



MIDCAP

Maryland Intersection and Interchange Design & Capacity Analysis Program

July 17, 2017





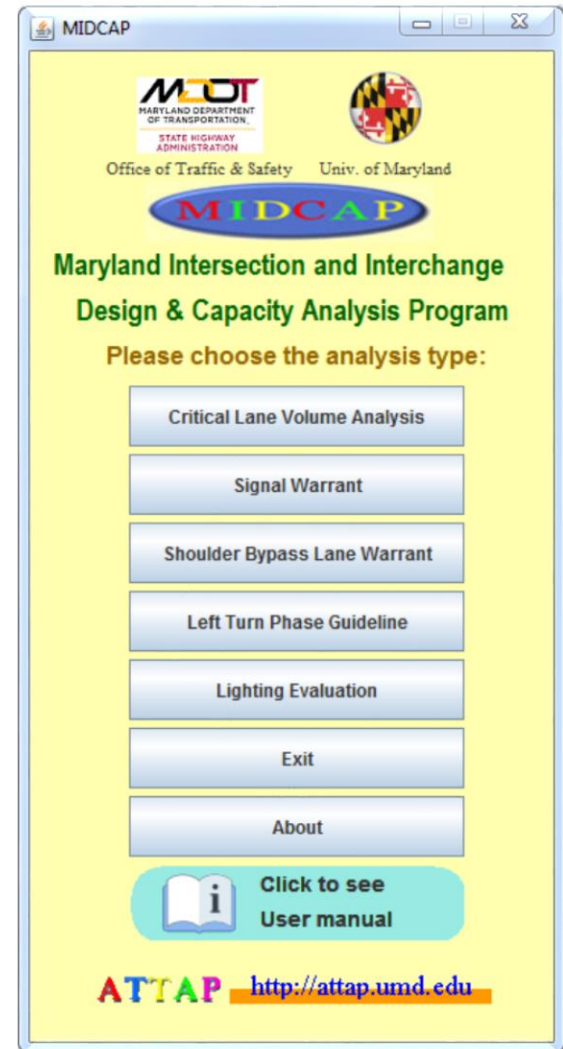
MDOT State Highway Administration
Office of Traffic & Safety
Traffic Development & Support Division



University of Maryland, College Park
Dept. of Civil & Environmental Engineering
Traffic Safety & Operations Lab

INTRODUCTION

- ❑ Software development by **UMD**
- ❑ Sponsored by **MDOT SHA** through the Applied Technology & Traffic Analysis Program (ATTAP) funding
- ❑ **User-friendly** traffic engineering software for intersection analysis regarding
 - Capacity or queuing
 - Traffic signal warrant
 - Shoulder bypass lane warrant
 - Left turn phase selection 
 - Lighting recommendation 



MAIN MODULES

1. Critical Lane Volume (CLV) Analysis
2. Signal Warrant
3. Shoulder Bypass Lanes (SBLs) Warrant
4. Left Turn Phase Guideline
5. Lighting Evaluation

MODULE 1: CRITICAL LANE VOLUME ANALYSIS

Critical Lane Volume (CLV) analysis module conducts a **sketch-level** capacity / queuing analysis for **signalized** intersection(s) or interchange ramp terminal(s) along an arterial.

MODULE 1: CRITICAL LANE VOLUME ANALYSIS

Procedure

INPUT

- Intersection type
- Turning movement volumes
- Lane configuration
- Right-turn restriction
- Split or non-split phase

Identify non-concurrent sets of movements



Determine CLV of each sets and sum



Calculate v/c and determine LOS




Calculate Max. queue length

- Intersection CLV
- Intersection v/c and LOS
- Maximum queue length

OUTPUT

MODULE 1: CRITICAL LANE VOLUME ANALYSIS

Submodules

1. Intersection (**Single or Multiple** locations up to 10)
 - 3-leg
 - 4-leg
 - Continuous Flow (or Displaced Left Turn) Intersection
2. Interchange (**Single** location only for alternatives analysis)
 - Regular Diamond Interchange
 - Partial Clover Leaf Interchange 
 - Single Point Urban Interchange
 - Diverging Diamond Interchange
3. **Multi-hour** calculation

MODULE 1: CRITICAL LANE VOLUME ANALYSIS

Capacity (4-Leg Intersection)

- 1 Choose Intersection Type
- 2 Set Lane Configurations
- 3 Input Movement Volumes
- 4 Choose Right Turn Control Type
- 5 Click Calculate
- 6 Obtain LOS & V/C

AM Results

Mov.	Vol	Lane Fac	Lane Vol	Oppo Lefts	CLV	*
NB	27*	1.00	27	24	51	51
SB	29**	1.00	29	16	45	
WB	1827	0.55	1005	7	1012	1012
EB	741	0.55	408	42	450	
				AM Total	1063	AM V/C
				AM LOS	B	0.66

PM Results

Mov.	Vol	Lane Fac	Lane Vol	Oppo Lefts	CLV	*
NB	60*	1.00	50	63	113	113
SB	74**	1.00	74	27	101	
WB	1642	0.55	903	17	920	920
EB	1371	0.55	754	30	784	
				PM Total	1033	PM V/C
				PM LOS	B	0.65

Note

*: Volume subtracted by right turn overlap
 **: Volume adjusted by the PCE factor for permissive left

MODULE 1: CRITICAL LANE VOLUME ANALYSIS

Maximum Queue Lengths

AM Results

Mov.	Vol	Lane Fac	Lane Vol	Oppo Lefts	CLV	*
NB	27*	1.00	27	24	51	51
SB	29**	1.00	29	16	45	
WB	1827	0.55	1005	7	1012	1012
EB	741	0.55	408	42	450	
					AM Total	1063
					AM LOS	B 0.66

PM Results

Mov.	Vol	Lane Fac	Lane Vol	Oppo Lefts	CLV	*
NB	50*	1.00	50	63	113	113
SB	74**	1.00	74	27	101	
WB	1642	0.55	903	17	920	920
EB	1371	0.55	754	30	784	
					PM Total	1033
					PM LOS	B 0.65

Results

		AM	PM	
Northbound	L	50	75	
	T	N/A	N/A	
	R	100	125	
Southbound	L	50	100	
	T	N/A	N/A	
	R	25	50	
Eastbound	L	25	50	
	T	N/A	N/A	
	R	400	650	
Westbound	L	75	50	
	T	N/A	N/A	
	R	900	800	

Buttons: Calculate Queue Length, Save as Image, Exit

User Input



MODULE 1: CRITICAL LANE VOLUME ANALYSIS

Factors and Criteria

- **Editable** Lane Use Factors, LOS criteria, and Passenger Car Equivalent (PCE) values
- Applicable to each approach and AM / PM period

The screenshot shows the 'Factors and Criteria' software interface. The window title is 'Factors and Criteria'. It features a central diagram of a four-way intersection with traffic flow arrows. A red box highlights the top-left approach. To the right is a table for 'Factors' with columns for 'Num of Lane', 'Factors AM', and 'Factors PM'. Below this are two tables: 'Level of Service' and 'PCE'. The 'Level of Service' table has columns for 'Level' and 'CLV'. The 'PCE' table has columns for 'Opposing Volume' and 'PCE'. Each table has a 'Default' button at the bottom.

Num of Lane	Factors AM	Factors PM
1	1.0	1.0
2	0.55	0.55
3	0.4	0.4
4	0.3	0.3
5	0.24	0.24
Dbl Left	0.6	0.6
Tpl Left	0.45	0.45

Level	CLV
A <=	1000
B <=	1150
C <=	1300
D <=	1450
E <=	1600
F >	1600

Opposing Volume	PCE
<=199	1.1
<=599	2.0
<=799	3.0
<=999	4.0
>=1000	5.0

MODULE 1: CRITICAL LANE VOLUME ANALYSIS

Continuous Flow (or **Displaced Left Turn**) Intersection

3-Leg CFI

Disable Approach

Select One Approach to Disable

- North
- North
- South
- East
- West

AM Results for Sub Intersection

Location	Vol	LUF	Lane Vol	oppVol	LUF	Lane Vol	CLV	V/C	LOS
North	0	0	0	0	0	0	0		
South	230	1.0	230	384	0.4	153	383	0.24	A
East	0	0	0	0	0	0	0		
West	0	0	0	0	0	0	0		

PM Results for Sub Intersection

Location	Vol	LUF	Lane Vol	oppVol	LUF	Lane Vol	CLV	V/C	LOS
North	0	0	0	0	0	0	0		
South	406	1.0	406	1823	0.4	729	1135	0.71	B
East	0	0	0	0	0	0	0		
West	0	0	0	0	0	0	0		

Center AM Result for Main Intersection

movt.	vol.	LUF	Lane Vol	OppoLeft	CLV
N-S	230	1.0	230	0	230
E-W	1151	0.55	633	0	633
AM Total	883	AM V/C	0.54	AM LOS	A

Center PM Result for Main Intersection

movt.	Vol.	LUF	Lane Vol	OppoLeft	CLV
N-S	1823	0.45	820	0	820
E-W	434	0.55	239	0	239
PM Total	1659	PM V/C	0.66	PM LOS	B

4-Leg **Full** CFI

AM Results for Sub Intersection

Location	Vol	LUF	Lane Vol	oppVol	LUF	Lane Vol	CLV	V/C	LOS
North	1675	0.45	753	500	0.55	275	1028	0.64	B
South	100	1.0	100	500	0.55	275	375	0.23	A
East	175	0.6	105	4125	0.4	1950	1755	1.10	B
West	250	0.6	150	1250	0.4	500	650	0.41	A

PM Results for Sub Intersection

Location	Vol	LUF	Lane Vol	oppVol	LUF	Lane Vol	CLV	V/C	LOS
North	825	0.45	371	1000	0.55	550	921	0.58	A
South	125	1.0	125	800	0.55	440	565	0.35	A
East	400	0.6	240	2500	0.4	1000	1240	0.78	C
West	575	0.6	345	2650	0.4	1060	1405	0.88	D

Center AM Result for Main Intersection

movt.	vol.	LUF	Lane Vol	OppoLeft	CLV
N-S	1675	0.45	753	0	753
E-W	2450	0.4	980	0	980
AM Total	1733	AM V/C	1.08	AM LOS	B

Center PM Result for Main Intersection

movt.	Vol.	LUF	Lane Vol	OppoLeft	CLV
N-S	825	0.45	371	0	371
E-W	2525	0.4	1010	0	1010
PM Total	1381	PM V/C	0.66	PM LOS	B

MODULE 1: CRITICAL LANE VOLUME ANALYSIS

Continuous Flow (or **Displaced Left Turn**) Intersection

4-Leg Partial **Symmetric** CFI

Click on the arrows to change the lane group configuration.

Analyst: M.Kim
 Department: J00TS-TDSD
 Date: 12/23/2016
 Intersection: MD 4 @ MD 235
 Location: St. Mary's
 Type: CH Sym

Calculate Clear
 Print Open
 Save Save As
 Back Exit
 Undo Redo

Factors and Criteria
 Summary

AM Results for Sub Intersection

Location	Vol	LUF	Lane Vol	oppVol	LUF	Lane Vol	CLV	VIC	LOS
North	1675	0.45	753	500	0.55	275	1028	0.64	B
South	100	1.0	100	500	0.55	275	375	0.23	A
East	0	0	0	0	0	0	0	0	
West	0	0	0	0	0	0	0	0	

PM Results for Sub Intersection

Location	Vol	LUF	Lane Vol	oppVol	LUF	Lane Vol	CLV	VIC	LOS
North	325	0.45	371	1000	0.55	550	321	0.58	A
South	125	1.0	125	800	0.55	440	565	0.35	A
East	0	0	0	0	0	0	0	0	
West	0	0	0	0	0	0	0	0	

Center AM Result for Main Intersection

	movt	Vol	LUF	Lane Vol	OppoLeft	CLV
N-S		425	1.0	425	100	525
E-W		2450	0.4	980	105	1085
AM Total		1610	AM VIC	1.01	AM LOS	F

Center PM Result for Main Intersection

	movt	Vol	LUF	Lane Vol	OppoLeft	CLV
N-S		375	1.0	375	125	500
E-W		2525	0.4	1010	345	1355
PM Total		1855	PM VIC	1.16	PM LOS	F

Displace Approaches

Select Approaches to Displace Left Turn

- North-South
- North-South
- East-West

4-Leg Partial **Asymmetric** CFI

Click on the arrows to change the lane group configuration.

Analyst: M.Kim
 Department: J00TS-TDSD
 Date: 12/23/2016
 Intersection: MD 4 @ MD 235
 Location: St. Mary's
 Type: CFI Asym

Calculate Clear
 Print Open
 Save Save As
 Back Exit
 Undo Redo

Factors and Criteria
 Summary

AM Results for Sub Intersection

Location	Vol	LUF	Lane Vol	oppVol	LUF	Lane Vol	CLV	VIC	LOS
North	1675	0.45	753	500	0.55	275	1028	0.64	B
South	0	0	0	0	0	0	0	0	
East	175	0.6	105	4125	0.4	1650	1755	1.10	C
West	0	0	0	0	0	0	0	0	

PM Results for Sub Intersection

Location	Vol	LUF	Lane Vol	oppVol	LUF	Lane Vol	CLV	VIC	LOS
North	325	0.45	371	1000	0.55	550	321	0.58	A
South	0	0	0	0	0	0	0	0	
East	400	0.6	240	2500	0.4	1000	1240	0.78	C
West	0	0	0	0	0	0	0	0	

Center AM

	P1	P2	P3	P4	CLV	VIC	LOS
270	483	241	739	1733	1.08	F	

Center PM

	P1	P2	P3	P4	CLV	VIC	LOS
135	237	345	1010	1727	1.08	F	


Displace Approaches

Select Approaches to Displace Left Turn

- North-East
- North-East
- East-South
- South-West
- West-North

MODULE 1: CRITICAL LANE VOLUME ANALYSIS

Interchange Ramp Terminals (Regular Diamond)



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ATTAP <http://attap.umd.edu>
MIDCAP

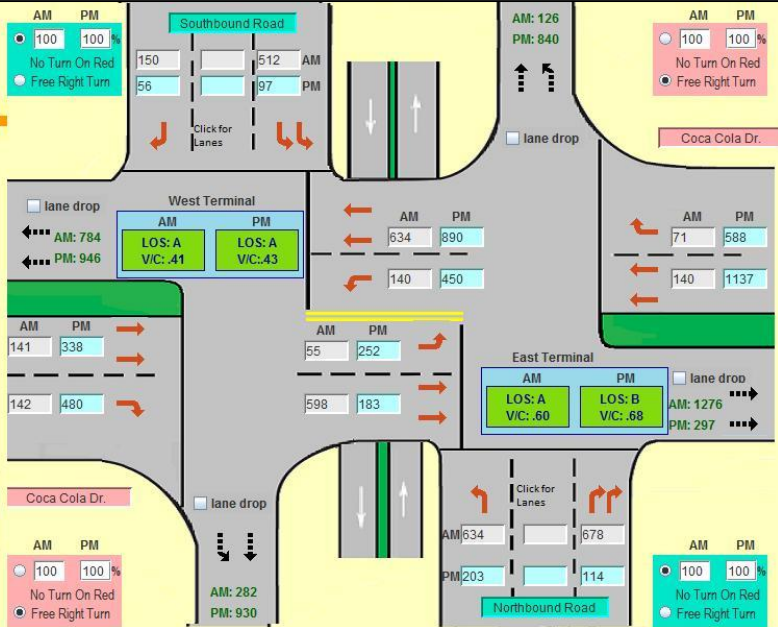
Click on the arrows to change the lane group configuration.


Analyst: H.Kim
 Department: ATTAP
 Date: 04/25/2017
 Intersection: MD 100 @ Coca Cola Dr.
 Location: Hanover
 Type: RDI
 Scenario:

Phase Split
 West terminal
 East terminal

Calculate Clear
 Print Open
 Save Save As
 Back Exit
 Undo Redo

Factors and Criteria
 Summary





AM West Terminal Results					
Mov.	Vol	Lane Fac	Oppo Lane	CLV	*
EB	141	0.55	140	218	0
WB	634	0.55	0	349	349
SB Ramp	512	0.6	0	307	307
			AM LOS	AM Total	AM V/C
			A	656	.41

AM East Terminal Results					
Mov.	Vol	Lane Fac	Oppo Lane	CLV	*
WB	140	0.55	55	132	0
EB	598	0.55	0	329	329
NB Ramp	634	1.0	0	634	634
			AM LOS	AM Total	AM V/C
			A	963	.60


PM West Terminal Results					
Mov.	Vol	Lane Fac	Oppo Lane	CLV	*
EB	338	0.55	450	636	636
WB	890	0.55	0	490	0
SB Ramp	97	0.6	0	58	58
			PM LOS	PM Total	PM V/C
			A	694	.43

PM East Terminal Results					
Mov.	Vol	Lane Fac	Oppo Lane	CLV	*
WB	1137	0.55	252	877	877
EB	183	0.55	0	101	0
NB Ramp	203	1.0	0	203	203
			PM LOS	PM Total	PM V/C
			B	1080	.68

Note

MODULE 1: CRITICAL LANE VOLUME ANALYSIS

Partial Clover Leaf Interchange



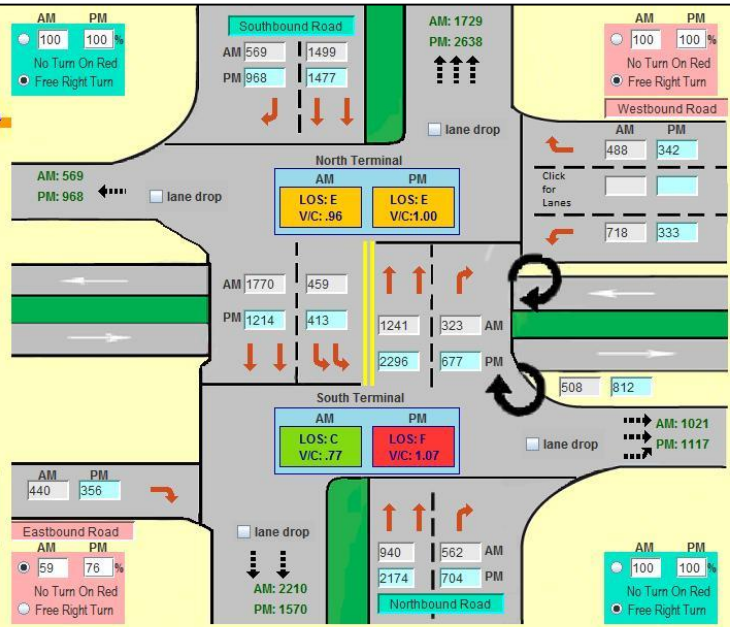
Click on the arrows to change the lane group configuration.

Analyst: H.Kim
 Department: ATTAP
 Date: 04/25/2017
 Intersection: US 1 at MD 100
 Location:
 Type: CLI
 Scenario: 2019 Total Traffic

Phase Split
 North terminal
 South terminal

Calculate Clear
 Print Open
 Save Save As
 Back Exit
 Undo Redo

Factors and Criteria
 Summary



AM North Terminal Results

Mov.	Vol	Lane Fac	Oppo Lane	CLV	*
SB	1499	0.55	0	824	824
NB	1241	0.55	0	683	0
WB Ramp	718	1.0	0	718	718
			AM LOS	AM Total	AM V/C
			E	1542	.96

PM North Terminal Results

Mov.	Vol	Lane Fac	Oppo Lane	CLV	*
SB	1477	0.55	0	812	0
NB	2296	0.55	0	1263	1263
WB Ramp	333	1.0	0	333	333
			PM LOS	PM Total	PM V/C
			E	1596	1.00

AM South Terminal Results

Mov.	Vol	Lane Fac	Oppo Lane	CLV	*
NB	940	0.55	275	792	0
SB	1770	0.55	0	974	974
EB Ramp	260	1.0	0	260	260
			AM LOS	AM Total	AM V/C
			C	1234	.77

PM South Terminal Results


Mov.	Vol	Lane Fac	Oppo Lane	CLV	*
NB	2174	0.55	248	1444	1444
SB	1214	0.55	0	668	0
EB Ramp	271	1.0	0	271	271
			PM LOS	PM Total	PM V/C
			F	1715	1.07

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MODULE 1: CRITICAL LANE VOLUME ANALYSIS

Single Point Urban Interchange



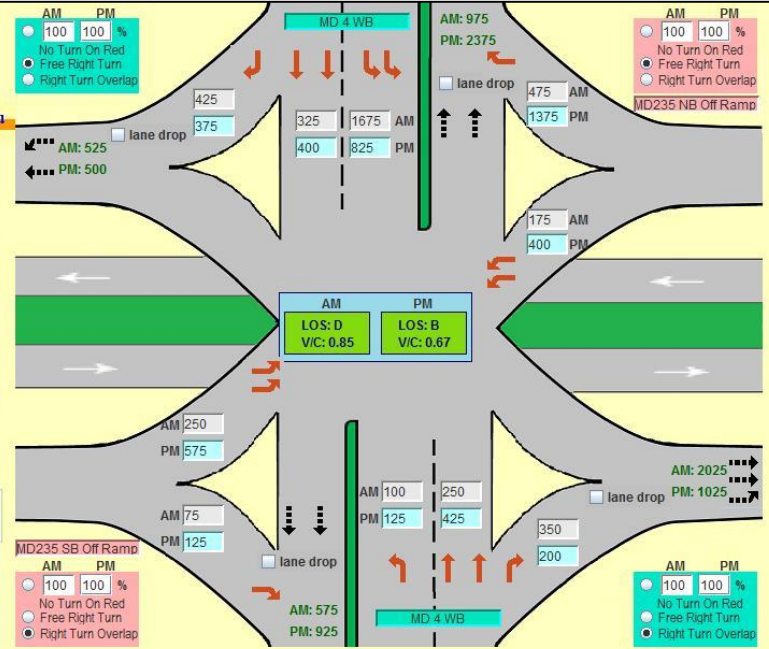
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ATTAP <http://attap.umd.edu>
MIDCAP

Click on the arrows to change the lane group configuration.

Analyst: Minseok Kim
 Department: OOTS-TDSD
 Date: 01/10/2014
 Intersection: MD 4 @ MD 235
 Location: St. Mary's Co.
 Type: SPUI
 Scenario: 2030 AM/PM peak hour

Phase Model Choose:
 North-South / East-West Split

Buttons: Calculate, Clear, Print, Open, Save, Save As, Back, Exit, Undo, Redo, Factors and Criteria, Summary



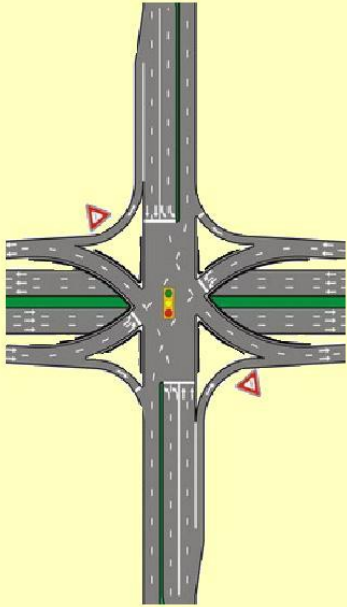
AM Results

Mov.	Vol	Lane Fac	CLV
From Ramp	250	0.6	150
NT-SL	200	1.0	1205
ST-NL	325	0.55	279
AM LOS		AM Total	AM V/C
	D	1355	0.85

PM Results

Mov.	Vol	Lane Fac	CLV
From Ramp	575	0.6	345
NT-SL	425	0.55	729
ST-NL	400	0.55	345
PM LOS		PM Total	PM V/C
	B	1074	0.67

*Note
 NT: Northbound Through
 NL: Northbound Left
 ST: Southbound Through
 SL: Southbound Left



MODULE 1: CRITICAL LANE VOLUME ANALYSIS

Diverging Diamond Interchange

Southbound Road

Eastbound Road

Westbound Road

Northbound Road

West Terminal

East Terminal

AM West Terminal Results

Mov.	Vol	Lane Fac	CLV	*
EB	141	0.55	78	0
Ramp Right	150	1.0	150	150
WB	634	0.55	349	349
Ramp Left	512	0.6	307	0
		AM LOS	AM Total	AM V/C
		A	499	0.31

AM East Terminal Results

Mov.	Vol	Lane Fac	CLV	*
WB	140	0.55	77	0
Ramp Right	678	0.55	373	373
EB	598	0.55	329	0
Ramp Left	634	1.0	634	634
		AM LOS	AM Total	AM V/C
		B	1007	0.63

PM West Terminal Results

Mov.	Vol	Lane Fac	CLV	*
EB	338	0.55	186	186
Ramp Right	56	1.0	56	0
WB	890	0.55	490	490
Ramp Left	97	0.6	58	0
		AM LOS	AM Total	AM V/C
		A	676	0.42

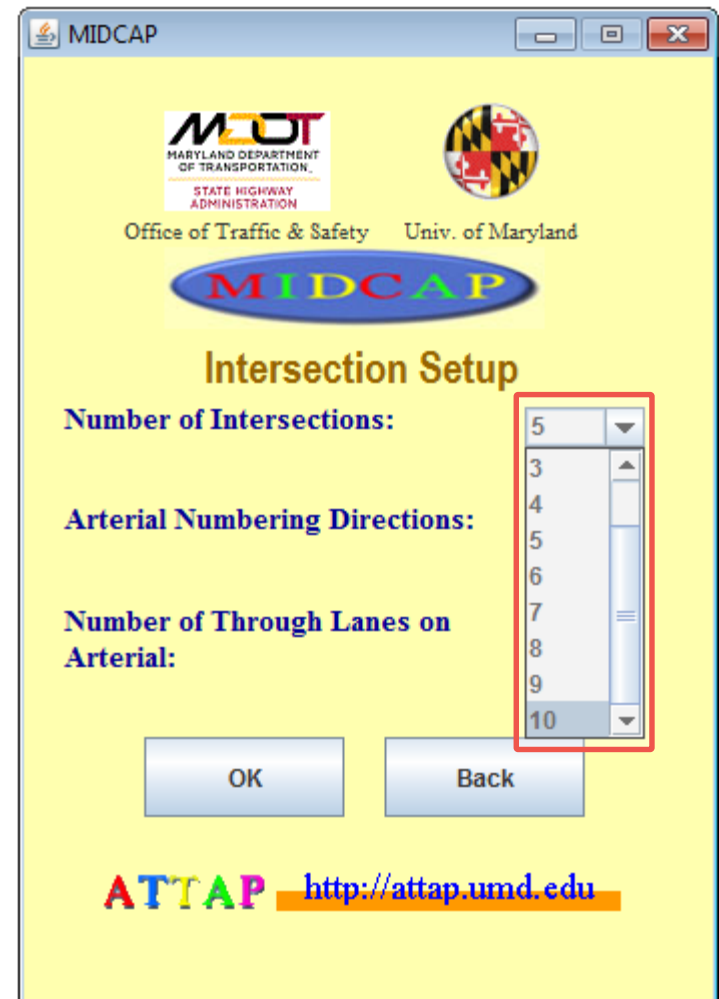
PM East Terminal Results

Mov.	Vol	Lane Fac	CLV	*
WB	1137	0.55	625	625
Ramp Right	114	0.55	63	0
EB	183	0.55	101	0
Ramp Left	203	1.0	203	203
		AM LOS	AM Total	AM V/C
		A	828	0.52

MODULE 1: CRITICAL LANE VOLUME ANALYSIS

Arterial (Corridor) analysis

- **Multiple intersections**
- Up to 10 intersections



The screenshot shows the MIDCAP software interface. At the top, there are logos for MDOT (Maryland Department of Transportation, State Highway Administration) and the University of Maryland, along with the text "Office of Traffic & Safety". Below these is the MIDCAP logo and the title "Intersection Setup". The dialog box contains three input fields: "Number of Intersections:" with a dropdown menu showing values 3, 4, 5, 6, 7, 8, 9, and 10; "Arterial Numbering Directions:"; and "Number of Through Lanes on Arterial:". The "Number of Intersections:" dropdown is highlighted with a red box. At the bottom, there are "OK" and "Back" buttons. The ATTAP logo and the URL <http://attap.umd.edu> are displayed at the bottom of the window.

MODULE 1: CRITICAL LANE VOLUME ANALYSIS

Arterial analysis

Arterial View

Distance To Next Intersection (ft): 133, 133, 133, 133, 133, 133

West 1 2 3 4 5 6 7

Click on the blue circle to input for an intersection.

Intersection Name	AM Peak LOS/VIC	PM Peak LOS/VIC	Type
at Seek Ln.	A, 0.54	D, 0.84	3 leg
at Carroll Ave	A, 0.53	A, 0.56	4 leg
at Merrimac Dr.	A, 0.55	B, 0.63	4 leg
at Lebanon St.	A, 0.59	C, 0.74	3 leg
at W. S hop Center	A, 0.54	A, 0.60	4 leg
at Takoma/Langley	A, 0.54	D, 0.90	4 leg
at MD 650	A, 0.54	D, 0.90	4 leg

Individual Intersection View

Office of Traffic & Safety Univ. of Maryland
ATTAP <http://attap.umd.edu>

Click on the arrows to change the lane group configuration.

Analyst: M. Kim
Department: DOTS-TDSD
Date: 12/23/2016
Intersection: at Merrimac Dr.
Location: Montgomery & PG County
Type: 4 Leg
Scenario: 2020 Build, Purple Line

Phase Split:
 Split NB and SB
 Split EB and WB

Calculate Clear

Print Open

Save Save As

Back Queue

Undo Redo

Factors And Criteria

Mov.	Vol	Lane Fac	Lane Vol	Oppo Lefts	CLV	*
NB	0	0.00	0	0	0	
SB	10*	1.00	10	0	10	10
WB	1437	0.55	790	52	842	842
EB	1005	0.55	553	107	650	
				AM Total	852	AM VIC
				AM LOS	A	0.53

Mov.	Vol	Lane Fac	Lane Vol	Oppo Lefts	CLV	*
NB	0	0.00	0	0	0	
SB	0	0.00	0	0	0	
WB	1380	0.55	759	134	893	893
EB	1180	0.55	649	139	788	
				PM Total	893	PM VIC
				PM LOS	A	0.56

Note: * Volume subtracted by right turn overlap

MODULE 1: CRITICAL LANE VOLUME ANALYSIS

Multi-hour analysis

Import or copy traffic counts in Excel from MDOT SHA's Internet Traffic Monitoring System (http://maps.roads.maryland.gov/itms_public/)

- 1 Set Lane Configurations
- 2 Choose Right Turn Control Type
- 3 Input Movement Volumes
- 4 Click Result


The screenshot shows the MIDCAP software interface with four numbered callouts: 1. Select Lane configurations (pointing to lane arrows), 2. Choose Right Turn control type and Phase Split (pointing to turn control options), 3. Input traffic count (pointing to the 'Input traffic count' button), and 4. Results (pointing to the 'Results' button).

The 'Input traffic count' dialog box is open, showing a table for inputting traffic counts. The table has columns for different directions and movements (L, T, R, TOT) and rows for time intervals from 0:00 to 23:00. A file path is entered in the input field: `rs\hkim\Desktop\MIDCAP_CLV_MH_traffic_count.xls`.

	MD 97 SB				MD 97 NB				Forest Glen (WB)				MD 192 EB				
Start	L	T	R	TOT	L	T	R	TOT	L	T	R	TOT	L	T	R	TOT	ALL
0:00																	
1:00																	
2:00																	
3:00																	
4:00																	
5:00																	
6:00	5	2264	36	2305	20	552	301	873	267	198	48	513	16	47	113	176	3867
7:00	0	3128	102	3228	0	925	243	1168	482	345	26	833	41	92	206	339	5558
8:00	0	3049	100	3149	0	1000	252	1252	516	353	36	905	63	161	228	452	5758
9:00	11	2363	84	2458	12	992	254	1258	425	214	57	696	48	118	157	323	4735
10:00	42	1737	54	1833	32	1112	249	1393	351	164	94	609	45	66	108	219	4054
11:00	35	1496	53	1584	50	1429	241	1720	250	87	103	440	39	71	88	198	3942
12:00	48	1588	52	1688	52	1494	254	1800	266	73	102	441	49	74	96	219	4148
13:00	33	1586	0	1619	36	1501	254	1791	244	74	83	401	55	62	95	212	4023
14:00	38	1675	47	1760	37	1748	294	2079	286	91	114	491	54	98	130	282	4612
15:00	25	1757	76	1858	25	1834	317	2176	339	118	118	575	93	192	184	469	5078
16:00	1	1722	83	1806	0	2307	333	2640	319	153	106	578	138	280	226	644	5668
17:00	0	1818	89	1907	0	2406	375	2781	299	197	104	600	192	361	177	730	6018
18:00	0	1650	74	1724	0	2274	417	2691	308	165	75	548	143	353	150	646	5609
19:00																	
20:00																	
21:00																	
22:00																	
23:00																	

MODULE 1: CRITICAL LANE VOLUME ANALYSIS

Multi-hour analysis: CLV, V/C and LOS for **each hour**



Office of Traffic & Safety Univ. of Maryland
ATTAP <http://attap.umd.edu>
MIDCAP


Analyst: H.Kim
 Department: ATTAP
 Date: 04/25/2017
 Intersection: MD 97 at MD 192
 Location: Scenario

Click on the arrows to change the lane group configuration.

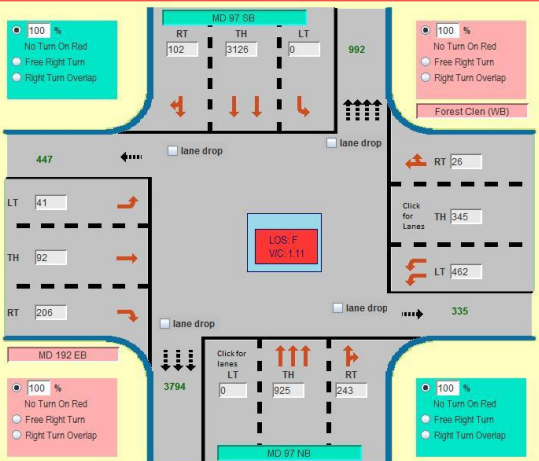
Phase Split
 Split NB and SB
 Split EB and WB

MultiHr Results

Begin Hour	CLV	V/C	LOS
0:00			
1:00			
2:00			
3:00			
4:00			
5:00			
6:00	1400	0.75	C
7:00	1774	1.11	F
8:00	1796	1.12	F
9:00	1391	0.87	D
10:00	1035	0.65	B
11:00	956	0.54	A



click



Time: 7:00

Mov.	Vol	Lane Fac	Lane Vol	Oppo Lefts	CLV	*
NB	1168	0.30	350	0	350	
SB	3228	0.40	1291	0	1291	1291
WB	371	1.00	371	41	412	
EB	206	1.00	206	277	483	483
AM Total					1774	AM V/C
AM LOS					F	1.11

Print Save As Back

MODUE 2: SIGNAL WARRANT

- ❑ Uses the Maryland Manual on Uniform Traffic Control Devices (**MdMUTCD**) **2011** edition
- ❑ Investigates the need for a traffic control signal by analyzing related factors such as traffic conditions and physical characteristics of the location
- ❑ Provides whether the following traffic signal warrant is satisfied at a particular location or not
 - Warrant 1. **Eight-Hour** Vehicular Volume
 - Warrant 2. **Four-Hour** Vehicular Volume
 - Warrant 3. **Peak Hour**
 - Warrant 9. Intersection **Near a Grade Crossing**

MODUE 2: SIGNAL WARRANT

Able to import or copy a traffic counts report from MDOT SHA's Internet Traffic Monitoring System (I-TMS) as input

One can load the I-TMS traffic data in excel format or input manually into the volume table

1

Load Traffic Volume Data

2

Set Location-specific Characteristics

3

Click Calculate

The screenshot shows the ATTAP MIDCAP software interface. On the left, there are three numbered callouts: 1 points to the 'Load' button, 2 points to the location input field, and 3 points to the 'Calculate' button. The main area contains a form with the following fields:

- Analyst: HKM
- Department: ATTAP
- Date of Analysis: 07/05/2017
- Date of Traffic data: 08/10/2015
- Location: MD 187 at Cordell Ave
- Scenario: [Empty]
- Community Less Than 10,000: [Checked]
- Major Street: MD 187
- Num. of Approach Lanes: 2 or more
- 85th Percentile Speed: below 40 mph
- Direction: North-South
- Minor Street: Cordell Ave
- Num. of Approach Lanes: 1

At the bottom, there are buttons for Calculate, Clear, Load, See Sample, Open, Print, Save, Save As, Back, and Exit.

On the right, there is a 'Volume' table with columns for Major Street (MD 187) and Minor Street (Cordell Ave). The table has columns for 'From North', 'From South', 'From East', and 'From West', each with sub-columns for L, T, R, and TOT. The table also includes a 'Summary' section with checkboxes for 'Warrants' and 'Warrants Satisfied'.

Volume Table Data:

Start	Major Street (MD 187)				Minor Street (Cordell Ave)				ALL								
	L	T	R	TOT	L	T	R	TOT									
5:00	0	0	0	0	0	0	0	0	0	0							
6:00	20	371	10	401	7	188	11	206	10	8	11	27	3	8	1	10	844
7:00	7	779	6	792	5	485	44	534	11	12	27	50	1	6	0	7	1383
8:00	14	1080	12	1106	1	605	63	669	6	28	50	84	5	12	3	20	1879
9:00	14	744	18	776	8	467	41	516	22	28	41	91	1	9	4	14	1397
10:00	26	673	17	716	2	459	53	514	31	23	50	104	3	6	5	14	1348
11:00	52	616	19	687	14	539	79	632	28	27	57	112	5	17	16	38	1469
12:00	21	430	13	464	1	715	106	822	27	23	62	112	7	15	10	32	1430
13:00	27	471	23	521	2	611	74	687	19	31	77	127	5	9	9	23	1358
14:00	33	463	16	512	5	273	59	337	15	19	38	72	6	6	6	18	939
15:00	34	550	12	596	3	1016	51	1070	20	28	78	126	9	4	6	18	1810
16:00	26	590	19	635	7	1095	88	1190	29	18	99	146	2	6	7	15	1986
17:00	16	725	48	789	4	1145	81	1230	18	21	75	114	9	9	13	31	2164
18:00	27	638	31	696	6	782	79	867	9	21	61	91	9	15	8	32	1686
19:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0


Summary:

Warrants	Warrants Satisfied
<input checked="" type="checkbox"/> 1. Eight-hour vehicular volume	YES
<input checked="" type="checkbox"/> 2. Four-hour vehicular volume	YES
<input checked="" type="checkbox"/> 3. Peak Hour	YES
<input type="checkbox"/> 9. Intersection Near a Grade Crossing	N/A


Warrants analysis results

MODUE 2: SIGNAL WARRANT

Evaluation results for Warrant 1



Office of Traffic & Safety Univ. of Maryland
ATTAP <http://attap.umd.edu>



Analyst:
 Department:
 Date of Analysis:
 Date of Traffic data:
 Location:
 Scenario:
 Community Less Than 10,000
 Major Street:
 Num. of Approach Lanes:
 85th Percentile Speed:
 Direction:
 Minor Street:
 Num. of Approach Lanes:

Input/Summary W9 Input W1A W1B W2 W3 W9

MUTCD Signal Warrant 1: Eight-hour Vehicular Volume

Table 4c-1. Warrant 1, Eight-Hour Vehicular Volume

Number of lanes for moving traffic on each approach Vehicles per hour on major street Vehicles per hour on higher-volume minor-street approach (one direction)

Condition A - Minimum Vehicular Volume

Major Street	Minor Street	Vehicles per hour on major street				Vehicles per hour on higher-volume minor-street approach (one direction)			
		100%	80%	70%	56%	100%	80%	70%	56%
1	1	500	400	350	280	150	120	105	84
2 or more	1	600	480	420	336	150	120	105	84
2 or more	2 or more	600	480	420	336	200	160	140	112
1	2 or more	500	400	350	280	200	160	140	112

Evaluation of Condition A

Evaluation of Condition A with the 100% columns (600, 150)					Evaluation of Condition A with the 80% columns (480, 120)				
Hour Start	Hour End	Major Volume	Minor Volume	Warrant	Hour Start	Hour End	Major Volume	Minor Volume	Warrant
5:00	6:00	0	0	no	5:00	6:00	0	0	no
6:00	7:00	607	27	no	6:00	7:00	607	27	no
7:00	8:00	1326	50	no	7:00	8:00	1326	50	no
8:00	9:00	1775	84	no	8:00	9:00	1775	84	no
9:00	10:00	1292	91	no	9:00	10:00	1292	91	no
10:00	11:00	1230	104	no	10:00	11:00	1230	104	no
11:00	12:00	1319	112	no	11:00	12:00	1319	112	no
12:00	13:00	1286	112	no	12:00	13:00	1286	112	no
13:00	14:00	1208	127	no	13:00	14:00	1208	127	yes
14:00	15:00	849	72	no	14:00	15:00	849	72	no
15:00	16:00	1666	126	no	15:00	16:00	1666	126	yes
16:00	17:00	1825	146	no	16:00	17:00	1825	146	yes
17:00	18:00	2019	114	no	17:00	18:00	2019	114	no
18:00	19:00	1563	91	no	18:00	19:00	1563	91	no
19:00	20:00	0	0	no	19:00	20:00	0	0	no
20:00	21:00	0	0	no	20:00	21:00	0	0	no
21:00	22:00	0	0	no	21:00	22:00	0	0	no

Condition A is not met
Total Number of Hours met: 0



Condition A is not met
Total Number of Hours met: 3

Evaluation criteria


Evaluation results

MODUE 2: SIGNAL WARRANT

Evaluation results for Warrant 2

Office of Traffic & Safety Univ. of Maryland
ATTAP <http://attap.umd.edu>

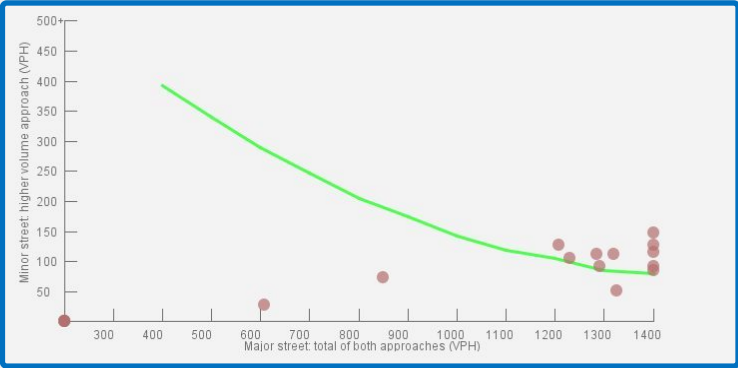


Analyst:
 Department:
 Date of Analysis:
 Date of Traffic data:
 Location:
 Scenario:
 Community Less Than 10,000
 Major Street:
 Num. of Approach Lanes:
 85th Percentile Speed:
 Direction:
 Minor Street:
 Num. of Approach Lanes:

Input/Summary
W9 Input
W1A
W1B
W2
W3
W9

MUTCD Signal Warrant 2: Four-hour Vehicular Volume

Figure 4C-1, Warrant 2 - Four-Hour Vehicular Volume



Hour	Major Volume	Minor Volume	Threshold	Warrant
5:00	0	0	n/a	no
6:00	607	27	285	no
7:00	1326	50	80	no
8:00	1775	84	80	yes
9:00	1292	91	86	yes
10:00	1230	104	98	yes
11:00	1319	112	80	yes
12:00	1286	112	87	yes
13:00	1208	127	102	yes
14:00	849	72	188	no
15:00	1666	126	80	yes
16:00	1825	146	80	yes
17:00	2019	114	80	yes
18:00	1563	91	80	yes
19:00	0	0	n/a	no
20:00	0	0	n/a	no
21:00	0	0	n/a	no




Warrant 2 is met
Total Number of Hours met: 10

Evaluation criteria

Evaluation results

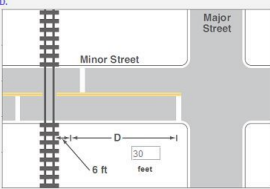
MODUE 2: SIGNAL WARRANT

Evaluation results for Warrant 9



 Office of Traffic & Safety Univ. of Maryland
ATTAP <http://attap.umid.edu>


Analyst: HKim
Department: ATTAP
Date of Analysis: 07/05/2017
Date of Traffic data: 06/10/2015
Location: MD 187 at Cordell Ave
Scenario:

Community Less Than 10,000
Major Street: MD 187
Num. of Approach Lanes: 2 or more
85th Percentile Speed: below 40 mph
Direction: North-South
Minor Street: Cordell Ave
Num. of Approach Lanes: 1

Warrant 9, Intersection Near a Grade Crossing
 Step 1: Enter the clear storage distance D.


Step 2: Choose the adjustment factors.

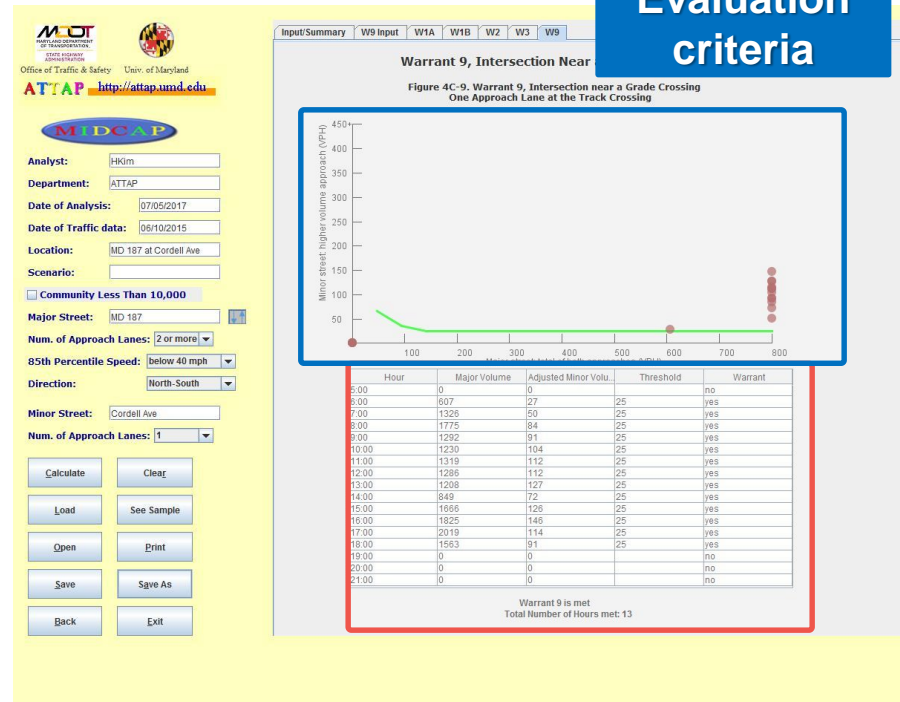
Rail Traffic/Day	Adjustment Factor	Selected
1	0.67	<input type="checkbox"/>
2	0.91	<input type="checkbox"/>
3 to 5	1.00	<input checked="" type="checkbox"/>
6 to 8	1.18	<input type="checkbox"/>
9 to 11	1.25	<input type="checkbox"/>
12 or more	1.33	<input type="checkbox"/>

% of high occupancy buses on Minor-Street	Adjustment Factor	Selected
0%	1.00	<input checked="" type="checkbox"/>
2%	1.00	<input type="checkbox"/>
4%	1.19	<input type="checkbox"/>
6% or more	1.32	<input type="checkbox"/>

% of Tractor-Trailer Trucks on Minor-Street Approach	D less than 70 feet	D of 70 feet or more	Selected
0% to 2.5%	0.50	0.50	<input type="checkbox"/>
2.6% to 7.5%	0.75	0.75	<input type="checkbox"/>
7.6% to 12.5%	1.00	1.00	<input checked="" type="checkbox"/>
12.6% to 17.5%	2.30	1.15	<input type="checkbox"/>
17.6% to 22.5%	2.70	1.35	<input type="checkbox"/>
22.6% to 27.5%	3.28	1.64	<input type="checkbox"/>
More than 27.5%	4.18	2.09	<input type="checkbox"/>

Step 3: Click Calculate button.

Additional input for W9



Evaluation criteria

Evaluation results

MODULE 3: SHOULDER BYPASS LANE WARRANT

- ❑ Uses the MDOT SHA's **Application and Design Guidelines for Shoulder Bypass Lanes** (SBLs)
- ❑ Investigates the need for shoulder bypass lanes versus left-turn lanes by analyzing related factors such as traffic conditions and physical characteristics of the location
- ❑ Provides whether the following shoulder bypass lane warrant is satisfied at **a two-lane, two-way unsignalized T-intersection** or not
 - Warrant 1. Vehicular **Volumes**
 - Warrant 2. Stopping **Sight Distance**
 - Warrant 3. **Accident** History

MODULE 3: SHOULDER BYPASS LANE WARRANT

How to Use

- 1 Input Traffic Volume Data
- 2 Set Location-specific Characteristics
- 3 Click Calculate

Shoulder Bypass Lane Warrant

Office of Traffic & Safety Univ. of Maryland
ATTAP <http://attap.umd.edu>

MIDCAP

Analyst: H.Kim
Department: ATTAP
Date: 04/25/2017
Intersection: MD 355 at Old Baltimore
Location: Montgomery
Major Street: MD 355
Minor Street: West old Baltimore Rd.
Scenario: Traffic Data Date: Wednesday 04/13/2016

Calculate Clear
Open Print
Save Save As
Back Exit

Input

Begin Hour	Advancing Left	Advancing Through	Opposing
6:00	32	194	748
7:00	41	379	974
8:00	50	374	1177
9:00	59	254	921
10:00	63	318	502
11:00	63	337	357
12:00	83	521	490
13:00	73	487	423
14:00	104	644	565
15:00	57	716	227
16:00	147	1248	623
17:00	198	1233	646
18:00	118	692	386
19:00	69	502	181
20:00			
21:00			

Input

Prevailing Speed: mph
Design Speed: mph
Advancing Approach Sight Distance: ft

Crash Frequency (Rear-end & Left Turn Types):
 during a 12-month period
 during a 24-month period

Summary

warrants satisfied


1. Vehicular Volume No (Consider a left turn lane)
2. Stopping Sight Distance N/A
3. Accident History N/A

Warrants analysis results


Shoulder Bypass Lane Warrant analysis is based on the MDSHA's Application and Design Guidelines for Shoulder Bypass Lanes.

MODULE 3: SHOULDER BYPASS LANE WARRANT

Evaluation results for Warrant 1



Office of Traffic & Safety Univ. of Maryland
ATTAP <http://attap.umd.edu>



Analyst H.Kim
Department ATTAP
Date 04/25/2017
Intersection MD 355 at Old Baltimore
Location Montgomery
Major Street MD 355
Minor Street West old Baltimore Rd.
Scenario Traffic Data Date: Wednesday 04/13/2016

Input/Summary w1 w2/w3

Warrant 1: Vehicular Volume

Guidelines for Installation of Shoulder Bypass/Left-Turn Lanes

5-10% 10-20% 20-30% Left-Turning Traffic



Begin Hour	Opposing	Advancing	Lower Bound	Upper Bound	% Left-Turning Traffic	Recommendation
6:00	748	226	55	190	10-20%	Consider a left-turn lane
7:00	974	420	N/A	N/A	Not Applicable	Not Applicable
8:00	1177	424	N/A	N/A	Not Applicable	Not Applicable
9:00	921	353	N/A	N/A	Not Applicable	Not Applicable
10:00	502	381	79	249	10-20%	Consider a left-turn lane
11:00	357	400	92	294	10-20%	Consider a left-turn lane
12:00	490	604	81	252	10-20%	Consider a left-turn lane
13:00	423	560	87	269	10-20%	Consider a left-turn lane
14:00	565	748	73	233	10-20%	Consider a left-turn lane
15:00	227	773	198	458	5-10%	Consider a left-turn lane
16:00	623	1395	67	219	10-20%	Consider a left-turn lane
17:00	646	1431	65	213	10-20%	Consider a left-turn lane
18:00	386	810	90	281	10-20%	Consider a left-turn lane
19:00	181	571	101	357	10-20%	Consider a left-turn lane
20:00						
21:00						

Shoulder Bypass Lane Warrant analysis is based on the MDSHA's Application and Design Guidelines for Shoulder Bypass Lanes.



Evaluation criteria

Evaluation results


MODULE 4: LEFT TURN PHASE GUIDELINE

- ❑ Uses the **Left Turn Phase Guideline** from the MDOT SHA's Traffic Engineering & Safety Manual
- ❑ Provides a recommended type of left turn phase among exclusive, permissive and exclusive/permissive at a particular location

MODULE 4: LEFT TURN PHASE GUIDELINE

Office of Traffic & Safety Univ. of Maryland
ATTAP <http://attap.umd.edu>



SHA Left Turn Phase Guide

Analyst	Minseok Kim
Department	OOTS-TDSD
Date	2016/10/12
Intersection	MD 108 and Ten Oaks Rd
Location	Howard Co.
Scenario	WB Left with 2015/6/11 Volumes & Proposed Improvements

Open

Clear

Undo

Redo

Save

Save As

Print

Back

Legend

Previous and selected step
 Next or unselected step
 Current step
 Unselected left turn phase
 Recommended left turn phase

Note

- ▶ This procedure applies to locations that have a separate left turn lane
- ▶ Restrictive Sight Distance:
 - < 250 ft. for speeds of 35 mph or less
 - < 400 ft. for speeds >= 40mph

Is left turn demand >2 per cycle?
(Average in highest hour)
 Yes No

↓ Yes

How many opposing lanes?
(Throughs plus rights)
 1 or 2 Lanes 3 Lanes

1 or 2 lanes

If 1 lane, is volume cross-product >70,000?
If 2 lanes, is volume cross-product >100,000?
 Yes No

↓ Yes

Is opposing speed > 45 mph?
 Yes No

↓ No

Is sight distance restricted?
 Yes No

↓ No

Is there a severe left-turn accident problem which could be corrected by exclusive phasing?
 Yes No

↓ Yes

↓ No

Consider EXCLUSIVE

Consider EXCLUSIVE PERMISSIVE

3 lanes

Is volume cross-product > 144,000?
 Yes No

↓ Yes

Consider EXCLUSIVE

↓ No

Is opposing speed > 45 mph?
 Yes No

↓ Yes

Consider EXCLUSIVE*

↓ No

Is sight distance restricted?
 Yes No

↓ Yes

Consider EXCLUSIVE**

↓ No

Is there a severe left-turn accident problem which could be corrected by exclusive phasing?
 Yes No

↓ Yes

Consider EXCLUSIVE

↓ No

Consider PERMISSIVE

← No



* An opposing speed >45 mph indicates a potential left turn accident problem. Consider exclusive phasing, realizing that non-left turn accidents may increase.

** Use Exclusive phasing with the understanding that non-left turn accidents may increase.


MODULE 5: LIGHTING EVALUATION

- ❑ Uses the MDOT SHA's **evaluation form for intersection lighting**.
- ❑ Provides whether or not the intersection lighting is to be considered based on the weighted sum of scores (13 or more) for criteria, such as signalization, the existence of medians, the existence of left turn bays and/or other auxiliary lanes, etc.

MODULE 5: LIGHTING EVALUATION

Office of Traffic & Safety Univ. of Maryland
ATTAP <http://attap.umd.edu>



**MDSHA
EVALUATION FORM FOR
INTERSECTION LIGHTING**

Analyst
Department
Date
Intersection
Location
Scenario

Criteria		Score Met = 1 Not Met = 0 (a)	Weight (b)	Total (a x b)	
A	Is intersection signalized?	<input checked="" type="radio"/> 0 <input type="radio"/> 1	5	0	
B	Does intersection have medians on any approach?	<input checked="" type="radio"/> 0 <input type="radio"/> 1	4		
C	Does intersection have left turn bays and /or other auxiliary lanes?	<input type="radio"/> 0 <input checked="" type="radio"/> 1	3		
D	Is intersection a freeway ramp terminal?	<input checked="" type="radio"/> 0 <input type="radio"/> 1	4		
E	Is there significant pedestrian volume after dark?	<input checked="" type="radio"/> 0 <input type="radio"/> 1	3	0	
F	Does intersection involve two or more state maintained highways?	<input type="radio"/> 0 <input checked="" type="radio"/> 1	1	1	
G	Does ADT of state highway exceed 15,000?	<input checked="" type="radio"/> 0 <input type="radio"/> 1	2	0	
H	Ratio of Night to total accidents (Min 5 accidents)	0.35-0.40	<input checked="" type="radio"/> 0 <input type="radio"/> 1	1	0
		0.40-0.45	<input checked="" type="radio"/> 0 <input type="radio"/> 1	3	0
		0.45-0.50	<input checked="" type="radio"/> 0 <input type="radio"/> 1	5	0
		> 0.50	<input checked="" type="radio"/> 0 <input type="radio"/> 1	8	0
I	Is intersection at school entrance or children walking to school?	<input checked="" type="radio"/> 0 <input type="radio"/> 1	3	0	
J	Is operating speed on any road approach greater than 50 MPH?	<input type="radio"/> 0 <input checked="" type="radio"/> 1	4	4	
K	Is intersection sight distance restricted?	<input type="radio"/> 0 <input checked="" type="radio"/> 1	5	5	
L	Are there any brightly lighted areas, i.e., parking lots, commercial area, etc. within 300 feet of the intersection?	<input checked="" type="radio"/> 0 <input type="radio"/> 1	4	0	
M	Are any of the road approaches continuously lighted?	<input checked="" type="radio"/> 0 <input type="radio"/> 1	4	0	
Total				13	

1) Intersection lighting is to be considered by a score of 13 or more.
 2) Potential for intersection lighting will be prioritized based on score.

User input

Weighted sum



THANK YOU!

For questions or technical support, contact us at MIDCAP@umd.edu.

ATTAP research team

<http://attap.umd.edu>