NCLOS Program Update for the HCM 6th Edition

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16. Abstract

In early 2016, the HCM 6th Edition will be available for transportation facility analyses. There are significant and important improvements for many of the methodologies in the new HCM based on the most recent national research over the last 5-6 years. As with previous editions of the manual, the HCM 6th Edition will become the standard for determining capacity of most highway facilities. NCLOS was re-programmed to incorporate these new methodologies and other enhancements to remain current with the state-of-the-practice.

This research project analyzed new traffic count data available from the Traffic Survey Group and found that travel patterns had not significantly changed, but did recommend default values for new variables that did not exist in previous editions of the HCM. The improved NCLOS software can be used to update the Comprehensive Transportation Planning Manual to bring the default tables and guidance up to speed with the HCM 6th Edition.

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EXECUTIVE SUMMARY

The North Carolina Level of Service (NCLOS) program is a planning-level highway capacity analysis tool developed for NCDOT under a previous project. The program originally used methodologies in the 2000 Highway Capacity Manual (HCM), along with specific default parameters from North Carolina data, to determine level-of-service (LOS) threshold "capacities" for freeways, multilane highways, two-lane highways, and arterial streets. Shortly after the release of the HCM 2010 edition, the NCLOS program was updated in a follow-up project. NCLOS is unique in that it provides a graphical display of the measures of effectiveness (MOE) plotted against AADT for each facility type. Users see best case, default case, and worst case curves, plus a highlighted curve for the LOS selected for the analysis.

The NCLOS program is being used extensively in planning applications within NCDOT. Output capacities are used in travel demand forecasting models and in developing Comprehensive Transportation Plans (CTP). Output values can also be used in the statewide travel demand model. Currently the tool is also used to provide data for the Performance Metrics Dashboard and is used as a scoring component in the Strategic Prioritization Process and Urban Loop Prioritization Process.

In early 2016, the HCM 6th Edition will be available for transportation facility analyses. There are significant and important improvements for many of the methodologies in the new HCM based on the most recent national research over the last 5-6 years. As with previous editions of the manual, the HCM 6th Edition will become the standard for determining capacity of most highway facilities. NCLOS was re-programmed to incorporate these new methodologies and other enhancements to remain current with the state-of-the-practice.

This research project analyzed new traffic count data available from the Traffic Survey Group and found that travel patterns had not significantly changed, but did recommend default values for new variables that did not exist in previous editions of the HCM. The improved NCLOS software can be used to update the Comprehensive Transportation Planning Manual to bring the default tables and guidance up to speed with the HCM 6th Edition.

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INTRODUCTION

The North Carolina Level of Service (NCLOS) program is a planning-level highway capacity analysis tool developed for NCDOT under a previous project. The program originally used methodologies in the 2000 Highway Capacity Manual (HCM), along with specific default parameters from North Carolina data, to determine level-of-service (LOS) threshold "capacities" for freeways, multilane highways, two-lane highways, and arterial streets. Shortly after the release of the HCM 2010 edition, the NCLOS program was updated in a follow-up project.

NCLOS is unique in that it provides a graphical display of the measures of effectiveness (MOE) plotted against AADT for each facility type. Users see best case, default case, and worst case curves, plus a highlighted curve for the LOS selected for the analysis.

The NCLOS program is being used extensively in planning applications within NCDOT. Output capacities are used in travel demand forecasting models and in developing Comprehensive Transportation Plans (CTP). Output values can also be used in the statewide travel demand model now under development. Currently the tool is also used to provide data for the Performance Metrics Dashboard and is used as a scoring component in the Strategic Prioritization Process and Urban Loop Prioritization Process.

In 2016, the HCM 6th Edition was released for transportation facility analyses. There are significant and important improvements for many of the methodologies in the new HCM based on the most recent national research over the last 5-6 years. As with previous editions of the manual, the HCM 6th Edition will become the standard for determining capacity of most highway facilities. It will be critical for NCLOS to be re-programmed to incorporate these new methodologies and other enhancements to remain current with the state-of-the-practice.

LITERATURE REVIEW

K Factor (K) is the percentage of AADT representing the 30th highest hourly volume in the design year. [1] For typical main rural highways, K-factors generally range from 12 to 18 percent. For urban facilities, K factors are typically somewhat lower, ranging from 8 to 12 percent. For calculation of AADT from short term volume counts Adjustment and Growth factor needs to be calculated that would account for variations in data (monthly, weekly, seasonal, etc). [2]

Every state has a different procedure for calculating these factors that depend on the functional classification, which are often documented in planning manuals, such as the Florida K Factor manual. [3] Typically, there are no separate procedures based on traffic volumes rather regional or urban/rural differences by functional classification. A national report [2] lists the different procedures used by the states of Ohio, Florida, Texas, California, Michigan, Virginia, Washington, Illinois, Massachusetts, and New Jersey.

Recreational Routes

The steering and implementation committee discussed ongoing research into the changes in K factor and adjustment factors that may be needed for recreational routes. The StIC noted significant data needed to estimate in North Carolina as well as the variation in facility peaking based on geography and land use. The research team found existing literature on the issue and recommends that additional field data collection may be needed in North Carolina to address state-specific issues and geography such as beach traffic, holiday or special event traffic, and the fall tourist traffic to see the leaves changing colors in western North Carolina. The FHWA report *Highway Performance Monitoring System Traffic Data For High Volume Routes: Best Practices And Guidelines* [2] reviewed additional analysis on methods for K factor analysis on recreational routes.

- "Michigan calculates adjustment factors from 2 year rolling averages of Permanent Traffic Recorders (PTR) data. Factors are calculated for 3 patterns of traffic (Urban to Recreational). These factors are calculated and adjusted every year.

- ILDOT uses a 4-year rolling average from ATR counts for seasonal factors (monthly factors) calculated from ATR data for five categories – urban interstate, urban non interstate, rural non-interstate and recreational roads. No Day-of-Week (DOW) factor is used as IDOT schedules only 24 hour counts on a weekday and does not count on weekend and holidays. The Chicago area does not have different adjustment factors as of date but IDOT is working towards developing a new set of factors for the Chicago area. To this end, IDOT has added 38 new ATRs in the Chicago region between 1998 and 2000.

- In New Jersey, pattern factors (Seasonal Adjustment Factors) are computed by grouping continuous monitoring stations into broad functional class groups (i.e., rural interstate,

other rural, urban interstate, other urban, and recreational). For each station, the monthly average weekday is compared to the AADT, as is done for the group as a whole. Stations at which three or more months deviate from the group average by more than 20 percent are rejected from the group and considered as recreational pattern. The stations in each group are then analyzed and it the variation exceeds 20 percent, the station is considered ungrouped. This process is iterated until the stations within each group conform to the group pattern. Axle Correction Factors are computed by grouping all available vehicle type classification data by functional classification. The sum of vehicles by type is divided by total vehicles to determine percentage of vehicles by type. By using axles per vehicle type, average axles per vehicle is determined, and when divided into 2, the Axle Correction Factors are determined. These are averaged for three years of classification data to provide a three-year moving average. The pattern factors (Seasonal Adjustment Factors) are updated annually. The Axle Correction Factors are updated annually based on a three-year moving average."

Previous NCLOS Defaults

The CTP Manual includes default AADT Capacities by roadway type for LOS D and LOS E. In the previous NCLOS capacity output from the default factors chosen were:

Table 1 Maximum capacity for LOS D under Default Conditions in HCM 2010

Highway Facility	Maximum Capacity for LOS D under Default Conditions by Highway Facility, Area Type, and Number of Lanes					
	Area Type	Total Number of Lanes				
		2	4	6	8	10
Freeways	Urban	32561	65122	97683	130244	162805
	Suburban	32561	65122	97683	130244	162805
	Rural	31519	63039	94559	126078	157598
Multi-lane Highways	Urban	N/A	58711	88067	117423	146778
	Suburban	N/A	65892	98839	131785	164731
	Rural	N/A	68175	102263	136351	170439
Superstreets	Urban	26981	53962	80943	107924	134906
	Suburban	26981	53962	80943	107924	134906
	Rural	23227	46454	69681	92909	116136
Two-lane Highways	Urban	N/A	N/A	N/A	N/A	N/A
	Suburban	N/A	N/A	N/A	N/A	N/A
	Rural	12834	N/A	N/A	N/A	N/A
Arterials	Urban	10666	21380	32098	42811	53525
	Suburban	13008	26131	39244	52357	65470
	Rural	N/A	N/A	N/A	N/A	N/A

*Note: N/A - the combination of highway facility and area type are not applicable by definition or for North Carolina highways; NCDOT default values for urban and suburban area types do not differ for freeways and superstreets

Table 2 Maximum capacity for LOS D under Default Conditions in HCM 2010

Highway Facility	Maximum Capacity for LOS E under Default Conditions by Highway Facility, Area Type, and Number of Lanes					
	Area Type	Total Number of Lanes				
		2	4	6	8	10
Freeways	Urban	37570	75140	112711	150281	187852
	Suburban	37570	75140	112711	150281	187852
	Rural	35851	71703	107555	143407	179259
Multi-lane Highways	Urban	N/A	66645	99968	133291	166613
	Suburban	N/A	74797	112195	149594	186993
	Rural	N/A	75750	113626	151501	189377
Superstreets	Urban	27899	55798	83697	111596	139495
	Suburban	27899	55798	83697	111596	139495
	Rural	24017	48035	72052	96070	120087
Two-lane Highways	Urban	N/A	N/A	N/A	N/A	N/A
	Suburban	N/A	N/A	N/A	N/A	N/A
	Rural	15538	N/A	N/A	N/A	N/A
Arterials	Urban	12962	25953	38953	51942	64938
	Suburban	15815	31692	47566	63456	79331
	Rural	N/A	N/A	N/A	N/A	N/A

*Note: N/A - the combination of highway facility and area type are not applicable by definition or for North Carolina highways; NCDOT default values for urban and suburban area types do not differ for freeways and superstreets

HCM 6TH EDITION CHANGES

Below is a summary of the changes to the HCM that potentially impact the NCLOS software:

Basic Freeway Segments and Multilane Highways (Chapter 12, HCM 6th Edition):

Basic Freeway (Chapter 11 of the HCM 2010) and Multilane Highways (Chapter 14, HCM 2010) is combined to one (Chapter 12, HCM 6th Edition).

Instead of rounding up the HCM now provides adjustment factor SAF (Speed Adjustment Factor) and CAF (Capacity Adjustment Factor). And, it also provides the equation to calculate the exact Breaking point (BP) instead of having to round up. The following is the table with all the new equations:

Table 3 HCM 6th Edition Exhibit 12-6, parameters for Speed Flow Curves for Basic Freeway and Multilane Highway Segments.

Para-meter	Definition and Units	Basic Freeway Segments	Multilane Highway Segments
FFS	Base segment free-flow speed (mi/h)	Measured OR predicted using Equation 12-2	Measured OR predicted using Equation 12-3
FFS_{adj}	Adjusted free-flow speed (mi/h)	$FFS_{adj} = FFS \times SAF$	No adjustments
SAF	Speed adjustment factor (decimal)	Locally calibrated OR estimated using Chapter 11; SAF=1.00 for base conditions	1.00
c	Base segment capacity (pc/h/ln)	$c = 2{,}200 + 10(FFS-50)$ $c \leq 2{,}400$ $55 \leq FFS \leq 75$	$c = 1{,}900 + 20(FFS-45)$ $c \leq 2{,}300$ $45 \leq FFS \leq 70$
c_{adj}	Adjusted segment capacity (pc/h/ln)	$c_{adj} = c \times CAF$	No adjustments
CAF	Capacity adjustment factor (decimal)	Locally calibrated OR estimated using Chapter 11; CAF=1.00 for base conditions	1.00
D_c	Density at capacity (pc/mi/ln)	45	45
BP	Breakpoint (pc/h/ln)	$BP_{adj} = [1{,}000 + 40 \times (75 - FFS_{adj})] \times CAF^2$	1,400
a	Exponent calibration parameter (decimal)	2.00	1.31

- Freeway and Multilane Highway speed flow equations are unified. Thus, the new speed flow relationship is as follows:

$$S = FFS_{adj} \qquad v_p \leq BP$$

$$S = FFS_{adj} - \frac{\left(FFS_{adj} - \frac{c_{adj}}{D_c}\right)\left(v_p - BP\right)^a}{\left(c_{adj} - BP\right)^a} \qquad BP < v_p \leq c$$

Freeway Truck impacts changed. The new methodology gives a new table for new Passenger Car Equivalent values with respect to the different composition of SUTs and TTs.

Table 4 HCM 6th Edition Exhibit 12-26, PCEs for a Mix of 30% SUTs and 70% TTs

% Grade	Length (mi)	Percentage of Trucks and Buses (%)								
		2%	4%	5%	6%	8%	10%	15%	20%	>25%
-2	0.125	2.62	2.37	2.30	2.24	2.17	2.12	2.04	1.99	1.97
	0.375	2.62	2.37	2.30	2.24	2.17	2.12	2.04	1.99	1.97
	0.625	2.62	2.37	2.30	2.24	2.17	2.12	2.04	1.99	1.97
	0.875	2.62	2.37	2.30	2.24	2.17	2.12	2.04	1.99	1.97
	1.25	2.62	2.37	2.30	2.24	2.17	2.12	2.04	1.99	1.97
	1.5	2.62	2.37	2.30	2.24	2.17	2.12	2.04	1.99	1.97
0	0.125	2.62	2.37	2.30	2.24	2.17	2.12	2.04	1.99	1.97
	0.375	2.62	2.37	2.30	2.24	2.17	2.12	2.04	1.99	1.97
	0.625	2.62	2.37	2.30	2.24	2.17	2.12	2.04	1.99	1.97
	0.875	2.62	2.37	2.30	2.24	2.17	2.12	2.04	1.99	1.97
	1.25	2.62	2.37	2.30	2.24	2.17	2.12	2.04	1.99	1.97
	1.5	2.62	2.37	2.30	2.24	2.17	2.12	2.04	1.99	1.97
2	0.125	2.62	2.37	2.30	2.24	2.17	2.12	2.04	1.99	1.97
	0.375	3.76	2.96	2.78	2.65	2.48	2.38	2.22	2.14	2.09
	0.625	4.47	3.33	3.08	2.91	2.68	2.54	2.34	2.23	2.17
	0.875	4.80	3.50	3.22	3.03	2.77	2.61	2.39	2.28	2.21
	1.25	5.00	3.60	3.30	3.09	2.83	2.66	2.42	2.30	2.23
	1.5	5.04	3.62	3.32	3.11	2.84	2.67	2.43	2.31	2.23
2.5	0.125	2.62	2.37	2.30	2.24	2.17	2.12	2.04	1.99	1.97
	0.375	4.11	3.14	2.93	2.78	2.58	2.46	2.28	2.19	2.13
	0.625	5.04	3.62	3.32	3.11	2.84	2.67	2.43	2.31	2.23
	0.875	5.48	3.85	3.51	3.27	2.96	2.77	2.50	2.36	2.28
	1.25	5.73	3.98	3.61	3.36	3.03	2.83	2.54	2.40	2.31
	1.5	5.80	4.02	3.64	3.38	3.05	2.84	2.55	2.41	2.32
3.5	0.125	2.62	2.37	2.30	2.24	2.17	2.12	2.04	1.99	1.97
	0.375	4.88	3.54	3.25	3.05	2.80	2.63	2.41	2.29	2.22
	0.625	6.34	4.30	3.87	3.58	3.20	2.97	2.64	2.48	2.38
	0.875	7.03	4.66	4.16	3.83	3.39	3.12	2.76	2.57	2.46
	1.25	7.44	4.87	4.33	3.97	3.50	3.22	2.82	2.62	2.50
	1.5	7.53	4.92	4.38	4.01	3.53	3.24	2.84	2.63	2.51
4.5	0.125	2.62	2.37	2.30	2.24	2.17	2.12	2.04	1.99	1.97
	0.375	5.80	4.02	3.64	3.38	3.05	2.84	2.55	2.41	2.32
	0.625	7.90	5.11	4.53	4.14	3.63	3.32	2.90	2.68	2.55
	0.875	8.91	5.64	4.96	4.50	3.92	3.56	3.07	2.82	2.67
	1	9.19	5.78	5.08	4.60	3.99	3.62	3.11	2.85	2.70
5.5	0.125	2.62	2.37	2.30	2.24	2.17	2.12	2.04	1.99	1.97
	0.375	6.87	4.58	4.10	3.77	3.35	3.09	2.73	2.55	2.44
	0.625	9.78	6.09	5.33	4.82	4.16	3.76	3.21	2.93	2.77
	0.875	11.20	6.83	5.94	5.33	4.56	4.09	3.45	3.12	2.93
	1	11.60	7.04	6.11	5.47	4.67	4.18	3.51	3.17	2.97
6	0.125	2.62	2.37	2.30	2.24	2.17	2.12	2.04	1.99	1.97
	0.375	7.48	4.90	4.36	3.99	3.52	3.23	2.83	2.63	2.51
	0.625	10.87	6.66	5.79	5.21	4.46	4.01	3.39	3.08	2.89
	0.875	12.54	7.54	6.51	5.81	4.94	4.40	3.67	3.30	3.08
	1	13.02	7.78	6.71	5.99	5.07	4.51	3.75	3.37	3.14

Note: Interpolation in the exhibit is permitted.

Table 5 HCM 6th Edition Exhibit 12-27, PCEs for a Mix of 50% SUTs and 50% TTs

% Grade	Length (mi)	Percentage of Trucks and Buses (%)								
		2%	4%	5%	6%	8%	10%	15%	20%	>25%
-2	0.125	2.67	2.38	2.31	2.25	2.16	2.11	2.02	1.97	1.93
	0.375	2.67	2.38	2.31	2.25	2.16	2.11	2.02	1.97	1.93
	0.625	2.67	2.38	2.31	2.25	2.16	2.11	2.02	1.97	1.93
	0.875	2.67	2.38	2.31	2.25	2.16	2.11	2.02	1.97	1.93
	1.25	2.67	2.38	2.31	2.25	2.16	2.11	2.02	1.97	1.93
	1.5	2.67	2.38	2.31	2.25	2.16	2.11	2.02	1.97	1.93
0	0.125	2.67	2.38	2.31	2.25	2.16	2.11	2.02	1.97	1.93
	0.375	2.67	2.38	2.31	2.25	2.16	2.11	2.02	1.97	1.93
	0.625	2.67	2.38	2.31	2.25	2.16	2.11	2.02	1.97	1.93
	0.875	2.67	2.38	2.31	2.25	2.16	2.11	2.02	1.97	1.93
	1.25	2.67	2.38	2.31	2.25	2.16	2.11	2.02	1.97	1.93
	1.5	2.67	2.38	2.31	2.25	2.16	2.11	2.02	1.97	1.93
2	0.125	2.67	2.38	2.31	2.25	2.16	2.11	2.02	1.97	1.93
	0.375	3.76	2.95	2.77	2.64	2.47	2.36	2.20	2.11	2.06
	0.625	4.32	3.24	3.01	2.84	2.63	2.49	2.29	2.19	2.12
	0.875	4.57	3.37	3.11	2.93	2.70	2.55	2.33	2.22	2.15
	1.25	4.71	3.45	3.17	2.99	2.74	2.58	2.36	2.24	2.17
	1.5	4.74	3.47	3.19	3.00	2.75	2.59	2.36	2.24	2.17
2.5	0.125	2.67	2.38	2.31	2.25	2.16	2.11	2.02	1.97	1.93
	0.375	4.10	3.13	2.92	2.77	2.57	2.44	2.26	2.16	2.10
	0.625	4.84	3.52	3.23	3.03	2.77	2.61	2.38	2.26	2.18
	0.875	5.17	3.69	3.37	3.15	2.87	2.69	2.43	2.30	2.22
	1.25	5.36	3.79	3.45	3.22	2.92	2.73	2.47	2.33	2.24
	1.5	5.40	3.81	3.47	3.24	2.93	2.74	2.47	2.33	2.25
3.5	0.125	2.67	2.38	2.31	2.25	2.16	2.11	2.02	1.97	1.93
	0.375	4.89	3.54	3.25	3.05	2.79	2.62	2.39	2.26	2.19
	0.625	6.05	4.15	3.75	3.47	3.11	2.89	2.58	2.42	2.32
	0.875	6.58	4.43	3.97	3.66	3.26	3.01	2.67	2.49	2.39
	1.25	6.88	4.58	4.10	3.77	3.35	3.09	2.72	2.53	2.42
	1.5	6.95	4.62	4.13	3.80	3.37	3.10	2.73	2.54	2.43
4.5	0.125	2.67	2.38	2.31	2.25	2.16	2.11	2.02	1.97	1.93
	0.375	5.83	4.03	3.65	3.39	3.05	2.84	2.55	2.39	2.30
	0.625	7.53	4.92	4.38	4.01	3.53	3.24	2.83	2.62	2.50
	0.875	8.32	5.34	4.72	4.29	3.75	3.42	2.97	2.73	2.59
	1	8.53	5.45	4.81	4.37	3.81	3.47	3.00	2.76	2.62
5.5	0.125	2.67	2.38	2.31	2.25	2.16	2.11	2.02	1.97	1.93
	0.375	6.97	4.63	4.14	3.81	3.38	3.11	2.74	2.55	2.43
	0.625	9.37	5.89	5.16	4.68	4.05	3.67	3.14	2.88	2.72
	0.875	10.49	6.48	5.65	5.09	4.37	3.93	3.34	3.03	2.85
	1	10.80	6.64	5.78	5.20	4.46	4.01	3.39	3.08	2.89
6	0.125	2.67	2.38	2.31	2.25	2.16	2.11	2.02	1.97	1.93
	0.375	7.64	4.98	4.43	4.05	3.56	3.26	2.85	2.64	2.51
	0.625	10.45	6.45	5.63	5.07	4.36	3.92	3.33	3.03	2.85
	0.875	11.78	7.16	6.20	5.56	4.74	4.24	3.56	3.22	3.01
	1	12.15	7.35	6.36	5.69	4.85	4.33	3.62	3.27	3.05

Note: Interpolation in the exhibit is permitted.

Table 6 HCM 6th Edition Exhibit 12-28, PCEs for a Mix of 70% SUTs and 30% TTs

% Grade	Length (mi)	Percentage of Trucks and Buses (%)								
		2%	4%	5%	6%	8%	10%	15%	20%	>25%
-2	0.125	2.39	2.18	2.12	2.07	2.01	1.96	1.89	1.85	1.83
	0.375	2.39	2.18	2.12	2.07	2.01	1.96	1.89	1.85	1.83
	0.625	2.39	2.18	2.12	2.07	2.01	1.96	1.89	1.85	1.83
	0.875	2.39	2.18	2.12	2.07	2.01	1.96	1.89	1.85	1.83
	1.25	2.39	2.18	2.12	2.07	2.01	1.96	1.89	1.85	1.83
	1.5	2.39	2.18	2.12	2.07	2.01	1.96	1.89	1.85	1.83
0	0.125	2.39	2.18	2.12	2.07	2.01	1.96	1.89	1.85	1.83
	0.375	2.39	2.18	2.12	2.07	2.01	1.96	1.89	1.85	1.83
	0.625	2.39	2.18	2.12	2.07	2.01	1.96	1.89	1.85	1.83
	0.875	2.39	2.18	2.12	2.07	2.01	1.96	1.89	1.85	1.83
	1.25	2.39	2.18	2.12	2.07	2.01	1.96	1.89	1.85	1.83
	1.5	2.39	2.18	2.12	2.07	2.01	1.96	1.89	1.85	1.83
2	0.125	2.67	2.32	2.23	2.17	2.08	2.03	1.94	1.89	1.86
	0.375	3.63	2.82	2.64	2.52	2.35	2.25	2.10	2.02	1.97
	0.625	4.12	3.08	2.85	2.69	2.49	2.36	2.18	2.08	2.02
	0.875	4.37	3.21	2.96	2.78	2.56	2.42	2.22	2.11	2.05
	1.25	4.53	3.29	3.02	2.84	2.60	2.45	2.24	2.13	2.07
	1.5	4.58	3.31	3.04	2.86	2.61	2.46	2.25	2.14	2.07
2.5	0.125	2.75	2.36	2.27	2.20	2.11	2.04	1.95	1.90	1.87
	0.375	4.01	3.02	2.80	2.65	2.46	2.33	2.16	2.06	2.01
	0.625	4.66	3.35	3.08	2.88	2.64	2.48	2.26	2.15	2.08
	0.875	4.99	3.52	3.21	3.00	2.73	2.56	2.32	2.19	2.12
	1.25	5.20	3.64	3.30	3.08	2.79	2.60	2.35	2.22	2.14
	1.5	5.26	3.67	3.33	3.10	2.80	2.62	2.36	2.23	2.15
3.5	0.125	2.93	2.45	2.34	2.26	2.16	2.09	1.98	1.92	1.89
	0.375	4.86	3.46	3.16	2.96	2.69	2.53	2.30	2.18	2.10
	0.625	5.88	3.99	3.59	3.32	2.98	2.76	2.46	2.31	2.22
	0.875	6.40	4.26	3.81	3.51	3.12	2.88	2.55	2.38	2.28
	1.25	6.74	4.43	3.96	3.63	3.21	2.96	2.60	2.42	2.32
	1.5	6.83	4.48	3.99	3.66	3.24	2.98	2.62	2.44	2.33
4.5	0.125	3.13	2.56	2.43	2.34	2.21	2.13	2.01	1.95	1.91
	0.375	5.88	3.99	3.59	3.32	2.98	2.76	2.46	2.31	2.22
	0.625	7.35	4.75	4.22	3.85	3.39	3.10	2.71	2.51	2.39
	0.875	8.11	5.15	4.54	4.13	3.60	3.27	2.83	2.61	2.47
	1	8.33	5.27	4.63	4.21	3.66	3.33	2.87	2.64	2.50
5.5	0.125	3.37	2.69	2.53	2.42	2.28	2.19	2.05	1.98	1.94
	0.375	7.09	4.62	4.11	3.76	3.31	3.04	2.66	2.47	2.36
	0.625	9.13	5.68	4.97	4.49	3.88	3.51	3.00	2.74	2.59
	0.875	10.21	6.24	5.43	4.88	4.18	3.76	3.18	2.89	2.71
	1	10.52	6.41	5.57	5.00	4.27	3.83	3.24	2.93	2.75
6	0.125	3.51	2.76	2.59	2.47	2.32	2.22	2.08	2.00	1.95
	0.375	7.78	4.98	4.40	4.01	3.51	3.20	2.78	2.56	2.44
	0.625	10.17	6.23	5.42	4.87	4.17	3.75	3.18	2.88	2.71
	0.875	11.43	6.88	5.95	5.32	4.53	4.04	3.39	3.06	2.86
	1	11.81	7.08	6.11	5.46	4.64	4.13	3.45	3.11	2.90

Note: Interpolation in the exhibit is permitted.

The values in the tables above can be interpolated. For the values related to the SUT and TT mix other than the ones mentioned in the above three tables can be interpolated between the tables.

HCM 6th Edition Volume 4 also discusses a mixed flow method to do the above calculations, however this method is data intensive and would result in too complex of a formulation for NCLOS's use in the planning level.

Additional Changes:

- There is no more driver population factor.
- Multilane highway capacity is now a constant 45 pcphpl, this moved LOS E-F

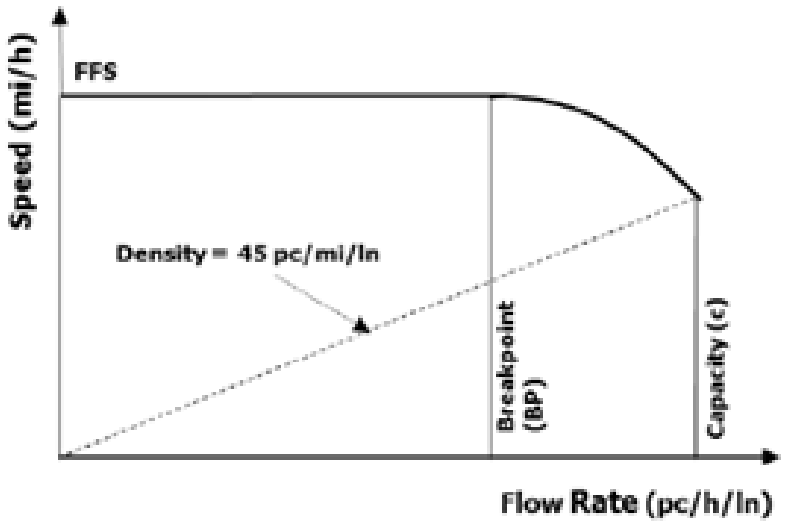

Figure 1 HCM 6th Edition Exhibit 12-5, general form for Speed-Flow Curves on Basic Freeway and Multilane Highway Segments

Signalized Intersections (Chapter 19, HCM 6th Edition)

In the supplement to this chapter, i.e HCM 6th Edition Volume 4, a new planning level analysis has been introduced that focuses on through movements. The method is divided in to two parts. The first one estimates the intersection capacity and the second one estimate the delay and LOS by extending the first part analysis.
In the first part:

a) Left turn operation is determined by using the guidelines mentioned.
b) Movement volumes are then converted to passenger car equivalents using HCM 6th Edition, equation 31- 157:

$$v_{adj} = V\ E_{HV}\ E_{PHF}\ E_{LT}\ E_{RT}\ E_p\ E_{LU}\ E_{\text{other}}$$

where

v_{adj} = equivalent through movement flow rate expressed in through passenger cars per hour (tpc/h),

V = movement volume (veh/h),

E_{HV} = equivalency factor for heavy vehicles,

E_{PHF} = equivalency factor for peaking characteristics,

E_{RT} = equivalency factor for right turns,

E_{LT} = equivalency factor for left turns,

E_p = equivalency factor for parking activity,

E_{LU} = equivalency factor for lane utilization, and

E_{other} = equivalency factor for other conditions.

The ways to determine the values of the factors mentioned above are given in HCM 6th Edition, equation 31- 158, 31 – 159 and Exhibit 31 – 33 through Exhibit 31- 36

c) Flow rates to Lane groups were assigned using HCM 6th Edition, Equation 31- 160

$$v_i = \frac{v_{adj,i}}{N_i}$$

where

v_i = lane flow rate for lane group i expressed in through passenger cars per hour per lane (tpc/h/ln);

$v_{adj,i}$ = equivalent through movement flow rate for lane group i (tpc/h), and

N_i = number of lanes associated with lane group i, accounting for defacto lanes (ln).

d) Determination of Critical Lane groups

The right turn flow rate needs to be adjusted by subtracting the flow rate of the protected left turn movement from the cross street, from it.

For identifying the lane groups for different cases HCM 6th Edition equations 31-161 through 31-166. Then to calculate the sum of critical flow rates use HCM 6th Edition equations 31-167 through 31-170 according to the case that is applicable for the particular project. Using all this, critical phases are identified

e) Determination of intersection sufficiency

If the cycle length is not known then it is assumed as 30 seconds for each critical phase, keeping in mind the policies of the local agencies. Then the intersection capacity is calculated by using HCM 6th Edition equation 31-171:

$$c_I = s_o \frac{C - (n_{cp}\, l_t)}{C}$$

c_I = intersection capacity (tpc/h/ln),

s_o = base saturation flow rate (pc/h/ln),

C = cycle length (s),

n_{cp} = number of critical phases, and

l_t = phase lost time (s).

A default lost time of 4s for each phase is recommended.

After the calculation of the intersection capacity, the volume to capacity ratio is calculated using HCM 6th Edition equation 31-172. And finally the assessment of sufficiency is done using HCM 6th Edition Exhibit 31-37:

Table 7 Planning level Analysis : Intersection Volume-to-Capacity Ratio Assessment Levels

Critical Intersection Volume-to-Capacity Ratio	Description	Capacity Assessment
<0.85	All demand is able to be accommodated; delays are low to moderate.	Under
0.85–0.98	Demand for critical lane groups near capacity and some lane groups require more than one cycle to clear the intersection; all demand is able to be processed within the analysis period; delays are moderate to high	Near
>0.98	Demand for critical lane groups is just able to be accommodated within a cycle but oftentimes requires multiple cycles to clear the intersection; delays are high and queues are long.	Over

In the second part:

f) Capacity is calculated using HCM 6th Edition equation 31-173 through equation 31-178.
g) Delay and level of service is calculated using HCM 6th Edition equation 31- 179 through 31-181 and Exhibit 31- 38

For Protected- Permitted Left Turn Operations:

For Protected- permitted Left turns there are slight changes in steps b and d from the above method. The changes are as follows:

b) For conversion of movement volumes to through passenger car equivalents HCM 6th Edition Equation 31-182 should be used:

$$E_{LT} = \frac{E_{LT,pt}\, g_{lt,pt} + E_{LT,pm}\, g_{lt,pm}}{g_{lt,pt} + g_{lt,pm}}$$

where

E_{LT} = equivalency factor for left turns,

$E_{LT,pt}$ = equivalency factor for protected left-turn operation,

$E_{LT,pm}$ = equivalency factor for permitted left-turn operation,

$g_{lt,pt}$ = effective green time for the protected left-turn phase (s), and

$g_{lt,pm}$ = effective green time for permitted left-turn operation during the through phase (s).

d) For determination of Critical Lane Groups HCM 6th Edition Equation 31- 183 needs to be used:

$$v_{lt,pt} = v_{lt} \frac{g_{lt,pt}}{g_{lt,pt} + g_{lt,pm}}$$

where

$v_{lt,pt}$ = lane flow rate for the left-turn lane group during the protected left-turn phase (tpc/h/ln),

v_{lt} = lane flow rate for the left-turn lane group (tpc/h/ln), and

all other variables are as previously defined.

Ramp Terminal and Alternative Intersections (Chapter 23, HCM 6th Edition)

Unlike the previous version of the HCM, Superstreets are included as RCUTs. This method includes major changes to Superstreet capacity but is very data intensive. In determining the level of service experienced at a RCUT requires more than just the control delay because of the additional distance a vehicle must travel if making a left turn or through movement from the minor road. As such, the extra distance traveled must also be considered and to do so requires an additional input, namely, the freeflow travel time between the sub-intersections. This extra distance travel time (EDTT) in addition to the control delay at each junction (d_i), creates the overall experienced travel time (ETT) by which a RCUTs level of service is measured. The EDTT subtracts the hypothetical freeflow travel time which would be experienced at a 90-degree turn from the actual freeflow travel time of the turn.

$$ETT = \sum d_i + \sum EDTT$$

The level of service is automatically F if the volume to capacity ratio (v/c) or average queue to storage ratio (R_Q) for any lane group exceeds one.

	Condition		
ETT (s/veh)	v/c ≤ 1 and $R_Q \leq 1$ for every lane group	v/c > 1 for any lane group	$R_Q > 1$ for any lane group
≤ 10	A	F	F
> 10 – 20	B	F	F
> 20 – 35	C	F	F
> 35 – 55	D	F	F
> 55 – 80	E	F	F
> 80	F	F	F

For movements on the major approaches, there is no meaningful EDTT because both turning movements occur in the manner they would at a standard intersection. Therefore, the ETT is based only on the control delay at the junctions.

While there is no adjustment in the calculation of control delay for major approach movements at either signal-, stop-, or yield-controlled intersections, some default values may differ. Additional data required for these adjustments include:

- Arrival types at second intersection
- G/C Ratio at both intersections
- Progression quality between intersections

Overall, the research team does not recommend using the new HCM Superstreets method until appropriate field data can be collected to determine default values. Field data collection is outside of the scope of the current project, so the research team recommends use of the simplified signal method used for past HCM editions until another research project/data collection effort is able to establish appropriate defaults.

RECOMMENDED DEFAULT VALUES

Default values from the previous version of NCLOS were reviewed to determine if any new variables should be added or previous variables needed deletion due to the changes in the HCM 6th Edition. Extensive analysis of data collected by NCDOT beginning in 1988 and includes information up until 2015 found that K and D factors did not show statistically significant changes from 2013 defaults. Detailed data from Automated Traffic Recorder (ATR) stations were obtained from the NCDOT Traffic Survey Unit in the form of a large database. The procedures in HCM 6th Edition were calibrated to reflect specific observed conditions within the state of North Carolina. The analysis of default values generally showed few trends across facility types and geographic region, although various outlier locations were observed for any of the data points. The research team recommends the following default data for NCLOS.

Of note, the research team identified the impact of changing the truck Passenger Car Equivalent (PCE) value based on the new Single Unit and Tractor Trailer percentage as potentially having a negative impact on capacity. Truck performance has not degraded since the HCM 2010 so lower capacities based on the new methodology is not desired. The researchers have identified that the research used to develop the new PCE values was limited to mostly simulations and is planned to be updated as more data may be collected. Due to this, the research team recommends keeping the 30% SUT and 70% TT PCEs as the default values.

Table 8 NCLOS 6th Edition Freeway, Multilane Highway, and Superstreet Default Values

Facility Type		Input	Program Limits: Restrict Input Within Boundary		Practical Limits: Alert Users of Uncommon Input		NCLOS Default Value		
			Maximum	Minimum	Worst	Best	Urban	Suburban	Rural
Freeway	Traffic Factors	D	0.50	1.00	0.80	0.50	0.60	0.60	0.60
		K	0.04	1.00	0.13	0.08	0.09	0.09	0.09
		PHF	0.25	1.00	0.75	1.00	0.90	0.90	0.85
		% Heavy Vehicles *	0.00	100.00	50.00	0.00	5.00	5.00	10.00
		%SUT **	0.00	100.00	0.00	100.00	30.00	30.00	30.00
	Roadway factors	Terrain Type	N/A	N/A	N/A	N/A	Level	Level	Level
		Lane width	8.00	14.00	10.00	12.00	12.00	12.00	12.00
		Length of Grade (miles)	0.00	10.00	5.00	0.00	0.00	0.00	0.00
		Number of Lanes (per directi	2.00	10.00	2.00	5.00	2.00	2.00	2.00
		Percent Grade	-100.00	100.00	12.00	0.00	0.00	0.00	0.00
		Right- Side Lateral Clearance	0.00	12.00	6.00	0.00	10.00	10.00	10.00
		Total Ramp Density	0.00	12.00	6.00	0.00	1.00	1.00	0.50
Multilane Highway	Traffic Factors	D	0.50	1.00	0.75	0.50	0.60	0.55	0.60
		K	0.04	1.00	0.13	0.08	0.09	0.09	0.09
		PHF	0.25	1.00	0.75	1.00	0.90	0.90	0.90
		% Heavy Vehicles *	0.00	100.00	50.00	0.00	5.00	5.00	5.00
		%SUT **	0.00	100.00	0.00	100.00	30.00	30.00	30.00
	Roadway factors	Access Points Per Mile	0.00	100.00	40.00	0.00	25.00	16.00	8.00
		BFFS	30.00	80.00	45.00	65.00	60.00	60.00	60.00
		Terrain Type	N/A	N/A	N/A	N/A	Level	Level	Level
		Lane Width	8.00	14.00	10.00	12.00	12.00	12.00	12.00
		Lateral Clearance	0.00	12.00	0.00	12.00	8.00	10.00	12.00
		Length of Grade	0.00	10.00	5.00	0.00	0.00	0.00	0.00
		Median Type	N/A	N/A	Undivided	Divided	Divided	Divided	Divided
		Percent Grade	-100.00	100.00	12.00	0.00	0.00	0.00	0.00
		Total Number of Lanes	4.00	10.00	4.00	6.00	2.00	2.00	2.00
Super Streets	Traffic Factors	D	0.50	1.00	0.75	0.50	0.60	0.60	0.60
		K	0.04	1.00	0.13	0.08	0.09	0.09	0.09
		PHF	0.25	1.00	0.75	1.00	0.90	0.90	0.90
		Percent RVs	0.00	100.00	10.00	0.00	0.00	0.00	0.00
		Percent Trucks/Buses	0.00	100.00	40.00	0.00	5.00	5.00	5.00
		Saturated Flow Rate	1000.00	2100.00	1500.00	1800.00	1800.00	1800.00	1800.00
	Roadway factors	Cycle Length	60.00	300.00	80.00	200.00	120.00	120.00	120.00
		G/C Ratio	0.00	1.00	0.60	0.80	0.70	0.70	0.70
		Terrain Type	N/A	N/A	N/A	N/A	Level	Level	Level
		Lateral Clearance	0.00	12.00	0.00	6.00	6.00	6.00	6.00
		Number of Lanes (per directi	1.00	8.00	2.00	4.00	3.00	2.00	2.00

* Includes Trucks, Buses, and RVs
** Consider RVs as Single Unit Trucks (SUT), % Tractor Trailer (%TT) = 1 - %SUT

Table 9 NCLOS 6th Edition Two-Lane Highway and Arterial Default Values

Facility Type		Input	Program Limits: Restrict Input Within Boundary		Practical Limits: Alert Users of Uncommon Input		NCLOS Default Value		
			Maximum	Minimum	Worst	Best	Urban	Suburban	Rural
Two-Lane Highway	Traffic Factors	D	0.50	1.00	0.90	0.50			0.60
		FFS	30.00	80.00	45.00	65.00			60.00
		K	0.04	1.00	0.13	0.08			0.09
		PHF	0.25	1.00	0.75	1.00			0.85
		Percent RVs	0.00	100.00	10.00	0.00			4.00
		Percent Trucks/Buses	0.00	100.00	40.00	0.00			5.00
	Roadway Factors	Access Points Per Mile	0.00	100.00	40.00	0.00			8.00
		BFFS	30.00	80.00	45.00	65.00			60.00
		Terrain Type	N/A	N/A	N/A	N/A			Level
		Lane Width	8.00	14.00	9.00	12.00			12.00
		Lateral Clearance	0.00	12.00	0.00	6.00			6.00
		Length of Grade (miles)	0.00	10.00	5.00	0.00			0.00
		Percent Grade	-100.00	100.00	12.00	0.00			0.00
		Percent No Passing Zones	0.00	100.00	100.00	0.00			20.00
		Two Lane Class	I	I	I	I			I
Arterials	Traffic Factors	BFFS (mph)	30.00	70.00	30.00	60.00	45.00	45.00	
		K	0.04	1.00	0.13	0.08	0.09	0.09	
		Midsegment Volume	0.00	10,000.00	0.00	5,000.00	User	User	
		Other Delays (sec)	0.00	100.00	0.00	50.00	10.00	10.00	
		PHF	0.25	1.00	0.75	1.00	0.90	0.90	
		Platoon Ratio	0.00	1.00	0.20	0.80	0.60	0.60	
		Saturated Flow Rate (per lane)	1,300.00	1,900.00	1,500.00	1,900.00	1,800.00	1,800.00	
		Startup Time Lost (sec)	1.00	4.00	1.00	2.50	1.50	1.50	
		Total Delay Due To Turns (sec)	0.00	100.00	0.00	50.00	10.00	10.00	
		Upstream Volume Capacity Ratio	0.20	2.50	1.50	0.50	0.90	0.80	
	Roadway Factors	Access Points Per Mile	0.00	60.00	60.00	0.00	25.00	16.00	
		Cycle Length (sec)	60.00	300.00	80.00	200.00	120.00	120.00	
		G/C Ratio	0.00	1.00	0.10	0.60	0.35	0.35	
		Intersection Width (feet)	24.00	120.00	36.00	84.00	60.00	60.00	
		Length (feet)	0.00	100,000.00	0.00	20,000.00	10,000.00	10,000.00	
		Length with Restrictive Median (fe	0.00	100,000.00	0.00	20,000.00	2,000.00	2,000.00	
		Number of Lanes (per direction)	1.00	8.00	1.00	4.00	2.00	2.00	
		Proportion with Curb	0.00	100.00	50.00	100.00	100.00	0.00	
		Speed Limit	15.00	60.00	25.00	60.00	45.00	45.00	

Table 10 NCLOS 6th Edition LOS D Capacities

Highway Facility	Maximum Capacity for LOS D under Default Conditions by Highway Facility, Area Type, Number of Lanes					
	Area Type	Total Number of Lanes				
		2	4	6	8	10
Freeways	Urban					
	Suburban					
	Rural					
Multi - Lane Highways	Urban					
	Suburban					
	Rural					
Superstreets	Urban					
	Suburban					
	Rural					
Two - Lane Highways	Urban					
	Suburban					
	Rural					
Arterials	Urban					
	Suburban					
	Rural					

Table 11 NCLOS 6th Edition LOS E Capacities

Highway Facility	Maximum Capacity for LOS E under Default Conditions by Highway Facility, Area Type, Number of Lanes					
	Area Type	Total Number of Lanes				
		2	4	6	8	10
Freeways	Urban					
	Suburban					
	Rural					
Multi - Lane Highways	Urban					
	Suburban					
	Rural					
Superstreets	Urban					
	Suburban					
	Rural					
Two - Lane Highways	Urban					
	Suburban					
	Rural					
Arterials	Urban					
	Suburban					
	Rural					

CONCLUSIONS AND RECOMMENDATIONS

The research team reviewed the changes in the Highway Capacity Manual 6th Edition methodologies including Freeways, Multilane Highways, Superstreets, Two-Lane Highways, and Arterials. Overall, the research team found that through extensive permanent count station data analysis there were no statistically significant changes in existing default values from the 2013 NCLOS study. However, there were new variables identified in the HCM 6th Edition procedures that did need new default values. One major change to the Freeway and Multilane Highways methodology was a new Passenger Car Equivalent (PCE) table based on the percent of Single Unit and Tractor Trailer trucks. The new PCE tables show higher values than the 2010 version for some percentages, which may result in lower Freeway/Multilane Highway capacities solely due to a methodology change when truck performance has not degraded. The research team recommends using the 30%/70% SUT/TT table as a default until future research updates the currently simulation-based PCE tables.

Another major methodological change is the inclusion of Restricted Crossing U-Turns (RCUTs or Superstreets as they are called in North Carolina) in the HCM. The Superstreet method is based on additional delay compared to traditional intersection layouts, but requires more input data that would need field observation. The research team recommends maintaining the previous Superstreet methodology for the current update, and recommends future research focused on field data collection on typical Superstreet signal timing and origin-destination volumes to support the adoption of the new HCM 6th Edition methodology in the future.

Finally, the research team reviewed existing literature on K Factors and seasonal adjustment factors for recreational routes nationwide. Many states do address recreational routes in their counts programs however there were many differences in approach. Multiple states developed special adjustment factors based on similar “outlier” permanent or temporary count data and others identified the route purpose (such as beach/tourist routes) and developed factors based on purpose. The research team recommends the NCDOT support ongoing and new research projects on recreational route travel patterns to support the variety of recreational routes in North Carolina.

REFERENCES

[1] TxDOT, "Roadway Design Manual, Section 2: Traffic Characteristics," 01 October 2014. [Online]. Available: http://onlinemanuals.txdot.gov/txdotmanuals/rdw/traffic_characteristics.htm. [Accessed 09 March 2018].

[2] P. Dr. Edward Fekpe, M. D. Gopalakrishna and D. D. M. (TTI), "HIGHWAY PERFORMANCE MONITORING SYSTEM TRAFFIC DATA FOR HIGH VOLUME ROUTES: BEST PRACTICES AND GUIDELINES," Office of Highway Policy Information Federal Highway Administration U.S. Department of Transportation, Washington, D.C., 2004.

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APPENDIX A: COMPREHENSIVE TRANSPORTATION PLANNING MANUAL UPDATES

This section should be used to update the Default Capacities based on the new version of the NCLOS software.

CTP Terminology	HCM Terminology	LOS D Criteria	Median Type	Traffic Signals/mile	HCM Default FFS	Interchanges/ Mile
Freeway						
Urban	Freeway	< 35 pc/per mile/ per lane	Divided	None	65	1
Suburban	Freeway	< 35 pc/per mile/ per lane	Divided	None	70	0.5
Rural	Freeway	< 35 pc/per mile/ per lane	Divided	None	70	0.5

CTP Terminology	HCM Terminology	LOS D Criteria	Median Type	Traffic Signals/ Mile	HCM Default FFS	Access points / Mile
Expressway						
Urban	Multi-lane Highway	< 35 pc/per mile/ per lane	Divided	None/ < 0.5 mile	60	15

Suburban	Multi-lane Highway	< 35 pc/per mile/ per lane	Divided	None/ < 0.5 mile	65	10
Rural	Multi-lane Highway	< 35 pc/per mile/ per lane	Divided	None/ < 0.5 mile	65	5

CTP Terminology	HCM Terminology	LOS D Criteria	Median Type	Traffic Signals/ Mile	HCM Default FFS	Arrival Type	% Left Turn	g/C Ratio	Cycle Length
Boulevards 55 MPH									
Urban	Urban Arterial I	ATS > 21 MPH	Divided	1.5	50	3	15	0.6	200
Suburban	Urban Arterial I	ATS > 21 MPH	Divided	1	50	4	10	0.6	200
Rural	Urban Arterial I	ATS > 21 MPH	Divided	0.5	50	5	10	0.6	200
Boulevards 55 MPH									
Urban	Urban Arterial II	ATS > 17 MPH	Divided	3.0	40	3	20	0.55	150
Suburban	Urban Arterial II	ATS > 17 MPH	Divided	1.5	40	4	15	0.55	150
Rural	Urban Arterial I	ATS > 17 MPH	Divided	0.5	40	4 , 5	15	0.6	200
Boulevards 35 MPH									
Urban	Urban Arterial IV	ATS > 14 MPH	Divided	6.0	30	4	20	0.42	120
Suburban	Urban Arterial II	ATS > 14 MPH	Divided	3.0	35	3	15	0.55	150
Boulevards 25 MPH									

Urban	Urban Arterial IV	ATS > 9 MPH	Divided	8.0	30	4	20	0.42	120

CTP Terminology	HCM Terminology	LOS D Criteria	Median Type	Traffic Signals/ Mile	HCM Default FFS	Arrival Type	% Left Turn	g/C Ratio	Cycle Length
4 - Lane Major Thoroughfares 55 MPH									
Urban	Urban Arterial I	ATS > 21 MPH	Undivided	2	50	3	5	0.6	200
Suburban	Urban Arterial I	ATS > 21 MPH	Undivided	1.5	50	3	5	0.6	200
Rural	Urban Arterial I	ATS > 21 MPH	Undivided	1	50	3	5	0.6	200
4 - Lane Major Thoroughfares 45 MPH									
Urban	Urban Arterial I	ATS > 17 MPH	Undivided	3	40	3	10	0.6	200
Suburban	Urban Arterial II	ATS > 17 MPH	Undivided	2	40	3	10	0.55	150
Rural	Urban Arterial II	ATS > 17 MPH	Undivided	1	40	3	10	0.55	150
4 - Lane Major Thoroughfares 35 MPH									
Urban	Urban Arterial IV	ATS > 14 MPH	Undivided	6	35	4	8	0.42	120
Suburban	Urban Arterial II	ATS > 14 MPH	Undivided	3	35	3	5	0.55	150
4 - Lane Major Thoroughfares 25 MPH									
Urban	Urban Arterial IV	ATS > 9 MPH	Undivided	16	30	3	8	0.42	120

4 - Lane Major Thoroughfares With Center Left-Turn Lane 55 MPH									
Urban	Urban Arterial I	ATS > 21 MPH	Undivided	2	50	4	10	0.6	200
Suburban	Urban Arterial I	ATS > 21 MPH	Undivided	1.5	50	4	10	0.6	200
Rural	Urban Arterial I	ATS > 21 MPH	Undivided	1	50	4	10	0.6	200
4 - Lane Major Thoroughfares With Center Left-Turn Lane 45 MPH									
Urban	Urban Arterial I	ATS > 17 MPH	Undivided	3	40	3	10	0.6	200
Suburban	Urban Arterial II	ATS > 17 MPH	Undivided	2	40	4	10	0.55	150
Rural	Urban Arterial II	ATS > 17 MPH	Undivided	1	40	4	10	0.55	150
4 - Lane Major Thoroughfares With Center Left-Turn Lane 35 MPH									
Urban	Urban Arterial IV	ATS > 14 MPH	Undivided	6	35	3	16	0.42	120
Suburban	Urban Arterial II	ATS > 14 MPH	Undivided	3	35	3	10	0.55	150
4 - Lane Major Thoroughfares With Center Left-Turn Lane 25 MPH									
Urban	Urban Arterial IV	ATS > 9 MPH	Undivided	6	30	4	16	0.42	120

CTP Terminology	HCM Terminology	LOS D Criteria	Median Type	Traffic Signals/ Mile	HCM Default FFS	Arrival Type	% Left Turn	g/C Ratio	Cycle Length

2 - Lane Major Thoroughfares 55 MPH									
Urban	Urban Arterial I	ATS > 21 MPH	Undivided	2	50	3	5	0.6	200
Suburban	Urban Arterial I	ATS > 21 MPH	Undivided	1.5	50	3	5	0.6	200
Rural	Urban Arterial I	ATS > 21 MPH	Undivided	1	50	3	5	0.6	200
2 - Lane Major Thoroughfares 45 MPH									
Urban	Urban Arterial I	ATS > 17 MPH	Undivided	3	40	3	10	0.6	200
Suburban	Urban Arterial II	ATS > 17 MPH	Undivided	2	40	3	10	0.55	150
Rural	Urban Arterial II	ATS > 17 MPH	Undivided	1	40	3	10	0.55	150
2 - Lane Major Thoroughfares 35 MPH									
Urban	Urban Arterial IV	ATS > 14 MPH	Undivided	6	35	3	8	0.42	120
Suburban	Urban Arterial II	ATS > 14 MPH	Undivided	3	35	3	5	0.55	150
2 - Lane Major Thoroughfares 25 MPH									
Urban	Urban Arterial IV	ATS > 9 MPH	Undivided	16	30	4	8	0.42	120
2 - Lane Major Thoroughfares With Center Left-Turn Lane 55 MPH									
Urban	Urban Arterial I	ATS > 21 MPH	Undivided	2	50	3	10	0.6	200

Suburban	Urban Arterial I	ATS > 21 MPH	Undivided	1.5	50	3	10	0.6	200
Rural	Urban Arterial I	ATS > 21 MPH	Undivided	1	50	3	10	0.6	200
2 - Lane Major Thoroughfares With Center Left-Turn Lane 45 MPH									
Urban	Urban Arterial I	ATS > 17 MPH	Undivided	3	40	3	10	0.6	200
Suburban	Urban Arterial II	ATS > 17 MPH	Undivided	2	40	3	10	0.55	150
Rural	Urban Arterial II	ATS > 17 MPH	Undivided	1	40	3	10	0.55	150
2 - Lane Major Thoroughfares With Center Left-Turn Lane 35 MPH									
Urban	Urban Arterial IV	ATS > 14 MPH	Undivided	6	35	3	20	0.42	120
Suburban	Urban Arterial II	ATS > 14 MPH	Undivided	3	35	3	10	0.55	150
2 - Lane Major Thoroughfares With Center Left-Turn Lane 25 MPH									
Urban	Urban Arterial IV	ATS > 9 MPH	Undivided	6	30	4	20	0.42	120

CTP Terminology	HCM Terminology	LOS D Criteria	Truck Percentage	No Passing Zone	Shoulder Width	Access Points/ Mile
Coastal Rural 2 Lane Highway (Class I)						
Minimum	2 Lane Highway (Class I)	ATS > 40 MPH	15%	60%	2 , 3	20

Standard	2 Lane Highway (Class I)	ATS > 40 MPH	10%	40%	4 , 5	15
Maximum	2 Lane Highway (Class I)	ATS > 40 MPH	5%	20%	6+	10
Piedmont Rural 2 Lane Highway (Class I)						
Minimum	2 Lane Highway (Class I)	ATS > 40 MPH	15%	70%	2 , 3	20
Standard	2 Lane Highway (Class I)	ATS > 40 MPH	10%	50%	4 , 5	15
Maximum	2 Lane Highway (Class I)	ATS > 40 MPH	5%	30%	6+	10
Mountains LEVEL Rural 2 Lane Highway (Class I)						
Minimum	2 Lane Highway (Class I)	ATS > 40 MPH	15%	80%	2 , 3	20
Standard	2 Lane Highway (Class I)	ATS > 40 MPH	10%	60%	4 , 5	15
Maximum	2 Lane Highway (Class I)	ATS > 40 MPH	5%	40%	6+	10
Mountains ROLLING Rural 2 Lane Highway (Class I)						

Minimum	2 Lane Highway (Class I)	ATS > 40 MPH	15%	80%	2 , 3	20
Standard	2 Lane Highway (Class I)	ATS > 40 MPH	10%	60%	4 , 5	15
Maximum	2 Lane Highway (Class I)	ATS > 40 MPH	5%	40%	6+	10