

CHAPTER 1

JUSTIFYING THE NEED FOR TRAFFIC SIGNALS

1.1 Justification for Traffic Signal Control

In order to determine whether or not the installation of a traffic signal control is justified an engineering study and a warrant analysis shall be performed as required by the MUTCD. The engineering study shall be signed and sealed by a registered professional engineer in Tennessee and in good standing. The engineering study shall be approved, in writing, by the TDOT Design Manager.

Generally, the installation of a traffic control signal is considered only after all of the following conditions are met:

- One or more of the MUTCD traffic signal warrants are met; and
- An engineering study shows that traffic signalization will improve the overall traffic operations and/or safety of an intersection and the resulting traffic signal will not seriously disrupt the progressive traffic flow from adjacent traffic signals.

The MUTCD cautions that “the satisfaction of a traffic signal warrant or warrants shall not in itself require the installation of a traffic control signal.”

1.1.1 Engineering Study Data Collection

The following data should be included as a minimum in an engineering study:

- **Traffic Counts:** Traffic counts should be made on a typical weekday for the location, normally in the middle of the week (Tuesday through Thursday). Additionally, if the location is affected by school traffic, then the count should be made when school is in session. Counts should be avoided on holidays, and during special events or inclement weather. The practitioner should be aware that counts may be inaccurate due to data collection errors, and it is possible for traffic to vary significantly from day to day, week to week, and month to month.
 - **Vehicular 24-Hour Traffic Counts:** Twenty-four hour traffic counts should be conducted on each approach counting all vehicles entering the intersection. The 24-hour traffic volume profiles are an important element in the data collection effort of an engineering study and are used to identify the hours of the day during which total traffic entering the intersection is greatest. The 24-hour traffic volumes are usually collected using temporary road tubes.

- **Vehicular Turning Movement Counts:** Turning movement counts should be conducted on each approach of the intersection showing all vehicular movements classified by vehicle type (trucks, passenger cars, and public-transit vehicles) during each 15-minute interval for a minimum of two hours in each of the AM, midday, and PM peak periods. In any case, these hours should include the periods during which total traffic entering the intersection is greatest as revealed by the previously conducted 24-hour traffic counts.
- **Pedestrian Traffic Counts:** If pedestrians are a concern, pedestrian volume counts should be conducted on each approach for the same periods as the vehicular turning movement counts and during the periods of peak pedestrian volumes. The presence of nearby facilities that could generate young, elderly, or disabled pedestrian traffic should be noted. The traffic count data should be submitted in a format that shows hourly pedestrian volumes by approach.
- **Bicycle Traffic Counts:** If bicycles are a concern, bicycle volume counts should be conducted on each approach of the intersection showing all bicycle movements for the same periods as the traffic movement counts and during the periods of peak bicycle volumes. The count data should be submitted in a format that shows hourly bicycle volumes by approach. According to the MUTCD, bicycles may be counted as pedestrians when using pedestrian facilities.

Examples of vehicular, pedestrian, and bicycle counts are shown in Figure 1.1.

- **Traffic Volumes Hourly Percentages when using AADT Volumes:** In lieu of vehicular 24-hour traffic counts, Tennessee statewide average traffic volumes hourly percentages for arterial facilities (i.e. not interstate facilities) when using AADT Volumes are presented in Tables 1.1 to 1.5. In Table 1.1, the Tennessee statewide average traffic volumes hourly percentages shown include two lane facilities, multi-lane facilities, and overall for both facility types. Shaded areas indicate the eight highest hourly percentages for traffic signal warrant analysis purposes. In Tables 1.2 to 1.5, TDOT Region average traffic volumes hourly percentages shown include two lane facilities and multi-lane facilities. Further breakdown of the TDOT Region average traffic volumes hourly percentages include population tiers from larger cities (Tier A) to smaller cities/rural areas (Tier E).
- **Speed Data:** Information on the posted or statutory speed limit should be collected and a speed study showing the 85th percentile speeds on the uncontrolled approach of the intersection should be conducted.
- **Condition Diagram:** A condition diagram of an intersection typically shows details of the physical layout, including such features as geometry, channelization, grades, sight-distance restrictions, pavement markings,

signs (traffic, business marquees, and billboards), driveways, utility poles, roadway lighting, parking conditions, transit stops, sidewalks and curb ramps, vegetation (if over three feet in height), adjacent land use, nearby railroad crossings, and the distance to the nearest traffic signal (if less than one mile). An example of a condition diagram is shown in Figure 1.2.

- **Collision Diagram:** A collision diagram or listing shows the crash record for the intersection covering as a minimum, the most recent 12-month period for which crash records are available. However, it is desirable to show the most recent 3-year period. Each crash symbol, or record, should show the crash type, travel direction of the vehicles, date, time of day, severity (injuries/fatalities), pavement condition, weather, and lighting conditions. An example of a collision diagram is shown in Figure 1.3.

Figure 1.1 – Vehicular, Pedestrian, and Bicycle Counts Example

Source: Traffic Signal Timing Manual

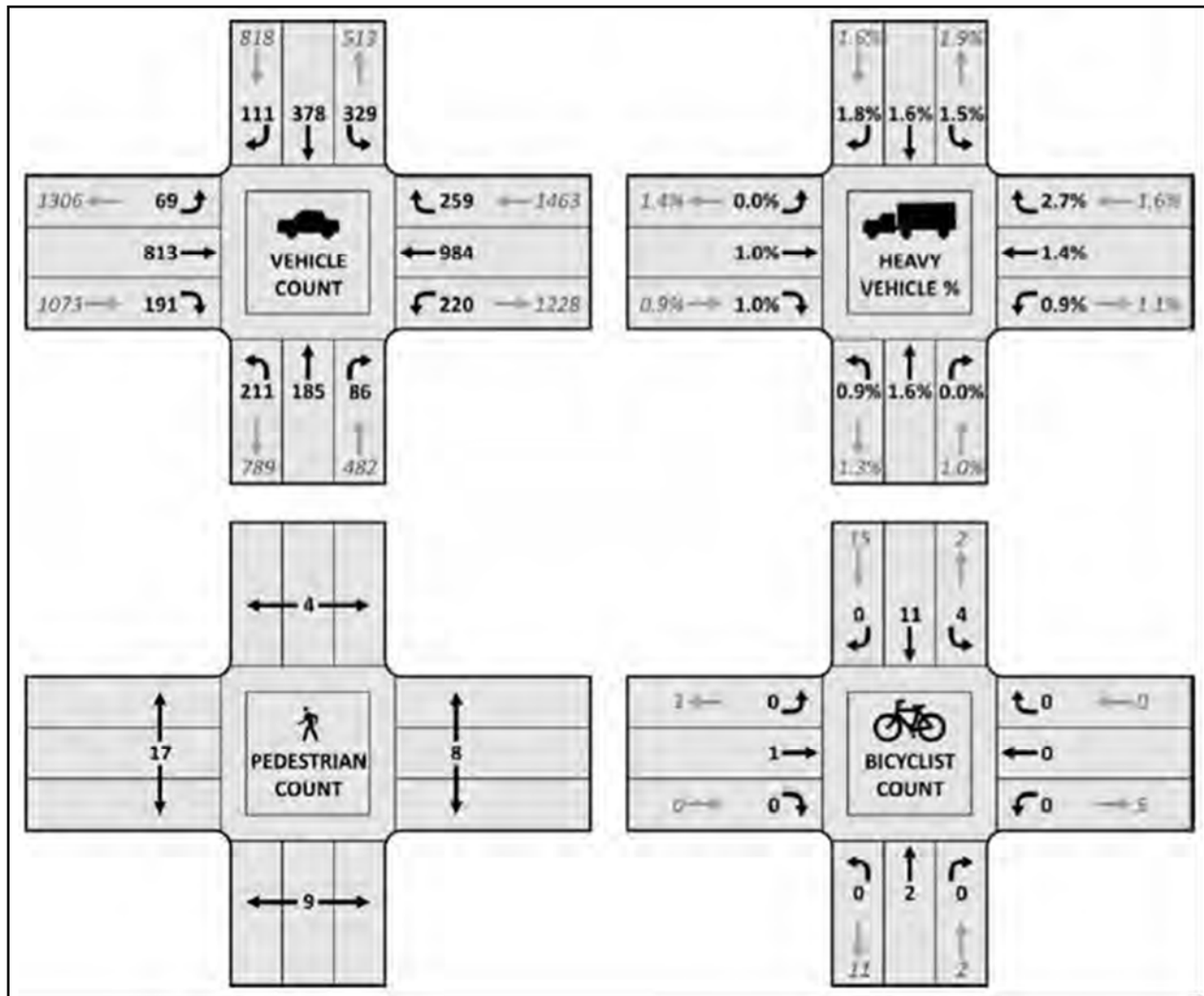


Table 1.1 – Tennessee Statewide Average Traffic Volumes Hourly Percentages

TRAFFIC OPERATIONS DIVISION - TRAFFIC ENGINEERING OFFICE

2017 TRAFFIC VOLUMES HOURLY PERCENTAGES

TENNESSEE STATEWIDE AVERAGE FOR ARTERIAL FACILITIES



Hour		TENNESSEE STATEWIDE AVERAGE FOR ARTERIAL FACILITIES		
From	To	Two Lane Facilities	Multi-Lane Facilities	Overall for Both Facility Types
12:00 M	1:00 AM	0.57	0.59	0.58
1:00 AM	2:00 AM	0.37	0.40	0.39
2:00 AM	3:00 AM	0.32	0.33	0.33
3:00 AM	4:00 AM	0.42	0.41	0.42
4:00 AM	5:00 AM	0.77	0.78	0.78
5:00 AM	6:00 AM	1.89	1.94	1.92
6:00 AM	7:00 AM	4.09	4.05	4.07
7:00 AM	8:00 AM	7.29	6.79	7.04
8:00 AM	9:00 AM	5.96	5.93	5.95
9:00 AM	10:00 AM	5.06	5.29	5.18
10:00 AM	11:00 AM	5.06	5.40	5.23
11:00 AM	12:00 N	5.62	6.05	5.84
12:00 N	1:00 PM	6.08	6.56	6.32
1:00 PM	2:00 PM	6.10	6.46	6.28
2:00 PM	3:00 PM	6.86	6.77	6.82
3:00 PM	4:00 PM	7.92	7.61	7.77
4:00 PM	5:00 PM	8.33	8.04	8.19
5:00 PM	6:00 PM	8.39	8.06	8.23
6:00 PM	7:00 PM	6.15	5.91	6.03
7:00 PM	8:00 PM	4.35	4.24	4.30
8:00 PM	9:00 PM	3.44	3.34	3.39
9:00 PM	10:00 PM	2.38	2.42	2.40
10:00 PM	11:00 PM	1.58	1.62	1.60
11:00 PM	12:00 M	1.00	1.02	1.01

- Notes:
1. The seven (7) highest hours are shown in green highlight and the eighth (8th) highest hour is shown in orange highlight.
 2. The average traffic volumes hourly percentages shown were based traffic volume data collected at 504 representative traffic count locations (e.g. 126 locations per Region).
 3. Values shown are calculated and rounded up which may result in small rounding errors.



TRAFFIC OPERATIONS DIVISION - TRAFFIC ENGINEERING OFFICE
 2017 TRAFFIC VOLUMES HOURLY PERCENTAGES
 TDOT REGION 1 AVERAGE FOR ARTERIAL FACILITIES

Table 1.2 – TDOT Region 1 Average Traffic Volumes Hourly Percentages

AVERAGE FOR TWO LANE FACILITIES													AVERAGE FOR MULTI-LANE FACILITIES												
Hour		Population Tier Location (See Note 2 Below)					Overall Regional Average	Hour		Population Tier Location (See Note 2 Below)					Overall Regional Average										
From	To	A	B	C	D	E		From	To	A	B	C	D	E											
12:00 M	1:00 AM	0.41	0.65	0.56	0.65	0.87	0.59	12:00 AM	1:00 AM	0.48	0.68	0.61	0.67	0.48	0.59										
1:00 AM	2:00 AM	0.22	0.35	0.29	0.36	0.43	0.33	1:00 AM	2:00 AM	0.34	0.44	0.38	0.41	0.34	0.38										
2:00 AM	3:00 AM	0.18	0.32	0.28	0.22	0.34	0.27	2:00 AM	3:00 AM	0.27	0.34	0.29	0.31	0.27	0.30										
3:00 AM	4:00 AM	0.26	0.29	0.28	0.27	0.44	0.31	3:00 AM	4:00 AM	0.31	0.35	0.37	0.30	0.31	0.33										
4:00 AM	5:00 AM	0.56	0.53	0.70	0.42	0.94	0.63	4:00 AM	5:00 AM	0.63	0.51	0.71	0.47	0.63	0.59										
5:00 AM	6:00 AM	1.56	1.62	1.99	1.20	2.37	1.75	5:00 AM	6:00 AM	1.47	1.44	2.01	1.38	1.47	1.55										
6:00 AM	7:00 AM	4.07	3.50	3.87	2.92	3.74	3.62	6:00 AM	7:00 AM	3.57	3.29	4.29	2.75	3.57	3.50										
7:00 AM	8:00 AM	9.03	6.16	7.58	7.03	6.40	7.24	7:00 AM	8:00 AM	7.20	6.63	7.01	5.70	7.20	6.75										
8:00 AM	9:00 AM	6.78	5.53	5.96	6.47	5.57	6.06	8:00 AM	9:00 AM	6.60	5.80	5.93	5.50	6.60	6.09										
9:00 AM	10:00 AM	4.94	5.01	4.79	5.37	5.17	5.06	9:00 AM	10:00 AM	5.07	5.27	5.27	5.41	5.07	5.22										
10:00 AM	11:00 AM	4.58	5.54	4.67	5.43	5.33	5.11	10:00 AM	11:00 AM	5.05	5.43	5.26	6.00	5.05	5.36										
11:00 AM	12:00 N	4.68	5.99	5.73	5.92	5.88	5.60	11:00 AM	12:00 PM	5.52	5.92	5.71	6.53	5.52	5.84										
12:00 N	1:00 PM	5.17	6.61	6.27	6.11	6.03	6.04	12:00 PM	1:00 PM	6.11	6.50	6.27	6.70	6.11	6.34										
1:00 PM	2:00 PM	5.54	6.54	5.83	6.17	6.03	6.02	1:00 PM	2:00 PM	6.24	6.48	6.22	6.70	6.24	6.38										
2:00 PM	3:00 PM	6.34	6.67	6.36	6.84	6.48	6.54	2:00 PM	3:00 PM	6.39	6.70	6.59	7.12	6.39	6.64										
3:00 PM	4:00 PM	7.83	7.46	7.81	7.66	7.70	7.69	3:00 PM	4:00 PM	7.34	7.51	7.53	7.69	7.34	7.48										
4:00 PM	5:00 PM	8.79	8.00	8.81	8.09	8.18	8.37	4:00 PM	5:00 PM	8.48	7.78	7.77	7.79	8.48	8.06										
5:00 PM	6:00 PM	9.64	8.53	9.13	8.36	8.25	8.78	5:00 PM	6:00 PM	9.50	8.41	8.21	7.89	9.50	8.70										
6:00 PM	7:00 PM	7.17	6.40	6.49	6.57	6.33	6.59	6:00 PM	7:00 PM	6.87	6.29	6.06	6.04	6.87	6.43										
7:00 PM	8:00 PM	4.33	4.75	4.35	4.74	4.67	4.57	7:00 PM	8:00 PM	4.54	4.53	4.43	4.67	4.54	4.54										
8:00 PM	9:00 PM	3.26	3.96	3.38	3.71	3.82	3.58	8:00 PM	9:00 PM	3.36	3.96	3.70	3.68	3.36	3.61										
9:00 PM	10:00 PM	2.48	2.73	2.46	2.62	2.83	2.62	9:00 PM	10:00 PM	2.38	2.75	2.69	2.80	2.38	2.60										
10:00 PM	11:00 PM	1.38	1.76	1.52	1.75	1.72	1.63	10:00 PM	11:00 PM	1.40	1.86	1.68	2.17	1.40	1.70										
11:00 PM	12:00 M	0.80	1.06	0.91	1.12	1.07	0.99	11:00 PM	12:00 AM	0.89	1.11	1.01	1.31	0.89	1.04										

3/15/2017

Notes: 1. The seven (7) highest hours are shown in green highlight and the eighth (8th) highest hour is shown in orange highlight.

2. The population tier locations are as follows:

- Population Tier A → Knoxville
- Population Tier B → Johnson City and Kingsport
- Population Tier C → Bristol, Maryville, Morristown, and Oak Ridge
- Population Tier D → Farragut, Greenville, and Sevierville
- Population Tier E → All other cities not shown above and rural areas

3. Values shown are calculated and rounded up which may result in small rounding errors.



TRAFFIC OPERATIONS DIVISION - TRAFFIC ENGINEERING OFFICE
 2017 TRAFFIC VOLUMES HOURLY PERCENTAGES
 TDOT REGION 2 AVERAGE FOR ARTERIAL FACILITIES

Table 1.3 – TDOT Region 2 Average Traffic Volumes Hourly Percentages

AVERAGE FOR TWO LANE FACILITIES												
Hour		Population Tier Location (See Note 2 Below)					Overall Regional Average					
From	To	A	B	C	D	E						
12:00 AM	1:00 AM	0.68	0.52	0.60	0.66	0.42	0.57					
1:00 AM	2:00 AM	0.46	0.33	0.39	0.42	0.36	0.39					
2:00 AM	3:00 AM	0.34	0.30	0.28	0.28	0.34	0.31					
3:00 AM	4:00 AM	0.29	0.52	0.41	0.29	0.45	0.39					
4:00 AM	5:00 AM	0.52	1.00	0.86	0.70	0.77	0.77					
5:00 AM	6:00 AM	1.37	2.23	1.88	1.64	1.94	1.81					
6:00 AM	7:00 AM	3.63	3.28	3.51	3.59	4.74	3.75					
7:00 AM	8:00 AM	7.32	6.88	7.73	6.36	7.84	7.18					
8:00 AM	9:00 AM	7.03	5.63	5.55	5.57	5.37	5.83					
9:00 AM	10:00 AM	5.20	4.80	5.47	5.01	5.03	5.10					
10:00 AM	11:00 AM	5.08	5.11	5.69	5.10	5.29	5.25					
11:00 AM	12:00 N	6.06	5.61	6.27	5.60	5.38	5.79					
12:00 N	1:00 PM	6.86	6.28	6.43	6.19	6.06	6.32					
1:00 PM	2:00 PM	6.23	6.41	6.54	6.31	6.30	6.36					
2:00 PM	3:00 PM	6.74	6.90	6.97	6.87	7.31	6.94					
3:00 PM	4:00 PM	8.09	8.03	7.92	7.78	7.88	7.94					
4:00 PM	5:00 PM	8.63	8.27	8.02	8.65	8.09	8.33					
5:00 PM	6:00 PM	8.83	8.31	7.93	8.82	7.49	8.28					
6:00 PM	7:00 PM	5.34	5.00	5.42	6.81	6.36	5.99					
7:00 PM	8:00 PM	3.74	4.82	4.02	4.55	4.01	4.23					
8:00 PM	9:00 PM	2.82	3.85	3.20	3.41	4.25	3.51					
9:00 PM	10:00 PM	2.14	2.50	2.24	2.60	2.28	2.35					
10:00 PM	11:00 PM	1.58	1.47	1.66	1.75	1.34	1.56					
11:00 PM	12:00 M	1.23	1.08	1.01	1.05	0.93	1.06					

AVERAGE FOR MULTI-LANE FACILITIES												
Hour		Population Tier Location (See Note 2 Below)					Overall Regional Average					
From	To	A	B	C	D	E						
12:00 AM	1:00 AM	0.64	0.61	0.60	0.53	0.56	0.59					
1:00 AM	2:00 AM	0.43	0.44	0.42	0.38	0.46	0.43					
2:00 AM	3:00 AM	0.36	0.35	0.29	0.27	0.47	0.35					
3:00 AM	4:00 AM	0.39	0.48	0.35	0.37	0.66	0.45					
4:00 AM	5:00 AM	0.82	0.90	0.65	0.66	1.37	0.88					
5:00 AM	6:00 AM	1.88	1.98	1.77	1.72	2.85	2.04					
6:00 AM	7:00 AM	4.47	3.78	3.00	3.69	4.42	3.87					
7:00 AM	8:00 AM	7.52	6.77	6.18	6.48	6.05	6.60					
8:00 AM	9:00 AM	6.71	5.47	5.54	5.92	5.33	5.80					
9:00 AM	10:00 AM	5.17	5.09	5.50	5.56	5.52	5.37					
10:00 AM	11:00 AM	5.06	5.30	5.98	5.98	5.69	5.60					
11:00 AM	12:00 PM	5.58	6.11	6.86	6.65	6.29	6.30					
12:00 PM	1:00 PM	6.06	6.54	7.37	6.80	6.66	6.68					
1:00 PM	2:00 PM	5.97	6.25	7.11	6.69	6.73	6.55					
2:00 PM	3:00 PM	6.48	6.63	7.17	6.75	7.05	6.82					
3:00 PM	4:00 PM	7.53	8.02	7.83	7.67	7.55	7.72					
4:00 PM	5:00 PM	8.36	8.03	7.99	8.02	7.86	8.05					
5:00 PM	6:00 PM	8.40	8.05	7.45	7.74	7.26	7.78					
6:00 PM	7:00 PM	5.69	6.11	5.64	6.03	5.13	5.72					
7:00 PM	8:00 PM	3.91	4.27	4.33	4.47	3.87	4.17					
8:00 PM	9:00 PM	3.31	3.38	3.19	3.12	3.35	3.27					
9:00 PM	10:00 PM	2.33	2.63	2.30	2.13	2.31	2.34					
10:00 PM	11:00 PM	1.74	1.78	1.52	1.36	1.57	1.59					
11:00 PM	12:00 AM	1.20	1.04	0.95	0.99	1.02	1.04					

3/15/2017

Notes: 1. The seven (7) highest hours are shown in green highlight and the eighth (8th) highest hour is shown in orange highlight.

2. The population tier locations are as follows:

Population Tier A → Chattanooga

Population Tier B → Cleveland

Population Tier C → Cookeville

Population Tier D → East Ridge and Tullahoma

Population Tier E → All other cities not shown above and rural areas

3. Values shown are calculated and rounded up which may result in small rounding errors.



TRAFFIC OPERATIONS DIVISION - TRAFFIC ENGINEERING OFFICE
 2017 TRAFFIC VOLUMES HOURLY PERCENTAGES
 TDOT REGION 3 AVERAGE FOR ARTERIAL FACILITIES

AVERAGE FOR TWO LANE FACILITIES													AVERAGE FOR MULTI-LANE FACILITIES												
Hour		Population Tier Location (See Note 2 Below)					Overall Regional Average	Hour		Population Tier Location (See Note 2 Below)					Overall Regional Average										
From	To	A	B	C	D	E		From	To	A	B	C	D	E											
12:00 AM	1:00 AM	0.76	0.26	0.54	0.58	0.71	0.57	12:00 AM	1:00 AM	0.71	0.44	0.58	0.50	0.56	0.56										
1:00 AM	2:00 AM	0.47	0.15	0.35	0.35	0.56	0.37	1:00 AM	2:00 AM	0.49	0.29	0.37	0.33	0.40	0.37										
2:00 AM	3:00 AM	0.45	0.11	0.26	0.31	0.35	0.29	2:00 AM	3:00 AM	0.38	0.27	0.32	0.29	0.31	0.31										
3:00 AM	4:00 AM	0.45	0.15	0.33	0.44	0.56	0.39	3:00 AM	4:00 AM	0.44	0.30	0.39	0.36	0.57	0.41										
4:00 AM	5:00 AM	0.75	0.32	0.71	1.06	1.30	0.83	4:00 AM	5:00 AM	0.83	0.61	0.84	0.87	1.15	0.86										
5:00 AM	6:00 AM	2.20	1.20	2.42	2.55	3.42	2.36	5:00 AM	6:00 AM	2.01	2.00	2.53	2.10	3.01	2.33										
6:00 AM	7:00 AM	5.47	4.72	4.58	4.80	5.36	4.99	6:00 AM	7:00 AM	4.42	4.92	4.83	4.28	5.18	4.73										
7:00 AM	8:00 AM	7.46	8.35	6.40	7.13	6.96	7.26	7:00 AM	8:00 AM	7.08	6.97	6.21	6.36	6.78	5.68										
8:00 AM	9:00 AM	5.89	6.99	5.31	5.32	4.94	5.69	8:00 AM	9:00 AM	6.31	6.15	5.34	5.30	5.29	5.68										
9:00 AM	10:00 AM	4.85	5.27	5.17	5.16	4.67	5.02	9:00 AM	10:00 AM	5.67	5.15	5.16	5.21	5.28	5.30										
10:00 AM	11:00 AM	4.61	5.03	5.38	5.31	4.86	5.04	10:00 AM	11:00 AM	5.61	5.00	5.38	5.42	5.54	5.39										
11:00 AM	12:00 PM	4.94	5.60	5.96	6.08	5.56	5.63	11:00 AM	12:00 PM	6.25	5.67	6.08	6.42	6.26	6.14										
12:00 PM	1:00 PM	5.52	6.18	6.33	6.28	6.01	6.06	12:00 PM	1:00 PM	6.51	6.43	6.50	6.98	6.54	6.59										
1:00 PM	2:00 PM	5.65	6.08	6.40	6.68	5.61	6.08	1:00 PM	2:00 PM	6.43	6.26	6.40	6.69	6.35	6.43										
2:00 PM	3:00 PM	6.63	6.77	6.90	7.35	7.01	6.93	2:00 PM	3:00 PM	6.64	6.58	6.77	6.75	6.64	6.68										
3:00 PM	4:00 PM	7.65	7.69	7.59	8.28	8.06	7.85	3:00 PM	4:00 PM	7.27	7.62	7.48	7.67	7.85	7.58										
4:00 PM	5:00 PM	8.44	8.69	7.96	7.69	8.24	8.20	4:00 PM	5:00 PM	7.83	8.13	7.92	7.91	7.99	7.96										
5:00 PM	6:00 PM	8.42	8.80	7.81	7.42	7.98	8.08	5:00 PM	6:00 PM	7.25	8.13	7.79	7.86	7.53	7.71										
6:00 PM	7:00 PM	6.40	6.65	6.22	5.40	5.55	6.04	6:00 PM	7:00 PM	5.35	6.51	6.10	6.05	5.44	5.89										
7:00 PM	8:00 PM	4.28	4.28	4.59	4.12	4.21	4.30	7:00 PM	8:00 PM	3.93	4.50	4.41	4.47	3.75	4.21										
8:00 PM	9:00 PM	3.42	3.06	3.71	3.11	3.25	3.31	8:00 PM	9:00 PM	3.00	3.35	3.60	3.49	3.11	3.31										
9:00 PM	10:00 PM	2.37	2.01	2.53	2.22	2.35	2.30	9:00 PM	10:00 PM	2.47	2.32	2.48	2.36	2.23	2.37										
10:00 PM	11:00 PM	1.63	1.10	1.58	1.47	1.51	1.46	10:00 PM	11:00 PM	1.88	1.52	1.51	1.51	1.42	1.57										
11:00 PM	12:00 PM	1.30	0.55	0.97	0.91	0.95	0.94	11:00 PM	12:00 AM	1.25	0.87	1.00	0.81	0.84	0.95										

3/15/2017

Notes: 1. The seven (7) highest hours are shown in green highlight and the eighth (8th) highest hour is shown in orange highlight.

2. The population tier locations are as follows:

Population Tier A → Clarksville, Murfreesboro, and Nashville

Population Tier B → Brentwood, Franklin, Hendersonville, and Smyrna

Population Tier C → Columbia, Gellatin, La Vergne, Lebanon, Mount Juliet, and Spring Hill

Population Tier D → Dickson, Goodlettsville, Shelbyville, and Springfield

Population Tier E → All other cities not shown above and rural areas

3. Values shown are calculated and rounded up which may result in small rounding errors.



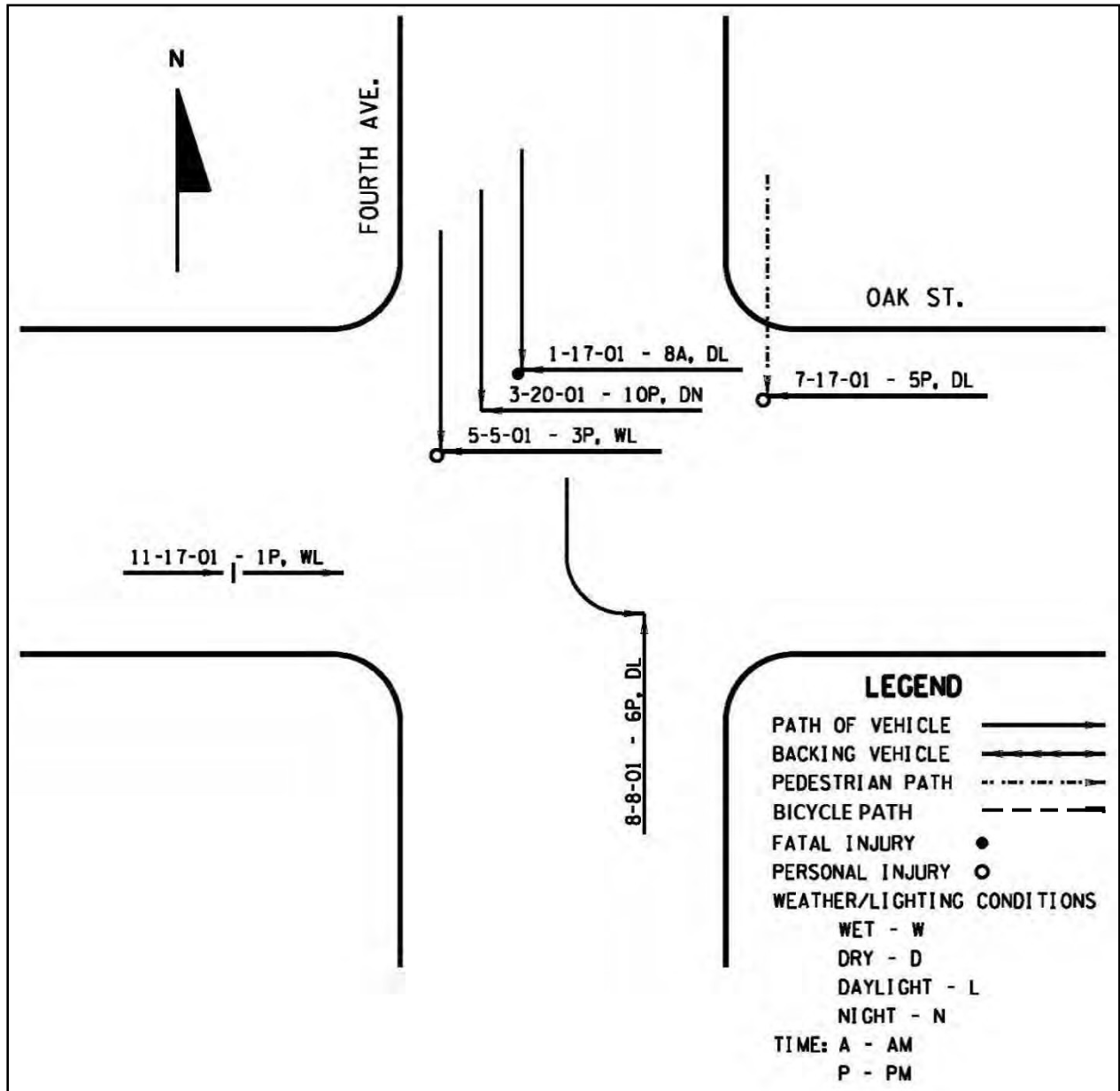
TRAFFIC OPERATIONS DIVISION - TRAFFIC ENGINEERING OFFICE
 2017 TRAFFIC VOLUMES HOURLY PERCENTAGES
 TDOT REGION 4 AVERAGE FOR ARTERIAL FACILITIES

Table 1.5 – TDOT Region 4 Average Traffic Volumes Hourly Percentages

AVERAGE FOR TWO LANE FACILITIES													AVERAGE FOR MULTI-LANE FACILITIES												
Hour			Population Tier Location (See Note 2 Below)					Overall Regional Average	Hour			Population Tier Location (See Note 2 Below)					Overall Regional Average								
From	To		A	B	C	D	E		From	To		A	B	C	D	E									
12:00 M	1:00 AM		1.11	0.45	0.20	0.47	0.43	0.53	12:00 AM	1:00 AM		0.94	0.65	0.32	0.62	0.58	0.62								
1:00 AM	2:00 AM		0.76	0.34	0.11	0.40	0.23	0.37	1:00 AM	2:00 AM		0.80	0.36	0.17	0.44	0.45	0.41								
2:00 AM	3:00 AM		0.96	0.19	0.10	0.46	0.26	0.39	2:00 AM	3:00 AM		0.58	0.28	0.11	0.46	0.38	0.36								
3:00 AM	4:00 AM		1.96	0.24	0.08	0.39	0.40	0.61	3:00 AM	4:00 AM		0.59	0.36	0.13	0.44	0.66	0.44								
4:00 AM	5:00 AM		1.79	0.49	0.20	0.99	0.72	0.84	4:00 AM	5:00 AM		0.91	0.65	0.26	0.92	1.14	0.77								
5:00 AM	6:00 AM		1.68	1.32	0.81	2.14	2.33	1.65	5:00 AM	6:00 AM		2.17	1.54	0.86	1.91	2.70	1.84								
6:00 AM	7:00 AM		2.97	4.00	4.31	3.91	4.89	4.02	6:00 AM	7:00 AM		4.42	4.01	3.53	3.52	4.98	4.09								
7:00 AM	8:00 AM		5.80	6.18	7.91	8.83	8.65	7.47	7:00 AM	8:00 AM		6.01	7.20	8.64	6.50	7.39	7.15								
8:00 AM	9:00 AM		5.75	6.45	7.98	5.66	5.39	6.24	8:00 AM	9:00 AM		5.89	6.33	7.23	5.58	5.85	6.18								
9:00 AM	10:00 AM		5.26	5.42	5.25	4.95	4.50	5.08	9:00 AM	10:00 AM		5.22	5.04	5.61	5.30	5.30	5.29								
10:00 AM	11:00 AM		4.53	5.19	4.49	4.92	5.10	4.85	10:00 AM	11:00 AM		5.15	4.92	5.15	5.64	5.43	5.26								
11:00 AM	12:00 N		5.15	5.95	4.88	5.96	5.40	5.47	11:00 AM	12:00 PM		5.87	5.44	5.77	6.58	6.02	5.94								
12:00 N	1:00 PM		5.62	6.11	5.15	6.36	6.27	5.90	12:00 PM	1:00 PM		6.76	6.76	6.31	6.95	6.25	6.61								
1:00 PM	2:00 PM		5.76	6.28	5.35	6.08	6.12	5.92	1:00 PM	2:00 PM		6.63	6.48	6.23	6.76	6.29	6.48								
2:00 PM	3:00 PM		6.45	7.44	7.15	7.07	7.01	7.02	2:00 PM	3:00 PM		6.91	6.92	7.03	7.24	6.61	6.94								
3:00 PM	4:00 PM		7.45	7.84	8.00	9.41	8.32	8.20	3:00 PM	4:00 PM		7.42	7.59	7.21	8.44	7.68	7.67								
4:00 PM	5:00 PM		8.02	8.72	8.78	7.98	8.58	8.42	4:00 PM	5:00 PM		7.43	8.54	8.11	8.12	8.27	8.09								
5:00 PM	6:00 PM		7.79	8.34	9.85	7.71	8.48	8.44	5:00 PM	6:00 PM		7.24	8.47	8.98	7.61	7.81	8.03								
6:00 PM	7:00 PM		4.96	6.40	7.76	5.17	5.66	5.99	6:00 PM	7:00 PM		5.41	5.79	6.50	5.15	5.22	5.61								
7:00 PM	8:00 PM		4.02	4.40	5.25	3.89	3.99	4.31	7:00 PM	8:00 PM		4.04	4.15	4.35	3.93	3.67	4.03								
8:00 PM	9:00 PM		3.85	3.61	3.25	3.02	3.07	3.36	8:00 PM	9:00 PM		3.38	3.36	3.36	3.05	2.77	3.18								
9:00 PM	10:00 PM		3.08	2.27	1.97	1.99	1.95	2.25	9:00 PM	10:00 PM		2.84	2.44	2.27	2.19	2.18	2.38								
10:00 PM	11:00 PM		3.38	1.48	0.81	1.26	1.43	1.67	10:00 PM	11:00 PM		2.14	1.60	1.21	1.61	1.47	1.60								
11:00 PM	12:00 M		1.94	0.88	0.35	0.99	0.83	1.00	11:00 PM	12:00 AM		1.44	1.11	0.64	1.06	0.89	1.03								

Notes: 1. The seven (7) highest hours are shown in green highlight and the eighth (8th) highest hour is shown in orange highlight.
 2. The population tier locations are as follows:
 Population Tier A → Memphis
 Population Tier B → Bartlett, Collierville, and Jackson
 Population Tier C → Germantown
 Population Tier D → Dyersburg
 Population Tier E → All other cities not shown above and rural areas
 3. Values shown are calculated and rounded up which may result in small rounding errors.

Figure 1.3 – Collision Diagram Example



2.1.1 Traffic Signal Warrants

Traffic signal warrants define minimum threshold levels of vehicular volume, pedestrian volume, progression conditions, crashes, delay, and proximity to railroad crossings that need to be met for an intersection to become a candidate for a traffic control signal. Once met, signal warrants become part of an engineering study that will determine if the installation of a traffic control signal will improve the overall safety and/or operation of the intersection. The MUTCD identifies nine traffic signal warrants as follows:

- Warrant 1 – Eight Hour Vehicular Volume
- Warrant 2 – Four Hour Vehicular Volume
- Warrant 3 – Peak Hour
- Warrant 4 – Pedestrian Volume
- Warrant 5 – School Crossing
- Warrant 6 – Coordinated Signal System
- Warrant 7 – Crash Experience*
- Warrant 8 – Roadway Network
- Warrant 9 – Intersection Near a Grade Crossing

*In addition to the MUTCD Traffic Signal Warrant 7 – Crash Experience, FHWA has provided an interim approval for optional use of an Alternative Signal Warrant 7 – Crash Experience (IA-19). TDOT applied and received IA-19 (Optional Use of Alternative Signal Warrant 7 – Crash Experience) from FHWA for all state and local jurisdictions in Tennessee. Any jurisdiction in Tennessee that chooses the option of IA-19 must coordinate the traffic signal warrant with the TDOT State Traffic Engineer.

Even though these nine warrants can justify a traffic signal installation, TDOT considers Warrant 1 and Warrant 7 as the primary warrants that should be utilized for traffic signal installation approval. If geometric improvements are proposed as part of the project, Warrant 7 may not be applicable if the proposed improvements are expected to reduce crashes. The following are additional considerations for use in an engineering study:

- **Effect of Right-Turning Vehicles:** Engineering judgment should be used to determine what, if any, portion of the right-turn traffic is subtracted from the minor-street traffic count when evaluating the count against the signal warrant threshold tables.
 - **Shared Right-Turn Lane:** Right-turn traffic should be considered when a shared lane contains both through and right-turning traffic.
 - **Exclusive or Channelized Right-Turn Lane:** Right-turn traffic should not be considered when an exclusive or channelized right-turn lane is present.

- **Lane Configuration:** Engineering judgment should also be used when determining if an approach should be considered a one-lane or a two-lane approach for signal warrant analysis.
 - **Left-turn Lane:** For an approach with one lane for through and right-turning traffic plus an exclusive left-turn lane, if engineering judgment indicates that it should be considered a one-lane approach because the traffic using the left-turn lane is minor, the total traffic volume approaching the intersection should be applied against the signal warrants as a one-lane approach. The approach should be considered two lanes if approximately half of the traffic on the approach turns left and the left-turn lane is of sufficient length to accommodate all left-turn vehicles.
 - **Right-Turn Lane:** If an exclusive right-turn lane is present on an approach, it may be considered an approach lane if it has a significant volume of traffic, has sufficient storage capacity to store right turning traffic, and is not channelized away from the intersection. However, if right-turn volumes have been eliminated from the approach volumes for warrant analysis, then any exclusive right-turn lane present should not be included in the number of approach lanes.
- **Estimating Future Conditions:** At a location where a signal study is requested, but the future development is not yet in place, the hourly generated traffic volumes must be estimated based on the phase of development to be completed at the time of signal installation using the following procedures:
 - **Similar Developments:** Where similar developments, in both type and size, exist in the same or similar size community, actual hourly generated traffic volumes can be measured and applied to the new site. Signal warrants can then be applied using these volumes.
 - **Estimating Procedure:** Where similar developments do not exist, peak hour trip generated volumes can be estimated using the current ITE *Trip Generation Manual* or based on an existing similar development. In all cases, all assumptions and trip estimates shall be pre-approved by a TDOT Region Traffic Engineer and/or the State Traffic Engineer prior to developing traffic volumes.
- **Access to Adjacent Signals:** Consideration is to be given as to whether the side street or driveway traffic being studied has access to an existing traffic signal. If access to an adjacent signal exists, a new signal may not be needed.

- **Capacity and Progression Analysis:** A capacity analysis should be considered to determine the impacts of installing traffic signal control at an intersection. If the traffic signal control is to be installed on an existing coordinated system or if progression on the corridor should be considered, a progression analysis should also be completed.

In all cases, engineering judgment must be exercised in the justification of a traffic signal installation.

1.2 Authorization for Installation and Ownership of Traffic Signal Control

Even though they may be installed under TDOT construction projects, TDOT does not own, operate, or maintain traffic signal devices after the conclusion of a project unless there are special circumstances. Therefore, ownership of the traffic signal installation, along with responsibility for operation and maintenance, reverts to the local governing agency.

- **TDOT Projects (State or Local Routes):** It shall be the responsibility of the Traffic Signal Design Manager, a Regional Traffic Engineer, and/or the State Traffic Engineer to review, comment, and/or approve the installation or upgrade of any traffic signals installed as part of a TDOT managed project. All TDOT studies proposing traffic signals are to be reviewed by Headquarters and Regional Traffic Engineers prior to final study approval. Proposed signal operation should safely, economically, and efficiently accommodate current and future traffic and safety needs. Although some local governmental agencies may request certain aesthetic features, enhancement of signal systems with materials or equipment that goes beyond meeting basic operational needs may require the local agency to cover the additional costs with local funds. The local agency will be required to execute a Local Agency Program Agreement accepting ownership and responsibility for the operation and future maintenance of the traffic signals.
- **Non-TDOT Projects (on State Routes):** Per TCA 54-5-603, an incorporated municipality wishing to install traffic signals is not required to obtain approval from TDOT, but they must comply with the requirements of the MUTCD. An incorporated municipality may seek concurrence from TDOT regarding a signal in which case the parties will execute a MOU. All other locally initiated signal design projects shall follow procedures and conform to guidelines given in this manual. The local agency must submit an installation request to the Regional Traffic Engineer along with an engineering study signed by a registered professional engineer. The local agency will be required to execute a MOA accepting ownership and responsibility for the operation and future maintenance of the traffic signals. It is TDOT's goal to provide a safe, reliable, and economically sound traffic control installation that is best suited to the maintenance capabilities of the local agency. In this regard and in limited cases, TDOT has prepared Special Provisions for inclusion in contract documents that address the specific requirements of several local government agencies. TDOT also provides special notes and details on certain projects to conform to other agency practices.

4.2.1 Additional Requirements

- **Environmental Requirements:** Basic signal installation projects usually require little in the way of environmental permits due to the minimal impact of locating poles, pull boxes, and conduit. However, larger projects involving installation of turn lanes or widening of the road may require various permits. Permit needs are assessed and applications are processed and acquired by TDOT's Environmental Planning Division. The Environmental Planning Division may require some special maps, forms, and plan sheets as prepared by the design engineer. Hydrological permits may include:
 - **Tennessee Department of Environment and Conservation (TDEC):**
 - Notice of Intent (NOI)
 - Aquatic Resource Alteration Permit (ARAP)
 - Class V Injection Well Permit
 - **Corps of Engineers (COE):** Section 404 of the Clean Water Act requires permit applications for any stream, spring, wetland, or sinkhole impact or total project impact of ½ acre or more.
 - **Tennessee Valley Authority (TVA):** Section 26a is required when any project impacts any water resource in the Tennessee River Valley or on TVA lands. If the impact is low, TVA may issue a letter of no objection.
 - **Tennessee Wildlife Resources Agency (TWRA):** Any impact on the Reelfoot Lake Basin requires a TWRA permit.

Projects that contain federal funds shall require an environmental study. The design engineer shall consult with the Environmental Division for the latest requirements and guidelines for any environmental permits.

- **Right-of-Way:** Right-of-way impacts are categorized as acquisitions or easements. If no right-of-way impacts are involved in the project, then the project is categorized as Utilities Only. The goal of most traffic signal projects are to minimize the right-of-way impacts, as most impacts are usually limited to pole and controller foundations, pull boxes, and conduits. All right-of-way activities are handled within the Right-of-Way Division.
- **Erosion Control:** Most simple traffic signal projects require minimal erosion control, as the impact is usually limited to pole foundations and trenching for conduit. A short list of items (i.e., filter socks, sediment tubes, etc.) and standard drawings is all that is usually required. No separate plan is required. On larger projects with grading and drainage, an erosion control plan will be required. Any project involving grading and drainage should also include a drainage map.