

HCM 2010: WORK ZONES



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MoDOT Work-Zone Guidelines



[http://epg.modot.org/index.php?title=616.25.MoDOT Work Zone Guidelines](http://epg.modot.org/index.php?title=616.25.MoDOT%20Work%20Zone%20Guidelines)

[http://epg.modot.org/index.php?title=616.14 Work Zone Safety and Mobility Policy](http://epg.modot.org/index.php?title=616.14%20Work%20Zone%20Safety%20and%20Mobility%20Policy)

Work Zone Guidelines

Multi-Discipline District/Division Team

- Statewide/District Work Zone Coordinators
- Strategies to improve work zones
- Provide roadway capacities for lane restriction

Roadway Capacity Guidelines

- Based on Highway Capacity Manual Edition 1999
- Maximum Capacity that would not allow delay or queue
- Create a Capacity Restriction and Capacity Cautionary Zone for work zone.

Roadway Capacities

Work zones limit the amount of traffic that can travel a roadway because of reduced speed limits, closed lanes and additional driver distractions. The following guidelines address these issues with different types of state routes to improve conditions while ensuring safety is the top priority.

The following table shows various open- and closed-lane scenarios with the expected vehicle capacities.

Interstate & Freeway Lane Conditions		Capacity Restrictions		Cautionary Zone	
total number of lanes	number of open lanes	vehicles per hour per lane	total capacity in open lanes	vehicles per hour per lane	total capacity in open lanes
3	1	960	960	750	750
2	1	1240	1240	1000	1000
5	2	1320	2640	1000	2000
4	2	1420	2840	1100	2200
3	2	1430	2860	1100	2200
4	3	1480	4440	1100	3300

Transportation Management System

TF3800C - Traffic Segment Hourly Volume														
File Window Help														
Travelway	IS 70		E		Begin Log 193.29900		End Log 193.50000							
Segment	RTS A-B		RTS A-B		RTS A-B		RTS A-B		RTS A-B		RTS A-B		RTS A-B	
Roadway	FREEWAY		FREEWAY		FREEWAY		FREEWAY		FREEWAY		FREEWAY		FREEWAY	
Lanes / Open	2	1	2	1	2	1	2	1	2	1	2	1	2	1
Date of Count	11/08/2010		11/09/2010		11/10/2010		11/11/2010		11/12/2010		11/13/2010		11/14/2010	
Cap. / Cautionary	1240	1000	1240	1000	1240	1000	1240	1000	1240	1000	1240	1000	1240	1000
12:00 MIDNIGHT - 1 AM	261		273		287		270		316		284		280	
1:00 - 2:00 AM	190		198		208		196		229		206		203	
2:00 - 3:00 AM	227		237		249		234		274		246		243	
3:00 - 4:00 AM	246		257		270		253		297		267		263	
4:00 - 5:00 AM	328		343		360		339		396		356		351	
5:00 - 6:00 AM	528		551		579		544		637		573		564	
6:00 - 7:00 AM	611		639		671		631		738		664		654	
7:00 - 8:00 AM	710		743		780		733		858		771		760	
8:00 - 9:00 AM	732		766		804		756		885		795		784	
9:00 - 10:00 AM	888		928		975		916		1072		964		950	
10:00 - 11:00 AM	966		1010		1061		997		1167		1049		1034	
11 AM - 12 NOON	898		938		985		926		1084		975		960	
12 NOON - 1:00 PM	943		985		1035		973		1139		1024		1009	
1:00 - 2:00 PM	963		1006		1057		994		1163		1045		1030	
2:00 - 3:00 PM	1034		1080		1135		1067		1248		1122		1106	
3:00 - 4:00 PM	1041		1088		1143		1075		1258		1131		1114	
4:00 - 5:00 PM	1077		1126		1182		1112		1301		1169		1152	
5:00 - 6:00 PM	986		1031		1083		1018		1191		1071		1055	
6:00 - 7:00 PM	845		883		928		872		1021		918		904	
7:00 - 8:00 PM	700		732		769		723		846		760		749	
8:00 - 9:00 PM	567		593		623		586		685		616		607	
9:00 - 10:00 PM	557		582		612		575		673		605		596	
10:00 - 11:00 PM	428		447		470		441		517		464		458	
11 PM - 12:00 MIDNIGHT	383		400		420		395		462		415		409	
TOTAL ADT	16111		16837		17684		16626		19456		17492		17233	

■	Expected volume exceeds open lane capacity
■	Approaching capacity, may impact traffic
■	Capacity values were not found for the selected lane counts

Transportation Management System

TF3800C - Traffic Segment Hourly Volume									
File Window Help									
Travelway	IS 70		E		Begin Log 208.09900		End Log 208.25000		
Segment	RTS W-T		RTS W-T		RTS W-T		RTS W-T		RTS W-T
Roadway	FREEWAY		FREEWAY		FREEWAY		FREEWAY		FREEWAY
Lanes / Open	2 / 1	2 / 1	2 / 1	2 / 1	2 / 1	2 / 1	2 / 1	2 / 1	2 / 1
Date of Count	11/15/2010		11/16/2010		11/17/2010		11/18/2010		11/19/2010
Cap. / Cautionary	1240	1000	1240	1000	1240	1000	1240	1000	1240 1000
12:00 MIDNIGHT - 1 AM	241	254	265	258	265	223	208		
1:00 - 2:00 AM	164	173	180	176	181	152	142		
2:00 - 3:00 AM	192	203	211	206	211	178	166		
3:00 - 4:00 AM	196	206	215	210	215	181	169		
4:00 - 5:00 AM	404	426	444	434	445	375	348		
5:00 - 6:00 AM	1095	1155	1203	1175	1205	1015	944		
6:00 - 7:00 AM	1746	1841	1918	1874	1922	1619	1505		
7:00 - 8:00 AM	1621	1710	1781	1741	1785	1504	1398		
8:00 - 9:00 AM	1396	1472	1534	1499	1537	1294	1204		
9:00 - 10:00 AM	1290	1360	1417	1384	1420	1196	1112		
10:00 - 11:00 AM	1139	1201	1251	1223	1254	1056	982		
11 AM - 12 NOON	1198	1263	1316	1286	1319	1110	1033		
12 NOON - 1:00 PM	1228	1295	1349	1319	1352	1139	1059		
1:00 - 2:00 PM	1027	1083	1128	1103	1131	952	886		
2:00 - 3:00 PM	1346	1420	1479	1445	1482	1248	1161		
3:00 - 4:00 PM	1373	1448	1508	1474	1511	1273	1183		
4:00 - 5:00 PM	1328	1401	1459	1426	1462	1232	1145		
5:00 - 6:00 PM	1098	1158	1206	1178	1208	1018	946		
6:00 - 7:00 PM	873	921	959	937	961	809	753		
7:00 - 8:00 PM	745	786	818	800	820	691	642		
8:00 - 9:00 PM	681	718	748	731	750	631	587		
9:00 - 10:00 PM	512	540	563	550	564	475	442		
10:00 - 11:00 PM	395	417	434	424	435	366	341		
11 PM - 12:00 MIDNIGHT	284	299	312	304	312	263	244		
TOTAL ADT	21572	22751	23697	23158	23749	20002	18599		

■	Expected volume exceeds open lane capacity
■	Approaching capacity, may impact traffic
■	Capacity values were not found for the selected lane counts

Ensure work is performed during off-peak hours

(Capacity Restriction Concerns)

- Hourly Volume tables should be used to determine when to work off-peak hours (i.e. 9 am – 3 pm)
- Staff should use off-peak work-hour guidelines when scheduling lane closures
- Nighttime or weekend work may be required, when necessary
- Consider statewide effects of special events along major routes

HCM Changes

- Since 1999, the HCM has changed on calculating work zone capacity and queuing.
- The Work Zone Guidelines work well, but care must be given in determining working hours.
- Some projects did not performed as shown on the TMS hourly volume chart.
- Depending on terrain, truck percentage, and type of work, a project may have a longer delay than expected or may not have a delay.

“Easier to Use” Software Program

UMC/MoDOT Calibration

- Tool that is easy to use by Design, Construction and Maintenance Personnel
- Interstate, freeway and multi-lane projects
- Accuracy of travel time
- Estimated queue lengths
- Traffic delays and associated user cost
- Based on Highway Capacity Manual

HCM Short-Term Work Zone

$$C_a = \{[(1,600 + I) \times f_{HV}] \times N\} - R$$

- Base capacity is 1600 pc/hr/ln
- C_a = adjusted mainline capacity (veh/hr)
- I = adjustment factor for type, intensity, and proximity of work activity, pc/hr/ln (ranges between 160 pc/hr/ln)
- f_{HV} = heavy-vehicle adjustment factor
- N = number of lanes open through the work zone
- R = manual adjustment for on ramps (veh/h)

Work Zone Equation Values

- 1600 pc/hr/ln is capacity through a work area with normal intensity of work, passenger cars, flat, etc.
- Intensity of work refers to:
 - number of workers on site
 - number & size of work vehicles on site
 - proximity of work activity to travel lanes
- Research suggest intensity range as much as $\pm 10\%$, so factor applied based on professional judgment and local experience.

Work Zone Equation Values

$$f_{\text{HV}} = \frac{1}{1 + P_{\text{T}}(E_{\text{T}} - 1) + P_{\text{R}}(E_{\text{R}} - 1)}$$

- Heavy-vehicle adjustment factor
- P_{T} & P_{R} – Proportion of Trucks, buses & RV's based on percentage of total volume.
- E_{T} & E_{R} – Passenger-car equivalent of Trucks, buses & RV's based on grade of roadway, length of roadway and % of large vehicles.

Work Zone Equation Values

- N = Number of lanes open through the work zone
- R = manual adjustment for on-ramps

EPG 616.13 Work Zone Capacity, Queue, and Travel Delay

- 616.13.2 Interstate, Freeways and Multi-lane Roadways
- MoDOT Work Zone Impact Analysis Spreadsheet with HCM Program and Directions

Highway Capacity Manual 2010 Program for the MoDOT's Work Zone Impact Analysis Spreadsheet

Work Location	Travel Lane Width (ft)	Capacity of Work Zone Before Trucks (pc/h/ln)	Percent of Trucks*	E _T - Equivalent Truck*	Lane Width Factor (f _{LW})	Capacity (w/Trucks) veh/lane/hr	Number of Lanes Open	Total Capacity for Spreadsheet (veh/hr)
Workers & equipment less than 4-feet from travel lane	> 11.5	1440	30.0	1.5	1.000	1252	1	1252
	10 - 11.5	1440	30.0	1.5	0.910	1139	1	1139
	<10	1440	30.0	1.5	0.860	1077	1	1077
Workers & equipment greater than 4-feet from travel lane	> 11.5	1600	30.0	1.5	1.000	1391	1	1391
	10 - 11.5	1600	30.0	1.5	0.910	1266	1	1266
	<10	1600	30.0	1.5	0.860	1197	1	1197
Barrier located less than 2-feet from travel lane	> 11.5	1500	30.0	1.5	1.000	1304	1	1304
	10 - 11.5	1500	30.0	1.5	0.910	1187	1	1187
	<10	1500	30.0	1.5	0.860	1122	1	1122
Barrier located greater than 2-feet from travel lane	> 11.5	1600	30.0	1.5	1.000	1391	1	1391
	10 - 11.5	1600	30.0	1.5	0.910	1266	1	1266
	<10	1600	30.0	1.5	0.860	1197	1	1197
Ramp (used as bypass)	> 11.5	1680	30.0	1.5	1.000	1461	1	1461
	10 - 11.5	1680	30.0	1.5	0.910	1329	1	1329
	<10	1680	30.0	1.5	0.860	1256	1	1256
Crossover on Divided Highway	> 11.5	1760	30.0	1.5	1.000	1530	1	1530
	10 - 11.5	1760	30.0	1.5	0.910	1393	1	1393
	<10	1760	30.0	1.5	0.860	1316	1	1316

* Percent of Trucks and E_T - Equivalent Truck located in the below chart.

Capacity of Work Before Trucks = 1600 + I (pc/h/ln)

Intensity of Work = I; I is the adjustment factor for type, intensity and proximity of work activity

I ranges between + or - 160 pc/h/ln based on professional judgement and local experience

E_T = passenger-car equivalent for truck (based on percent of trucks and climbing grade)

Lane Width Factor (f_{LW}) = Restricted lane widths will negatively affect capacity.

Passenger - Car Equivalents for Trucks on Upgrades

Climbing Grade (%)*	Length (mi)	E _T - Passenger - Car Equivalents for Trucks on Upgrades												
		Percentage of Trucks												
		2	4	5	6	8	10	15	20	25	30	35	40	
< 2		1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
>2-3	0 - 0.49	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
	0.50 - 1.00	2.0	2.0	2.0	2.0	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
	>1.00	3.0	3.0	2.5	2.5	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
>3-4	0 - 0.49	2.0	2.0	2.0	2.0	2.0	2.0	1.5	1.5	1.5	1.5	1.5	1.5	1.5
	0.50 - 1.00	3.0	3.0	2.5	2.5	2.5	2.5	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	>1.00	4.0	3.5	3.0	3.0	3.0	3.0	2.5	2.5	2.5	2.5	2.5	2.5	2.5
>4-5	0 - 0.49	3.0	2.5	2.5	2.5	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	0.50 - 1.00	4.0	3.5	3.5	3.5	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
	>1.00	5.0	4.0	4.0	4.0	3.5	3.5	3.0	3.0	3.0	3.0	3.0	3.0	3.0
>5-6	0 - 0.49	4.5	4.0	3.5	3.0	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
	0.50 - 1.00	5.5	5.0	4.5	4.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
	>1.00	6.0	5.0	5.0	4.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
>6	0 - 0.49	5.0	4.5	4.0	4.0	3.5	3.0	2.5	2.5	2.5	2.5	2.5	2.5	2.5
	0.50 - 1.00	6.0	5.5	5.0	5.0	4.5	4.0	3.5	3.5	3.5	3.5	3.5	3.5	3.5
	>1.00	7.0	6.0	5.5	5.5	5.0	4.5	4.0	4.0	4.0	4.0	4.0	4.0	4.0

*Climbing Grade can be located anywhere throughout the entire work zone project.

Work Location	Travel Lane Width (ft)	Capacity of Work Zone Before Trucks (pc/h/ln)	Percent of Trucks*	E_T - Equivalent Truck*	Lane Width Factor (f_{LW})	Capacity (w/Trucks) (veh/lane/hr)	Number of Lanes Open	Total Capacity for Spreadsheet (veh/hr)
Workers & equipment less than 4-feet from travel lane	> 11.5	1440	30.0	1.5	1.000	1252	1	1252
	10 - 11.5	1440	30.0	1.5	0.910	1139	1	1139
	<10	1440	30.0	1.5	0.860	1077	1	1077
Workers & equipment greater than 4-feet from travel lane	> 11.5	1600	30.0	1.5	1.000	1391	1	1391
	10 - 11.5	1600	30.0	1.5	0.910	1266	1	1266
	<10	1600	30.0	1.5	0.860	1197	1	1197
Barrier located less than 2-feet from travel lane	> 11.5	1500	30.0	1.5	1.000	1304	1	1304
	10 - 11.5	1500	30.0	1.5	0.910	1187	1	1187
	<10	1500	30.0	1.5	0.860	1122	1	1122
Barrier located greater than 2-feet from travel lane	> 11.5	1600	30.0	1.5	1.000	1391	1	1391
	10 - 11.5	1600	30.0	1.5	0.910	1266	1	1266
	<10	1600	30.0	1.5	0.860	1197	1	1197
Ramp (used as bypass)	> 11.5	1680	30.0	1.5	1.000	1461	1	1461
	10 - 11.5	1680	30.0	1.5	0.910	1329	1	1329
	<10	1680	30.0	1.5	0.860	1256	1	1256
Crossover on Divided Highway	> 11.5	1760	30.0	1.5	1.000	1530	1	1530
	10 - 11.5	1760	30.0	1.5	0.910	1393	1	1393
	<10	1760	30.0	1.5	0.860	1316	1	1316

* Percent of Trucks and E_T - Equivalent Truck located in the below chart.

Capacity of Work Before Trucks = $1600 + I$ (pc/h/ln)

Intensity of Work = I ; I is the adjustment factor for type, intensity and proximity of work activity

I ranges between + or - 160 pc/h/ln based on professional judgement and local experience

E_T = passenger-car equivalent for truck (based on percent of trucks and climbing grade)

Lane Width Factor (f_{LW}) = Restricted lane widths will negatively affect capacity.

Spreadsheet Variables

- Travel Lane Width – Based on HCM and modified for simplicity.
- Lane Width Factor – Capacity is reduced due to restricted lane width.
- Capacity of Work Zone Before Trucks – The capacity is based on data from a UMC & MST and North Carolina Studies. The studies reviewed intensity of work, location of work to traveling public, and lane width.

Passenger - Car Equivalents for Trucks on Upgrades

Climbing Grade (%)*	Length (mi)	E _T - Passenger - Car Equivalents for Trucks on Upgrades											
		Percentage of Trucks											
		2	4	5	6	8	10	15	20	25	30	35	40
< 2		1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
>2-3	0 - 0.49	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
	0.50 - 1.00	2.0	2.0	2.0	2.0	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
	>1.00	3.0	3.0	2.5	2.5	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
>3-4	0 - 0.49	2.0	2.0	2.0	2.0	2.0	2.0	1.5	1.5	1.5	1.5	1.5	1.5
	0.50 - 1.00	3.0	3.0	2.5	2.5	2.5	2.5	2.0	2.0	2.0	2.0	2.0	2.0
	>1.00	4.0	3.5	3.0	3.0	3.0	3.0	2.5	2.5	2.5	2.5	2.5	2.5
>4-5	0 - 0.49	3.0	2.5	2.5	2.5	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	0.50 - 1.00	4.0	3.5	3.5	3.5	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
	>1.00	5.0	4.0	4.0	4.0	3.5	3.5	3.0	3.0	3.0	3.0	3.0	3.0
>5-6	0 - 0.49	4.5	4.0	3.5	3.0	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
	0.50 - 1.00	5.5	5.0	4.5	4.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
	>1.00	6.0	5.0	5.0	4.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
>6	0 - 0.49	5.0	4.5	4.0	4.0	3.5	3.0	2.5	2.5	2.5	2.5	2.5	2.5
	0.50 - 1.00	6.0	5.5	5.0	5.0	4.5	4.0	3.5	3.5	3.5	3.5	3.5	3.5
	>1.00	7.0	6.0	5.5	5.5	5.0	4.5	4.0	4.0	4.0	4.0	4.0	4.0

*Climbing Grade can be located anywhere throughout the entire work zone project.

MoDOT WORK ZONE IMPACT ANALYSIS SPREADSHEET

Developed by University of Missouri - Columbia

TOTAL NUMBER OF LANES	2	NUMBER OF LANES OPEN	1
TRUCK PERCENTAGE	33	OPEN LANE CAPACITY	1600

TOTAL CAPACITY OF WORKZONE 1240

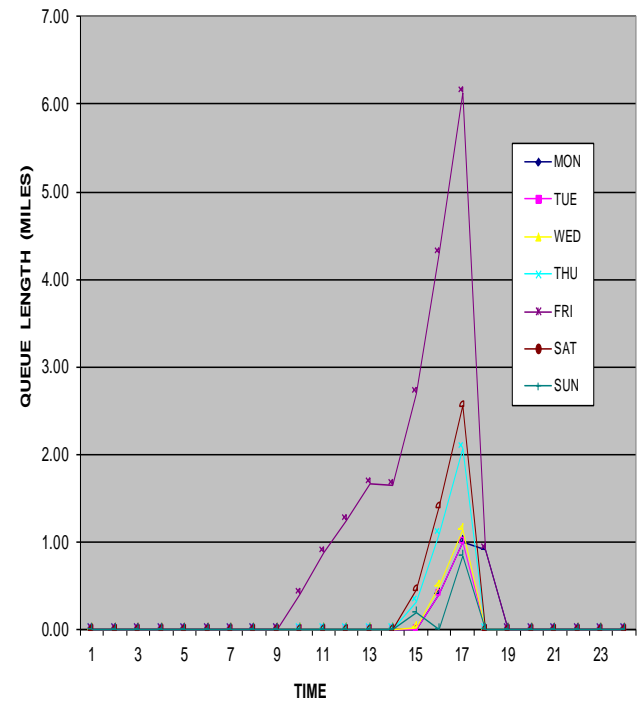
(The capacity value is consistent with MoDOT's recommended value for the chosen lane configuration)

USER COST	TRUCKS	\$22.70
	CARS	\$10.30

Start Time	6
Duration of closure	12

MONDAY	TIME	DEMAND	CAPACITY	TOTAL ARRIVALS	TOTAL DEPARTURES	QUEUED VEHICLES	QUEUE LENGTH	DELAY
AM	0:00	350	3200	350	350	0	0.00	0.00
	1:00	335	3200	685	685	0	0.00	0.00
	2:00	279	3200	964	964	0	0.00	0.00
	3:00	281	3200	1245	1245	0	0.00	0.00
	4:00	333	3200	1578	1578	0	0.00	0.00
	5:00	428	3200	2006	2006	0	0.00	0.00
	6:00	685	1240	2691	2691	0	0.00	0.00
	7:00	808	1240	3499	3499	0	0.00	0.00
	8:00	956	1240	4455	4455	0	0.00	0.00
	9:00	1072	1240	5527	5527	0	0.00	0.00
	10:00	1091	1240	6618	6618	0	0.00	0.00
	11:00	1064	1240	7682	7682	0	0.00	0.00
PM	12:00	1074	1240	8756	8756	0	0.00	0.00
	13:00	968	1240	9724	9724	0	0.00	0.00
	14:00	1234	1240	10958	10958	0	0.00	0.00
	15:00	1370	1240	12328	12198	130	0.41	6.29
	16:00	1429	1240	13757	13438	319	1.00	15.44
	17:00	1211	1240	14968	14678	290	0.91	14.03
	18:00	1157	3200	16125	16125	0	0.00	0.00
	19:00	878	3200	17003	17003	0	0.00	0.00
	20:00	804	3200	17807	17807	0	0.00	0.00
	21:00	655	3200	18462	18462	0	0.00	0.00
	22:00	512	3200	18974	18974	0	0.00	0.00
	23:00	463	3200	19437	19437	0	0.00	0.00

MAX DELAY	Minutes	15.44
AVE DELAY		2.28
COST (\$)		\$2,353.34
MAX QUEUE LENGTH		1.00



MoDOT WORK ZONE IMPACT ANALYSIS SPREADSHEET

TOTAL NUMBER OF LANES	2	NUMBER OF LANES OPEN	1
TRUCK PERCENTAGE (*)	33	OPEN LANE CAPACITY	1600

TOTAL CAPACITY OF WORKZONE	1240
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(The capacity value is consistent with MoDOT's recommended value for the chosen lane configuration)

USER COST	TRUCKS	\$22.70
	CARS	\$10.30

<u>FRIDAY</u>		TIME	DEMAND	CAPACITY	TOTAL ARRIVALS	TOTAL DEPARTURES	QUEUED VEHICLES	QUEUE LENGTH	DELAY
	AM	0:00	228	3200	228	228	0	0.00	0.00
		1:00	202	3200	430	430	0	0.00	0.00
		2:00	186	3200	616	616	0	0.00	0.00
		3:00	226	3200	842	842	0	0.00	0.00
		4:00	261	3200	1103	1103	0	0.00	0.00
		5:00	334	3200	1437	1437	0	0.00	0.00
		6:00	468	1240	1905	1905	0	0.00	0.00
		7:00	648	1240	2553	2553	0	0.00	0.00
		8:00	901	1240	3454	3454	0	0.00	0.00
		9:00	1030	1240	4484	4484	0	0.00	0.00
		10:00	1038	1240	5522	5522	0	0.00	0.00
		11:00	1052	1240	6574	6574	0	0.00	0.00
	PM	12:00	1262	1240	7836	7814	22	0.07	1.06
		13:00	1280	1240	9116	9054	62	0.20	3.00
		14:00	1256	1240	10372	10294	78	0.25	3.77
		15:00	1447	1240	11819	11534	285	0.90	13.79
		16:00	1496	1240	13315	12774	541	1.70	26.18
		17:00	1200	1240	14515	14014	501	1.58	24.24
		18:00	947	1240	15462	15254	208	0.65	10.06
		19:00	673	1240	16135	16135	0	0.00	0.00
		20:00	654	1240	16789	16789	0	0.00	0.00
		21:00	457	1240	17246	17246	0	0.00	0.00
		22:00	514	1240	17760	17760	0	0.00	0.00
		23:00	432	1240	18192	18192	0	0.00	0.00

Spreadsheet Variables

- Queued Vehicles – The difference from the total arrivals and total departures.
- Queued Length (miles) – Number of queued vehicles and length of cars (25-ft) & trucks (50-ft).
- Delay – Number of Queued Vehicles/Capacity converted to minutes.
- Cost – Total user cost of cars and trucks.

Start Time	6
Duration of closure	18

MAX DELAY	26.18
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AVE DELAY	5.60
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COST (\$)	\$7,875.94
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MAX QUEUE LENGTH	1.70
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MoDOT Work Zone Impact Analysis Spreadsheet with HCM Program

[http://epg.modot.org/index.php?title=616.13 Work Zone Capacity%2C Queue and Travel Delay](http://epg.modot.org/index.php?title=616.13_Work_Zone_Capacity%2C_Queue_and_Travel_Delay)

Questions?

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