KYSTM Update: Speeds and Capacities Using HCM 2010 Methods

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HCM Methods

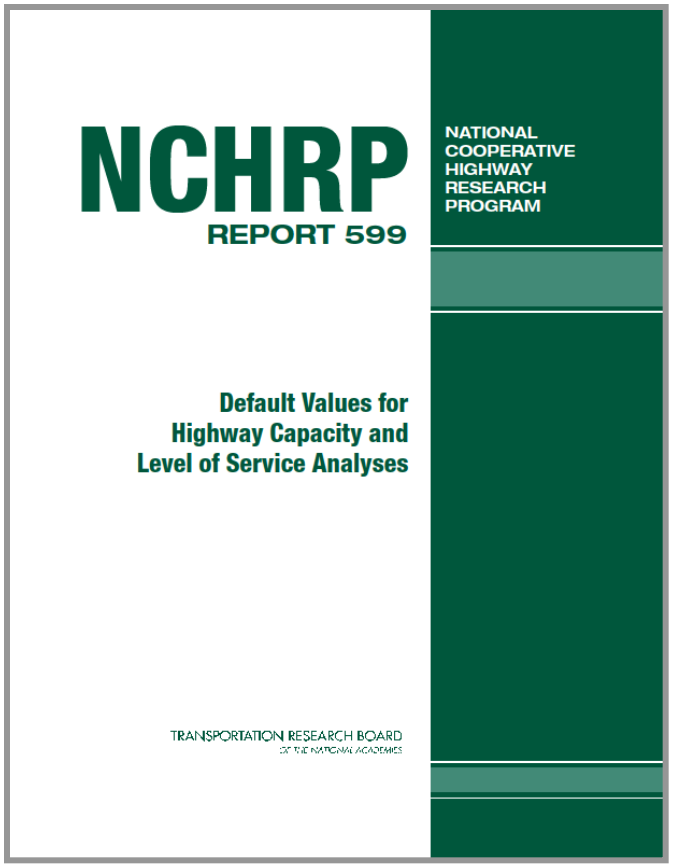
- Basic Freeway Segments
- Multilane Highways
- Two-Lane Highways
- Urban Streets
- Ramps

HCM Methods

- **Basic Freeway Segments**
- Multilane Highways
- Two-Lane Highways
- **Urban Streets**
- Ramps

Default Values

- NCHRP Report 599, *Default Values for Highway Capacity and Level of Service Analyses*
- Definition: “Constant to be used in an equation as a substitute for a field measured or estimated value.”
- Can be used for input variables or calibration factors
- Should represent typical values for conditions being analyzed



BASIC FREEWAY SEGMENTS

HCM Methods vs. Rural/Urban

Rural

- Basic Freeway Segments
- Multilane Highways
- Two-Lane Highways

Urban

- Basic Freeway Segments*
- Urban Streets

* *Will consider Freeway Facilities, but may require too many inputs*

Model Parameters

- Functional Classification
- Claritas Area Type
- Kentucky links only (INKY=1)

Functional Classification

FUNCT	Description
1	Rural Interstate
2	Rural Major Arterial
6	Rural Minor Arterial
7	Rural Major Collector
8	Rural Minor Collector
9	Rural Local

FUNCT	Description
11	Urban Interstate
12	Urban Other Freeways
14	Urban Major Arterial
16	Urban Minor Arterial
17	Urban Collector
19	Urban Local

Nielsen Claritas Area Type

AREATYPE	Description
1	Rural
2	Town
3	Suburban
4	Second City
5	Urban

KSTM Updated Network Attributes

- Free-Flow Speed
- Capacity

Free-Flow Speed

$$FFS = 75.4 - f_{LW} - f_{LC} - 3.22*TRD^{0.84}$$

FFS	=	Free-Flow Speed
f_{LW}	=	Lane width adjustment
f_{LC}	=	Lateral clearance adjustment
TRD	=	Total ramp density (ramps/mi)

Adjustment Factors

Average Lane Width (ft)	Reduction in FFS, f_{LW} (mi/h)
≥ 12	0.0
≥ 11 < 12	1.9
≥ 10 < 11	6.6

Exhibit 11-8
Adjustment to FFS for Average Lane Width

Exhibit 11-9
Adjustment to FFS, f_{LC} for Right-Side Lateral Clearance (mi/h)

Right-Side Lateral Clearance (ft)	Lanes in One Direction			
	2	3	4	≥ 5
≥ 6	0.0	0.0	0.0	0.0
5	0.6	0.4	0.2	0.1
4	1.2	0.8	0.4	0.2
3	1.8	1.2	0.6	0.3
2	2.4	1.6	0.8	0.4
1	3.0	2.0	1.0	0.5
0	3.6	2.4	1.2	0.6

FFS Default Values

AREATYPE	f_{LW}	f_{LC}	TRD**
1	0	0.0	0.35
2	0	0.0	0.60
3	0	0.0	1.00
4	0	0.0	1.50
5	1.9	0.5*	2.00

* For 5’ lateral clearance, this is the average speed reduction between 2 lanes and 3 lanes (directional)

** Based on limited checking of the KYSTM network

Note: We can obtain shoulder widths from HIS database and create a lookup table; however, the number of links where the lateral clearance will be less than 5’ will be very few.

Example Free-Flow Speeds (Basic Freeway Segments)

AREATYPE	f_{LW}	f_{LC}	TRD	FFS (mph)
1	0.0	0.0	0.4	74.1
2	0.0	0.0	0.6	73.3
3	0.0	0.0	1.0	72.2
4	0.0	0.0	1.5	70.9
5	1.9	0.5	2.0	67.2

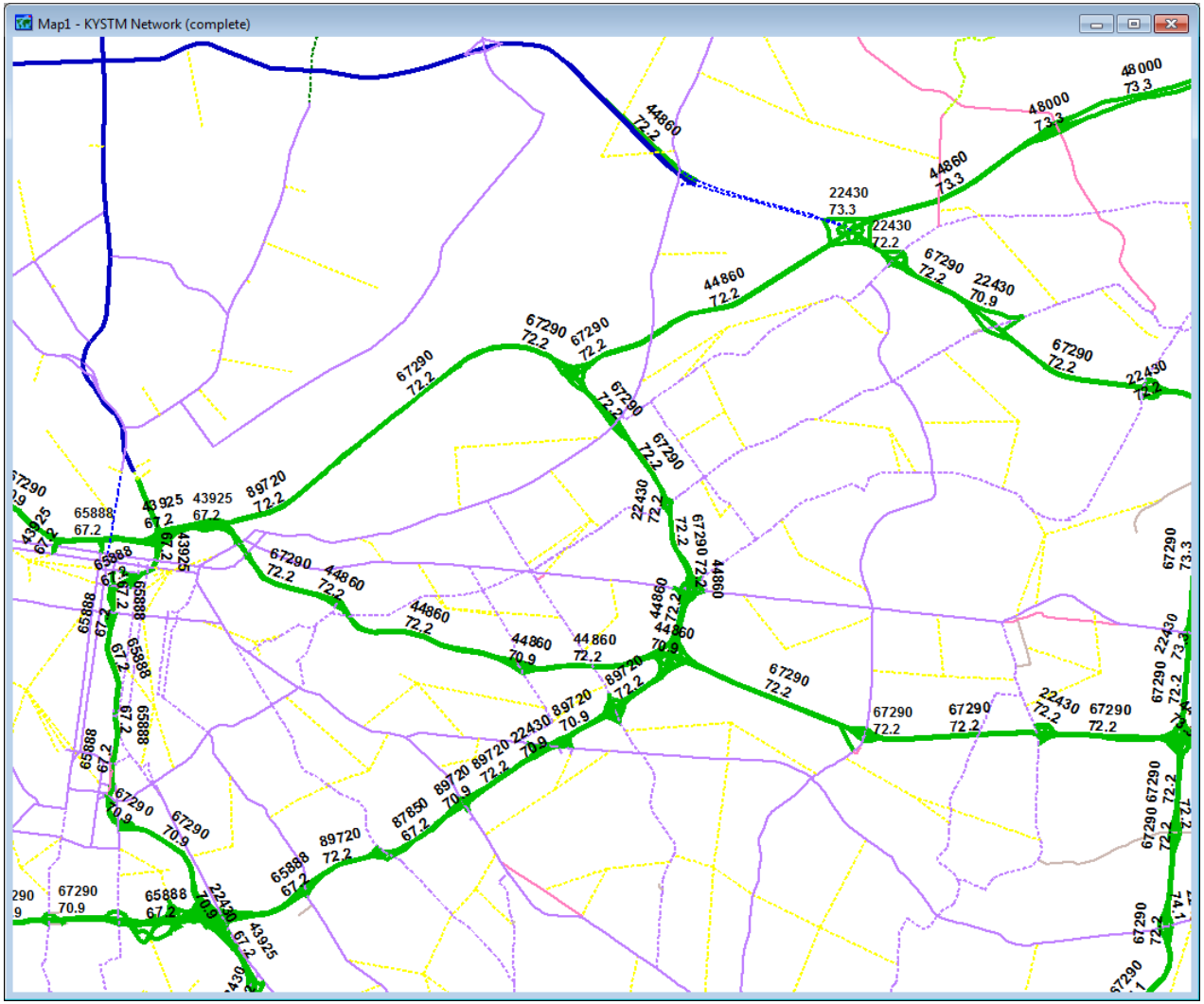
$$FFS = 75.4 - f_{LW} - f_{LC} - 3.22*TRD^{0.84}$$

Capacity*

Free-Flow Speed (mph)	Capacity (pc/h/l)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

*Ch. 11 Basic Freeway Segments, 2010 HCM

Freeway Speeds and Capacities



URBAN STREETS

HCM 2010 Relevant Chapters

- Ch. 16 Urban Street Facilities
- Ch. 17 Urban Street Segments
- Ch. 18 Signalized Intersections

Urban Street Facilities

- Definition

  A length of roadway composed as contiguous urban street segments and functionally classified as arterial or collector

- Length
  - Downtown areas $\geq$ 1 mile (range 0.75 – 2 miles; 1 mile typical)
  - Other areas $\geq$ 2 miles (range 1.5 – 5 miles; 3 miles typical)
- Auto LOS based on through vehicle travel speed

Model Parameters

- Functional Classification
- Claritas Area Type
- Kentucky links only (INKY=1)
- Number of Lanes
- Pct. Heavy Vehicles

Functional Classification

FUNCT	Description
1	Rural Interstate
2	Rural Major Arterial
6	Rural Minor Arterial
7	Rural Major Collector
8	Rural Minor Collector
9	Rural Local

FUNCT	Description
11	Urban Interstate
12	Urban Other Freeways
14	Urban Major Arterial
16	Urban Minor Arterial
17	Urban Collector
19	Urban Local

Free-Flow Speed

$$S_f = S_{fo} * f_L$$

S_f	=	Free-Flow Speed
S_{fo}	=	Base Free-Flow Speed
f_L	=	Signal spacing adjustment factor

S_{fo}, Base Free-Flow Speed

$$S_{fo} = S_o + f_{CS} + f_A$$

S_o	=	Speed constant
S_{fo}	=	Base Free-Flow Speed
f_{CS}	=	Adjustment for cross-section
f_A	=	Adjustment for access points

S_o, f_{CS}, f_A

"SH" HIS Extract
SHLDTYPE <> 8
SHLDTYPE = 8

"MD" HIS Extract
Based on MEDTYPE field

Exhibit 17-10
Base Free-Flow Speed Adjustment Factors

S_o

f_{CS}

f_A

Speed Limit (mi/h)	Speed Constant S_0 (mi/h) [a]	Median Type	Percent with Restrictive Median (%)	Adjustment for Cross Section f_{CS} (mi/h) [b] No Curb	Curb
25	37.4	Restrictive	20	0.3	-0.9
30	39.7		40	0.6	-1.4
35	42.1		60	0.9	-1.8
40	44.4		80	1.2	-2.2
45	46.8		100	1.5	-2.7
50	49.1	Non-Restrict.	not applicable	0.0	-0.5
55	51.5	No median	not applicable	0.0	-0.5

Access Density D_a (points/mi)	Adjustment for Access Points f_A by Lanes N_{th} (mi/h) [c] 1 Lane	2 Lanes	3 Lanes	4 Lanes
0	0.0	0.0	0.0	0.0
2	-0.2	-0.1	-0.1	0.0
4	-0.3	-0.2	-0.1	-0.1
10	-0.8	-0.4	-0.3	-0.2
20	-1.6	-0.8	-0.5	-0.4
40	-3.1	-1.6	-1.0	-0.8
60	-4.7	-2.3	-1.6	-1.2

Notes:
[a] $S_0 = 25.6 + 0.47 S_{pl}$ where S_{pl} = posted speed limit (mi/h).
[b] $f_{CS} = 1.5\ p_{rm} - 0.47\ p_{curb} - 3.7\ p_{curb}\ p_{rm}$ where p_{rm} = proportion of link length with restrictive median (decimal) and p_{curb} = proportion of segment with curb on the right-hand side (decimal).
[c] $f_A = -0.078\ D_a / N_{th}$ with $D_a = 5{,}280\ (N_{ap,s} + N_{ap,o})/(L\text{-}W_i)$ where D_a = access point density on segment (points/mi); N_{th} = number of through lanes on the segment in the subject direction of travel (ln); and W_i = width of signalized intersection (ft).

Default Values*
Access Point Density, D_a

Functional Class	D_{ap} (points/mi)	FUNCT	AREATYPE
Urban Arterial	34	14, 16	4,5
Suburban Arterial	21	14, 16	2, 3
Urban Collector	61	17,19	4,5
Suburban Collector	48	17, 19	2, 3

* 2010 HCM. Exhibit 17-22

Use default values to interpolate Ex. 17-22

f_L, Signal Spacing Adjustment Factor

$$f_L = 1.02 - 4.7\frac{S_{fo} - 19.5}{L_S} < 1.0$$

f_L = Signal Spacing Adjustment Factor
S_{fo} = Base Free-Flow Speed
L_S = Distance between adjacent signalized intersections

FUNCT	Urban Street Class*	Default** Signals/Mile	Ave. Spacing, Ls (ft.)
14	I	0.8	6,600
16	II	3	1,760
17	III	6	880
19	IV	10	528

** HCM 2000 Classification scheme*
***From NCHRP Report 599*

Saturation Flow Rate

$$s = s_o f_w f_{HV} f_g f_p f_{bb} f_a f_{LU} f_{LT} f_{RT} f_{Lpb} f_{Rpb}$$

s	=	Adjusted saturation flow rate (veh/hr/ln)
s_o	=	Base saturation flow rate (veh/hr/ln)
$f_{...}$	=	Adjustment factors

Default Base Saturation Flow Rates*

Population Size	AREATYPE	Base Sat. Flow (veh/hr/ln)
Metro Area (Pop. > 250,000)	4, 5	1,900
Other Areas (Pop. <250,000)	1, 2, 3	1,750

** 2010 HCM*

Saturation Flow Adjustment Factors*

- f_W
- f_{HV}
- f_a

* Values that we can use from network database or for which we can develop defaults

f_W, Lane Width Adjustment

Lane Width (ft.)	f_W
< 10.0	0.96
10 – 12.9	1.00
> 12.9	1.04
HCM 2010 Exhibit 18-13	

f_{HV}, Heavy Vehicle Adjustment

$$f_{HV} = \frac{100}{100 + P_{HV}\left(E_T - 1\right)}$$

P_{HV} = Percent heavy vehicles (network field value)

E_T = Passenger car equivalency factor; HCM default = 2.0

f_a, Area Type Adjustment

AREATYPE	f_a
1 – 4	1.00
5 (CBD)	0.90

Capacity*

$$c = Ns\frac{g}{C}$$

c	=	Capacity (veh/h)
N	=	Directional number of through lanes
s	=	Adjusted saturation flow rate
g/C	=	Effective through movement green-to-cycle length ratio

* Major street through movement capacity

g/C Default Values

FUNCT	Description	g/C*
14	Urban Major Arterial	0.45
16	Urban Minor Arterial	0.42
17	Urban Collector	0.38
19	Urban Local	0.31

Notes

- g/C values are highly subjective and can be adjusted during model calibration
- Initial g/C values are based on work done in Florida

Field Speeds

- Free-flow speed based on field data collection
- Ability to override estimated speeds using HCM methods
- Calibration, network refinement at the project level
- Must be *free-flow*

TransCAD GISDK Macros

- *SpeedCap* “master” macro
- Indivudual sub-macros
  - Basic Freeway Segments Free-Flow Speeds
  - Basic Freeway Segments Capacities
  - Urban Streets Free-Flow Speeds
  - Urban Streets Capacities
  - Etc.
- Could be adapted to any travel demand model

Questions?