MIDCAP

Maryland Intersection and Interchange Design & Capacity Analysis Program

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

July 17, 2017
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

© 2017 ATTAP. All rights reserved.
1. Critical Lane Volume (CLV) Analysis
2. Signal Warrant
3. Shoulder Bypass Lanes (SBLs) Warrant
4. Left Turn Phase Guideline
5. Lighting Evaluation
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.
Procedure

**INPUT**
- Identify non-concurrent sets of movements

**Determine CLV of each sets and sum**
- Intersection type
- Turning movement volumes
- Lane configuration
- Right-turn restriction
- Split or non-split phase

**Calculate v/c and determine LOS**

**Calculate Max. queue length**
- Intersection CLV
- Intersection v/c and LOS
- Maximum queue length

**OUTPUT**

© 2017 ATTAP. All rights reserved.
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
**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

---

© 2017 ATTAP. All rights reserved.
MODULE 1: CRITICAL LANE VOLUME ANALYSIS

Maximum **Queue** Lengths

Results

User Input

© 2017 ATTAP. All rights reserved.
Factors and Criteria

- **Editable** Lane Use Factors, LOS criteria, and Passenger Car Equivalent (PCE) values
- Applicable to each approach and AM / PM period
MODULE 1: CRITICAL LANE VOLUME ANALYSIS

Continuous Flow (or Displaced Left Turn) Intersection

3-Leg CFI

4-Leg Full CFI
Continuous Flow (or Displaced Left Turn) Intersection

4-Leg Partial Symmetric CFI

4-Leg Partial Asymmetric CFI
MODULE 1: CRITICAL LANE VOLUME ANALYSIS

Interchange Ramp Terminals (Regular Diamond)

© 2017 ATTAP. All rights reserved.
Partial Clover Leaf Interchange

**MODULE 1: CRITICAL LANE VOLUME ANALYSIS**

**North Terminal Results**

<table>
<thead>
<tr>
<th>Movement</th>
<th>Vol (veh)</th>
<th>Lane Fac</th>
<th>Opp Lane</th>
<th>CLV</th>
<th>*</th>
</tr>
</thead>
<tbody>
<tr>
<td>NB</td>
<td>1498</td>
<td>0.55</td>
<td>0</td>
<td>924</td>
<td></td>
</tr>
<tr>
<td>SB</td>
<td>1774</td>
<td>0.55</td>
<td>0</td>
<td>974</td>
<td></td>
</tr>
<tr>
<td>WB Ramp</td>
<td>250</td>
<td>1.0</td>
<td>0</td>
<td>250</td>
<td></td>
</tr>
</tbody>
</table>

**South Terminal Results**

<table>
<thead>
<tr>
<th>Movement</th>
<th>Vol (veh)</th>
<th>Lane Fac</th>
<th>Opp Lane</th>
<th>CLV</th>
<th>*</th>
</tr>
</thead>
<tbody>
<tr>
<td>NB</td>
<td>340</td>
<td>0.55</td>
<td>275</td>
<td>792</td>
<td>0</td>
</tr>
<tr>
<td>SB</td>
<td>1214</td>
<td>0.55</td>
<td>0</td>
<td>663</td>
<td>0</td>
</tr>
<tr>
<td>WB Ramp</td>
<td>271</td>
<td>1.0</td>
<td>0</td>
<td>271</td>
<td>0</td>
</tr>
</tbody>
</table>

**PM North Terminal Results**

<table>
<thead>
<tr>
<th>Movement</th>
<th>Vol (veh)</th>
<th>Lane Fac</th>
<th>Opp Lane</th>
<th>CLV</th>
<th>*</th>
</tr>
</thead>
<tbody>
<tr>
<td>NB</td>
<td>1774</td>
<td>0.55</td>
<td>0</td>
<td>974</td>
<td></td>
</tr>
<tr>
<td>SB</td>
<td>1214</td>
<td>0.55</td>
<td>0</td>
<td>663</td>
<td></td>
</tr>
<tr>
<td>WB Ramp</td>
<td>271</td>
<td>1.0</td>
<td>0</td>
<td>271</td>
<td></td>
</tr>
</tbody>
</table>

**PM South Terminal Results**

<table>
<thead>
<tr>
<th>Movement</th>
<th>Vol (veh)</th>
<th>Lane Fac</th>
<th>Opp Lane</th>
<th>CLV</th>
<th>*</th>
</tr>
</thead>
<tbody>
<tr>
<td>NB</td>
<td>2174</td>
<td>0.55</td>
<td>248</td>
<td>1444</td>
<td>0</td>
</tr>
<tr>
<td>SB</td>
<td>1214</td>
<td>0.55</td>
<td>0</td>
<td>663</td>
<td>0</td>
</tr>
<tr>
<td>WB Ramp</td>
<td>271</td>
<td>1.0</td>
<td>0</td>
<td>271</td>
<td>0</td>
</tr>
</tbody>
</table>

© 2017 ATTAP. All rights reserved.
Module 1: Critical Lane Volume Analysis

Single Point Urban Interchange

AM Results

<table>
<thead>
<tr>
<th>Mov.</th>
<th>Vol</th>
<th>Lane Fac</th>
<th>CLV</th>
</tr>
</thead>
<tbody>
<tr>
<td>From Ramp</td>
<td>250</td>
<td>0.6</td>
<td>150</td>
</tr>
<tr>
<td>NT-RL</td>
<td>293</td>
<td>1.0</td>
<td>1205</td>
</tr>
<tr>
<td>ST-RL</td>
<td>325</td>
<td>0.55</td>
<td>270</td>
</tr>
<tr>
<td>AM LOS</td>
<td>AM Total</td>
<td>AM VIC</td>
<td></td>
</tr>
<tr>
<td>1333</td>
<td>1333</td>
<td>0.83</td>
<td></td>
</tr>
</tbody>
</table>

Notes:
- NT: Northbound Through
- RL: Northbound Left
- ST: Southbound Through
- SL: Southbound Left

PM Results

<table>
<thead>
<tr>
<th>Mov.</th>
<th>Vol</th>
<th>Lane Fac</th>
<th>CLV</th>
</tr>
</thead>
<tbody>
<tr>
<td>From Ramp</td>
<td>575</td>
<td>0.6</td>
<td>345</td>
</tr>
<tr>
<td>NT-RL</td>
<td>425</td>
<td>0.55</td>
<td>725</td>
</tr>
<tr>
<td>ST-RL</td>
<td>400</td>
<td>0.55</td>
<td>345</td>
</tr>
<tr>
<td>PM LOS</td>
<td>PM Total</td>
<td>PM VIC</td>
<td></td>
</tr>
<tr>
<td>1074</td>
<td>1074</td>
<td>0.67</td>
<td></td>
</tr>
</tbody>
</table>
Diverging Diamond Interchange

MODULE 1: CRITICAL LANE VOLUME ANALYSIS

© 2017 ATTAP. All rights reserved.
Arterial (Corridor) analysis

- **Multiple intersections**
- Up to 10 intersections
MODULE 1: CRITICAL LANE VOLUME ANALYSIS

Arterial analysis

Individual Intersection View

Arterial View
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/](http://maps.roads.maryland.gov/itms_public/))
Multi-hour analysis: CLV, V/C and LOS for each hour
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**
Able to import or copy a traffic counts report from MDOT SHA’s Internet Traffic Monitoring System (I-TMS) as input

1. **Load Traffic Volume Data**
2. **Set Location-specific Characteristics**
3. **Click Calculate**

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

**Warrants analysis results**
Evaluation results for Warrant 1
Evaluation results for Warrant 2

**MUTCD Signal Warrant 2: Four-hour Vehicular Volume**

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

- **Input Summary**
  - **V9 Input**
  - **W1A**
  - **W1B**
  - **W2**
  - **W3**
  - **W8**

- **Table**
  - | Hour | Major Volume | Minor Volume | Threshold | Warrant |
  - |------|--------------|--------------|----------|---------|
  - | 0:00 | 607          | 27           | 285      | no      |
  - | 7:00 | 1329         | 59           | 80       | no      |
  - | 8:00 | 1775         | 84           | 80       | yes     |
  - | 9:00 | 1392         | 91           | 88       | yes     |
  - | 10:00| 1229         | 104          | 98       | yes     |
  - | 11:00| 1319         | 112          | 80       | yes     |
  - | 12:00| 1386         | 112          | 87       | yes     |
  - | 13:00| 1208         | 127          | 102      | yes     |
  - | 14:00| 849          | 72           | 188      | no      |
  - | 15:00| 1695         | 128          | 80       | yes     |
  - | 16:00| 1420         | 145          | 80       | yes     |
  - | 17:00| 2019         | 114          | 80       | yes     |
  - | 18:00| 1563         | 91           | 80       | yes     |
  - | 19:00| 0            | 0            | 0        | no      |
  - | 20:00| 0            | 0            | 0        | no      |
  - | 21:00| 0            | 0            | 0        | no      |

- **Summary**
  - Warrant 2 is met
  - Total Number of Hours met: 10
Evaluation results for Warrant 9

Additional input for W9

Evaluation criteria
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
How to Use

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

Warrants analysis results

Shoulder Bypass Lane Warrant analysis is based on the MD/SHA’s Application and Design Guidelines for Shoulder Bypass Lanes.
Evaluation results for Warrant 1
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
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

#### MDSHA EVALUATION FORM FOR INTERSECTION LIGHTING

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Score Met</th>
<th>Score Not Met</th>
<th>Weight</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Is intersection signalized?</td>
<td>0</td>
<td>1</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>B Does intersection have medians on any approach?</td>
<td>0</td>
<td>1</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>C Does intersection have left turn bays and/or other auxiliary lanes?</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>D Is intersection a freeway ramp terminal?</td>
<td>0</td>
<td>1</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>E Is there significant pedestrian volume after dark?</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>F Does intersection involve two or more state maintained highways?</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>G Does AOT of state highway exceed 15,000?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>H Ratio of Night to Total accidents (Min 5 accidents)</td>
<td>0.35-0.40</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>0.40-0.45</td>
<td>0</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>0.45-0.50</td>
<td>0</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>&gt; 0.50</td>
<td>0</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>I Is intersection at school entrance or children walking to school?</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>J Is operating speed on any road approach greater than 30 MPH?</td>
<td>0</td>
<td>1</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>K Is intersection sight distance restricted?</td>
<td>0</td>
<td>1</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>L Are there any brightly lit areas, i.e., parking lots, commercial area, etc., within 200 feet of the intersection?</td>
<td>0</td>
<td>1</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>M Are any of the road approaches continuously lighted?</td>
<td>0</td>
<td>1</td>
<td>4</td>
<td>0</td>
</tr>
</tbody>
</table>

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.
THANK YOU!

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

ATTAP research team
http://attap.umd.edu