



MIDCAP

Maryland **I**ntersection and Interchange **D**esign & **C**apacity **A**nalysis **P**rogram

July 17, 2017





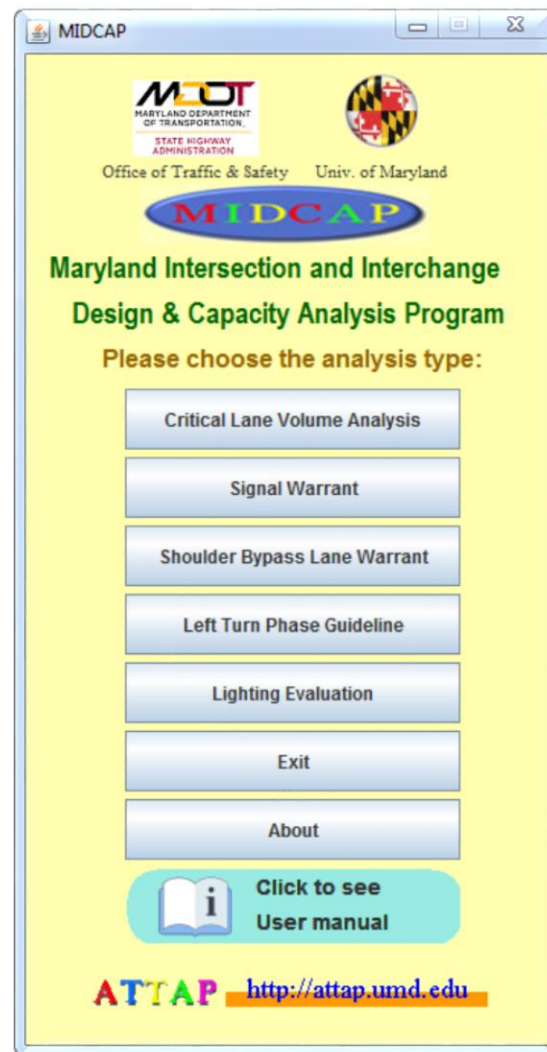
MDOT State Highway Administration
Office of Traffic & Safety
Traffic Development & Support Division



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

INTRODUCTION

- ❑ Software developed 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 for alternative interchange designs 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

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

Click on the arrows to change the lane group configuration.

Analyst: H.Kim
Department: ATTAP
Date: 03/21/2017
Intersection: MD 193 at West Park Dr.
Location: Prince George Co.

Type: 4 Leg
Scenario: 4 Leg
Phase Split: ☐ Split NB and SB ☐ Split EB and WB

Calculate Clear
Print Open
Save Save As
Back Queue
Undo Redo
Factors And Criteria

Intersection Diagram: Shows West Park Dr. and University Blvd (WB) with lane configurations and movement volumes. Red boxes and numbers 1-6 highlight the steps in the process.

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	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 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

MDOT
MICHIGAN DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION
Office of Traffic & Safety Univ. of Maryland
ATTAP <http://attap.umd.edu>
MIDCAP

Click on the arrows to change the lane group configuration.

Analyst: H.Kim
Department: ATTAP
Date: 03/21/2017
Intersection: MD 193 at West Park Dr.
Location: Prince George Co.
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

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	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 V/C
PM LOS					B	0.65

Note

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

Results

Num of Phases: 2 phase
Cycle Length(sec): AM 90 PM 90

Queue Length(ft):

		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

Storage Length(ft):

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' window with a diagram of a four-way intersection. The diagram highlights the northbound through lane with a red box and an arrow. The window is divided into three main sections: Lane Use Factors, Level of Service, and PCE.

Lane Use Factors

Num of Lane	Factors AM	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

Default

Level of Service

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

Default

PCE

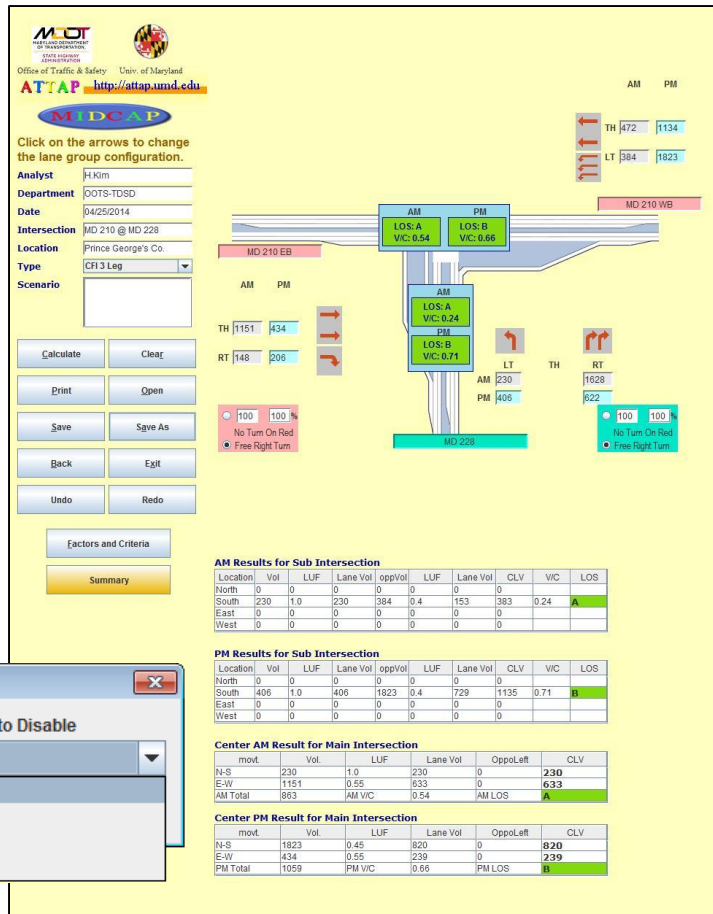
Opposing Volume	PCE
<=199	1.1
<=599	2.0
<=799	3.0
<=999	4.0
>=1000	5.0

Default

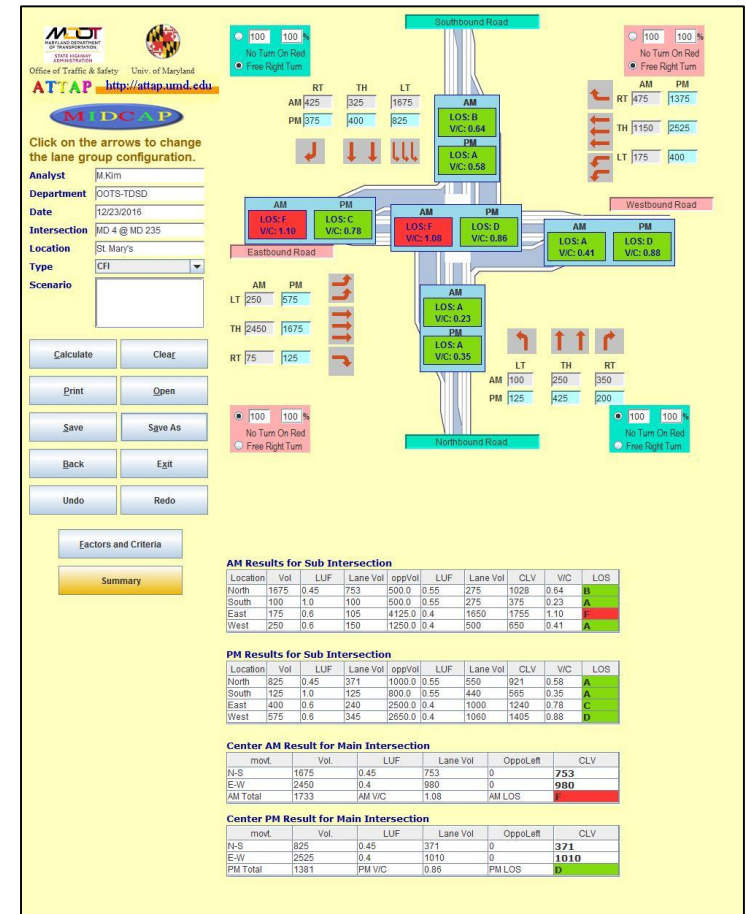
MODULE 1: CRITICAL LANE VOLUME ANALYSIS

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

3-Leg CFI



4-Leg **Full** CFI



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: JOTS-TSDS
Date: 12/23/2016
Intersection: MD 4 @ MD 235
Location: St. Mary's
Type: CFI Sym
Scenario:

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

mov.	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	

Center PM Result for Main Intersection

mov.	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	

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: JOTS-TSDS
Date: 12/23/2016
Intersection: MD 4 @ MD 235
Location: St. Mary's
Type: CFI Asym
Scenario:

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:
Department:
Date:
Intersection:
Location:
Type:
Scenario:

Phase Split
☐ West terminal
☐ East terminal

AM PM
☒ 100 ☐ 100 %
No Turn On Red
Free Right Turn

Southbound Road

AM: 126 PM: 840

AM: 784 PM: 946
LOS: A V/C: .41

AM: 141 PM: 338
AM: 634 PM: 890
AM: 140 PM: 450
AM: 598 PM: 183
AM: 1276 PM: 297
LOS: A V/C: .60
LOS: B V/C: .68

Coca Cola Dr.

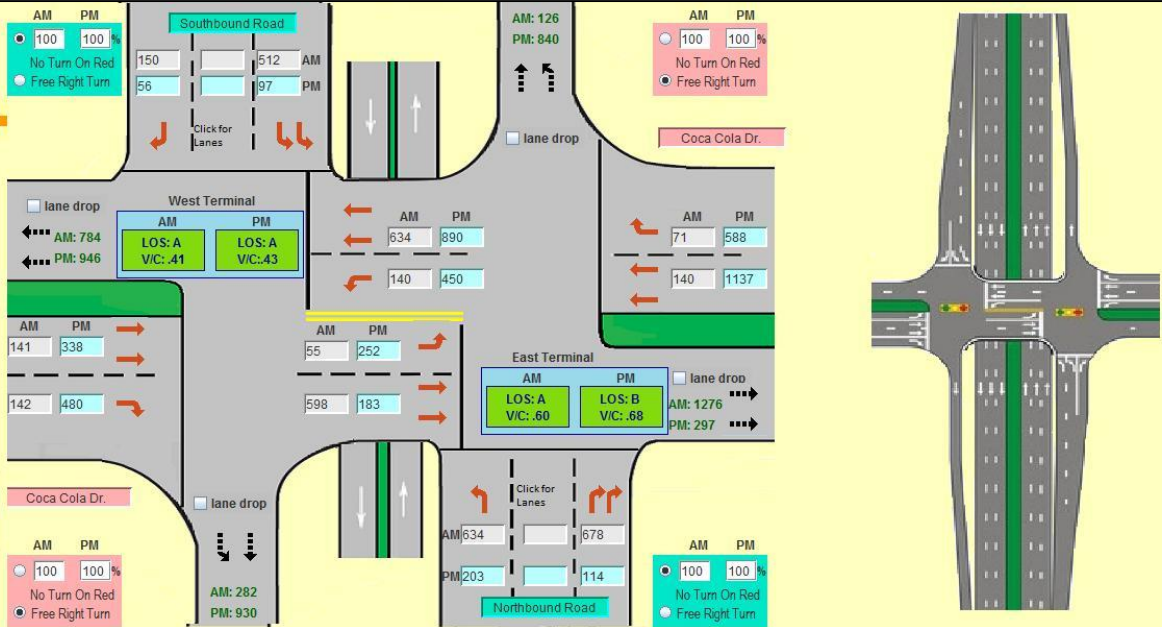
AM: 282 PM: 930

AM: 100 PM: 100 %
No Turn On Red
Free Right Turn

Northbound Road

AM: 634 PM: 578
AM: 203 PM: 114

AM: 100 PM: 100 %
No Turn On Red
Free Right Turn



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

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

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 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

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STATE HIGHWAY ADMINISTRATION
Office of Traffic & Safety Univ. of Maryland
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: 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 PM
100 100 %
No Turn On Red
Free Right Turn

Southbound Road
AM: 569 PM: 1499
PM: 968 1477

AM: 1729 PM: 2638

AM PM
100 100 %
No Turn On Red
Free Right Turn

Westbound Road
AM: 488 PM: 342
718 333

Click for Lanes

AM: 569 PM: 968
lane drop

North Terminal
AM LOS: E V/C: .96
PM LOS: E V/C: 1.00

AM: 1770 PM: 1214
459 413
1241 323
2296 677

South Terminal
AM LOS: C V/C: .77
PM LOS: F V/C: 1.07

AM: 440 PM: 356
lane drop

Eastbound Road
AM: 59 PM: 76
No Turn On Red
Free Right Turn

AM: 2210 PM: 1570
lane drop

AM: 940 PM: 562
2174 704
Northbound Road

AM PM
100 100 %
No Turn On Red
Free Right Turn

AM: 1021 PM: 1117
lane drop

508 812

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

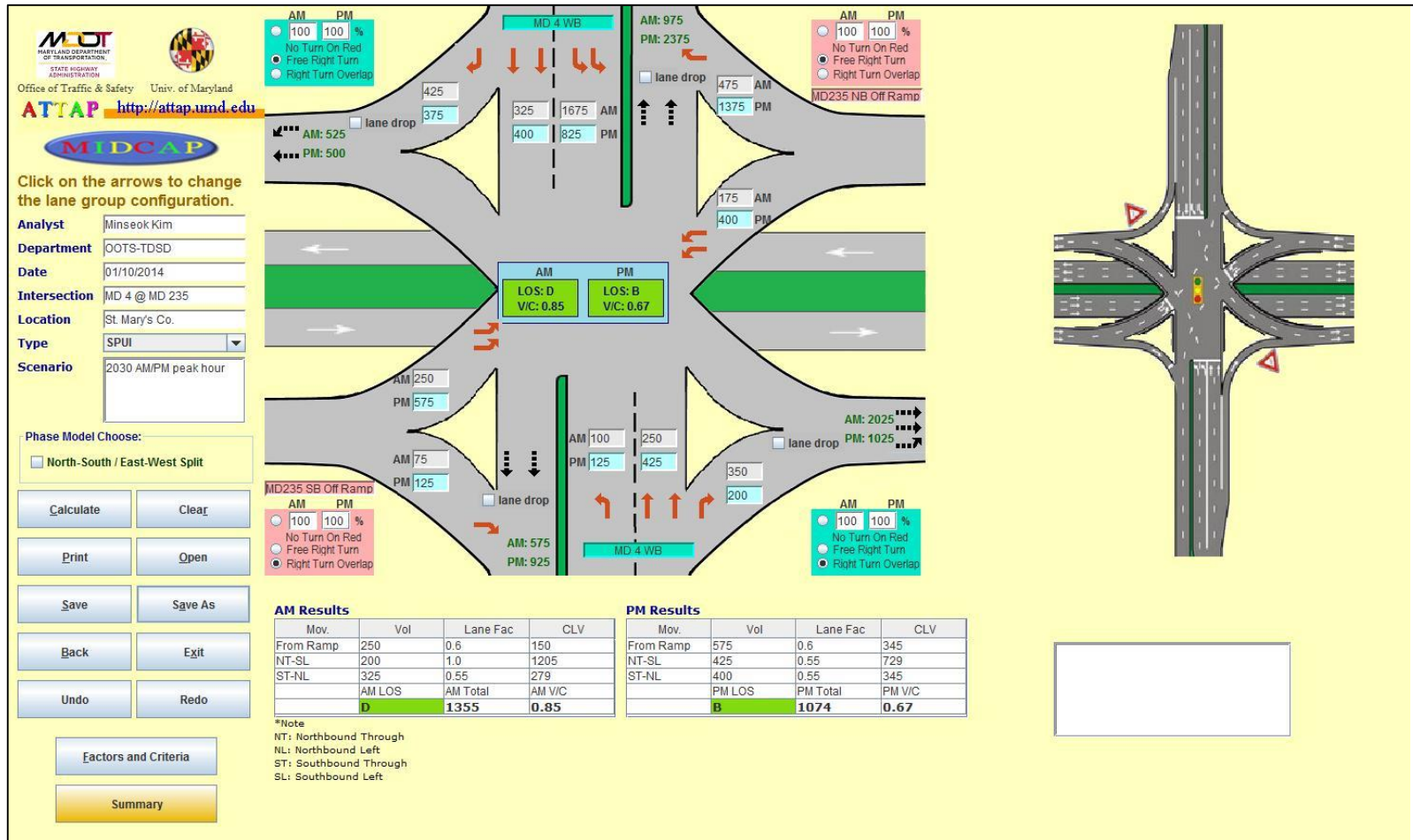
Mov.	Vol	Lane Fac	Oppo Lane	CLV	*
NB	940	0.55	275	792	0
SB	1770	0.55	0	974	974
EB Ramp	260	1.0	0	260	260
			AM LOS	AM Total	AM V/C
			C	1234	.77

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

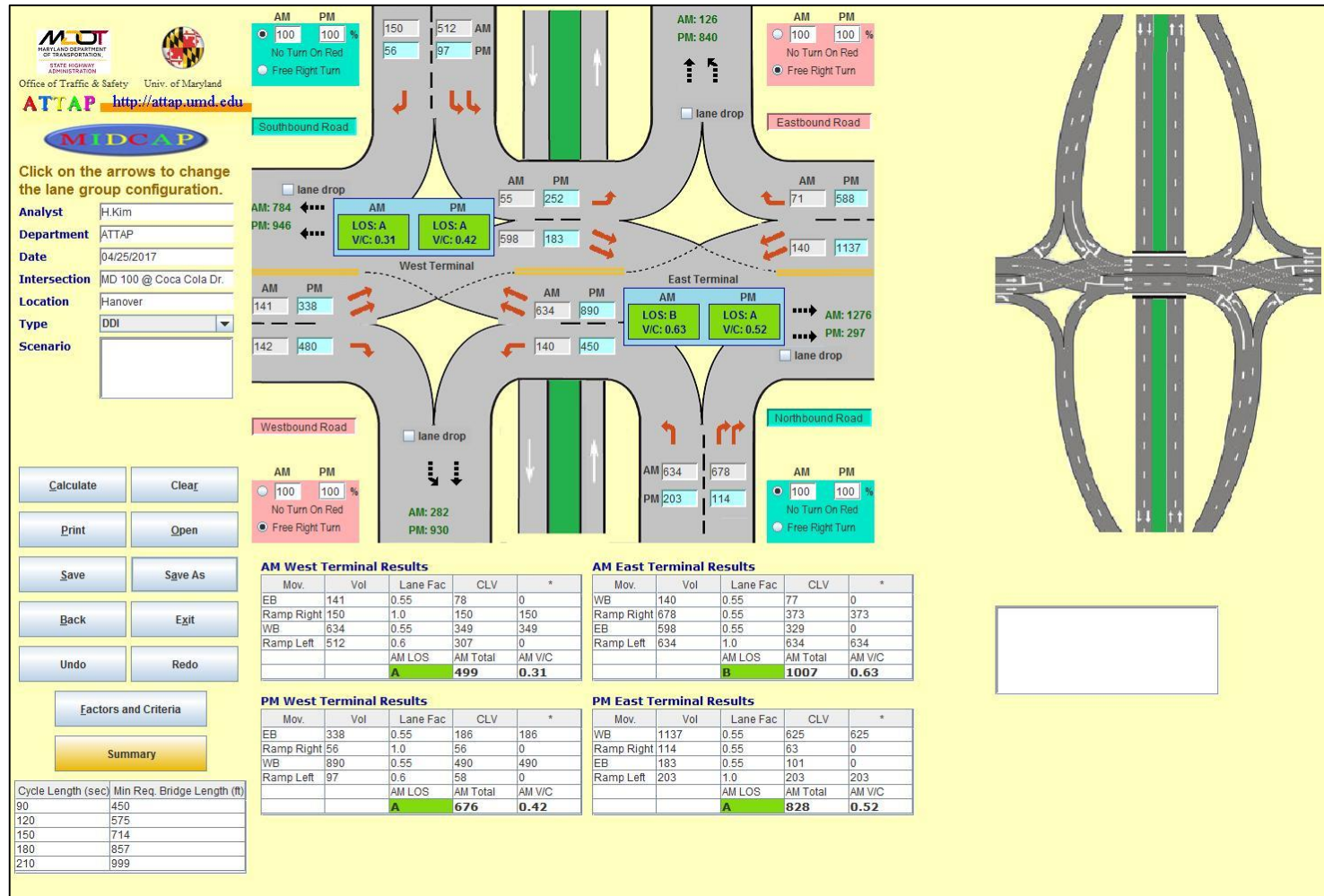
MODULE 1: CRITICAL LANE VOLUME ANALYSIS

Single Point Urban Interchange



MODULE 1: CRITICAL LANE VOLUME ANALYSIS

Diverging Diamond Interchange



MODULE 1: CRITICAL LANE VOLUME ANALYSIS

Arterial (Corridor) analysis

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

The screenshot shows the MIDCAP software window. At the top, it displays the logos for the Maryland Department of Transportation (MDOT) and the University of Maryland, along with the text 'Office of Traffic & Safety' and 'Univ. of Maryland'. Below this is the 'MIDCAP' logo. The main section is titled 'Intersection Setup'. It contains three labels: 'Number of Intersections:', 'Arterial Numbering Directions:', and 'Number of Through Lanes on Arterial:'. To the right of these labels is a vertical list of numbers from 3 to 10, with a red box highlighting the entire list. Below the list are two buttons: 'OK' and 'Back'. At the bottom, the 'ATTAP' logo is displayed next to the URL 'http://attap.umd.edu'.

MODULE 1: CRITICAL LANE VOLUME ANALYSIS

Arterial analysis

Arterial View

MIDCAP
Office of Traffic & Safety Univ. of Maryland
Click on the blue circle to input for an intersection.

Analyst: M. Kim
Department: DOTD-TDSD
Date: 12/23/2016
Arterial: MD 193 (University Blvd)
Location: Montgomery & PG County
Scenario: 2020 Build, Purple Line

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

West 1 2 3 4 5 6 7

Intersection Name: at Seek Ln. at Carroll Ave. at Merrimac Dr. at Lebanon St. at W. S hop Center at Takoma Langley at MD 650

AM Peak: A: 0.54 D: 0.84 A: 0.53 A: 0.55 A: 0.59 A: 0.54 D: 0.90
LOS V/C

PM Peak: A: 0.52 C: 0.78 A: 0.56 B: 0.63 C: 0.74 A: 0.50 E: 0.81
LOS V/C

Type: 3 leg 4 leg 4 leg 3 leg 4 leg 4 leg 4 leg

Buttons: Back, Print, Open, Save, Save As, Add, Remove, Summary

Individual Intersection View

MIDCAP
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: DOTD-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

Buttons: Calculate, Clear, Print, Open, Save, Save As, Back, Queue, Undo, Redo, Factors And Criteria

Intersection Diagram: Merrimac Dr. (SB), University Blvd (WB), University Blvd (EB), Merrimac Dr. (NB)

AM Results:

Mov.	Vol	Lane Fac	Lane Vol	Oppo Lefts	CLV	*
NB	0	0.00	0	0	0	
SB	1047	1.00	10	0	10	
WB	1437	0.55	790	52	842	842
EB	1005	0.55	553	107	660	
			AM Total	852	AM V/C	
			AM LOS	A	0.53	

PM Results:

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 V/C	
			PM LOS	A	0.56	

Note: *: Volume subtracted by right turn overlap

MODULE 1: CRITICAL LANE VOLUME ANALYSIS

Multi-hour analysis

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

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

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

Click on the arrows to change the lane group configuration.

Analyst: H. Kim
Department: ATTAP
Date: 04/25/2017
Intersection: MD 97 at MD 192
Location: Montgomery Co.
Type: I-Long
Scenario:

Phase Split:
☐ Split NB and SB
☐ Split EB and WB

Buttons: Open, Clear, Save, Save As, Back, Print, Factors And Criteria

1. Select Lane configurations
2. Choose Right Turn control type and Phase Split
3. Input traffic count
4. Results

Input traffic count

Load the .xls traffic count file or type into the table below.
(If Load fails, see Sample and compare file formats)

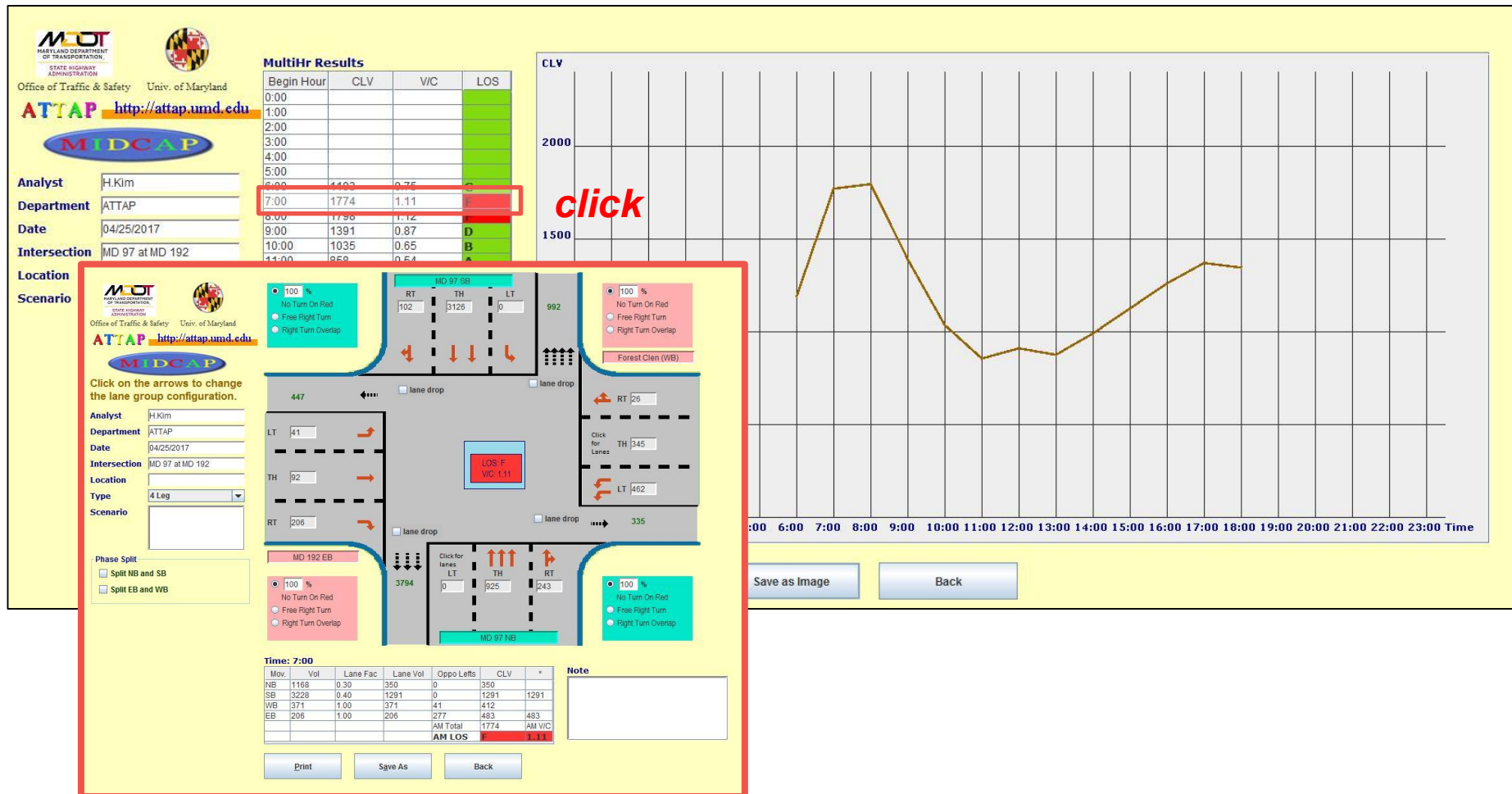
	MD 97 SB				MD 97 NB				Forest Glen (WB)				MD 192 EB				
Start	L	T	R	TOT	L	T	R	TOT	L	T	R	TOT	L	T	R	TOT	ALL
0:00																	
1:00																	
2:00																	
3:00																	
4:00																	
5:00																	
6:00	5	2264	36	2305	20	552	301	873	267	198	48	513	16	47	113	176	3867
7:00	0	3126	102	3228	0	925	243	1168	462	345	26	833	41	92	206	339	5568
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	86	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	265	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																	

File path:

Buttons: Load, See Sample, Clear, Back

MODULE 1: CRITICAL LANE VOLUME ANALYSIS

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



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

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

MIDCAP

Analyst: HKM
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

Calculate Clear
Load See Sample
Open Print
Save Save As
Back Exit

Input/Summary W9 Input W1A W1B W2 W3 W9

1 Hour Interval
15 Minute Interval

Volume

Major Street MD 187
Minor Street Cordell Ave

	From North				From South				From East				From West				
Start	L	T	R	TOT	L	T	R	TOT	L	T	R	TOT	L	T	R	TOT	ALL
5:00	0	0	0	0	0	0	0	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	811	74	887	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	128	8	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

- ☒ 1. Eight-hour vehicular volume
- ☒ 2. Four-hour vehicular volume
- ☒ 3. Peak Hour
- ☐ 9. Intersection Near a Grade Crossing




Warrants Satisfied

- YES
- YES
- YES
- 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	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

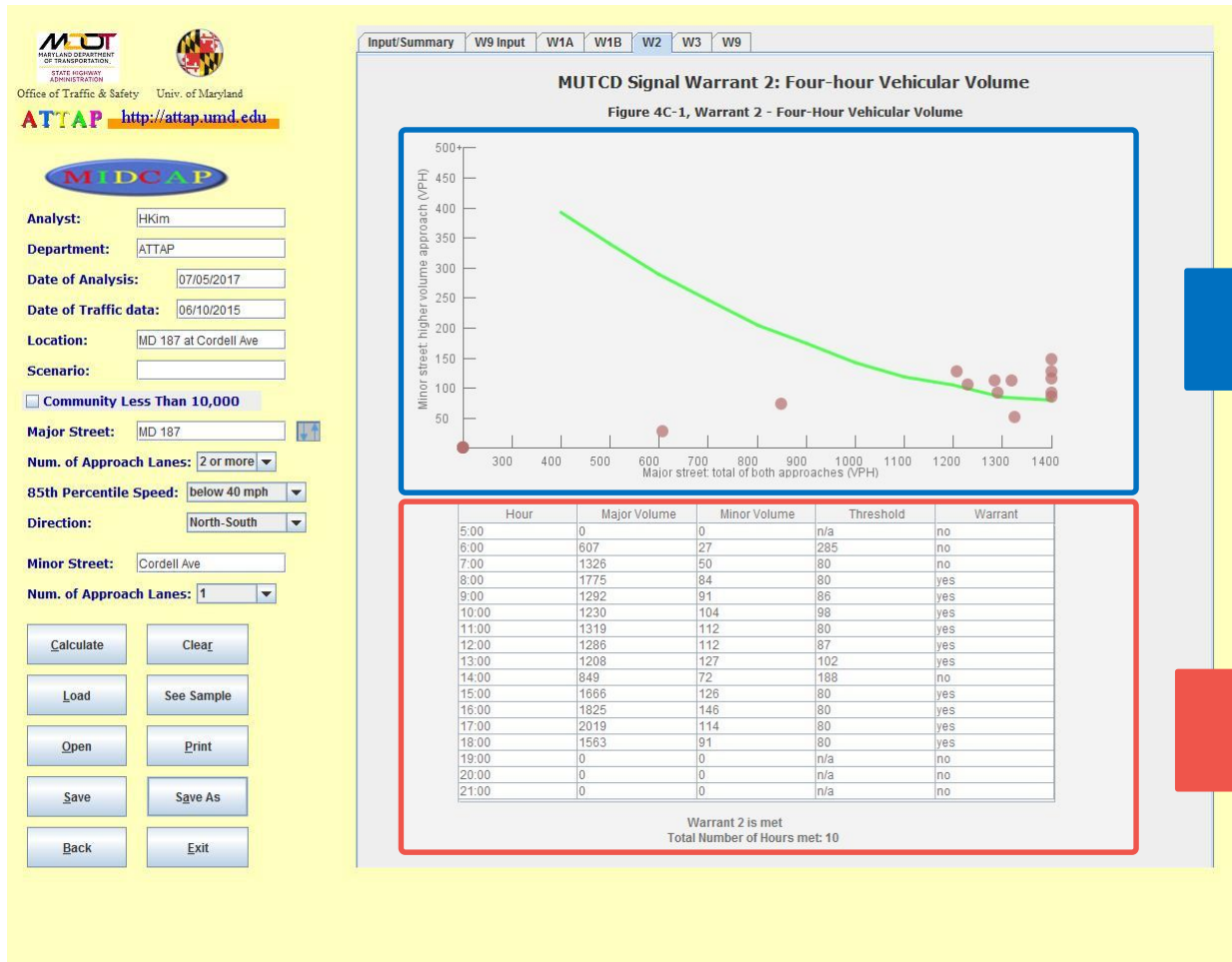
Condition A is not met
Total Number of Hours met: 3

Evaluation
criteria

Evaluation
results

MODUE 2: SIGNAL WARRANT

Evaluation results for Warrant 2



Evaluation
criteria

Evaluation
results

MODUE 2: SIGNAL WARRANT

Evaluation results for Warrant 9

MDOT
Office of Traffic & Safety
ATTAP - <http://attap.umd.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

Calculate Clear Load Open Save Back

Warrant 9, Intersection Near a Grade Crossing

Step 1: Enter the clear storage distance D.

Step 2: Choose the adjustment factors.

Table 4C-2. Warrant 9, Adjustment Factor for Daily Frequency of Rail Traffic

Rail Traffic/Daily	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"/>

Table 4C-3. Warrant 9, Adjustment Factor for Percentage of High-Occupancy Buses

% 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"/>

Table 4C-4. Warrant 9, Adjustment Factor for Percentage of Tractor-Trailer Trucks

% 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

MDOT
Office of Traffic & Safety
ATTAP - <http://attap.umd.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

Calculate Clear Load Open Save Back

Warrant 9, Intersection Near a Grade Crossing

Figure 4C-9. Warrant 9, Intersection near a Grade Crossing
One Approach Lane at the Track Crossing

Warrant 9 is met
Total Number of Hours met: 13

Hour	Major Volume	Adjusted Minor Volu.	Threshold	Warrant
6:00	0	0	25	no
7:00	1326	50	25	yes
8:00	1775	84	25	yes
9:00	1292	91	25	yes
10:00	1230	104	25	yes
11:00	1319	112	25	yes
12:00	1286	112	25	yes
13:00	1208	127	25	yes
14:00	849	72	25	yes
15:00	1066	126	25	yes
16:00	1825	146	25	yes
17:00	2019	114	25	yes
18:00	1563	91	25	yes
19:00	0	0	25	no
20:00	0	0	25	no
21:00	0	0	25	no

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

Maryland Department of Transportation
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

Shoulder Bypass Lane Warrant

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	294	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			

Prevaling 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

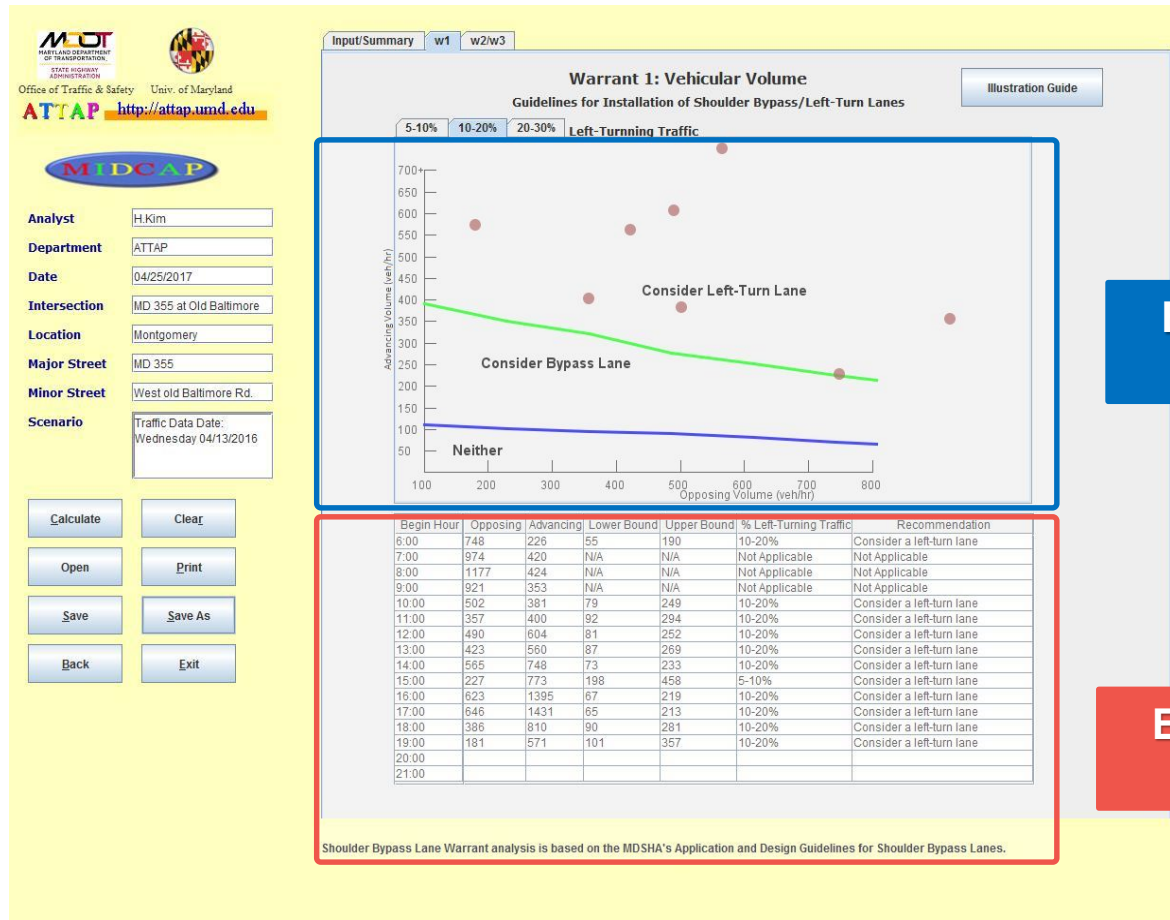
1. Vehicular Volume	No (Consider a left turn lane)
2. Stopping Sight Distance	N/A
3. Accident History	N/A

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




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

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?
☐ Yes ☒ No

If 2 lanes, is volume cross-product >100,000?
☐ Yes ☒ No

Is opposing speed > 45 mph?
☐ Yes ☒ No

Is sight distance restricted?
☐ Yes ☒ No

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

3 lanes

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

Is opposing speed > 45 mph?
☐ Yes ☒ No

Is sight distance restricted?
☐ Yes ☒ No

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

Consider EXCLUSIVE*

Consider EXCLUSIVE**

Consider EXCLUSIVE

Consider EXCLUSIVE PERMISSIVE

Consider EXCLUSIVE

Consider EXCLUSIVE

Consider EXCLUSIVE

Consider PERMISSIVE


* 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 Sam DeLaurence
Department District 7, Traffic Division
Date 07/25/2016
Intersection MD 26 at MD31
Location Frederick
Scenario

Open Clear

Save Save As

Print Back

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

<http://attap.umd.edu>