicle adjustment, fHV	0.847	0.971	0.847	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	3734	249	388	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 3734 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	3983	4800	No
v_{R12}	3983	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 28.6 pc/mi/ln

Level of service for ramp-freeway junction areas of influence D

Speed Estimation

Intermediate speed variable,	M_S = 0.380	
Space mean speed in ramp influence area,	S_R = 59.4	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 59.4	mph

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	TDK
Agency/Co.:	PBS&J
Date performed:	7/31/09
Analysis time period:	PM Peak
Freeway/Dir of Travel:	Monroe Connector/Bypass WB
Junction:	On Ramp from Unionville Indian
Jurisdiction:	551
Analysis Year:	2035 Build Toll Alternative 3A
Description:	Monroe Connector/Bypass

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1865	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	60.0	mph
Volume on ramp	186	vph
Length of first accel/decel lane	1250	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	222	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	3524	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1865	186	222	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	518	52	62	v
Trucks and buses	12	2	12	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

Heavy vehicle adjustment, fHV	0.847	0.971	0.847	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	2445	213	291	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 2445 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	2658	4800	No
v_{R12}	2658	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 18.3 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable,	M_S = 0.227	
Space mean speed in ramp influence area,	S_R = 63.7	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 63.7	mph

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	TDK
Agency/Co.:	PBS&J
Date performed:	7/31/09
Analysis time period:	AM Peak
Freeway/Dir of Travel:	Monroe Connector/Bypass EB
Junction:	On Ramp from Unionville Indian
Jurisdiction:	552
Analysis Year:	2035 Build Toll Alternative 3A
Description:	Monroe Connector/Bypass

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1865	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	60.0	mph
Volume on ramp	222	vph
Length of first accel/decel lane	1110	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	186	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	3524	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1865	222	186	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	518	62	52	v
Trucks and buses	12	2	12	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

Heavy vehicle adjustment, fHV	0.847	0.971	0.847	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	2445	254	244	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 2445 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	2699	4800	No
v_{R12}	2699	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 19.5 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable,	M_S = 0.246	
Space mean speed in ramp influence area,	S_R = 63.1	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 63.1	mph

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	TDK
Agency/Co.:	PBS&J
Date performed:	7/31/09
Analysis time period:	PM Peak
Freeway/Dir of Travel:	Monroe Connector/Bypass EB
Junction:	On Ramp from Unionville Indian
Jurisdiction:	552
Analysis Year:	2035 Build Toll Alternative 3A
Description:	Monroe Connector/Bypass

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	2848	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	60.0	mph
Volume on ramp	296	vph
Length of first accel/decel lane	1110	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	218	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	3524	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	2848	296	218	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	791	82	61	v
Trucks and buses	12	2	12	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

Heavy vehicle adjustment, fHV	0.847	0.971	0.847	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	3734	339	286	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 3734 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	4073	4800	No
v_{R12}	4073	4600	No

Level of Service Determination (if not F)

Density, $D = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 30.1 pc/mi/ln

Level of service for ramp-freeway junction areas of influence D

Speed Estimation

Intermediate speed variable,	M_S = 0.417	
Space mean speed in ramp influence area,	S_R = 58.3	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 58.3	mph

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	TDK
Agency/Co.:	PBS&J
Date performed:	7/31/09
Analysis time period:	AM Peak
Freeway/Dir of Travel:	Monroe Connector/Bypass WB
Junction:	Off Ramp to Unionville Indian
Jurisdiction:	553
Analysis Year:	2035 Build Toll Alternative 3A
Description:	Monroe Connector/Bypass

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	3144	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	60.0	mph
Volume on ramp	296	vph
Length of first accel/decel lane	725	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent ramp		vph
Position of adjacent ramp		
Type of adjacent ramp		
Distance to adjacent ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	3144		296			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	873		82			v
Trucks and buses	12		12			%
Recreational vehicles	0		0			%
Terrain type:	Rolling		Rolling			
Grade	0.00	%	0.00	%		%
Length	0.00	mi	0.00	mi		mi
Trucks and buses PCE, ET	2.5		2.5			
Recreational vehicle PCE, ER	2.0		2.0			

Heavy vehicle adjustment, fHV	0.847	0.847	
Driver population factor, fP	1.00	1.00	
Flow rate, vp	4122	388	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 4122 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	4122	4800	No
v_{12}	4122	4400	No
$v_{FO} = v_F - v_R$	3734	4800	No
v_R	388	2200	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 33.2 pc/mi/ln

Level of service for ramp-freeway junction areas of influence D

Speed Estimation

Intermediate speed variable,	D_S = 0.138	
Space mean speed in ramp influence area,	S_R = 66.1	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 66.1	mph

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	TDK
Agency/Co.:	PBS&J
Date performed:	7/31/09
Analysis time period:	PM Peak
Freeway/Dir of Travel:	Monroe Connector/Bypass WB
Junction:	Off Ramp to Unionville Indian
Jurisdiction:	553
Analysis Year:	2035 Build Toll Alternative 3A
Description:	Monroe Connector/Bypass

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	2087	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	60.0	mph
Volume on ramp	222	vph
Length of first accel/decel lane	725	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent ramp		vph
Position of adjacent ramp		
Type of adjacent ramp		
Distance to adjacent ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	2087		222			vph
Peak-hour factor, PHF	0.90		0.90			
Peak 15-min volume, v15	580		62			v
Trucks and buses	12		12			%
Recreational vehicles	0		0			%
Terrain type:	Rolling		Rolling			
Grade	0.00	%	0.00	%		%
Length	0.00	mi	0.00	mi		mi
Trucks and buses PCE, ET	2.5		2.5			
Recreational vehicle PCE, ER	2.0		2.0			

Heavy vehicle adjustment, fHV	0.847	0.847	
Driver population factor, fP	1.00	1.00	
Flow rate, vp	2736	291	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 2736 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	2736	4800	No
v_{12}	2736	4400	No
$v_{FO} = v_F - v_R$	2445	4800	No
v_R	291	2200	No

Level of Service Determination (if not F)

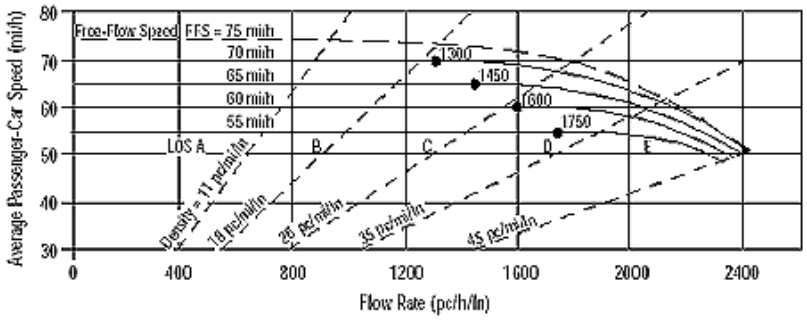
Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 21.3 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable,	D_S = 0.129	
Space mean speed in ramp influence area,	S_R = 66.4	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 66.4	mph

BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	TDK
Agency or Company	PBS&J
Date Performed	11/10/09
Analysis Time Period	AM Peak

Site Information

Highway/Direction of Travel	Monroe Connector/Bypass EB
From/To	Unionville & Rocky River
Jurisdiction	554
Analysis Year	2035 Build Toll Alternative 3A

Project Description Monroe Connector/Bypass

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	2087 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	12
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Rolling
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	2.0
E_T	2.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.847

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	2	
FFS (measured)		mi/h
Base free-flow Speed, BFFS	70.0	mi/h

Calc Speed Adj and FFS

f_{LW}	0.0	mi/h
f_{LC}	0.0	mi/h
f_{ID}	0.0	mi/h
f_N	4.5	mi/h
FFS	65.5	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1368	pc/h/ln
S	65.5	mi/h
D = v_p / S	20.9	pc/mi/ln
LOS	C	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
f_p - Page 23-12	f_N - Exhibit 23-6
LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7

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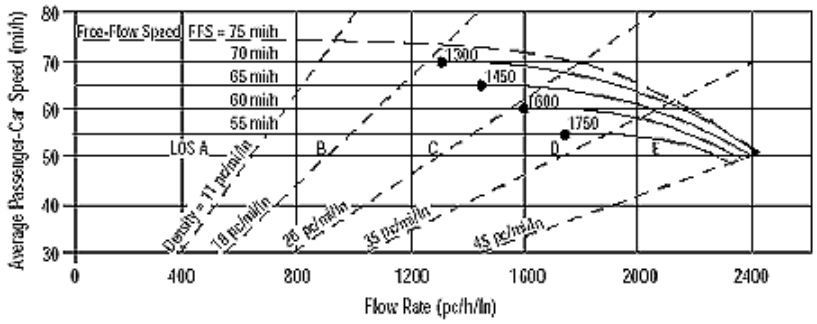
BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	OSR
Agency or Company	PBS&J
Date Performed	3/19/2008
Analysis Time Period	PM Peak

Site Information

Highway/Direction of Travel	Monroe Connector/Bypass EB
From/To	Unionville & Rocky River
Jurisdiction	554
Analysis Year	2035 Build Toll Alternative 3A

Project Description Monroe Connector/Bypass

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	3144 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	12
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Rolling
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	2.0
E_T	2.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.847

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	2	
FFS (measured)		mi/h
Base free-flow Speed, BFFS	70.0	mi/h

Calc Speed Adj and FFS

f_{LW}	0.0	mi/h
f_{LC}	0.0	mi/h
f_{ID}	0.0	mi/h
f_N	4.5	mi/h
FFS	65.5	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2061	pc/h/ln
S	60.7	mi/h
D = v_p / S	34.0	pc/mi/ln
LOS	D	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
f_p - Page 23-12	f_N - Exhibit 23-6
LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7

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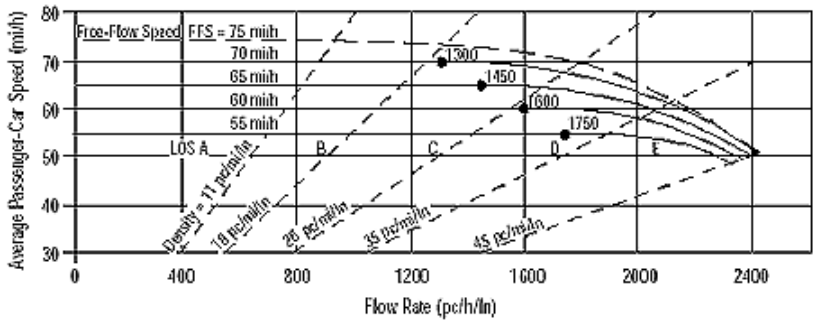
BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	OSR
Agency or Company	PBS&J
Date Performed	3/19/2008
Analysis Time Period	AM Peak

Site Information

Highway/Direction of Travel	Monroe Connector/Bypass WB
From/To	Rocky River & Unionville
Jurisdiction	555
Analysis Year	2035 Build Toll Alternative 3A

Project Description Monroe Connector/Bypass

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	3144 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	12
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Rolling
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	2.0
E_T	2.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.847

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	2	
FFS (measured)		mi/h
Base free-flow Speed, BFFS	70.0	mi/h

Calc Speed Adj and FFS

f_{LW}	0.0	mi/h
f_{LC}	0.0	mi/h
f_{ID}	0.0	mi/h
f_N	4.5	mi/h
FFS	65.5	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2061	pc/h/ln
S	60.7	mi/h
D = v_p / S	34.0	pc/mi/ln
LOS	D	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
f_p - Page 23-12	f_N - Exhibit 23-6
LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7

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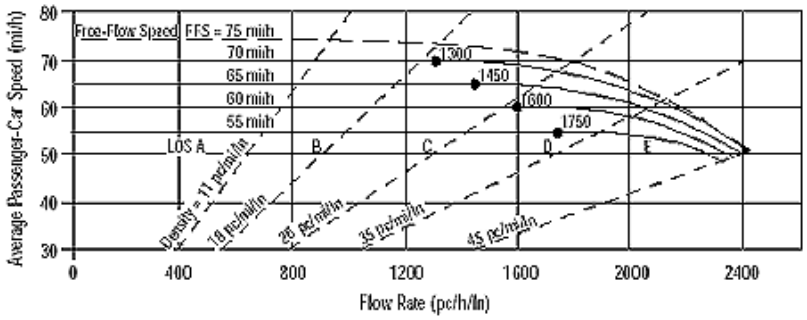
BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	TDK
Agency or Company	PBS&J
Date Performed	11/10/09
Analysis Time Period	PM Peak

Site Information

Highway/Direction of Travel	Monroe Connector/Bypass WB
From/To	Rocky River & Unionville
Jurisdiction	555
Analysis Year	2035 Build Toll Alternative 3A

Project Description Monroe Connector/Bypass

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	2087 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	12
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Rolling
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	2.0
E_T	2.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.847

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	2	
FFS (measured)		mi/h
Base free-flow Speed, BFFS	70.0	mi/h

Calc Speed Adj and FFS

f_{LW}	0.0	mi/h
f_{LC}	0.0	mi/h
f_{ID}	0.0	mi/h
f_N	4.5	mi/h
FFS	65.5	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1368	pc/h/ln
S	65.5	mi/h
D = v_p / S	20.9	pc/mi/ln
LOS	C	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
f_p - Page 23-12	f_N - Exhibit 23-6
LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7

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TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	*TDK*	Intersection	*560*
Agency/Co.	*PBS&J*	Jurisdiction	
Date Performed	*7/29/09*	Analysis Year	*2035 Build Alternative 3A*
Analysis Time Period	*AM Peak*		
Project Description	*Monroe Connector/Bypass*		
East/West Street:	*EB Connector/Bypass*	North/South Street:	*Unionville Indian Trail Road*
Intersection Orientation:	*North-South*	Study Period (hrs):	*0.25*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	*0*	*621*	*132*	*90*	*1003*	*0*
Peak-Hour Factor, PHF	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*
Hourly Flow Rate, HFR	*0*	*690*	*146*	*100*	*1114*	*0*
Percent Heavy Vehicles	*0*	--	--	*2*	--	--
Median Type	*Undivided*					
RT Channelized			*0*			*0*
Lanes	*0*	*2*	*1*	*1*	*2*	*0*
Configuration		*T*	*R*	*L*	*T*	
Upstream Signal		*0*			*1*	

Minor Street	Westbound			Eastbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	*0*	*0*	*0*	*63*	*0*	*123*
Peak-Hour Factor, PHF	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*
Hourly Flow Rate, HFR	*0*	*0*	*0*	*70*	*0*	*136*
Percent Heavy Vehicles	*0*	*0*	*0*	*12*	*0*	*12*
Percent Grade (%)		*0*			*0*	
Flared Approach		*N*			*N*	
Storage		*0*			*0*	
RT Channelized			*0*			*0*
Lanes	*0*	*0*	*0*	*1*	*0*	*1*
Configuration				*L*		*R*

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration		*L*				*L*		*R*
v (vph)		*100*				*70*		*136*
C (m) (vph)		*794*				*125*		*722*
v/c		*0.13*				*0.56*		*0.19*
95% queue length		*0.43*				*2.73*		*0.69*
Control Delay		*10.2*				*65.4*		*11.1*
LOS		*B*				*F*		*B*
Approach Delay	--	--				*29.6*		
Approach LOS	--	--				*D*		

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TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	*TDK*	Intersection	*560*
Agency/Co.	*PBS&J*	Jurisdiction	
Date Performed	*7/29/09*	Analysis Year	*2035 Build Alternative 3A*
Analysis Time Period	*PM Peak*		

Project Description	*Monroe Connector/Bypass*
East/West Street: *EB Connector/Bypass*	North/South Street: *Unionville Indian Trail Road*
Intersection Orientation: *North-South*	Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	*0*	*919*	*207*	*89*	*633*	*0*
Peak-Hour Factor, PHF	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*
Hourly Flow Rate, HFR	*0*	*1021*	*230*	*98*	*703*	*0*
Percent Heavy Vehicles	*0*	--	--	*2*	--	--
Median Type	*Undivided*					
RT Channelized			*0*			*0*
Lanes	*0*	*2*	*1*	*1*	*2*	*0*
Configuration		*T*	*R*	*L*	*T*	
Upstream Signal		*0*			*1*	

Minor Street	Westbound			Eastbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	*0*	*0*	*0*	*98*	*0*	*120*
Peak-Hour Factor, PHF	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*
Hourly Flow Rate, HFR	*0*	*0*	*0*	*108*	*0*	*133*
Percent Heavy Vehicles	*0*	*0*	*0*	*12*	*0*	*12*
Percent Grade (%)		*0*			*0*	
Flared Approach		*N*			*N*	
Storage		*0*			*0*	
RT Channelized			*0*			*0*
Lanes	*0*	*0*	*0*	*1*	*0*	*1*
Configuration				*L*		*R*

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration		*L*				*L*		*R*
v (vph)		*98*				*108*		*133*
C (m) (vph)		*552*				*144*		*843*
v/c		*0.18*				*0.75*		*0.16*
95% queue length		*0.64*				*4.50*		*0.56*
Control Delay		*12.9*				*81.5*		*10.1*
LOS		*B*				*F*		*B*
Approach Delay	--	--				*42.1*		
Approach LOS	--	--				*E*		

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Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	207	0	89	120	564	0	0	886	98
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		0	0		1000	1000		0	0		1000
Storage Lanes	0		0	1		1	1		0	0		1
Taper Length (ft)	25		25	25		25	25		25	25		25
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.95	1.00
Frt						0.850						0.850
Flt Protected				0.950			0.950					
Satd. Flow (prot)	0	0	0	1612	0	1442	1770	3539	0	0	3539	1583
Flt Permitted				0.950			0.950					
Satd. Flow (perm)	0	0	0	1612	0	1442	1770	3539	0	0	3539	1583
Right Turn on Red			No			No			No			No
Satd. Flow (RTOR)												
Link Speed (mph)		30			30			45			45	
Link Distance (ft)		1500			1500			350			1500	
Travel Time (s)		34.1			34.1			5.3			22.7	
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Heavy Vehicles (%)	0%	0%	0%	12%	0%	12%	2%	2%	0%	0%	2%	2%
Adj. Flow (vph)	0	0	0	230	0	99	133	627	0	0	984	109
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	0	0	230	0	99	133	627	0	0	984	109
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)		12			12			12			12	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			16			16			16	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors				1		1	1	2			2	1
Detector Template				Left		Right	Left	Thru			Thru	Right
Leading Detector (ft)				20		20	20	100			100	20
Trailing Detector (ft)				0		0	0	0			0	0
Detector 1 Position(ft)				0		0	0	0			0	0
Detector 1 Size(ft)				20		20	20	6			6	20
Detector 1 Type				Cl+Ex		Cl+Ex	Cl+Ex	Cl+Ex			Cl+Ex	Cl+Ex
Detector 1 Channel												
Detector 1 Extend (s)				0.0		0.0	0.0	0.0			0.0	0.0
Detector 1 Queue (s)				0.0		0.0	0.0	0.0			0.0	0.0
Detector 1 Delay (s)				0.0		0.0	0.0	0.0			0.0	0.0
Detector 2 Position(ft)								94			94	
Detector 2 Size(ft)								6			6	
Detector 2 Type								Cl+Ex			Cl+Ex	
Detector 2 Channel												
Detector 2 Extend (s)								0.0			0.0	
Turn Type				Prot		custom	Prot					Perm
Protected Phases				8			5	2			6	
Permitted Phases						8						6

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Detector Phase				8		8	5	2			6	6
Switch Phase												
Minimum Initial (s)				7.0		7.0	7.0	12.0			12.0	12.0
Minimum Split (s)				14.0		14.0	14.0	19.0			19.0	19.0
Total Split (s)	0.0	0.0	0.0	28.0	0.0	28.0	18.0	62.0	0.0	0.0	44.0	44.0
Total Split (%)	0.0%	0.0%	0.0%	31.1%	0.0%	31.1%	20.0%	68.9%	0.0%	0.0%	48.9%	48.9%
Maximum Green (s)				21.0		21.0	11.0	55.0			37.0	37.0
Yellow Time (s)				5.0		5.0	5.0	5.0			5.0	5.0
All-Red Time (s)				2.0		2.0	2.0	2.0			2.0	2.0
Lost Time Adjust (s)	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0
Total Lost Time (s)	2.0	2.0	2.0	5.0	2.0	5.0	5.0	5.0	2.0	2.0	5.0	5.0
Lead/Lag							Lead				Lag	Lag
Lead-Lag Optimize?												
Vehicle Extension (s)				3.0		3.0	3.0	3.0			3.0	3.0
Recall Mode				None		None	None	Min			Min	Min
Act Effct Green (s)				18.0		18.0	12.3	43.9			31.1	31.1
Actuated g/C Ratio				0.25		0.25	0.17	0.60			0.43	0.43
v/c Ratio				0.58		0.28	0.45	0.29			0.65	0.16
Control Delay				33.6		28.1	37.9	7.2			20.4	16.0
Queue Delay				0.0		0.0	0.0	0.0			0.0	0.0
Total Delay				33.6		28.1	37.9	7.2			20.4	16.0
LOS				C		C	D	A			C	B
Approach Delay								12.5			20.0	
Approach LOS								B			B	
Queue Length 50th (ft)				99		39	58	62			201	33
Queue Length 95th (ft)				189		89	125	102			291	70
Internal Link Dist (ft)		1420			1420			270			1420	
Turn Bay Length (ft)						1000	1000					1000
Base Capacity (vph)				552		494	343	2738			2056	920
Starvation Cap Reductn				0		0	0	0			0	0
Spillback Cap Reductn				0		0	0	0			0	0
Storage Cap Reductn				0		0	0	0			0	0
Reduced v/c Ratio				0.42		0.20	0.39	0.23			0.48	0.12

Intersection Summary	
Area Type:	Other
Cycle Length: 90	
Actuated Cycle Length: 72.7	
Natural Cycle: 60	
Control Type: Actuated-Uncoordinated	
Maximum v/c Ratio: 0.65	
Intersection Signal Delay: 19.2	Intersection LOS: B
Intersection Capacity Utilization 55.1%	ICU Level of Service B
Analysis Period (min) 15	

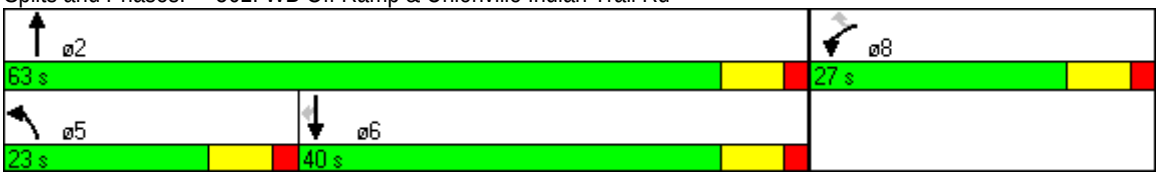
Splits and Phases: 561: WB Ramps & Unionville Indian Trail Rd

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	132	0	90	123	894	0	0	590	63
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		0	0		1000	1000		0	0		1000
Storage Lanes	0		0	1		1	1		0	0		1
Taper Length (ft)	25		25	25		25	25		25	25		25
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.95	1.00
Frt						0.850						0.850
Flt Protected				0.950			0.950					
Satd. Flow (prot)	0	0	0	1612	0	1442	1770	3539	0	0	3539	1583
Flt Permitted				0.950			0.950					
Satd. Flow (perm)	0	0	0	1612	0	1442	1770	3539	0	0	3539	1583
Right Turn on Red			No			No			No			No
Satd. Flow (RTOR)												
Link Speed (mph)		30			30			45			45	
Link Distance (ft)		1500			1500			350			1500	
Travel Time (s)		34.1			34.1			5.3			22.7	
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Heavy Vehicles (%)	0%	0%	0%	12%	0%	12%	2%	2%	0%	0%	2%	2%
Adj. Flow (vph)	0	0	0	147	0	100	137	993	0	0	656	70
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	0	0	147	0	100	137	993	0	0	656	70
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)		12			12			12			12	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			16			16			16	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors				1		1	1	2			2	1
Detector Template				Left		Right	Left	Thru			Thru	Right
Leading Detector (ft)				20		20	20	100			100	20
Trailing Detector (ft)				0		0	0	0			0	0
Detector 1 Position(ft)				0		0	0	0			0	0
Detector 1 Size(ft)				20		20	20	6			6	20
Detector 1 Type				Cl+Ex		Cl+Ex	Cl+Ex	Cl+Ex			Cl+Ex	Cl+Ex
Detector 1 Channel												
Detector 1 Extend (s)				0.0		0.0	0.0	0.0			0.0	0.0
Detector 1 Queue (s)				0.0		0.0	0.0	0.0			0.0	0.0
Detector 1 Delay (s)				0.0		0.0	0.0	0.0			0.0	0.0
Detector 2 Position(ft)								94			94	
Detector 2 Size(ft)								6			6	
Detector 2 Type								Cl+Ex			Cl+Ex	
Detector 2 Channel												
Detector 2 Extend (s)								0.0			0.0	
Turn Type				Prot		custom	Prot					Perm
Protected Phases				8			5	2			6	
Permitted Phases						8						6

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Detector Phase				8		8	5	2			6	6
Switch Phase												
Minimum Initial (s)				7.0		7.0	7.0	12.0			12.0	12.0
Minimum Split (s)				14.0		14.0	14.0	19.0			19.0	19.0
Total Split (s)	0.0	0.0	0.0	27.0	0.0	27.0	23.0	63.0	0.0	0.0	40.0	40.0
Total Split (%)	0.0%	0.0%	0.0%	30.0%	0.0%	30.0%	25.6%	70.0%	0.0%	0.0%	44.4%	44.4%
Maximum Green (s)				20.0		20.0	16.0	56.0			33.0	33.0
Yellow Time (s)				5.0		5.0	5.0	5.0			5.0	5.0
All-Red Time (s)				2.0		2.0	2.0	2.0			2.0	2.0
Lost Time Adjust (s)	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0
Total Lost Time (s)	2.0	2.0	2.0	5.0	2.0	5.0	5.0	5.0	2.0	2.0	5.0	5.0
Lead/Lag							Lead				Lag	Lag
Lead-Lag Optimize?												
Vehicle Extension (s)				3.0		3.0	3.0	3.0			3.0	3.0
Recall Mode				None		None	None	Min			Min	Min
Act Effct Green (s)				13.5		13.5	12.8	36.4			22.5	22.5
Actuated g/C Ratio				0.22		0.22	0.21	0.60			0.37	0.37
v/c Ratio				0.41		0.31	0.37	0.47			0.50	0.12
Control Delay				26.9		25.5	26.8	7.4			18.4	16.6
Queue Delay				0.0		0.0	0.0	0.0			0.0	0.0
Total Delay				26.9		25.5	26.8	7.4			18.4	16.6
LOS				C		C	C	A			B	B
Approach Delay								9.8			18.3	
Approach LOS								A			B	
Queue Length 50th (ft)				46		30	42	85			100	17
Queue Length 95th (ft)				116		84	108	157			187	51
Internal Link Dist (ft)		1420			1420			270			1420	
Turn Bay Length (ft)						1000	1000					1000
Base Capacity (vph)				622		556	559	3211			2172	972
Starvation Cap Reductn				0		0	0	0			0	0
Spillback Cap Reductn				0		0	0	0			0	0
Storage Cap Reductn				0		0	0	0			0	0
Reduced v/c Ratio				0.24		0.18	0.25	0.31			0.30	0.07

Intersection Summary	
Area Type:	Other
Cycle Length: 90	
Actuated Cycle Length: 60.5	
Natural Cycle: 50	
Control Type: Actuated-Uncoordinated	
Maximum v/c Ratio: 0.50	
Intersection Signal Delay: 14.6	Intersection LOS: B
Intersection Capacity Utilization 45.8%	ICU Level of Service A
Analysis Period (min) 15	

Splits and Phases: 561: WB Off Ramp & Unionville Indian Trail Rd



Intersection: 561: WB Ramps & Unionville Indian Trail Rd

Movement	WB	WB	NB	NB	NB	SB	SB	SB
Directions Served	L	R	L	T	T	T	T	R
Maximum Queue (ft)	255	161	137	108	122	250	257	96
Average Queue (ft)	127	59	66	48	58	130	149	38
95th Queue (ft)	224	121	120	90	105	210	225	83
Link Distance (ft)	1454			306	306	1466	1466	
Upstream Blk Time (%)								
Queuing Penalty (veh)								
Storage Bay Dist (ft)		1000	1000					1000
Storage Blk Time (%)								
Queuing Penalty (veh)								

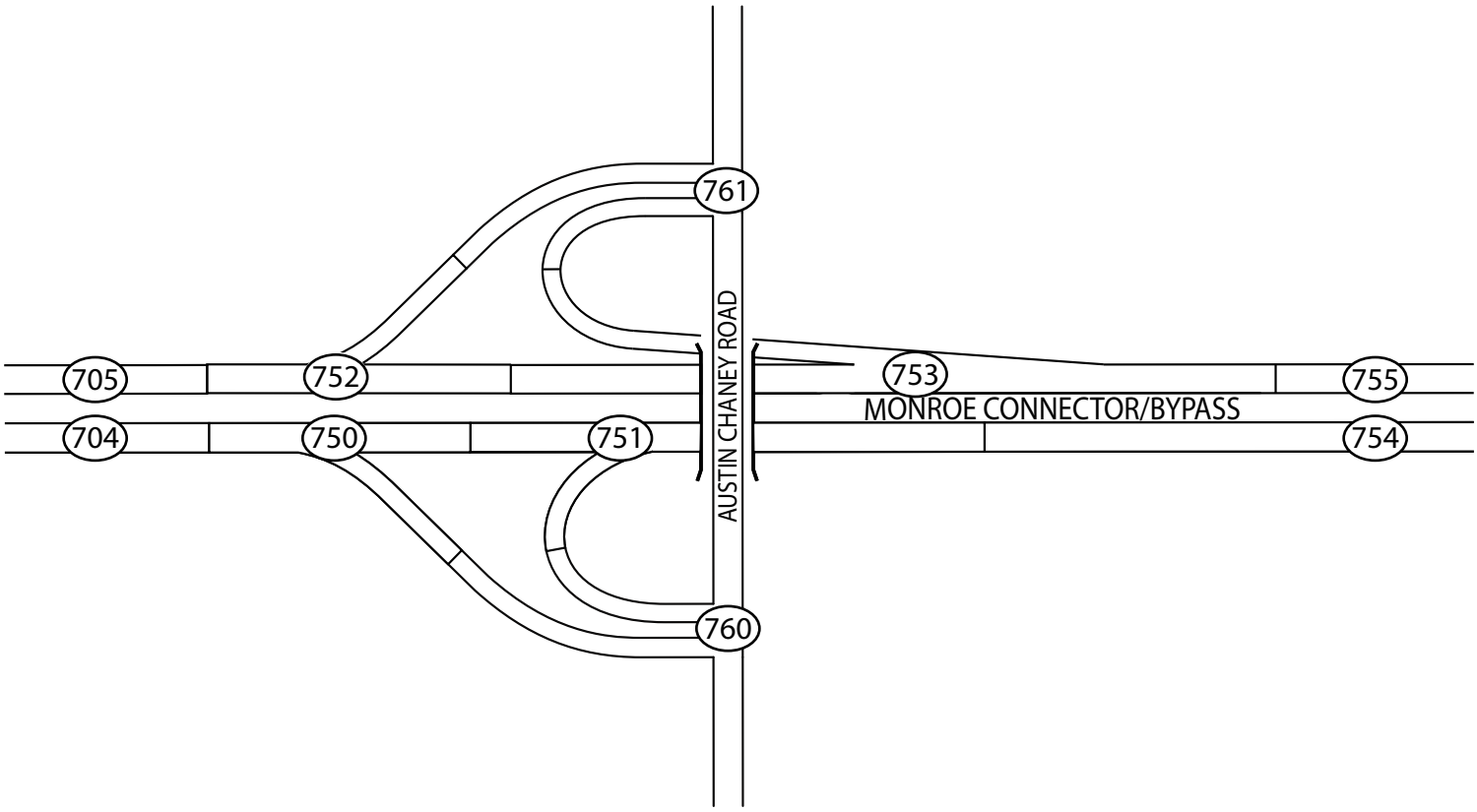
Intersection: 561: WB Off Ramp & Unionville Indian Trail Rd

Movement	WB	WB	NB	NB	NB	SB	SB	SB
Directions Served	L	R	L	T	T	T	T	R
Maximum Queue (ft)	179	134	148	138	166	166	175	78
Average Queue (ft)	79	59	65	67	83	79	95	25
95th Queue (ft)	145	109	118	117	138	135	153	59
Link Distance (ft)	1454			306	306	1466	1466	
Upstream Blk Time (%)								
Queuing Penalty (veh)								
Storage Bay Dist (ft)		1000	1000					1000
Storage Blk Time (%)								
Queuing Penalty (veh)								

APPENDIX A-B

Level of Service Analysis Printouts

Monroe Connector / Austin Chaney Road Interchange



NORTH CAROLINA Turnpike Authority

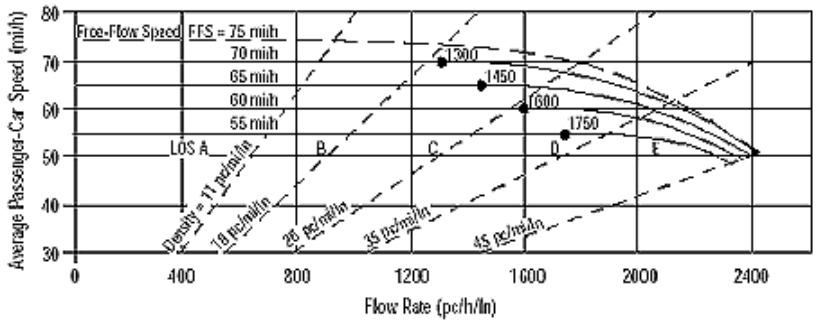
MONROE CONNECTOR / BYPASS
TIP Project Numbers R-3329 & R-2559
Mecklenburg and Union Counties

Monroe Connector / Bypass Corridor
Austin Chaney Road
Key Sheet

Appendix A-B

KeySheetConnectorAllInts.ai 07-18-08

BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	OSR
Agency or Company	PBS&J
Date Performed	3/19/2008
Analysis Time Period	AM Peak

Site Information

Highway/Direction of Travel	Monroe Connector/Bypass EB
From/To	NC 200 & Austin Chaney
Jurisdiction	704
Analysis Year	2035 Build Toll Alternative 3A

Project Description Monroe Connector/Bypass

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	1003 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	12
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Rolling
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	2.0
E_T	2.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.847

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	2	
FFS (measured)		mi/h
Base free-flow Speed, BFFS	70.0	mi/h

Calc Speed Adj and FFS

f_{LW}	0.0	mi/h
f_{LC}	0.0	mi/h
f_{ID}	0.0	mi/h
f_N	4.5	mi/h
FFS	65.5	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	658	pc/h/ln
S	65.5	mi/h
D = v_p / S	10.0	pc/mi/ln
LOS	A	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
f_p - Page 23-12	f_N - Exhibit 23-6
LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7

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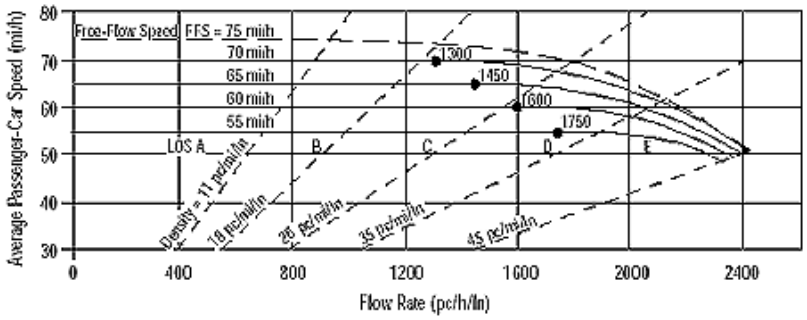
BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	TDK
Agency or Company	PBS&J
Date Performed	10/19/2009
Analysis Time Period	PM Peak

Site Information

Highway/Direction of Travel	Monroe Connector/Bypass EB
From/To	NC 200 & Austin Chaney
Jurisdiction	704
Analysis Year	2035 Build Toll Alternative 3A

Project Description Monroe Connector/Bypass

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	1473 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	12
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Rolling
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	2.0
E_T	2.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.847

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	2	
FFS (measured)		mi/h
Base free-flow Speed, BFFS	70.0	mi/h

Calc Speed Adj and FFS

f_{LW}	0.0	mi/h
f_{LC}	0.0	mi/h
f_{ID}	0.0	mi/h
f_N	4.5	mi/h
FFS	65.5	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	966	pc/h/ln
S	65.5	mi/h
D = v_p / S	14.7	pc/mi/ln
LOS	B	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
f_p - Page 23-12	f_N - Exhibit 23-6
LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7

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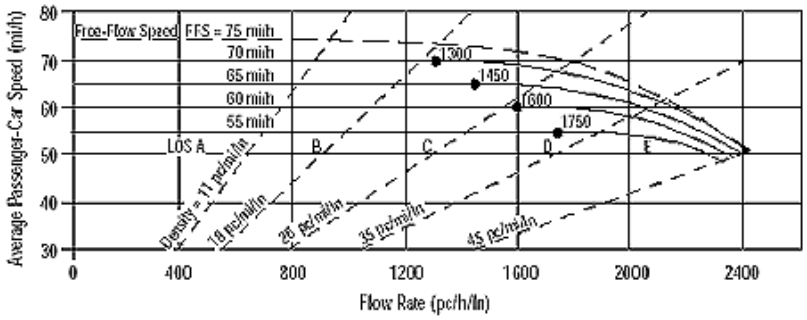
BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information / Site Information

General Information		Site Information	
Analyst	TDK	Highway/Direction of Travel	Monroe Connector/Bypass WB
Agency or Company	PBS&J	From/To	Austin Chaney & NC 200
Date Performed	10/13/2009	Jurisdiction	705
Analysis Time Period	AM Peak	Analysis Year	2035 Build Toll Alternative 3A

Project Description Monroe Connector/Bypass

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	1473 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	12
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Rolling
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	2.0
E_T	2.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.847

Speed Inputs / Calc Speed Adj and FFS

Speed Inputs			Calc Speed Adj and FFS		
Lane Width	12.0	ft	f_{LW}	0.0	mi/h
Rt-Shoulder Lat. Clearance	6.0	ft	f_{LC}	0.0	mi/h
Interchange Density	0.50	I/mi	f_{ID}	0.0	mi/h
Number of Lanes, N	2		f_N	4.5	mi/h
FFS (measured)		mi/h	FFS	65.5	mi/h
Base free-flow Speed, BFFS	70.0	mi/h			

LOS and Performance Measures / Design (N)

LOS and Performance Measures			Design (N)		
Operational (LOS)			Design (N)		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	966	pc/h/ln	Design LOS		
S	65.5	mi/h	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h
D = v_p / S	14.7	pc/mi/ln	S		mi/h
LOS	B		D = v_p / S		pc/mi/ln
			Required Number of Lanes, N		

Glossary / Factor Location

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
V - Hourly volume	D - Density	E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 23-12	f_N - Exhibit 23-6
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7
DDHV - Directional design hour volume			

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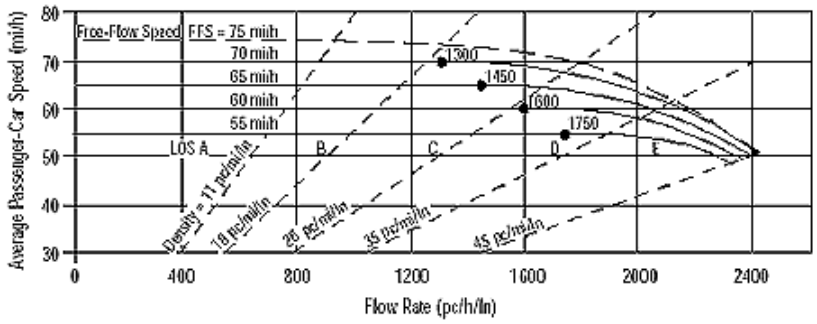
BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	OSR	Highway/Direction of Travel	Monroe Connector/Bypass WB
Agency or Company	PBS&J	From/To	Austin Chaney & NC 200
Date Performed	3/19/2008	Jurisdiction	705
Analysis Time Period	PM Peak	Analysis Year	2035 Build Toll Alternative 3A

Project Description Monroe Connector/Bypass

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	1003 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	12
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Rolling
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	2.0
E_T	2.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.847

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	2	
FFS (measured)		mi/h
Base free-flow Speed, BFFS	70.0	mi/h

Calc Speed Adj and FFS

f_{LW}	0.0	mi/h
f_{LC}	0.0	mi/h
f_{ID}	0.0	mi/h
f_N	4.5	mi/h
FFS	65.5	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	658	pc/h/ln
S	65.5	mi/h
D = v_p / S	10.0	pc/mi/ln
LOS	A	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h
S		mi/h
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
f_p - Page 23-12	f_N - Exhibit 23-6
LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7

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Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	TDK
Agency/Co.:	PBS&J
Date performed:	8/3/09
Analysis time period:	AM Peak
Freeway/Dir of Travel:	Monroe Connector/Bypass EB
Junction:	Off Ramp to Austin Chaney Rd
Jurisdiction:	750
Analysis Year:	2035 Build Toll Alternative 3A
Description:	Monroe Connector/Bypass

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1003	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	60.0	mph
Volume on ramp	312	vph
Length of first accel/decel lane	650	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	86	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1200	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	1003		312		86	vph
Peak-hour factor, PHF	0.90		0.90		0.90	
Peak 15-min volume, v15	279		87		24	v
Trucks and buses	12		12		2	%
Recreational vehicles	0		0		0	%
Terrain type:	Rolling		Rolling		Rolling	
Grade	0.00	%	0.00	%	0.00	%
Length	0.00	mi	0.00	mi	0.00	mi
Trucks and buses PCE, ET	2.5		2.5		2.5	
Recreational vehicle PCE, ER	2.0		2.0		2.0	

Heavy vehicle adjustment, fHV	0.847	0.847	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	1315	409	98	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 1315 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	1315	4800	No
v_{12}	1315	4400	No
$v_{FO} = v_F - v_R$	906	4800	No
v_R	409	2200	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 9.7 pc/mi/ln

Level of service for ramp-freeway junction areas of influence A

Speed Estimation

Intermediate speed variable, D_S = 0.140

Space mean speed in ramp influence area, S_R = 66.1 mph

Space mean speed in outer lanes, S_0 = N/A mph

Space mean speed for all vehicles, S = 66.1 mph

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	TDK
Agency/Co.:	PBS&J
Date performed:	8/3/09
Analysis time period:	PM Peak
Freeway/Dir of Travel:	Monroe Connector/Bypass EB
Junction:	Off Ramp to Austin Chaney Rd
Jurisdiction:	750
Analysis Year:	2035 Build Toll Alternative 3A
Description:	Monroe Connector/Bypass

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1473	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	60.0	mph
Volume on ramp	402	vph
Length of first accel/decel lane	650	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	118	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1200	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	1473		402		118	vph
Peak-hour factor, PHF	0.90		0.90		0.90	
Peak 15-min volume, v15	409		112		33	v
Trucks and buses	12		12		2	%
Recreational vehicles	0		0		0	%
Terrain type:	Rolling		Rolling		Rolling	
Grade	0.00	%	0.00	%	0.00	%
Length	0.00	mi	0.00	mi	0.00	mi
Trucks and buses PCE, ET	2.5		2.5		2.5	
Recreational vehicle PCE, ER	2.0		2.0		2.0	

Heavy vehicle adjustment, fHV	0.847	0.847	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	1931	527	135	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 1931 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	1931	4800	No
v_{12}	1931	4400	No
$v_{FO} = v_F - v_R$	1404	4800	No
v_R	527	2200	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 15.0 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable, D_S = 0.150

Space mean speed in ramp influence area, S_R = 65.8 mph

Space mean speed in outer lanes, S_0 = N/A mph

Space mean speed for all vehicles, S = 65.8 mph

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	TDK
Agency/Co.:	PBS&J
Date performed:	8/3/09
Analysis time period:	AM Peak
Freeway/Dir of Travel:	Monroe Connector/Bypass EB
Junction:	On Ramp from Austin Chaney
Jurisdiction:	751
Analysis Year:	2035 Build Toll Alternative 3A
Description:	Monroe Connector/Bypass

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	691	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	30.0	mph
Volume on ramp	86	vph
Length of first accel/decel lane	1650	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	312	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	1200	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	691	86	312	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	192	24	87	v
Trucks and buses	12	2	12	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

Heavy vehicle adjustment, fHV	0.847	0.971	0.847	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	906	98	409	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 906 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	1004	4800	No
v_{R12}	1004	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 2.9 pc/mi/ln

Level of service for ramp-freeway junction areas of influence A

Speed Estimation

Intermediate speed variable,	M_S = 0.233	
Space mean speed in ramp influence area,	S_R = 63.5	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 63.5	mph

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	TDK
Agency/Co.:	PBS&J
Date performed:	8/3/09
Analysis time period:	PM Peak
Freeway/Dir of Travel:	Monroe Connector/Bypass EB
Junction:	On Ramp from Austin Chaney
Jurisdiction:	751
Analysis Year:	2035 Build Toll Alternative 3A
Description:	Monroe Connector/Bypass

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1071	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	30.0	mph
Volume on ramp	118	vph
Length of first accel/decel lane	1650	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	402	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	1200	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1071	118	402	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	298	33	112	v
Trucks and buses	12	2	12	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

Heavy vehicle adjustment, fHV	0.847	0.971	0.847	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	1404	135	527	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 1404 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	1539	4800	No
v_{R12}	1539	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 7.1 pc/mi/ln

Level of service for ramp-freeway junction areas of influence A

Speed Estimation

Intermediate speed variable,	M_S = 0.240	
Space mean speed in ramp influence area,	S_R = 63.3	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 63.3	mph

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	TDK
Agency/Co.:	PBS&J
Date performed:	8/3/09
Analysis time period:	AM Peak
Freeway/Dir of Travel:	Monroe Connector/Bypass WB
Junction:	On Ramp from Austin Chaney
Jurisdiction:	752
Analysis Year:	2035 Build Toll Alternative 3A
Description:	Monroe Connector/Bypass

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1071	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	60.0	mph
Volume on ramp	402	vph
Length of first accel/decel lane	900	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	118	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	1200	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1071	402	118	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	298	112	33	v
Trucks and buses	12	2	12	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

Heavy vehicle adjustment, fHV	0.847	0.971	0.847	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	1404	460	155	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 1404 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	1864	4800	No
v_{R12}	1864	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 14.2 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable,	M_S = 0.238	
Space mean speed in ramp influence area,	S_R = 63.3	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 63.3	mph

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	TDK
Agency/Co.:	PBS&J
Date performed:	8/3/09
Analysis time period:	PM Peak
Freeway/Dir of Travel:	Monroe Connector/Bypass WB
Junction:	On Ramp from Austin Chaney
Jurisdiction:	752
Analysis Year:	2035 Build Toll Alternative 3A
Description:	Monroe Connector/Bypass

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	691	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	60.0	mph
Volume on ramp	312	vph
Length of first accel/decel lane	900	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	86	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	1200	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	691	312	86	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	192	87	24	v
Trucks and buses	12	2	12	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

Heavy vehicle adjustment, fHV	0.847	0.971	0.847	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	906	357	113	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 906 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	1263	4800	No
v_{R12}	1263	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 9.5 pc/mi/ln

Level of service for ramp-freeway junction areas of influence A

Speed Estimation

Intermediate speed variable,	M_S = 0.227	
Space mean speed in ramp influence area,	S_R = 63.6	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 63.6	mph

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	TDK
Agency/Co.:	PBS&J
Date performed:	8/3/09
Analysis time period:	AM Peak
Freeway/Dir of Travel:	Monroe Connector/Bypass WB
Junction:	Off Ramp to Austin Chaney
Jurisdiction:	753
Analysis Year:	2035 Build Toll Alternative 3A
Description:	Monroe Connector/Bypass

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1189	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	30.0	mph
Volume on ramp	118	vph
Length of first accel/decel lane	765	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	402	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1200	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	1189		118		402	vph
Peak-hour factor, PHF	0.90		0.90		0.90	
Peak 15-min volume, v15	330		33		112	v
Trucks and buses	12		12		2	%
Recreational vehicles	0		0		0	%
Terrain type:	Rolling		Rolling		Rolling	
Grade	0.00	%	0.00	%	0.00	%
Length	0.00	mi	0.00	mi	0.00	mi
Trucks and buses PCE, ET	2.5		2.5		2.5	
Recreational vehicle PCE, ER	2.0		2.0		2.0	

Heavy vehicle adjustment, fHV	0.847	0.847	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	1559	155	460	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 1559 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	1559	4800	No
v_{12}	1559	4400	No
$v_{FO} = v_F - v_R$	1404	4800	No
v_R	155	2000	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 10.8 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable, D_S = 0.507

Space mean speed in ramp influence area, S_R = 55.8 mph

Space mean speed in outer lanes, S_0 = N/A mph

Space mean speed for all vehicles, S = 55.8 mph

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	TDK
Agency/Co.:	PBS&J
Date performed:	8/3/09
Analysis time period:	PM Peak
Freeway/Dir of Travel:	Monroe Connector/Bypass WB
Junction:	Off Ramp to Austin Chaney
Jurisdiction:	753
Analysis Year:	2035 Build Toll Alternative 3A
Description:	Monroe Connector/Bypass

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	777	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	30.0	mph
Volume on ramp	86	vph
Length of first accel/decel lane	765	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	312	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1200	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	777		86		312	vph
Peak-hour factor, PHF	0.90		0.90		0.90	
Peak 15-min volume, v15	216		24		87	v
Trucks and buses	12		12		2	%
Recreational vehicles	0		0		0	%
Terrain type:	Rolling		Rolling		Rolling	
Grade	0.00	%	0.00	%	0.00	%
Length	0.00	mi	0.00	mi	0.00	mi
Trucks and buses PCE, ET	2.5		2.5		2.5	
Recreational vehicle PCE, ER	2.0		2.0		2.0	

Heavy vehicle adjustment, fHV	0.847	0.847	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	1019	113	357	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 1019 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	1019	4800	No
v_{12}	1019	4400	No
$v_{FO} = v_F - v_R$	906	4800	No
v_R	113	2000	No

Level of Service Determination (if not F)

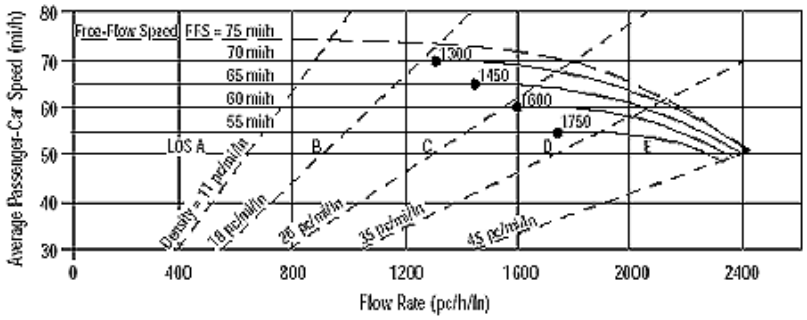
Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 6.1 pc/mi/ln

Level of service for ramp-freeway junction areas of influence A

Speed Estimation

Intermediate speed variable,	D_S = 0.503	
Space mean speed in ramp influence area,	S_R = 55.9	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 55.9	mph

BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information / Site Information

General Information		Site Information	
Analyst	TDK	Highway/Direction of Travel	Monroe Connector/Bypass EB
Agency or Company	PBS&J	From/To	Austin Chaney & Forest Hills
Date Performed	10/13/2009	Jurisdiction	754
Analysis Time Period	AM Peak	Analysis Year	2035 Build Toll Alternative 3A

Project Description Monroe Connector/Bypass

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	777 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	12
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Rolling
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	2.0
E_T	2.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.847

Speed Inputs / Calc Speed Adj and FFS

Speed Inputs			Calc Speed Adj and FFS		
Lane Width	12.0	ft	f_{LW}	0.0	mi/h
Rt-Shoulder Lat. Clearance	6.0	ft	f_{LC}	0.0	mi/h
Interchange Density	0.50	I/mi	f_{ID}	0.0	mi/h
Number of Lanes, N	2		f_N	4.5	mi/h
FFS (measured)		mi/h	FFS	65.5	mi/h
Base free-flow Speed, BFFS	70.0	mi/h			

LOS and Performance Measures / Design (N)

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	509	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	65.5	mi/h	S	mi/h
D = v_p / S	7.8	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	A		Required Number of Lanes, N	

Glossary / Factor Location

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits23-8, 23-10
E_T - Exhibits 23-8, 23-10, 23-11
f_p - Page 23-12
LOS, S, FFS, v_p - Exhibits 23-2, 23-3
f_{LW} - Exhibit 23-4
f_{LC} - Exhibit 23-5
f_N - Exhibit 23-6
f_{ID} - Exhibit 23-7

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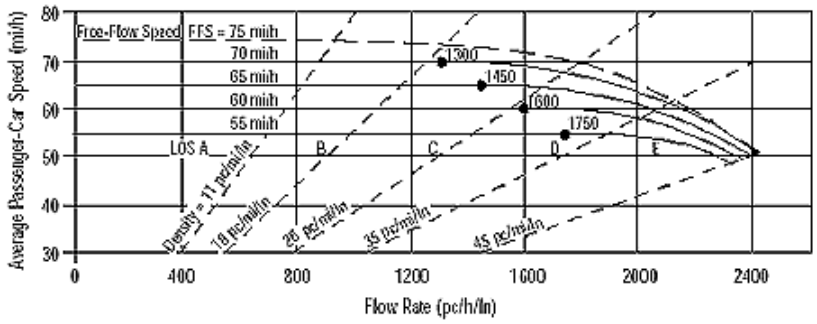
BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	OSR	Highway/Direction of Travel	Monroe Connector/Bypass EB
Agency or Company	PBS&J	From/To	Austin Chaney & Forest Hills
Date Performed	3/19/2008	Jurisdiction	754
Analysis Time Period	PM Peak	Analysis Year	2035 Build Toll Alternative 3A

Project Description Monroe Connector/Bypass

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	1189 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	12
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Rolling
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	2.0
E_T	2.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.847

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	2	
FFS (measured)		mi/h
Base free-flow Speed, BFFS	70.0	mi/h

Calc Speed Adj and FFS

f_{LW}	0.0	mi/h
f_{LC}	0.0	mi/h
f_{ID}	0.0	mi/h
f_N	4.5	mi/h
FFS	65.5	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	779	pc/h/ln
S	65.5	mi/h
D = v_p / S	11.9	pc/mi/ln
LOS	B	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
f_p - Page 23-12	f_N - Exhibit 23-6
LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7

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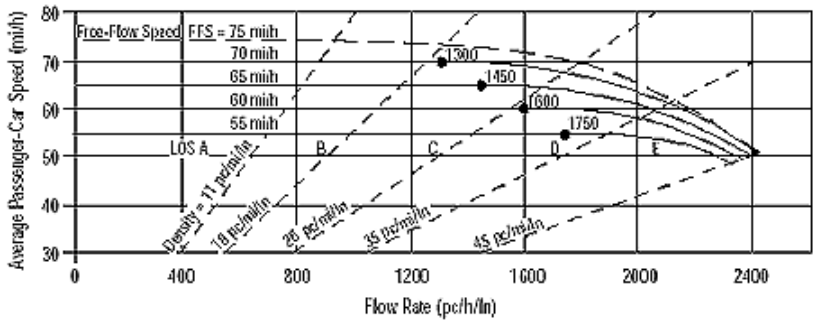
BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	OSR
Agency or Company	PBS&J
Date Performed	3/19/2008
Analysis Time Period	AM Peak

Site Information

Highway/Direction of Travel	Monroe Connector/Bypass WB
From/To	Forest Hills & Austin Chaney
Jurisdiction	755
Analysis Year	2035 Build Toll Alternative 3A

Project Description Monroe Connector/Bypass

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	1189 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	12
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Rolling
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	2.0
E_T	2.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.847

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	2	
FFS (measured)		mi/h
Base free-flow Speed, BFFS	70.0	mi/h

Calc Speed Adj and FFS

f_{LW}	0.0	mi/h
f_{LC}	0.0	mi/h
f_{ID}	0.0	mi/h
f_N	4.5	mi/h
FFS	65.5	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	779	pc/h/ln
S	65.5	mi/h
D = v_p / S	11.9	pc/mi/ln
LOS	B	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
f_p - Page 23-12	f_N - Exhibit 23-6
LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7

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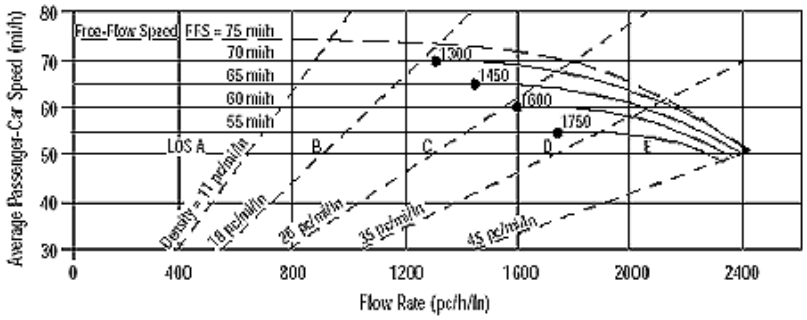
BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	TDK
Agency or Company	PBS&J
Date Performed	10/13/2009
Analysis Time Period	PM Peak

Site Information

Highway/Direction of Travel	Monroe Connector/Bypass WB
From/To	Forest Hills & Austin Chaney
Jurisdiction	755
Analysis Year	2035 Build Toll Alternative 3A

Project Description Monroe Connector/Bypass

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	777 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	12
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Rolling
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	2.0
E_T	2.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.847

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	2	
FFS (measured)		mi/h
Base free-flow Speed, BFFS	70.0	mi/h

Calc Speed Adj and FFS

f_{LW}	0.0	mi/h
f_{LC}	0.0	mi/h
f_{ID}	0.0	mi/h
f_N	4.5	mi/h
FFS	65.5	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	509	pc/h/ln
S	65.5	mi/h
D = v_p / S	7.8	pc/mi/ln
LOS	A	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
f_p - Page 23-12	f_N - Exhibit 23-6
LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7

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TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	*TDK*	Intersection	*760*
Agency/Co.	*PBS&J*	Jurisdiction	
Date Performed	*7/31/09*	Analysis Year	*2035 Build Toll Alternative 3A*
Analysis Time Period	*AM Peak*		

Project Description	*Monroe Connector/Bypass*
East/West Street: *EB Connector/Bypass Ramp*	North/South Street: *Austin Chaney Rd*
Intersection Orientation: *North-South*	Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	*8*	*863*	*0*	*0*	*446*	*78*
Peak-Hour Factor, PHF	*0.90*	*0.90*	*1.00*	*1.00*	*0.90*	*0.90*
Hourly Flow Rate, HFR	*8*	*958*	*0*	*0*	*495*	*86*
Percent Heavy Vehicles	*2*	--	--	*0*	--	--
Median Type	*Undivided*					
RT Channelized			*0*			*0*
Lanes	*1*	*1*	*0*	*0*	*1*	*1*
Configuration	*L*	*T*			*T*	*R*
Upstream Signal		*0*			*0*	

Minor Street	Westbound			Eastbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	*0*	*0*	*0*	*60*	*0*	*252*
Peak-Hour Factor, PHF	*1.00*	*1.00*	*1.00*	*0.90*	*1.00*	*0.90*
Hourly Flow Rate, HFR	*0*	*0*	*0*	*66*	*0*	*280*
Percent Heavy Vehicles	*0*	*0*	*0*	*12*	*0*	*12*
Percent Grade (%)		*0*			*0*	
Flared Approach		*N*			*N*	
Storage		*0*			*0*	
RT Channelized			*0*			*0*
Lanes	*0*	*0*	*0*	*1*	*0*	*1*
Configuration				*L*		*R*

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	*L*					*L*		*R*
v (vph)	*8*					*66*		*280*
C (m) (vph)	*993*					*132*		*555*
v/c	*0.01*					*0.50*		*0.50*
95% queue length	*0.02*					*2.34*		*2.82*
Control Delay	*8.7*					*56.9*		*17.9*
LOS	*A*					*F*		*C*
Approach Delay	--	--				*25.3*		
Approach LOS	--	--				*D*		

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TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	*TDK*	Intersection	*760*
Agency/Co.	*PBS&J*	Jurisdiction	
Date Performed	*7/31/09*	Analysis Year	*2035 Build Toll Alternative 3A*
Analysis Time Period	*PM Peak*		

Project Description	*Monroe Connector/Bypass*
East/West Street: *EB Connector/Bypass Ramp*	North/South Street: *Austin Chaney Rd*
Intersection Orientation: *North-South*	Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	*9*	*689*	*0*	*0*	*535*	*109*
Peak-Hour Factor, PHF	*0.90*	*0.90*	*1.00*	*1.00*	*0.90*	*0.90*
Hourly Flow Rate, HFR	*10*	*765*	*0*	*0*	*594*	*121*
Percent Heavy Vehicles	*2*	--	--	*0*	--	--
Median Type	*Undivided*					
RT Channelized			*0*			*0*
Lanes	*1*	*1*	*0*	*0*	*1*	*1*
Configuration	*L*	*T*			*T*	*R*
Upstream Signal		*0*			*0*	

Minor Street	Westbound			Eastbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	*0*	*0*	*0*	*66*	*0*	*336*
Peak-Hour Factor, PHF	*1.00*	*1.00*	*1.00*	*0.90*	*1.00*	*0.90*
Hourly Flow Rate, HFR	*0*	*0*	*0*	*73*	*0*	*373*
Percent Heavy Vehicles	*0*	*0*	*0*	*12*	*0*	*12*
Percent Grade (%)		*0*			*0*	
Flared Approach		*N*			*N*	
Storage		*0*			*0*	
RT Channelized			*0*			*0*
Lanes	*0*	*0*	*0*	*1*	*0*	*1*
Configuration				*L*		*R*

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	*L*					*L*		*R*
v (vph)	*10*					*73*		*373*
C (m) (vph)	*885*					*150*		*487*
v/c	*0.01*					*0.49*		*0.77*
95% queue length	*0.03*					*2.30*		*6.68*
Control Delay	*9.1*					*49.9*		*32.7*
LOS	*A*					*E*		*D*
Approach Delay	--	--				*35.5*		
Approach LOS	--	--				*E*		

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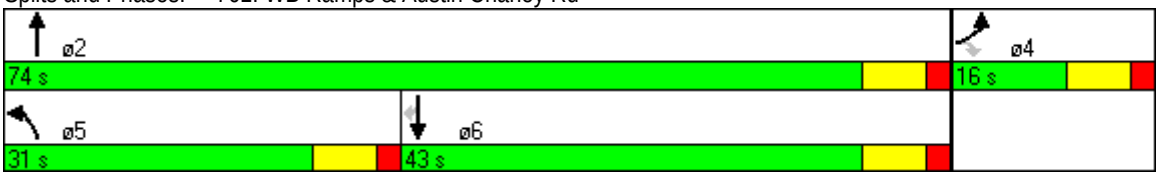
Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	109	9	336	587	515	66
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0	1000	1000			1000
Storage Lanes	1	1	1			1
Taper Length (ft)	25	25	25			25
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.850				0.850
Flt Protected	0.950		0.950			
Satd. Flow (prot)	1612	1442	1770	1863	1863	1583
Flt Permitted	0.950		0.950			
Satd. Flow (perm)	1612	1442	1770	1863	1863	1583
Right Turn on Red		No				No
Satd. Flow (RTOR)						
Link Speed (mph)	30			45	45	
Link Distance (ft)	1500			1360	1500	
Travel Time (s)	34.1			20.6	22.7	
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Heavy Vehicles (%)	12%	12%	2%	2%	2%	2%
Adj. Flow (vph)	121	10	373	652	572	73
Shared Lane Traffic (%)						
Lane Group Flow (vph)	121	10	373	652	572	73
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Right	Left	Left	Left	Right
Median Width(ft)	12			12	12	
Link Offset(ft)	0			0	0	
Crosswalk Width(ft)	16			16	16	
Two way Left Turn Lane						
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15	9	15			9
Number of Detectors	1	1	1	2	2	1
Detector Template	Left	Right	Left	Thru	Thru	Right
Leading Detector (ft)	20	20	20	100	100	20
Trailing Detector (ft)	0	0	0	0	0	0
Detector 1 Position(ft)	0	0	0	0	0	0
Detector 1 Size(ft)	20	20	20	6	6	20
Detector 1 Type	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex
Detector 1 Channel						
Detector 1 Extend (s)	0.0	0.0	0.0	0.0	0.0	0.0
Detector 1 Queue (s)	0.0	0.0	0.0	0.0	0.0	0.0
Detector 1 Delay (s)	0.0	0.0	0.0	0.0	0.0	0.0
Detector 2 Position(ft)				94	94	
Detector 2 Size(ft)				6	6	
Detector 2 Type				Cl+Ex	Cl+Ex	
Detector 2 Channel						
Detector 2 Extend (s)				0.0	0.0	
Turn Type		Perm	Prot			Perm
Protected Phases	4		5	2	6	
Permitted Phases		4				6

Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Detector Phase	4	4	5	2	6	6
Switch Phase						
Minimum Initial (s)	7.0	7.0	7.0	12.0	12.0	12.0
Minimum Split (s)	14.0	14.0	14.0	19.0	19.0	19.0
Total Split (s)	16.0	16.0	31.0	74.0	43.0	43.0
Total Split (%)	17.8%	17.8%	34.4%	82.2%	47.8%	47.8%
Maximum Green (s)	9.0	9.0	24.0	67.0	36.0	36.0
Yellow Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lead/Lag			Lead		Lag	Lag
Lead-Lag Optimize?						
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Recall Mode	None	None	None	Min	Min	Min
Act Effct Green (s)	11.1	11.1	22.6	60.9	31.1	31.1
Actuated g/C Ratio	0.15	0.15	0.30	0.80	0.41	0.41
v/c Ratio	0.51	0.05	0.71	0.44	0.75	0.11
Control Delay	44.6	35.3	35.3	4.7	28.1	16.5
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	44.6	35.3	35.3	4.7	28.1	16.5
LOS	D	D	D	A	C	B
Approach Delay	43.9			15.8	26.8	
Approach LOS	D			B	C	
Queue Length 50th (ft)	61	5	176	105	257	24
Queue Length 95th (ft)	#136	20	#299	155	391	51
Internal Link Dist (ft)	1420			1280	1420	
Turn Bay Length (ft)		1000	1000			1000
Base Capacity (vph)	250	224	650	1603	1000	849
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.48	0.04	0.57	0.41	0.57	0.09

Intersection Summary	
Area Type: Other	
Cycle Length: 90	
Actuated Cycle Length: 76.2	
Natural Cycle: 60	
Control Type: Actuated-Uncoordinated	
Maximum v/c Ratio: 0.75	
Intersection Signal Delay: 21.8	Intersection LOS: C
Intersection Capacity Utilization 64.3%	ICU Level of Service C
Analysis Period (min) 15	

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 761: WB Ramps & Austin Chaney Rd



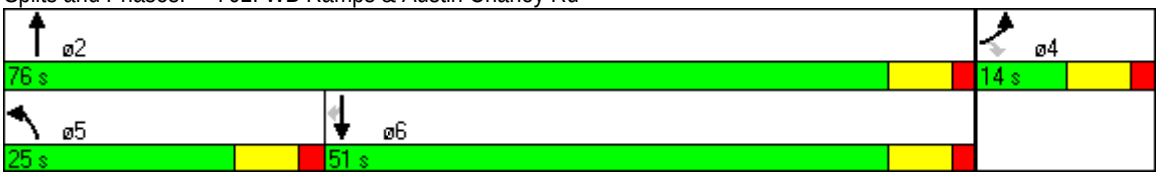
Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	78	8	252	503	636	60
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0	1000	1000			1000
Storage Lanes	1	1	1			1
Taper Length (ft)	25	25	25			25
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.850				0.850
Flt Protected	0.950		0.950			
Satd. Flow (prot)	1612	1442	1770	1863	1863	1583
Flt Permitted	0.950		0.950			
Satd. Flow (perm)	1612	1442	1770	1863	1863	1583
Right Turn on Red		No				No
Satd. Flow (RTOR)						
Link Speed (mph)	30			45	45	
Link Distance (ft)	1500			1360	1500	
Travel Time (s)	34.1			20.6	22.7	
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Heavy Vehicles (%)	12%	12%	2%	2%	2%	2%
Adj. Flow (vph)	87	9	280	559	707	67
Shared Lane Traffic (%)						
Lane Group Flow (vph)	87	9	280	559	707	67
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Right	Left	Left	Left	Right
Median Width(ft)	12			12	12	
Link Offset(ft)	0			0	0	
Crosswalk Width(ft)	16			16	16	
Two way Left Turn Lane						
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15	9	15			9
Number of Detectors	1	1	1	2	2	1
Detector Template	Left	Right	Left	Thru	Thru	Right
Leading Detector (ft)	20	20	20	100	100	20
Trailing Detector (ft)	0	0	0	0	0	0
Detector 1 Position(ft)	0	0	0	0	0	0
Detector 1 Size(ft)	20	20	20	6	6	20
Detector 1 Type	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex
Detector 1 Channel						
Detector 1 Extend (s)	0.0	0.0	0.0	0.0	0.0	0.0
Detector 1 Queue (s)	0.0	0.0	0.0	0.0	0.0	0.0
Detector 1 Delay (s)	0.0	0.0	0.0	0.0	0.0	0.0
Detector 2 Position(ft)				94	94	
Detector 2 Size(ft)				6	6	
Detector 2 Type				Cl+Ex	Cl+Ex	
Detector 2 Channel						
Detector 2 Extend (s)				0.0	0.0	
Turn Type		Perm	Prot			Perm
Protected Phases	4		5	2	6	
Permitted Phases		4				6

Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Detector Phase	4	4	5	2	6	6
Switch Phase						
Minimum Initial (s)	7.0	7.0	7.0	12.0	12.0	12.0
Minimum Split (s)	14.0	14.0	14.0	19.0	19.0	19.0
Total Split (s)	14.0	14.0	25.0	76.0	51.0	51.0
Total Split (%)	15.6%	15.6%	27.8%	84.4%	56.7%	56.7%
Maximum Green (s)	7.0	7.0	18.0	69.0	44.0	44.0
Yellow Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lead/Lag			Lead		Lag	Lag
Lead-Lag Optimize?						
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Recall Mode	None	None	None	Min	Min	Min
Act Effct Green (s)	9.9	9.9	18.0	61.1	35.7	35.7
Actuated g/C Ratio	0.13	0.13	0.24	0.82	0.48	0.48
v/c Ratio	0.41	0.05	0.66	0.37	0.80	0.09
Control Delay	43.2	37.0	38.2	3.6	25.1	12.0
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	43.2	37.0	38.2	3.6	25.1	12.0
LOS	D	D	D	A	C	B
Approach Delay	42.6			15.1	24.0	
Approach LOS	D			B	C	
Queue Length 50th (ft)	44	4	132	72	301	19
Queue Length 95th (ft)	#102	19	#254	108	446	40
Internal Link Dist (ft)	1420			1280	1420	
Turn Bay Length (ft)		1000	1000			1000
Base Capacity (vph)	214	191	522	1645	1197	1017
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.41	0.05	0.54	0.34	0.59	0.07

Intersection Summary	
Area Type: Other	
Cycle Length: 90	
Actuated Cycle Length: 74.8	
Natural Cycle: 65	
Control Type: Actuated-Uncoordinated	
Maximum v/c Ratio: 0.80	
Intersection Signal Delay: 20.7	Intersection LOS: C
Intersection Capacity Utilization 65.8%	ICU Level of Service C
Analysis Period (min) 15	

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 761: WB Ramps & Austin Chaney Rd



Intersection: 761: WB Ramps & Austin Chaney Rd

Movement	EB	EB	NB	NB	SB	SB
Directions Served	L	R	L	T	T	R
Maximum Queue (ft)	179	39	288	165	415	84
Average Queue (ft)	75	6	161	72	197	30
95th Queue (ft)	144	24	259	144	335	69
Link Distance (ft)	1453			1292	1466	
Upstream Blk Time (%)						
Queuing Penalty (veh)						
Storage Bay Dist (ft)		1000	1000			1000
Storage Blk Time (%)						
Queuing Penalty (veh)						

Intersection: 761: WB Ramps & Austin Chaney Rd

Movement	EB	EB	NB	NB	SB	SB
Directions Served	L	R	L	T	T	R
Maximum Queue (ft)	128	51	278	133	400	78
Average Queue (ft)	53	8	134	52	199	23
95th Queue (ft)	107	30	232	113	338	60
Link Distance (ft)	1453			1292	1466	
Upstream Blk Time (%)						
Queuing Penalty (veh)						
Storage Bay Dist (ft)		1000	1000			1000
Storage Blk Time (%)						
Queuing Penalty (veh)						