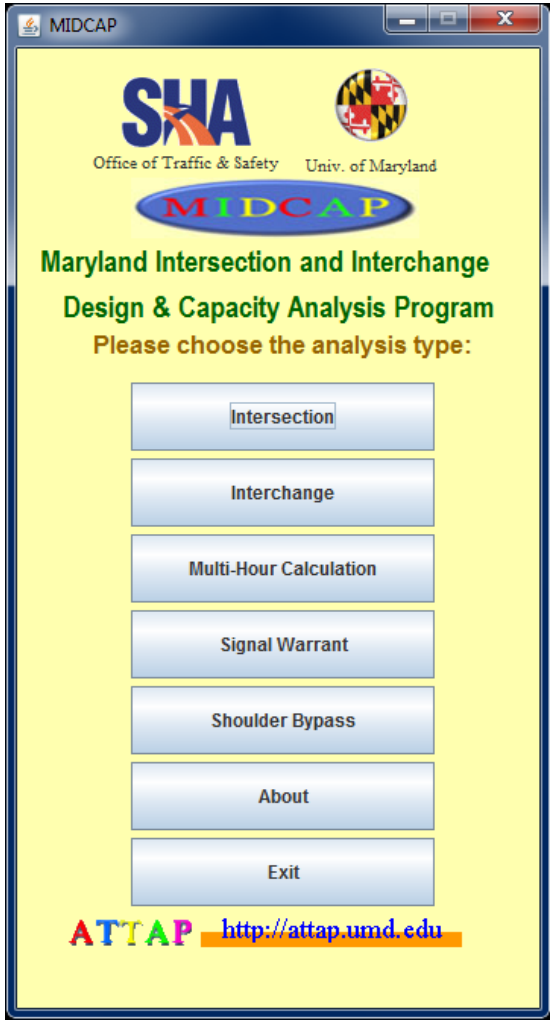


MIDCAP

Maryland Intersection and Interchange Design & Capacity Analysis Program

INTRODUCTION

- **M**aryland **I**ntersection and Interchange **D**esign & **C**apacity **A**nalysis **P**rogram (**MIDCAP**)
- Developed by University of Maryland, College Park and MDSHA
- A tool to conduct a capacity/ queuing analysis for signalized intersections and interchanges, signal warrant and shoulder bypass analysis at the preliminary, planning, or design stage



MODULES

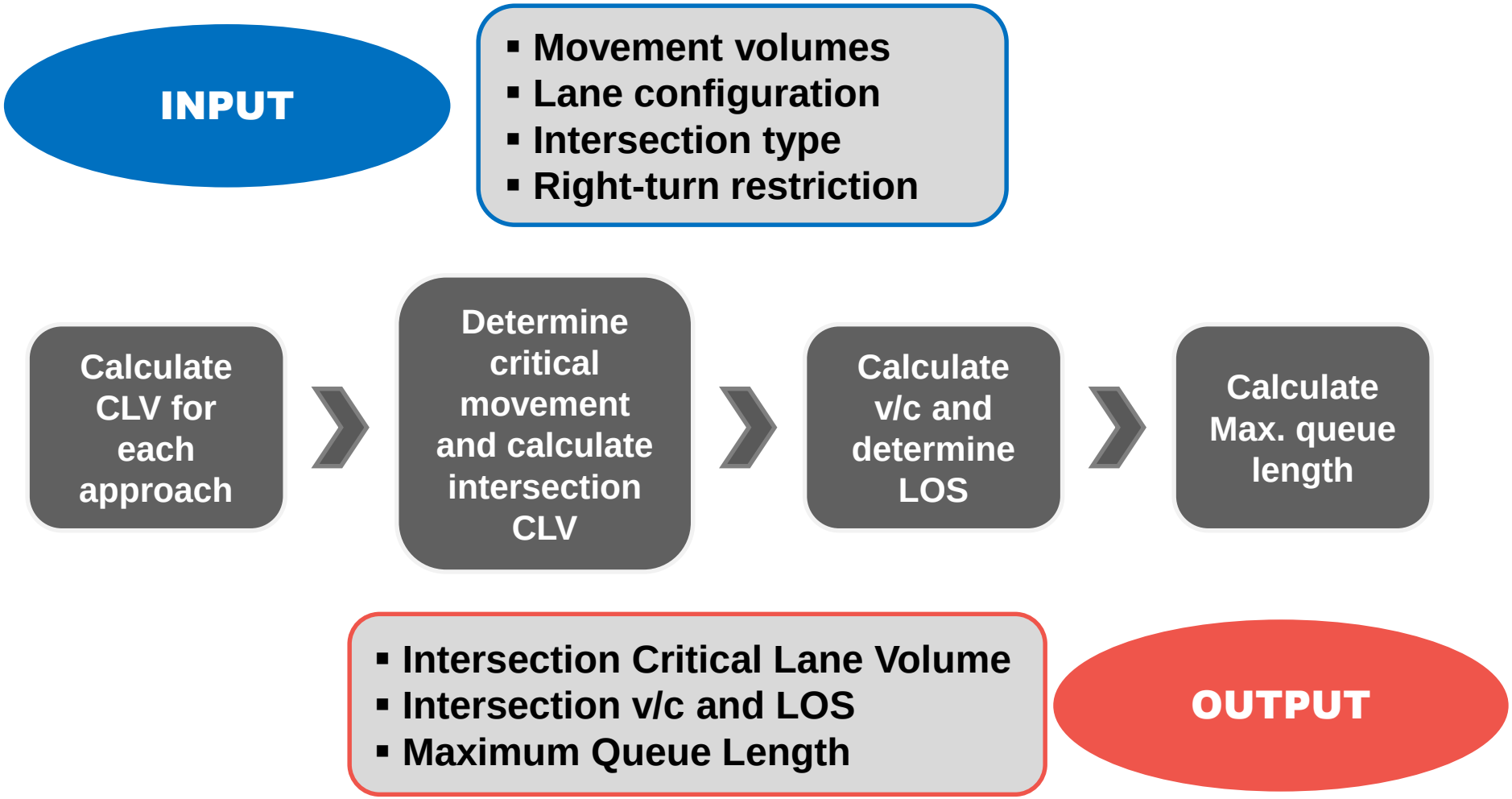
- Capacity and queue analysis
  - for signalized Intersections
  - for signalized interchanges
- Signal Warrant
- Shoulder Bypass Lanes (SBLs) Warrant

MODULE 1: CAPACITY AND QUEUE ANALYSIS

- Uses the CLV method and MDSHA's Queuing analysis procedure
- Provides the volume-to-capacity ratio and corresponding level of service associated with a particular intersection/interchange design, given hourly turning movement volumes, lane configurations, right turn restrictions, and phase control (split or non-split)
- Considers different types of intersection/interchange from conventional design (4 leg, 3 leg, diamond intersection) to unconventional design (Continuous Flow Intersection, Single Point Urban Interchange, and Diverging Diamond Interchange)

MODULE 1: CAPACITY AND QUEUE ANALYSIS

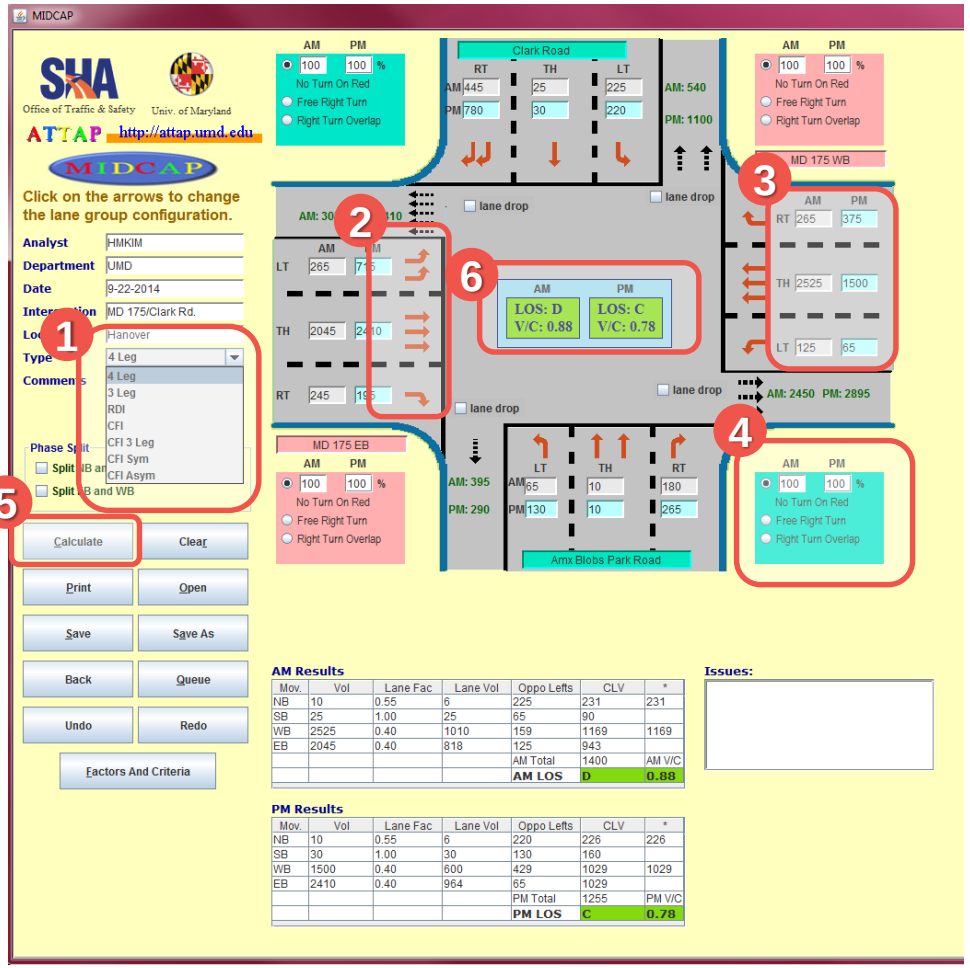
- Framework



MODULE 1: CAPACITY AND QUEUE ANALYSIS

User-friendly interface

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

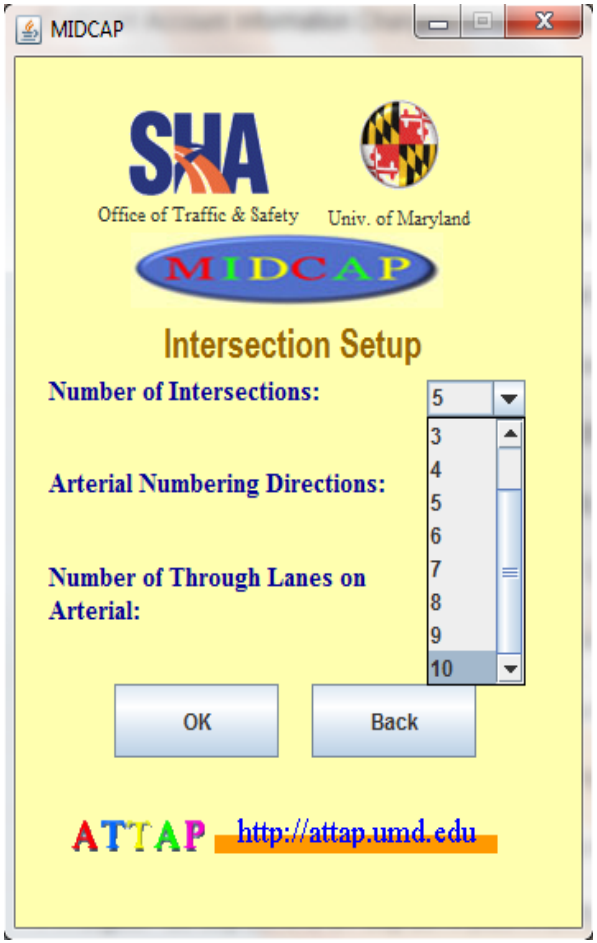


Mov.	Vol	Lane Fac	Lane Vol	Oppo Lefts	CLV	*
NB	10	0.55	6	225	231	231
SB	25	1.00	25	65	90	
WB	2525	0.40	1010	159	1169	1169
EB	2045	0.40	818	125	943	
				AM Total	1400	AM V/C
				AM LOS	D	0.88

Mov.	Vol	Lane Fac	Lane Vol	Oppo Lefts	CLV	*
NB	10	0.55	6	220	226	226
SB	30	1.00	30	130	160	
WB	1500	0.40	600	429	1029	1029
EB	2410	0.40	964	65	1029	
				PM Total	1255	PM V/C
				PM LOS	C	0.78

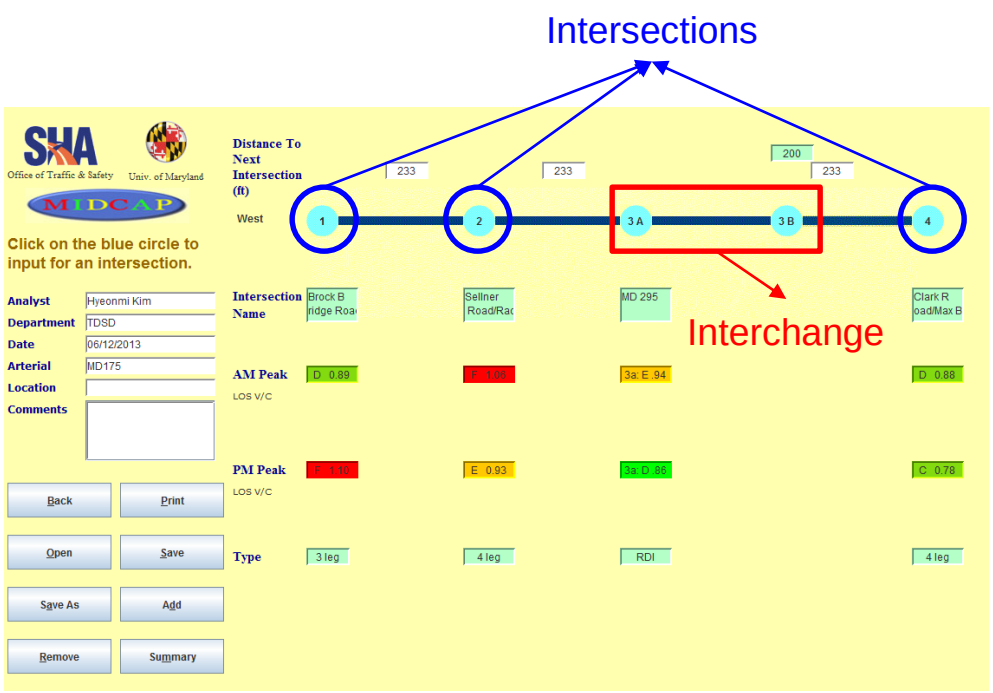
MODULE 1: CAPACITY AND QUEUE ANALYSIS

- Multiple intersections analysis
  - Corridor analysis
  - Up to 10 intersections



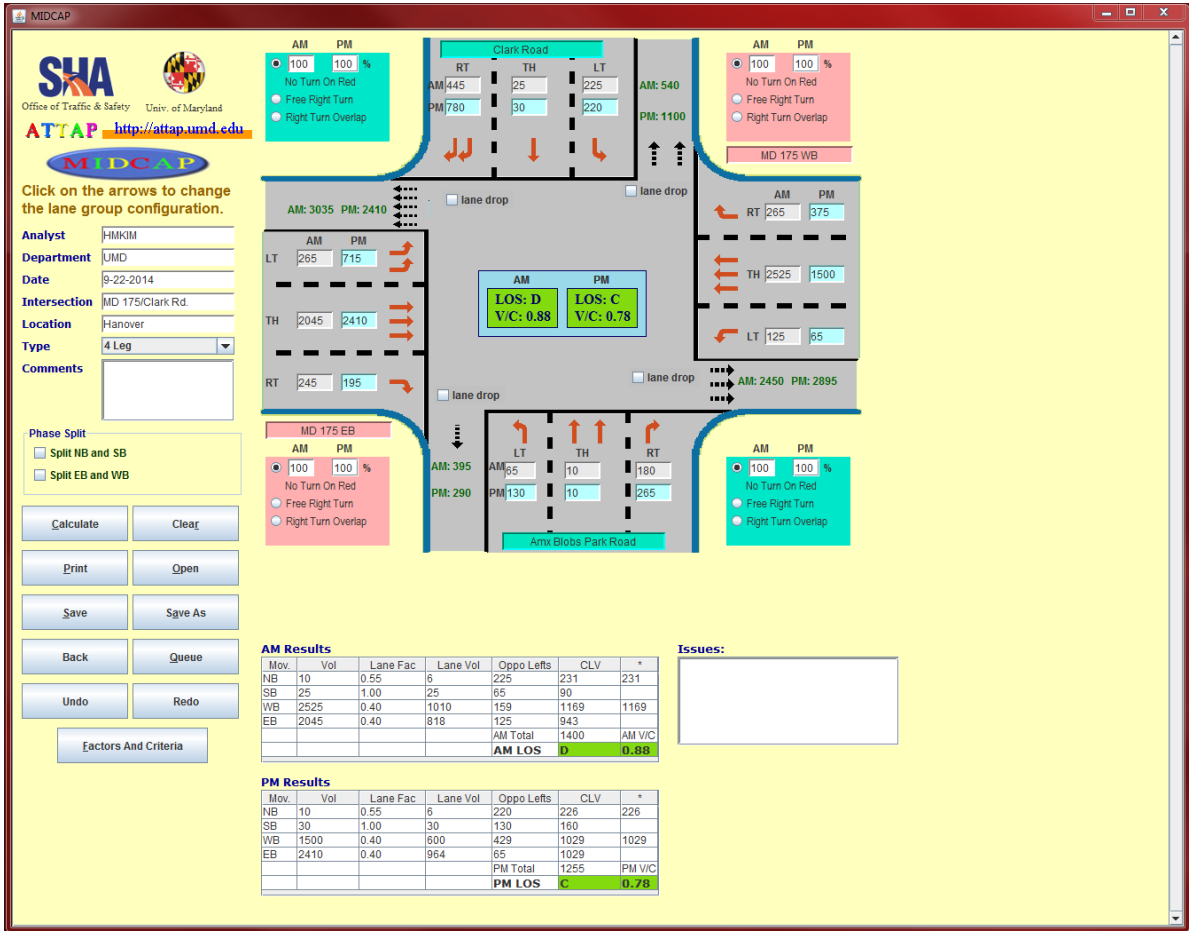
MODULE 1: CAPACITY AND QUEUE ANALYSIS

- Integration of intersection and interchange designs
  - On the multiple intersection analysis



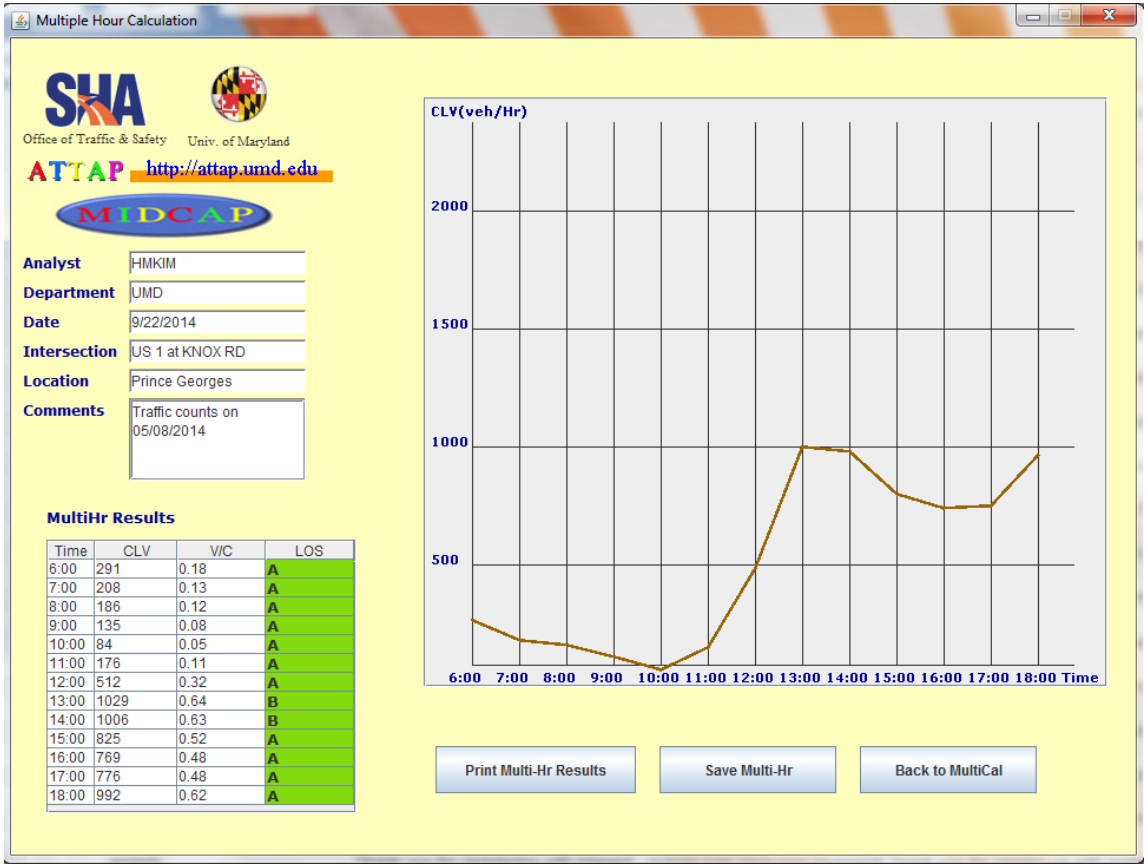
MODULE 1: CAPACITY AND QUEUE ANALYSIS

- Analysis for both AM and PM peak hours at a time



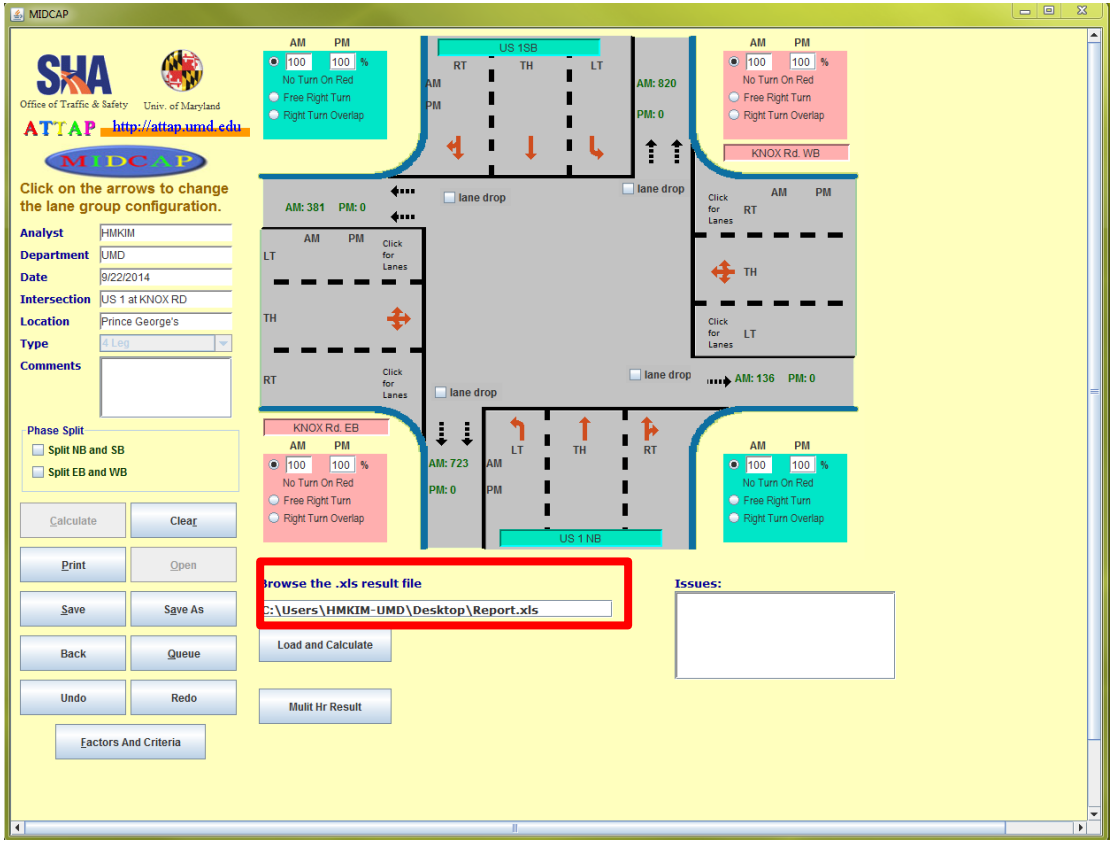
MODULE 1: CAPACITY AND QUEUE ANALYSIS

- Multi-hour analysis



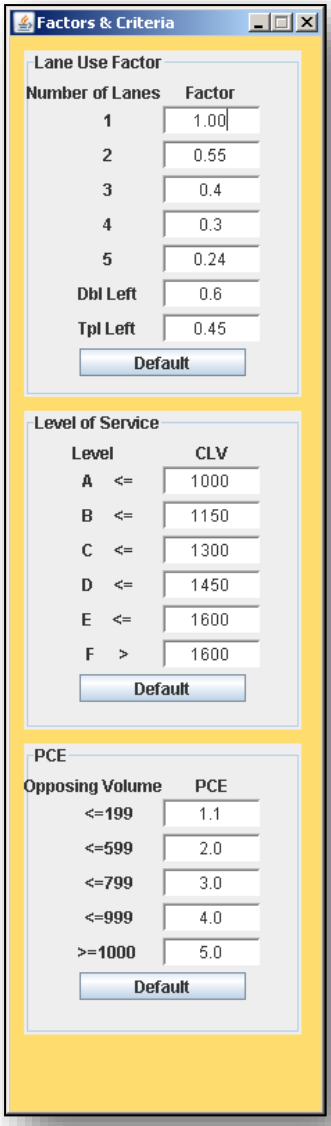
MODULE 1: CAPACITY AND QUEUE ANALYSIS

- Import a report from Internet Traffic Monitoring System (I-TMS) as traffic volume input



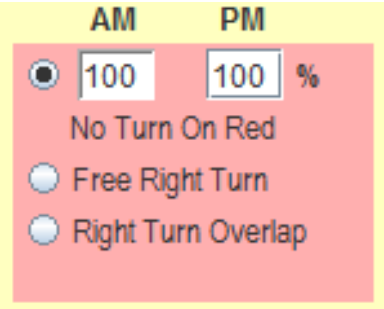
MODULE 1: CAPACITY AND QUEUE ANALYSIS

- Factors and Criteria
  - Editable Lane Use Factors, LOS criteria, and PCE values
  - Can be applied in different intersections and different approaches
  - Default values (see tables)



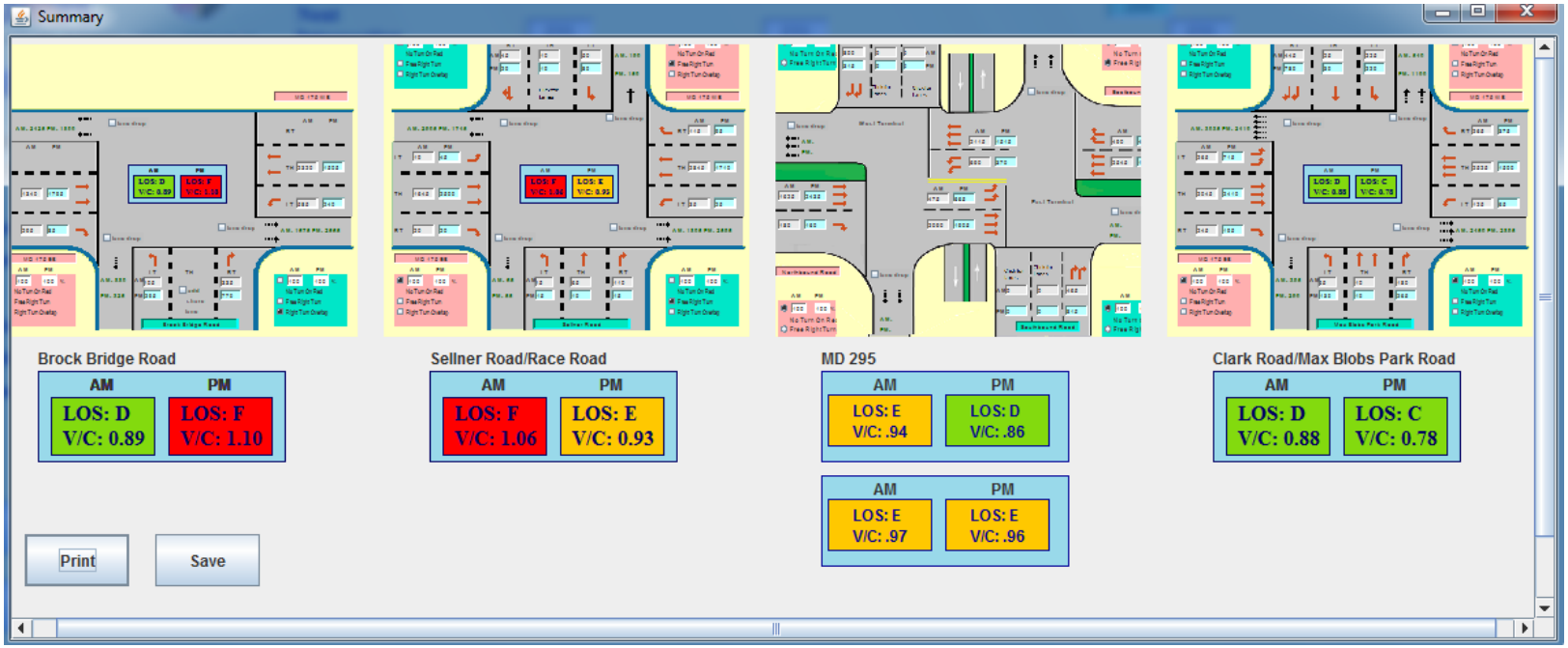
MODULE 1: CAPACITY AND QUEUE ANALYSIS

- Right turn restriction
  - Percentage of no-turn-on-red traffic
  - Free right turn
  - Right turn overlap



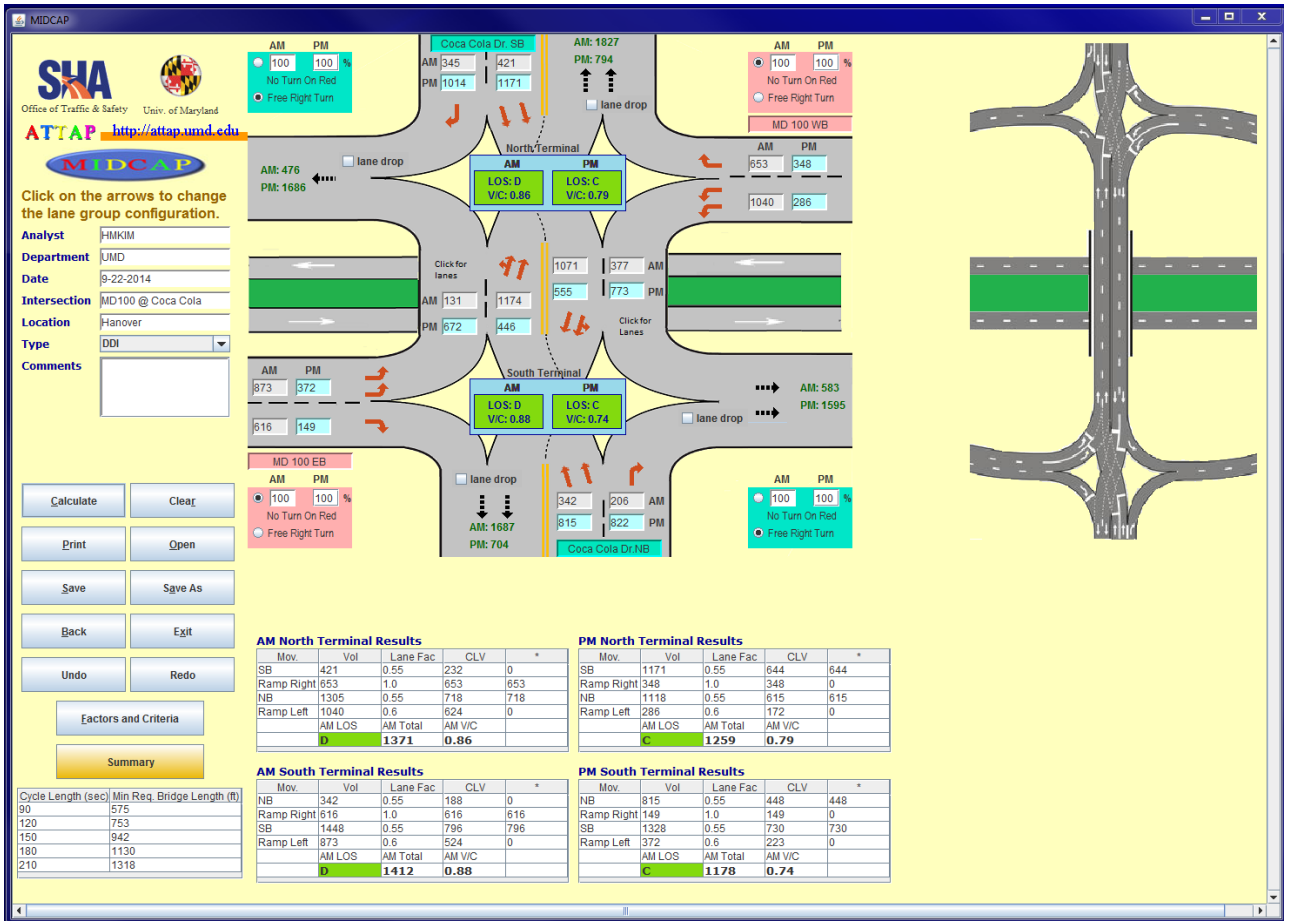
MODULE 1: CAPACITY AND QUEUE ANALYSIS

- Comparison summary



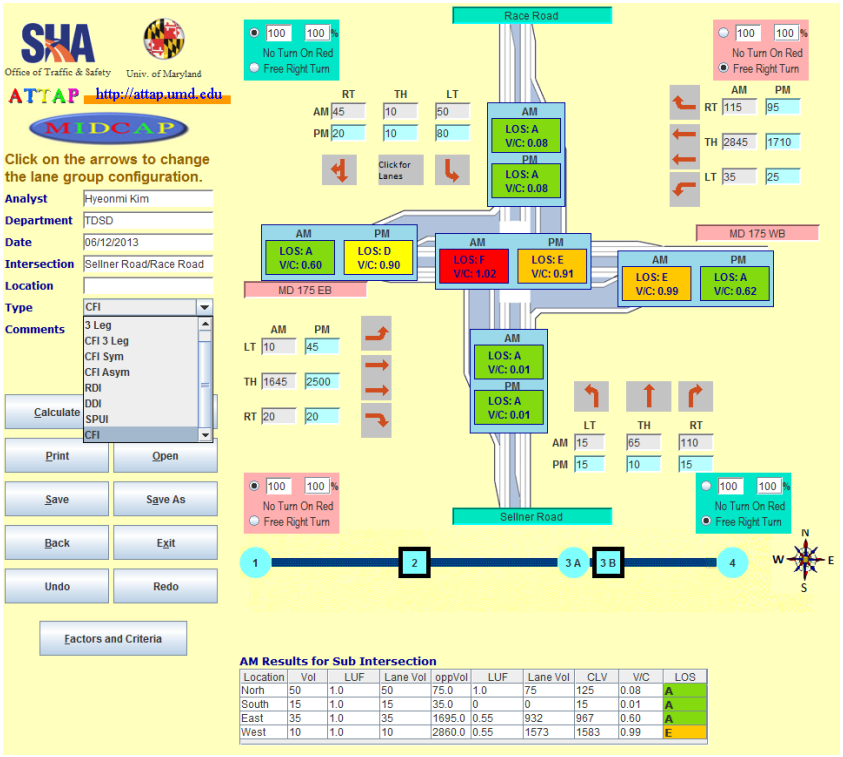
MODULE 1: CAPACITY AND QUEUE ANALYSIS

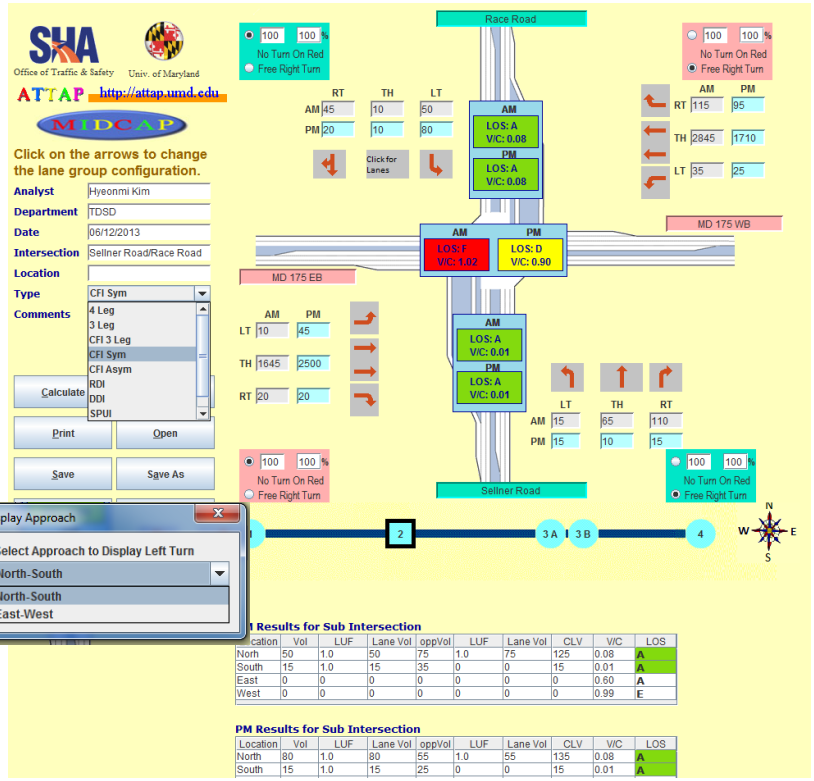
- Recommended bridge length for DDI design



MODULE 1: CAPACITY AND QUEUE ANALYSIS

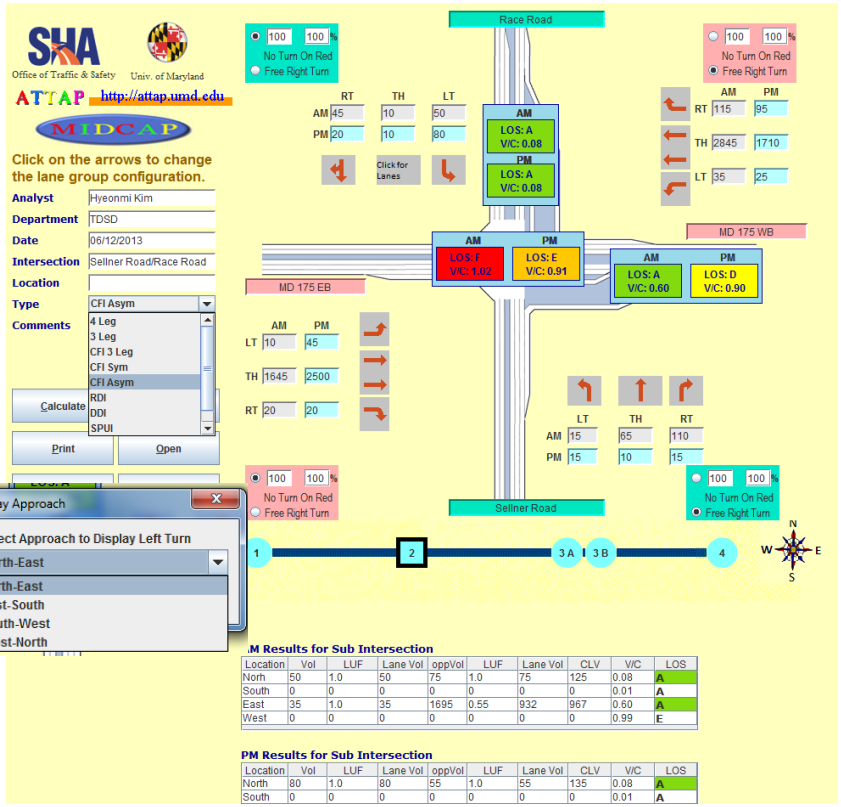
- Different intersection and interchange designs
  - Full CFI
  - Symmetric CFI

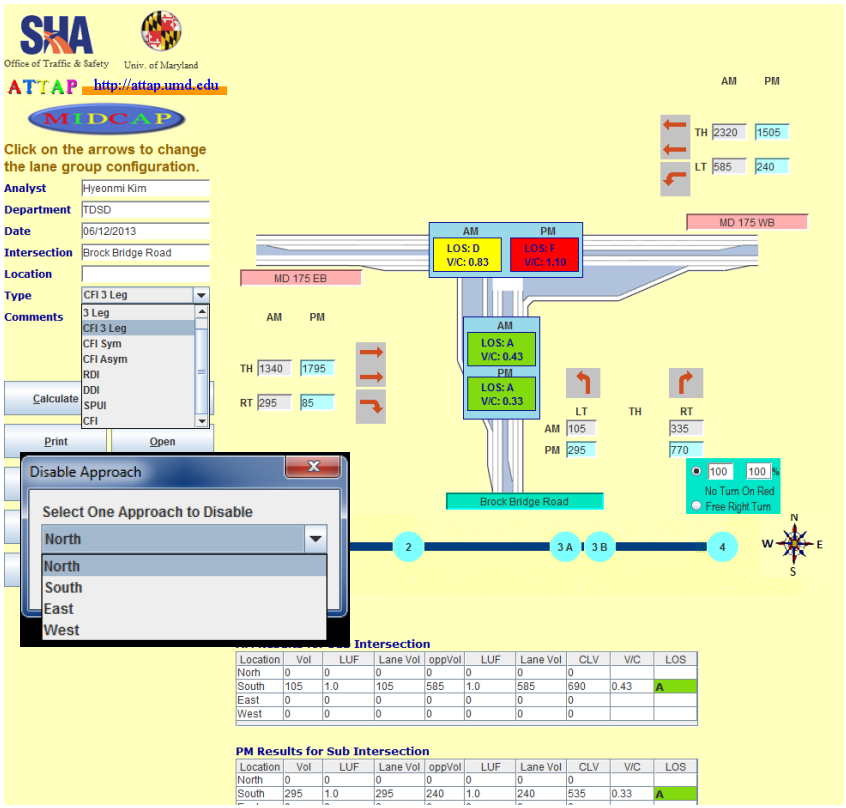




MODULE 1: CAPACITY AND QUEUE ANALYSIS

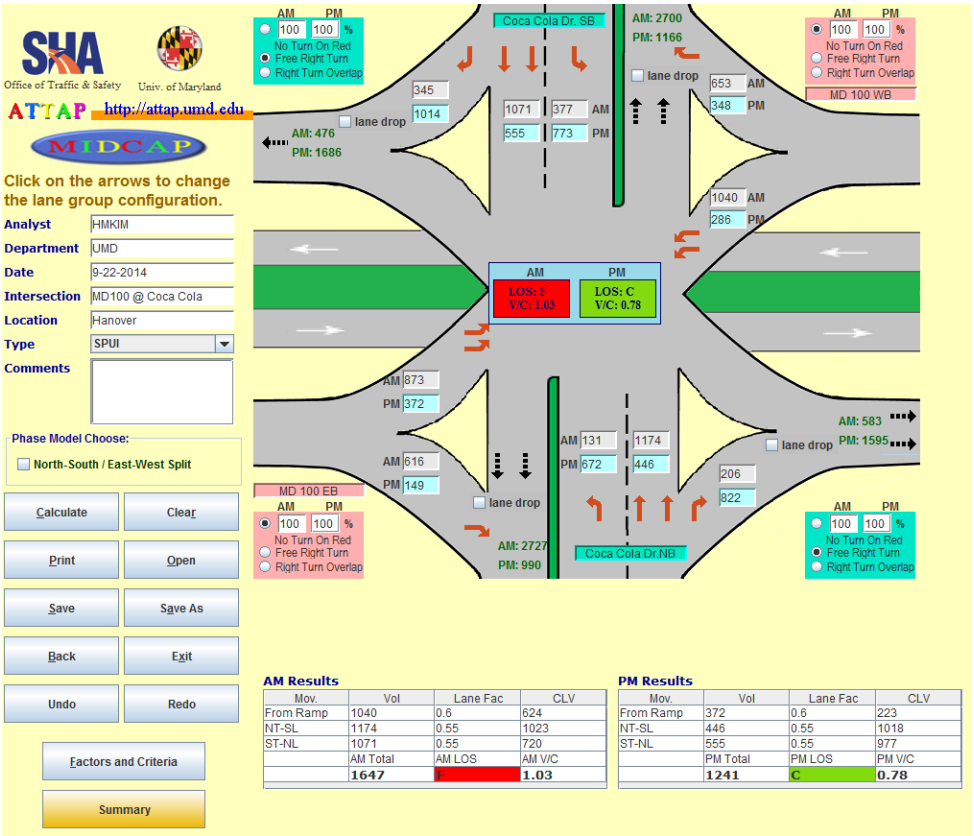
- Different intersection and interchange designs
  - Asymmetric CFI
  - CFI-T





MODULE 1: CAPACITY AND QUEUE ANALYSIS

- Different intersection and interchange designs
  - SPUI
  - DDI

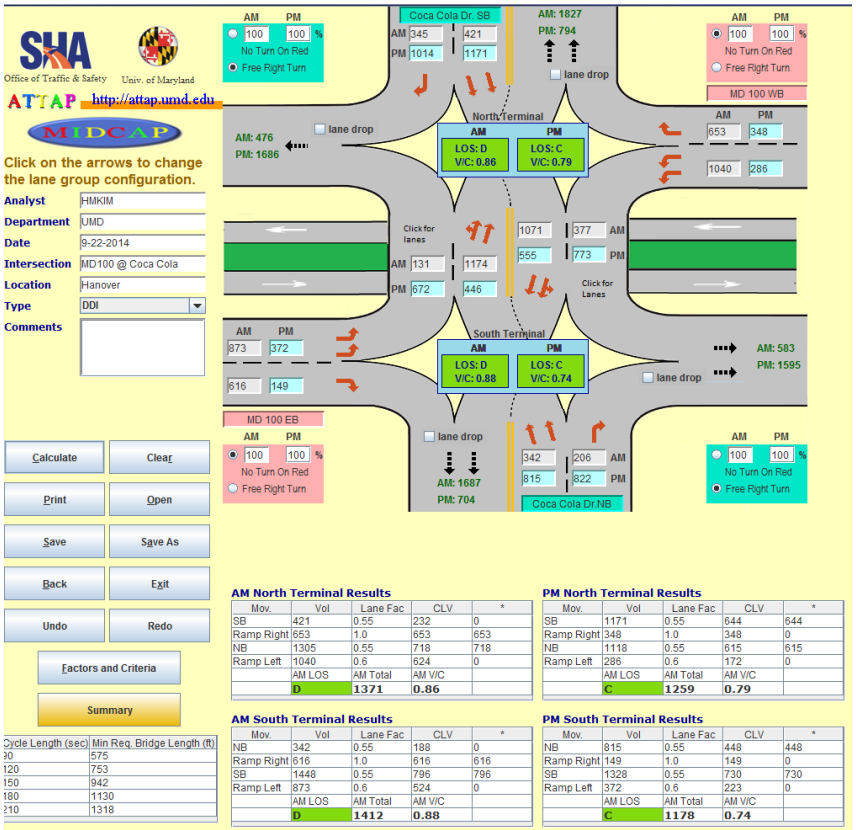


AM Results

Mov.	Vol	Lane Fac	CLV
From Ramp	1040	0.6	624
NT-SL	1174	0.55	1023
ST-NL	1071	0.55	720
	AM Total	AM LOS	AM V/C
	1647	**F**	**1.03**

PM Results

Mov.	Vol	Lane Fac	CLV
From Ramp	372	0.6	223
NT-SL	446	0.55	1018
ST-NL	555	0.55	977
	PM Total	PM LOS	PM V/C
	1241	**C**	**0.78**



Cycle Length (sec)	Min Req. Bridge Length (ft)
90	575
120	753
150	942
180	1130
210	1318

AM North Terminal Results

Mov.	Vol	Lane Fac	CLV	*
SB	421	0.55	232	0
Ramp Right	653	1.0	653	653
NB	1305	0.55	718	718
Ramp Left	1040	0.6	624	0
	AM LOS	AM Total	AM V/C	
	D	**1371**	**0.86**	

PM North Terminal Results

Mov.	Vol	Lane Fac	CLV	*
SB	1171	0.55	644	644
Ramp Right	348	1.0	348	0
NB	1118	0.55	615	615
Ramp Left	286	0.6	172	0
	AM LOS	AM Total	AM V/C	
	C	**1259**	**0.79**	

AM South Terminal Results

Mov.	Vol	Lane Fac	CLV	*
NB	342	0.55	188	0
Ramp Right	616	1.0	616	616
SB	1448	0.55	796	796
Ramp Left	873	0.6	524	0
	AM LOS	AM Total	AM V/C	
	D	**1412**	**0.88**	

PM South Terminal Results

Mov.	Vol	Lane Fac	CLV	*
NB	815	0.55	448	448
Ramp Right	149	1.0	149	0
SB	1328	0.55	730	730
Ramp Left	372	0.6	223	0
	AM LOS	AM Total	AM V/C	
	C	**1178**	**0.74**	

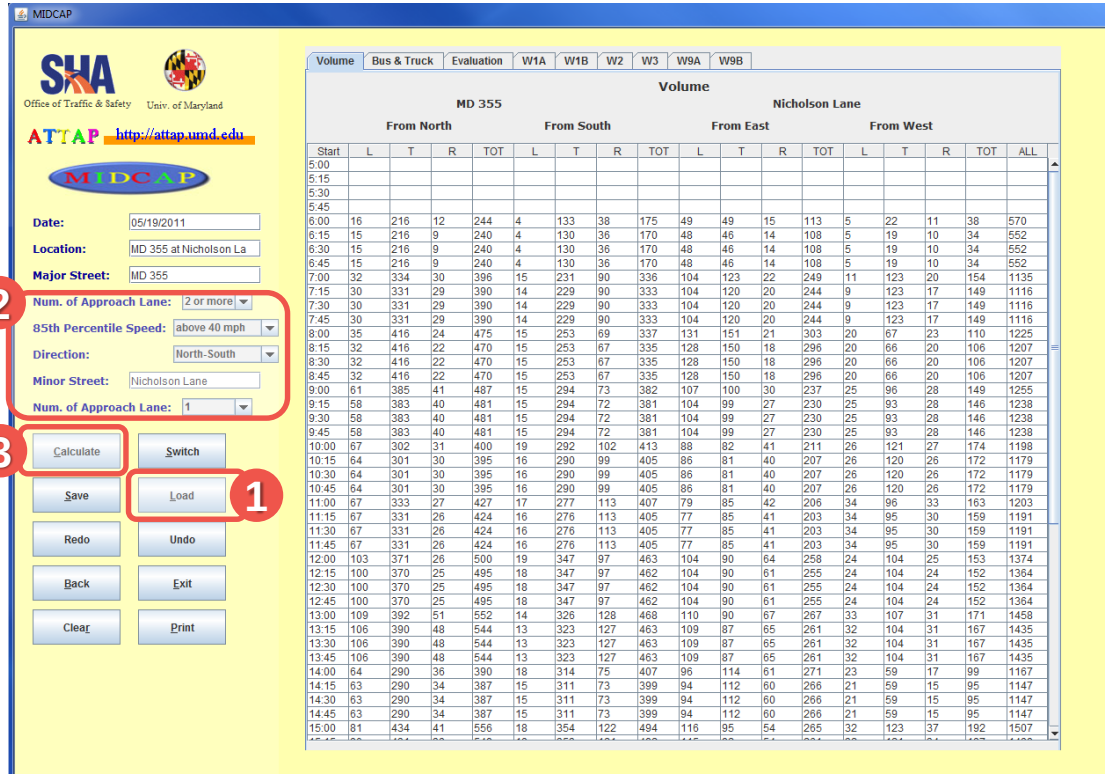
MODULE 2: SIGNAL WARRANT

- Uses the Maryland Manual on Uniform Traffic Control Devices (MUTCD) 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

MODULE 2: SIGNAL WARRANT

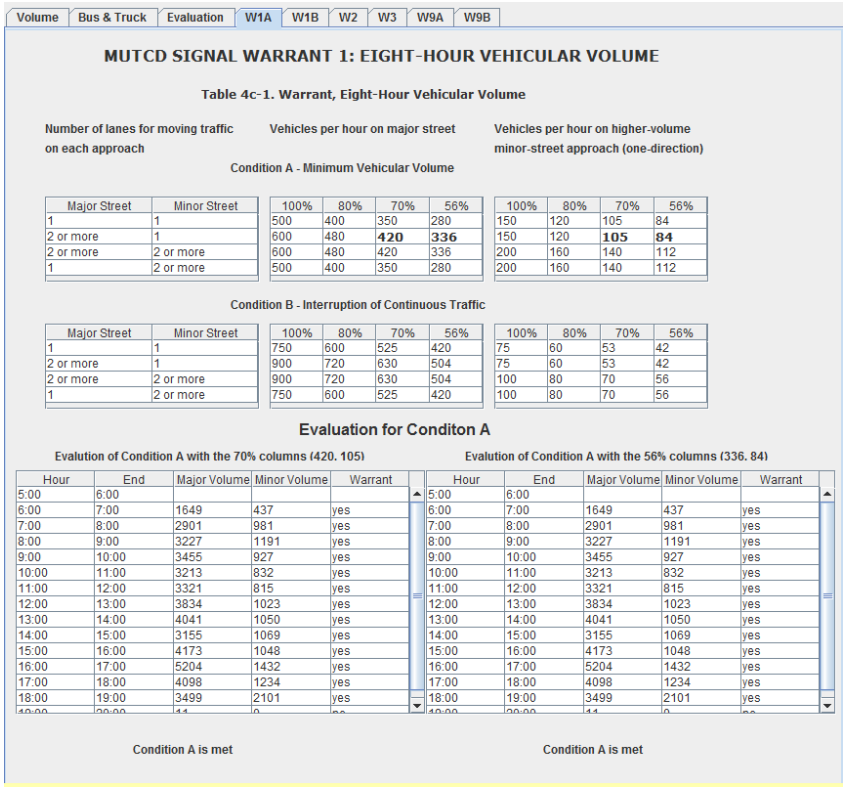
- User-friendly Interface
  - Import a turning movement report from Internet Traffic Monitoring System (I-TMS) as input

1. **Load Traffic volume data**
2. **Set Location-specific Characteristics**
3. **Click Calculate button**



MODULE 2: SIGNAL WARRANT

- User-friendly Interface
  - Evaluation results for Warrant 1



Volume | Bus & Truck | Evaluation | W1A | W1B | W2 | W3 | W9A | W9B

MUTCD SIGNAL WARRANT 1: EIGHT-HOUR VEHICULAR VOLUME

Table 4c-1. Warrant, 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

Condition B - Interruption of Continuous Traffic

Major Street	Minor Street	100%	80%	70%	56%	100%	80%	70%	56%
1	1	750	600	525	420	75	60	53	42
2 or more	1	900	720	630	504	75	60	53	42
2 or more	2 or more	900	720	630	504	100	80	70	56
1	2 or more	750	600	525	420	100	80	70	56

Evaluation for Conditon A

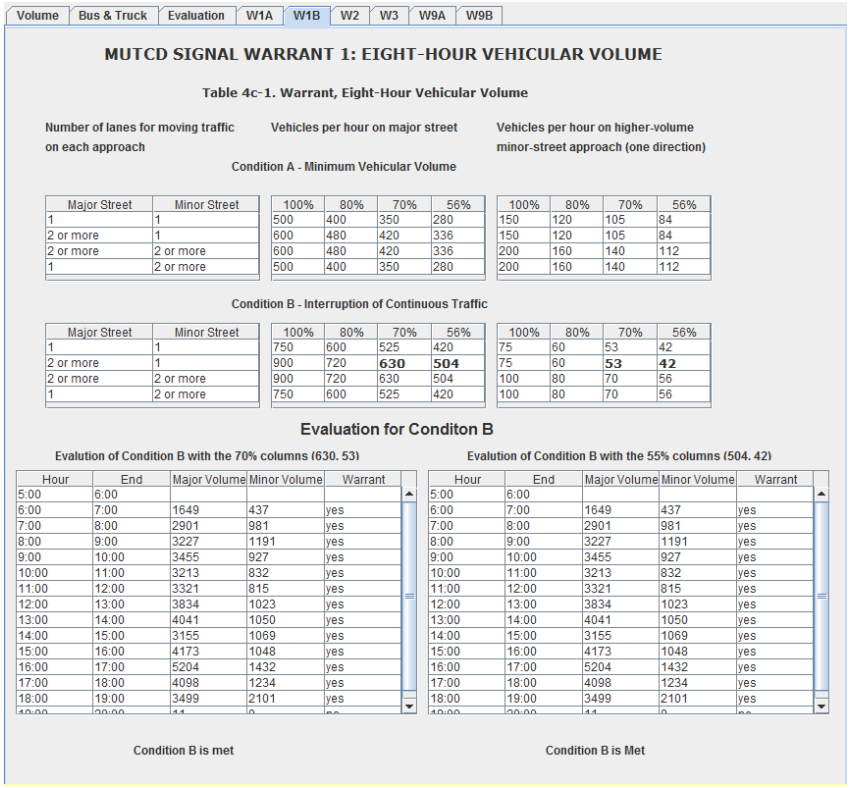
Evalution of Condition A with the 70% columns (420, 105)

Hour	End	Major Volume	Minor Volume	Warrant
5:00	6:00			
6:00	7:00	1649	437	yes
7:00	8:00	2901	981	yes
8:00	9:00	3227	1191	yes
9:00	10:00	3455	927	yes
10:00	11:00	3213	832	yes
11:00	12:00	3321	815	yes
12:00	13:00	3834	1023	yes
13:00	14:00	4041	1050	yes
14:00	15:00	3155	1069	yes
15:00	16:00	4173	1048	yes
16:00	17:00	5204	1432	yes
17:00	18:00	4098	1234	yes
18:00	19:00	3499	2101	yes

Evalution of Condition A with the 56% columns (336, 84)

Hour	End	Major Volume	Minor Volume	Warrant
5:00	6:00			
6:00	7:00	1649	437	yes
7:00	8:00	2901	981	yes
8:00	9:00	3227	1191	yes
9:00	10:00	3455	927	yes
10:00	11:00	3213	832	yes
11:00	12:00	3321	815	yes
12:00	13:00	3834	1023	yes
13:00	14:00	4041	1050	yes
14:00	15:00	3155	1069	yes
15:00	16:00	4173	1048	yes
16:00	17:00	5204	1432	yes
17:00	18:00	4098	1234	yes
18:00	19:00	3499	2101	yes

Condition A is met | Condition A is met



Volume | Bus & Truck | Evaluation | W1A | W1B | W2 | W3 | W9A | W9B

MUTCD SIGNAL WARRANT 1: EIGHT-HOUR VEHICULAR VOLUME

Table 4c-1. Warrant, 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

Condition B - Interruption of Continuous Traffic

Major Street	Minor Street	100%	80%	70%	56%	100%	80%	70%	56%
1	1	750	600	525	420	75	60	53	42
2 or more	1	900	720	**630**	**504**	75	60	**53**	**42**
2 or more	2 or more	900	720	630	504	100	80	70	56
1	2 or more	750	600	525	420	100	80	70	56

Evaluation for Conditon B

Evalution of Condition B with the 70% columns (630, 53)

Hour	End	Major Volume	Minor Volume	Warrant
5:00	6:00			
6:00	7:00	1649	437	yes
7:00	8:00	2901	981	yes
8:00	9:00	3227	1191	yes
9:00	10:00	3455	927	yes
10:00	11:00	3213	832	yes
11:00	12:00	3321	815	yes
12:00	13:00	3834	1023	yes
13:00	14:00	4041	1050	yes
14:00	15:00	3155	1069	yes
15:00	16:00	4173	1048	yes
16:00	17:00	5204	1432	yes
17:00	18:00	4098	1234	yes
18:00	19:00	3499	2101	yes

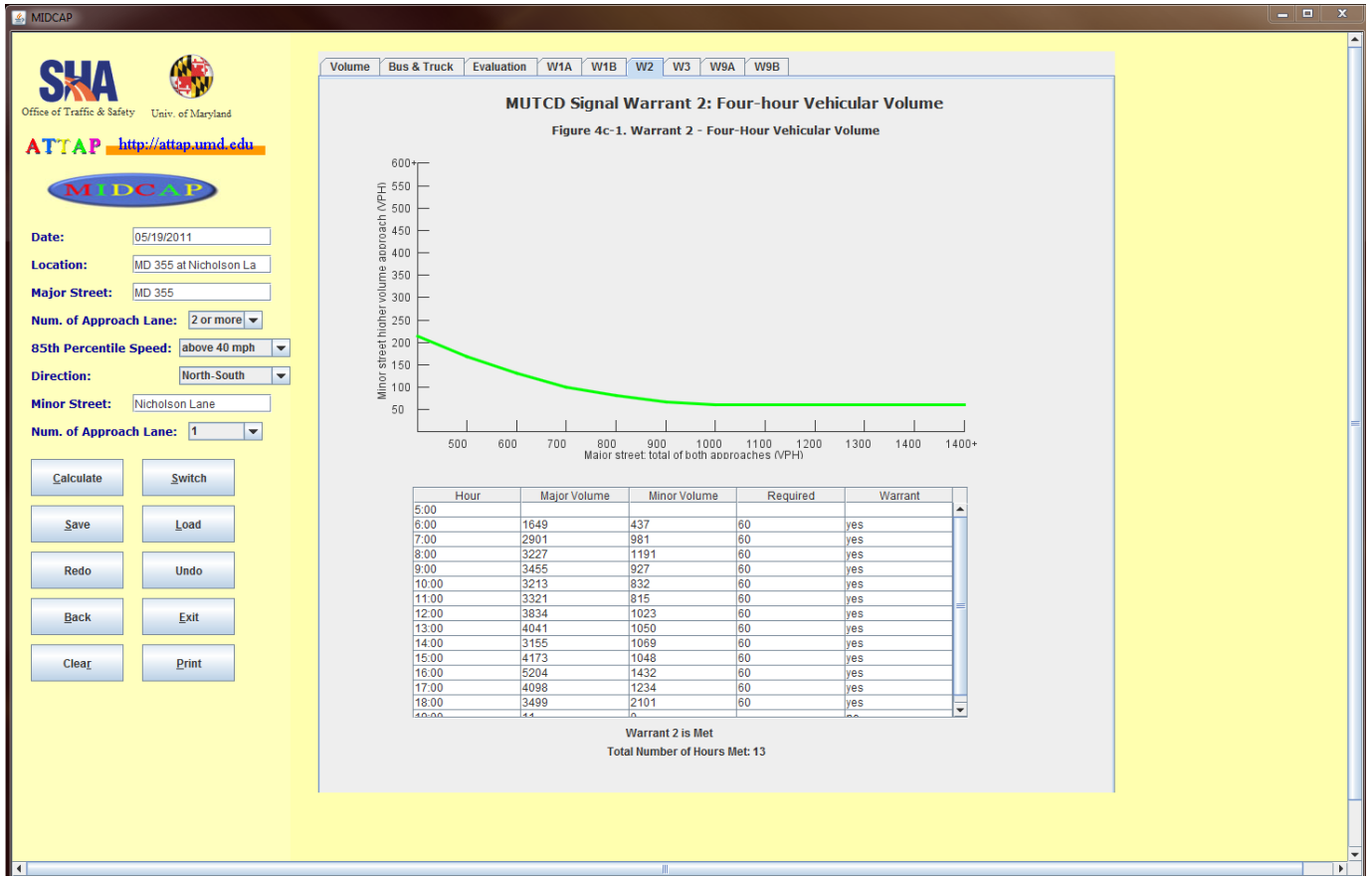
Evalution of Condition B with the 55% columns (504, 42)

Hour	End	Major Volume	Minor Volume	Warrant
5:00	6:00			
6:00	7:00	1649	437	yes
7:00	8:00	2901	981	yes
8:00	9:00	3227	1191	yes
9:00	10:00	3455	927	yes
10:00	11:00	3213	832	yes
11:00	12:00	3321	815	yes
12:00	13:00	3834	1023	yes
13:00	14:00	4041	1050	yes
14:00	15:00	3155	1069	yes
15:00	16:00	4173	1048	yes
16:00	17:00	5204	1432	yes
17:00	18:00	4098	1234	yes
18:00	19:00	3499	2101	yes

Condition B is met | Condition B is Met

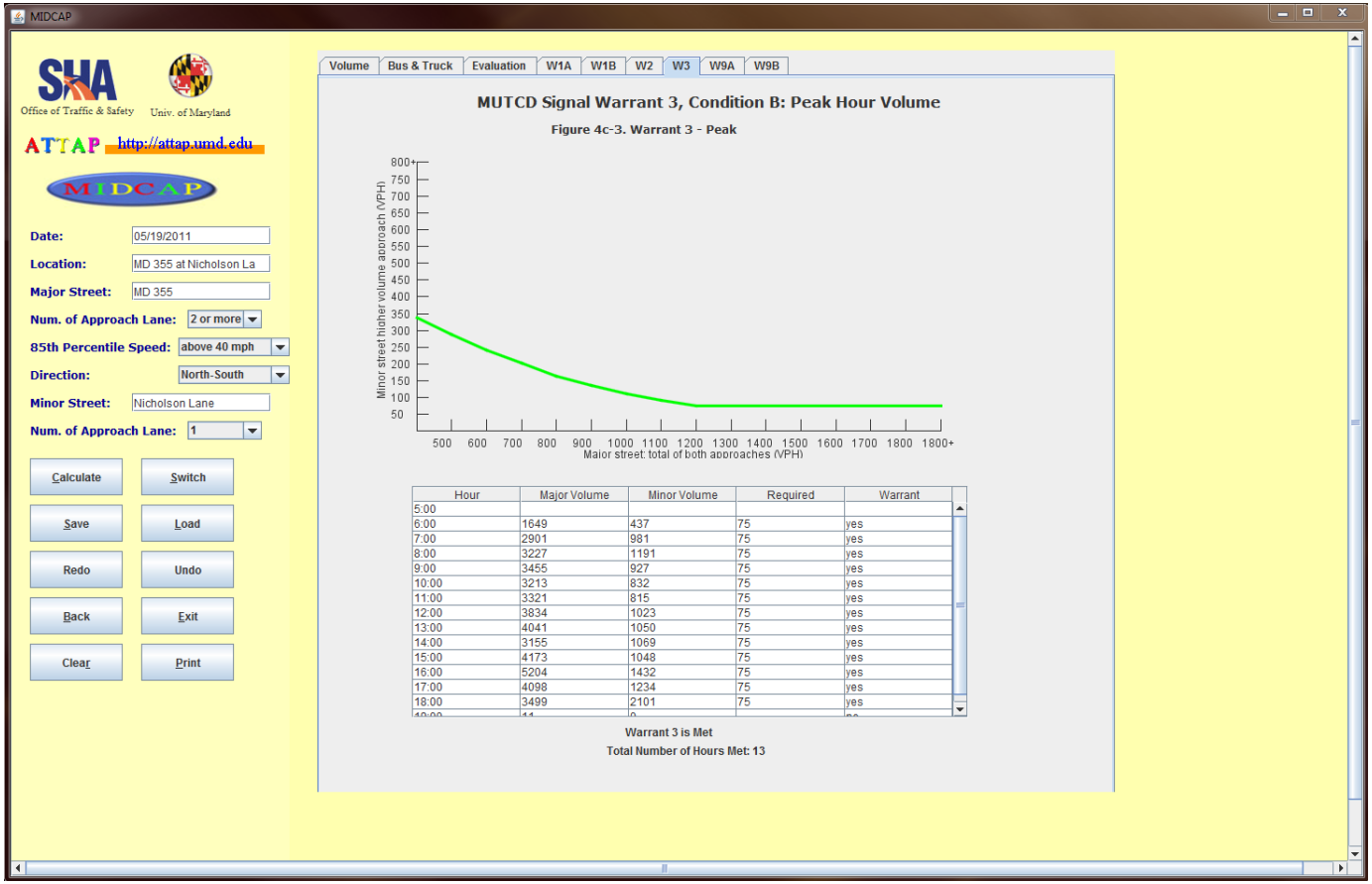
MODULE 2: SIGNAL WARRANT

- User-friendly Interface
  - Evaluation results for Warrant 2



MODULE 2: SIGNAL WARRANT

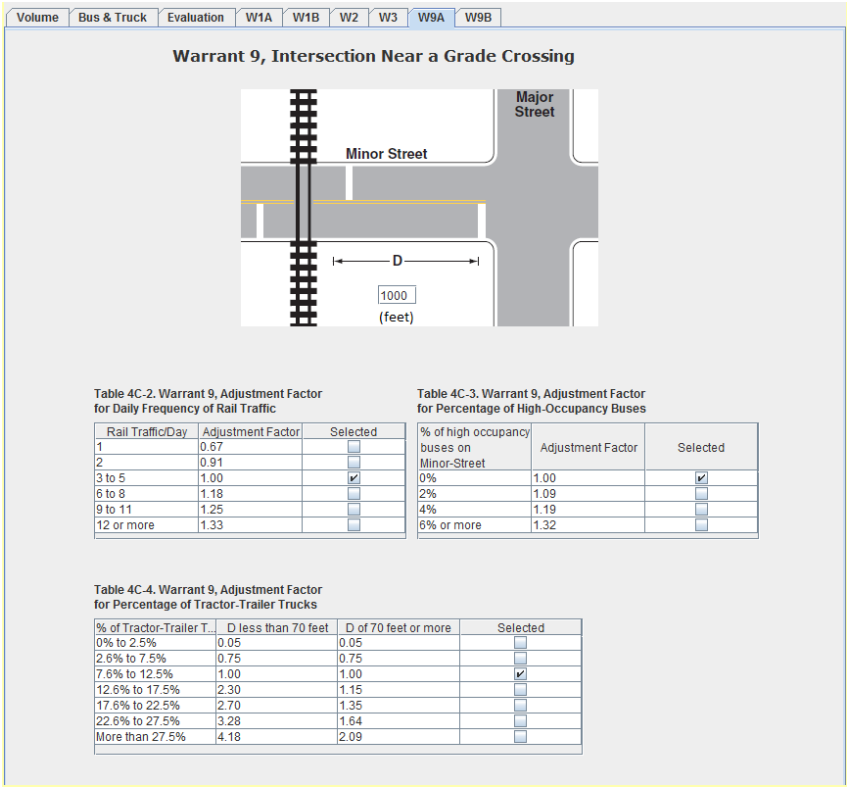
- User-friendly Interface
  - Evaluation results for Warrant 3

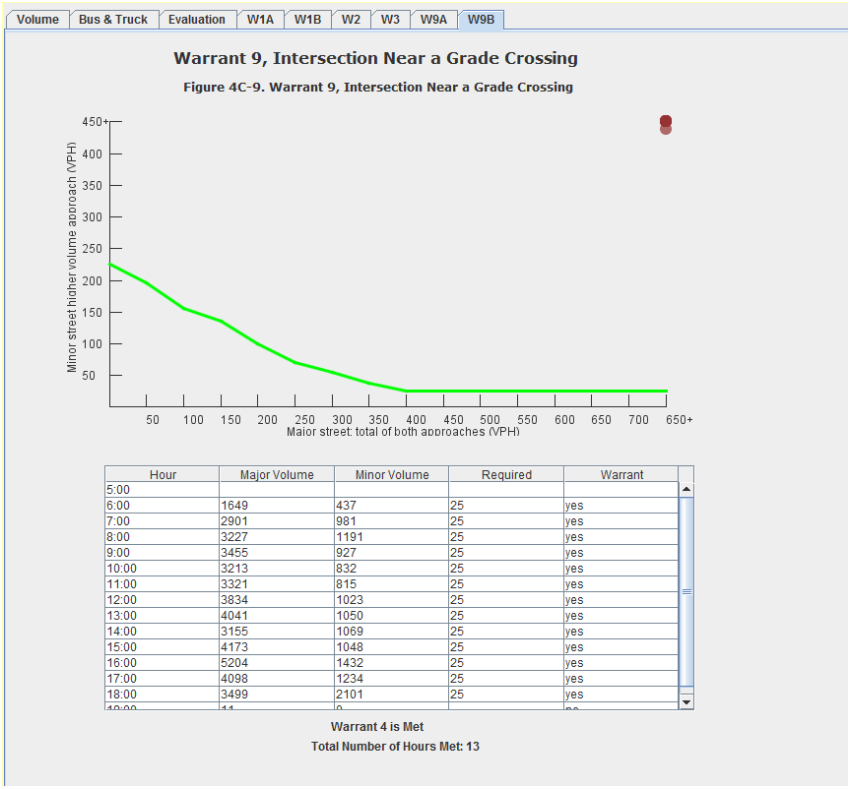


Hour	Major Volume	Minor Volume	Required	Warrant
5:00				
6:00	1649	437	75	yes
7:00	2901	981	75	yes
8:00	3227	1191	75	yes
9:00	3455	927	75	yes
10:00	3213	832	75	yes
11:00	3321	815	75	yes
12:00	3834	1023	75	yes
13:00	4041	1050	75	yes
14:00	3155	1069	75	yes
15:00	4173	1048	75	yes
16:00	5204	1432	75	yes
17:00	4098	1234	75	yes
18:00	3499	2101	75	yes

MODULE 2: SIGNAL WARRANT

- User-friendly Interface
  - Evaluation results for Warrant 9





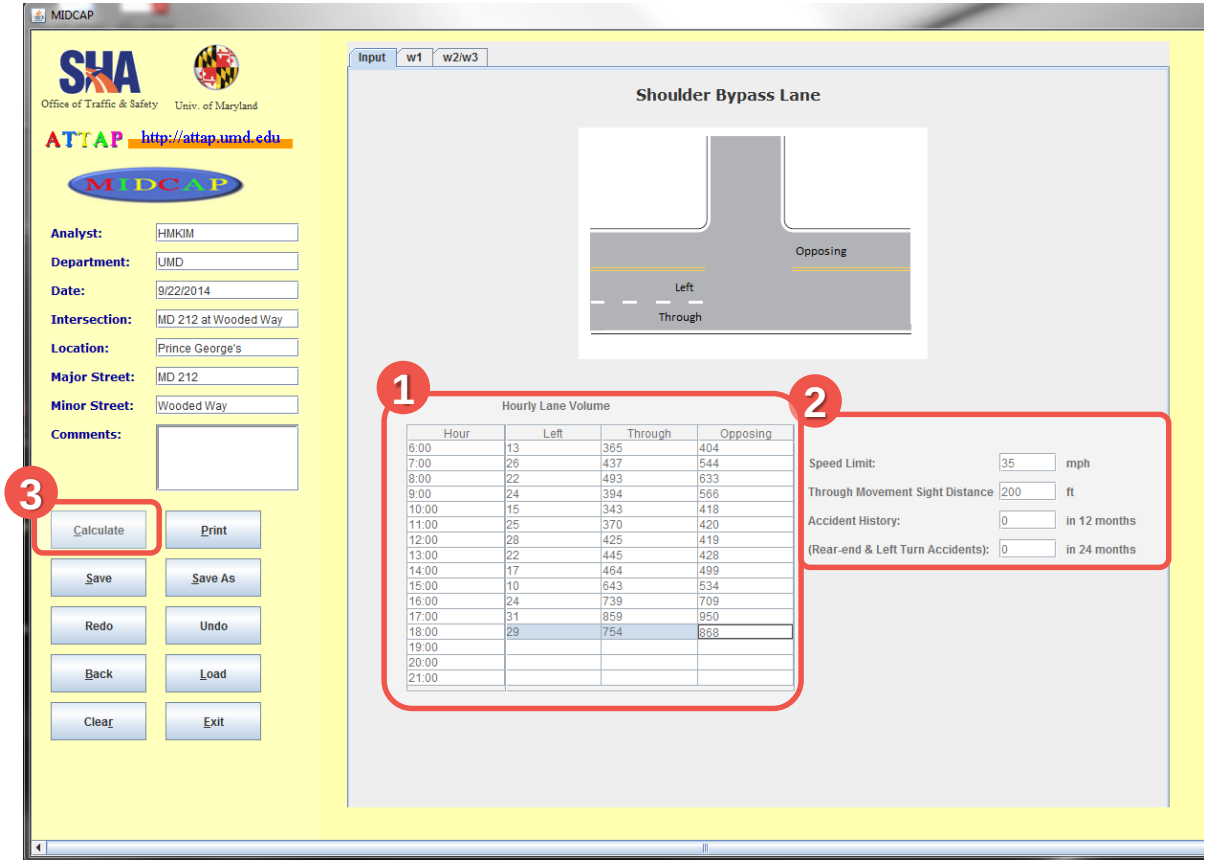
MODULE 3: SHOULDER BYPASS LANES(SBLs)

- Using the MDSHA's application and design guidelines for shoulder bypass lanes (SBLs)
- Investigates the need for shoulder bypass lanes and 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 particular location or not
  - Warrant 1. Vehicular Volumes
  - Warrant 2. Stopping Sight Distance
  - Warrant 3. Accident History

MODULE 3: SHOULDER BYPASS LANES(SBLs)

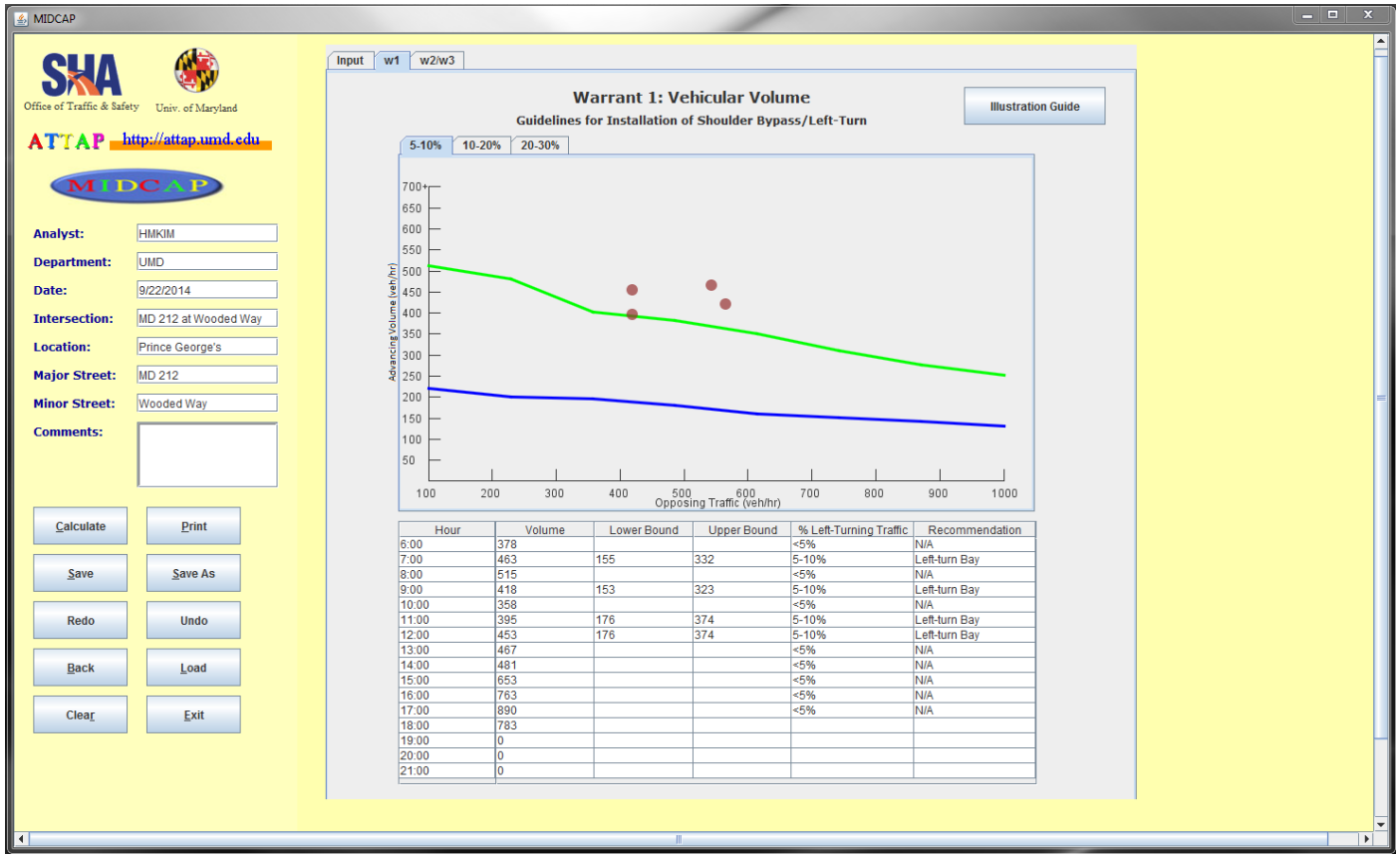
- User-friendly Interface

1. Input Traffic volume data
2. Set Location-specific Characteristics
3. Click Calculate button



MODULE 3: SHOULDER BYPASS LANES(SBLs)

- User-friendly Interface
  - Evaluation results for Warrant 1



MODULE 3: SHOULDER BYPASS LANES(SBLs)

- User-friendly Interface
  - Evaluation results for Warrant 2 and Warrant 3