

APPENDIX A: FREEWAY INPUTS

Appendix A1: HCM 2000 Freeway Equations

Free Flow Speed (FFS) is the mean speed of vehicles at low traffic flows and excluding all control delay due to signals, stop signs, and other traffic control devices (*HCM 2000*, p. 30-2). FFS is not equal to the speed limit, nor is it equal to the 85 percentile speed.

Freeways

The following equation is an approximation of one-way hourly capacity for basic freeway segments (not ramp influence areas), and is based on HCM 2000 Chapter 30 (Areawide Analysis). For the most accurate estimates of freeway capacity, refer to HCM 2000 Chapters 22 through 25.

NOTE: Two-way daily capacity = One-way hourly capacity/K /D.

$$c = Q \cdot N \cdot f_{HV} \cdot f_p \cdot PHF \quad (HCM \text{ Eqn. } 30-1)$$

Where:

- c = Capacity (vehicles/hour)
- Q = PCE (passenger-car equivalents) capacity, in pc/hr/ln, based on FFS* (Refer to *HCM 2000 Exhibit 23-2* for PCE capacity values.)
- N = Number of through lanes
- f_p = Driver population adjustment factor
- PHF = Peak-hour factor
- f_{HV} = Heavy-vehicle adjustment factor (See *HCM 2000 Exhibits 23-8 – 23-11* for all truck and RV equivalent values; only the most common values are provided below.)

$$f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)} \quad (HCM \text{ Eqn. } 23-3)$$

E_T = Passenger-car equivalents for trucks/buses

E_T = 1.5 (level terrain); 2.5 (rolling); 4.5 (mountainous)

E_R = Passenger-car equivalents for RVs

E_R = 1.2 (level terrain); 2.0 (rolling); 4.0 (mountainous)

P_T = Proportion of trucks/buses in traffic stream, expressed as a decimal fraction

P_R = Proportion of RVs in traffic stream, expressed as a decimal fraction

* FFS can be either measured in the field or calculated using the following equation.

$$FFS = BFFS - f_{LW} - f_{LC} - f_N - f_{ID}$$

Where:

BFFS = Base Free Flow Speed (BFFS = 75 mph Rural, 70 mph Urban/Suburban)

f_{LW} = Adjustment for land width (*HCM 2000 Exhibit 23-4*)

f_{LC} = Adjustment for right shoulder lateral clearance (*HCM 2000 Exhibit 23-5*)

f_N = Adjustment for number of lanes (*HCM 2000 Exhibit 23-6*)

f_{ID} = Adjustment for interchange density (*HCM 2000 Exhibit 23-7*)

For NCDOT – TPB Level of Service D for Systems Level Planning, the NCLOS 2.1 program was used in developing the freeway capacity tables.

Appendix A2: Coastal Freeway Inputs

Coastal Freeway Standard	2 Lanes Per Direction			3 Lanes Per Direction			4 Lanes Per Direction		
	Urban	Suburban	Rural	Urban	Suburban	Rural	Urban	Suburban	Rural
Terrain	Level	Level	Level	Level	Level	Level	Level	Level	Level
LOS	D	D	D	D	D	D	D	D	D
PHF	0.92	0.9	0.88	0.92	0.9	0.88	0.92	0.9	0.88
Driver Pop Factor	1	1	1	1	1	1	1	1	1
K Factor	10	10	10	10	10	10	10	10	10
D Factor	55	55	55	55	55	55	55	55	55
RV	0	0	0	0	0	0	0	0	0
Lane Width	12	12	12	12	12	12	12	12	12
Shoulder Width	6	6	6	6	6	6	6	6	6
Interchanges/Mile	1	0.5	0.5	1	0.5	0.5	1	0.5	0.5
0-5% Trucks (5%)	67400	66900	67900	102000	101300	101800	137300	136200	135700
6-10% Trucks (10%)	65700	65400	66200	99600	98900	99400	134000	133000	132500
11-15% Trucks (15%)	64200	63800	64700	97300	96600	97100	130900	129900	129400
16-20% Trucks (20%)	62800	62400	63200	95100	94400	94900	127900	126900	126500
21-25% Trucks (25%)	61400	61000	61800	93000	92300	92700	125100	124100	123700
26-30% Trucks (30%)	60000	59700	60500	90900	90300	90700	122400	121400	121000
31-35% Trucks (35%)	58800	58400	59200	89000	88400	88800	119800	118800	118400

Coastal Freeway Minimum	2 Lanes Per Direction			3 Lanes Per Direction			4 Lanes Per Direction		
	Urban	Suburban	Rural	Urban	Suburban	Rural	Urban	Suburban	Rural
Terrain	Level	Level	Level	Level	Level	Level	Level	Level	Level
LOS	D	D	D	D	D	D	D	D	D
PHF	0.92	0.9	0.88	0.92	0.9	0.88	0.92	0.9	0.88
Driver Pop Factor	1	1	1	1	1	1	1	1	1
K Factor	12	12	12	12	12	12	12	12	12
D Factor	65	60	60	65	60	60	65	60	60
RV	0	0	0	0	0	0	0	0	0
Lane Width	12	12	12	12	12	12	12	12	12
Shoulder Width	6	6	6	6	6	6	6	6	6
Interchanges/Mile	1	0.5	0.5	1	0.5	0.5	1	0.5	0.5
0-5% Trucks (5%)	47500	51100	51800	71900	77400	77800	96800	104100	103700
6-10% Trucks (10%)	46400	49900	50600	70200	75600	75900	94500	101600	101200
11-15% Trucks (15%)	45300	48800	49400	68600	73800	74100	92300	99200	98900
16-20% Trucks (20%)	44300	47700	48300	67000	72100	72500	90200	97000	96600
21-25% Trucks (25%)	43300	46600	47200	65500	70500	70800	88200	94800	94500
26-30% Trucks (30%)	42300	45600	46200	64100	69000	69300	86300	92800	92400
31-35% Trucks (35%)	41400	44600	45200	62800	67500	67800	84400	90800	90400

NOTE: Truck percentage occurs within the peak hour, not a daily truck percentage

Appendix A3: Piedmont Freeway Inputs

Piedmont Freeway Standard	2 Lanes Per Direction			3 Lanes Per Direction			4 Lanes Per Direction		
	Urban	Suburban	Rural	Urban	Suburban	Rural	Urban	Suburban	Rural
Terrain	Level	Level	Level	Level	Level	Level	Level	Level	Level
LOS	D	D	D	D	D	D	D	D	D
PHF	0.92	0.9	0.88	0.92	0.9	0.88	0.92	0.9	0.88
Driver Pop Factor	1	1	1	1	1	1	1	1	1
K Factor	10	10	10	10	10	10	10	10	10
D Factor	60	60	60	60	60	60	60	60	60
RV	0	0	0	0	0	0	0	0	0
Lane Width	12	12	12	12	12	12	12	12	12
Shoulder Width	6	6	6	6	6	6	6	6	6
Interchanges/Mile	1	0.5	0.5	1	0.5	0.5	1	0.5	0.5
0-5% Trucks (5%)	61700	61400	62200	93500	92900	93300	125800	124900	124400
6-10% Trucks (10%)	60300	59900	60700	91300	90700	91100	122800	121900	121500
11-15% Trucks (15%)	58900	58500	59300	89200	88600	89000	120000	119100	118600
16-20% Trucks (20%)	57500	57200	58000	87100	86500	87000	117300	116400	115900
21-25% Trucks (25%)	56300	55900	56700	85200	84600	85000	114700	113800	113400
26-30% Trucks (30%)	55000	54700	55400	83400	82800	83200	112200	111300	110900
31-35% Trucks (35%)	53900	53500	54300	81600	81000	81400	109800	108900	108500

Piedmont Freeway Minimum	2 Lanes Per Direction			3 Lanes Per Direction			4 Lanes Per Direction		
	Urban	Suburban	Rural	Urban	Suburban	Rural	Urban	Suburban	Rural
Terrain	Level	Level	Level	Level	Level	Level	Level	Level	Level
LOS	D	D	D	D	D	D	D	D	D
PHF	0.92	0.9	0.88	0.92	0.9	0.88	0.92	0.9	0.88
Driver Pop Factor	1	1	1	1	1	1	1	1	1
K Factor	11	11	11	11	11	11	11	11	11
D Factor	60	60	60	60	60	60	60	60	60
RV	0	0	0	0	0	0	0	0	0
Lane Width	12	12	12	12	12	12	12	12	12
Shoulder Width	6	6	6	6	6	6	6	6	6
Interchanges/Mile	1	0.5	0.5	1	0.5	0.5	1	0.5	0.5
0-5% Trucks (5%)	56100	55800	56600	85000	84400	84800	114400	113500	113100
6-10% Trucks (10%)	54800	54500	55200	83000	82400	82800	111700	110800	110400
11-15% Trucks (15%)	53500	53200	53900	81100	80500	80900	109100	108200	107800
16-20% Trucks (20%)	52300	52000	52700	79200	78700	79000	106600	105800	105400
21-25% Trucks (25%)	51100	50800	51500	77500	76900	77300	104200	103400	103100
26-30% Trucks (30%)	50000	49700	50400	75800	75300	75600	102000	101200	100800
31-35% Trucks (35%)	49000	48700	49300	74200	73700	74000	99800	99000	98700

NOTE: Truck percentage occurs within the peak hour, not a daily truck percentage

Appendix A4: Mountain (Level) Freeway Inputs

Mountain Freeway Standard (Level)	2 Lanes Per Direction			3 Lanes Per Direction			4 Lanes Per Direction		
	Urban	Suburban	Rural	Urban	Suburban	Rural	Urban	Suburban	Rural
Terrain	Level	Level	Level	Level	Level	Level	Level	Level	Level
LOS	D	D	D	D	D	D	D	D	D
PHF	0.92	0.9	0.88	0.92	0.9	0.88	0.92	0.9	0.88
Driver Pop Factor	1	1	1	1	1	1	1	1	1
K Factor	11	10	10	11	10	10	11	10	10
D Factor	60	60	60	60	60	60	60	60	60
RV	0	0	0	0	0	0	0	0	0
Lane Width	12	12	12	12	12	12	12	12	12
Shoulder Width	6	6	6	6	6	6	6	6	6
Interchanges/Mile	1	0.5	0.5	1	0.5	0.5	1	0.5	0.5
0-5% Trucks (5%)	56100	61400	62200	85000	92900	93300	114400	124900	124400
6-10% Trucks (10%)	54800	59900	60700	83000	90700	91100	111700	121900	121500
11-15% Trucks (15%)	53500	58500	59300	81100	88600	89000	109100	119100	118600
16-20% Trucks (20%)	52300	57200	58000	79200	86500	87000	106600	116400	115900
21-25% Trucks (25%)	51100	55900	56700	77500	84600	85000	104200	113800	113400
26-30% Trucks (30%)	50000	54700	55400	75800	82800	83200	102000	111300	110900
31-35% Trucks (35%)	49000	53500	54300	74200	81000	81400	99800	108900	108500

Mountain Freeway Minimum (Level)	2 Lanes Per Direction			3 Lanes Per Direction			4 Lanes Per Direction		
	Urban	Suburban	Rural	Urban	Suburban	Rural	Urban	Suburban	Rural
Terrain	Level	Level	Level	Level	Level	Level	Level	Level	Level
LOS	D	D	D	D	D	D	D	D	D
PHF	0.92	0.9	0.88	0.92	0.9	0.88	0.92	0.9	0.88
Driver Pop Factor	1	1	1	1	1	1	1	1	1
K Factor	12	12	12	12	12	12	12	12	12
D Factor	60	60	60	60	60	60	60	60	60
RV	0	0	0	0	0	0	0	0	0
Lane Width	12	12	12	12	12	12	12	12	12
Shoulder Width	6	6	6	6	6	6	6	6	6
Interchanges/Mile	1	0.5	0.5	1	0.5	0.5	1	0.5	0.5
0-5% Trucks (5%)	51400	51100	51800	77900	77400	77800	104900	104100	103700
6-10% Trucks (10%)	50200	49900	50600	76100	75600	75900	102400	101600	101200
11-15% Trucks (15%)	49100	48800	49400	74300	73800	74100	100000	99200	98900
16-20% Trucks (20%)	47900	47700	48300	72600	72100	72500	97700	97000	96600
21-25% Trucks (25%)	46900	46600	47200	71000	70500	70800	95500	94800	94500
26-30% Trucks (30%)	45900	45600	46200	69500	69000	69300	93500	92800	92400
31-35% Trucks (35%)	44900	44600	45200	68000	67500	67800	91500	90800	90400

NOTE: Truck percentage occurs within the peak hour, not a daily truck percentage

Appendix A5: Mountain (Rolling) Freeway Inputs

Mountain Freeway Standard (Rolling)	2 Lanes Per Direction			3 Lanes Per Direction			4 Lanes Per Direction		
	Urban	Suburban	Rural	Urban	Suburban	Rural	Urban	Suburban	Rural
Terrain	Rolling	Rolling	Rolling	Rolling	Rolling	Rolling	Rolling	Rolling	Rolling
LOS	D	D	D	D	D	D	D	D	D
PHF	0.92	0.9	0.88	0.92	0.9	0.88	0.92	0.9	0.88
Driver Pop Factor	1	1	1	1	1	1	1	1	1
K Factor	11	10	10	11	10	10	11	10	10
D Factor	60	60	60	60	60	60	60	60	60
RV	0	0	0	0	0	0	0	0	0
Lane Width	12	12	12	12	12	12	12	12	12
Shoulder Width	6	6	6	6	6	6	6	6	6
Interchanges/Mile	1	0.5	0.5	1	0.5	0.5	1	0.5	0.5
0-5% Trucks (5%)	53500	58500	59300	81100	88600	89000	109100	119100	118600
6-10% Trucks (10%)	50000	54700	55400	75800	82800	83200	102000	111300	110900
11-15% Trucks (15%)	47000	51400	52100	71100	77700	78100	95700	104500	104100
16-20% Trucks (20%)	44300	48400	49000	67000	73200	73600	90200	98500	98100
21-25% Trucks (25%)	41800	45700	46400	63400	69200	69600	85300	93100	92700
26-30% Trucks (30%)	39700	43400	44000	60100	65700	66000	80900	88300	87900
31-35% Trucks (35%)	37700	41200	41800	57100	62400	62700	76900	83900	83600

Mountain Freeway Minimum (Rolling)	2 Lanes Per Direction			3 Lanes Per Direction			4 Lanes Per Direction		
	Urban	Suburban	Rural	Urban	Suburban	Rural	Urban	Suburban	Rural
Terrain	Rolling	Rolling	Rolling	Rolling	Rolling	Rolling	Rolling	Rolling	Rolling
LOS	D	D	D	D	D	D	D	D	D
PHF	0.92	0.9	0.88	0.92	0.9	0.88	0.92	0.9	0.88
Driver Pop Factor	1	1	1	1	1	1	1	1	1
K Factor	12	12	12	12	12	12	12	12	12
D Factor	60	60	60	60	60	60	60	60	60
RV	0	0	0	0	0	0	0	0	0
Lane Width	12	12	12	12	12	12	12	12	12
Shoulder Width	6	6	6	6	6	6	6	6	6
Interchanges/Mile	1	0.5	0.5	1	0.5	0.5	1	0.5	0.5
0-5% Trucks (5%)	49100	48800	49400	74300	73800	74100	100000	99200	98900
6-10% Trucks (10%)	45900	45600	46200	69500	69000	69300	93500	92800	92400
11-15% Trucks (15%)	43000	42800	43400	65200	64800	65100	87700	87100	86800
16-20% Trucks (20%)	40600	40300	40900	61400	61000	61300	82700	82100	81700
21-25% Trucks (25%)	38400	38100	38600	58100	57700	58000	78200	77600	77300
26-30% Trucks (30%)	36400	36200	36600	55100	54700	55000	74100	73600	73300
31-35% Trucks (35%)	34600	34400	34800	52400	52000	52300	70500	69900	69700

NOTE: Truck percentage occurs within the peak hour, not a daily truck percentage