

Appendix 3.11-1
Level of Service Worksheets

HCS7 Basic Freeway Report

Project Information

Analyst	Transpo Group	Date	4/16/2018
Agency	WSDOT	Analysis Year	2018
Jurisdiction		Time Period Analyzed	PM Peak
Project Description	Existing (SR 705 North of I-5)		

Geometric Data

Number of Lanes (N), ln	3	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	75.4	Total Ramp Density (TRD), ramps/mi	1.50
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	70.9
Right-Side Lateral Clearance, ft	8		

Adjustment Factors

Driver Population	All Familiar	Final Speed Adjustment Factor (SAF)	1.000
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	1.000
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

Demand and Capacity

Volume (V), veh/h	3389	Heavy Vehicle Adjustment Factor (f _{HV})	0.980
Peak Hour Factor (PHF)	0.95	Flow Rate (v _p), pc/h/ln	1213
Total Trucks, %	2.00	Capacity (c), pc/h/ln	2400
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c _{adj}), pc/h/ln	2400
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.51
Passenger Car Equivalent (E _T)	2.000		

Speed and Density

Lane Width Adjustment (f _{LW})	0.0	Average Speed (S), mi/h	70.9
Right-Side Lateral Clearance Adj. (f _{RLC})	0.0	Density (D), pc/mi/ln	17.1
Total Ramp Density Adjustment	4.5	Level of Service (LOS)	B
Adjusted Free-Flow Speed (FFS _{adj}), mi/h	70.9		

HCS7 Basic Freeway Report

Project Information

Analyst	Transpo Group	Date	4/16/2018
Agency	WSDOT	Analysis Year	2018
Jurisdiction		Time Period Analyzed	PM Peak
Project Description	Existing PM Peak Period (I-5 @ S 48th St)		

Geometric Data

Number of Lanes (N), ln	4	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	75.4	Total Ramp Density (TRD), ramps/mi	1.00
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	72.2
Right-Side Lateral Clearance, ft	10		

Adjustment Factors

Driver Population	All Familiar	Final Speed Adjustment Factor (SAF)	1.000
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	1.000
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

Demand and Capacity

Volume (V), veh/h	7584	Heavy Vehicle Adjustment Factor (f _{HV})	0.980
Peak Hour Factor (PHF)	0.97	Flow Rate (v _p), pc/h/ln	1994
Total Trucks, %	2.00	Capacity (c), pc/h/ln	2400
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c _{adj}), pc/h/ln	2400
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.83
Passenger Car Equivalent (E _T)	2.000		

Speed and Density

Lane Width Adjustment (f _{LW})	0.0	Average Speed (S), mi/h	63.4
Right-Side Lateral Clearance Adj. (f _{RLC})	0.0	Density (D), pc/mi/ln	31.5
Total Ramp Density Adjustment	3.2	Level of Service (LOS)	D
Adjusted Free-Flow Speed (FFS _{adj}), mi/h	72.2		

HCS7 Basic Freeway Report

Project Information

Analyst	Transpo Group	Date	4/16/2018
Agency	WSDOT	Analysis Year	2018
Jurisdiction		Time Period Analyzed	PM Peak
Project Description	Existing (SR 512 East of I-5 Interchange)		

Geometric Data

Number of Lanes (N), ln	4	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	75.4	Total Ramp Density (TRD), ramps/mi	1.00
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	72.2
Right-Side Lateral Clearance, ft	10		

Adjustment Factors

Driver Population	All Familiar	Final Speed Adjustment Factor (SAF)	1.000
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	1.000
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

Demand and Capacity

Volume (V), veh/h	4235	Heavy Vehicle Adjustment Factor (f _{HV})	0.980
Peak Hour Factor (PHF)	0.95	Flow Rate (v _p), pc/h/ln	1137
Total Trucks, %	2.00	Capacity (c), pc/h/ln	2400
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c _{adj}), pc/h/ln	2400
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.47
Passenger Car Equivalent (E _T)	2.000		

Speed and Density

Lane Width Adjustment (f _{LW})	0.0	Average Speed (S), mi/h	72.2
Right-Side Lateral Clearance Adj. (f _{RLC})	0.0	Density (D), pc/mi/ln	15.7
Total Ramp Density Adjustment	3.2	Level of Service (LOS)	B
Adjusted Free-Flow Speed (FFS _{adj}), mi/h	72.2		

Phone: _____ Fax: _____
 E-Mail: _____

----- Directional Two-Lane Highway Segment Analysis -----

Analyst Transpo Group
 Agency/Co. WSDOT
 Date Performed 4/16/2018
 Analysis Time Period PM Peak
 Highway SR507
 From/To South of SR 7
 Jurisdiction
 Analysis Year Existing
 Description Existing SR 507 south of SR 7

----- Input Data -----

Highway class	Class 2	Peak hour factor, PHF	0.95	
Shoulder width	3.0 ft	% Trucks and buses	2	%
Lane width	12.0 ft	% Trucks crawling	0.0	%
Segment length	1.0 mi	Truck crawl speed	0.0	mi/hr
Terrain type	Level	% Recreational vehicles	0	%
Grade: Length	- mi	% No-passing zones	100	%
Up/down	- %	Access point density	1	/mi

Analysis direction volume, Vd 866 veh/h
 Opposing direction volume, Vo 433 veh/h

----- Average Travel Speed -----

Direction	Analysis(d)	Opposing (o)
PCE for trucks, ET	1.0	1.2
PCE for RVs, ER	1.0	1.0
Heavy-vehicle adj. factor,(note-5) fHV	1.000	0.996
Grade adj. factor,(note-1) fg	1.00	1.00
Directional flow rate,(note-2) vi	912 pc/h	458 pc/h

Free-Flow Speed from Field Measurement:

Field measured speed,(note-3) S FM - mi/h
 Observed total demand,(note-3) V - veh/h

Estimated Free-Flow Speed:

Base free-flow speed,(note-3) BFFS 60.0 mi/h
 Adj. for lane and shoulder width,(note-3) fLS 2.6 mi/h
 Adj. for access point density,(note-3) fA 0.3 mi/h

Free-flow speed, FFSd 57.2 mi/h

Adjustment for no-passing zones, fnp 2.9 mi/h
 Average travel speed, ATSD 43.6 mi/h
 Percent Free Flow Speed, PFFS 76.3 %

-----Percent Time-Spent-Following-----

Direction	Analysis(d)	Opposing (o)	
PCE for trucks, ET	1.0	1.0	
PCE for RVs, ER	1.0	1.0	
Heavy-vehicle adjustment factor, fHV	1.000	1.000	
Grade adjustment factor,(note-1) fg	1.00	1.00	
Directional flow rate,(note-2) vi	912 pc/h	456 pc/h	
Base percent time-spent-following,(note-4) BPTSFd	70.4	%	
Adjustment for no-passing zones, fnp	24.7		
Percent time-spent-following, PTSFd	86.9	%	

-----Level of Service and Other Performance Measures-----

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.54	
Peak 15-min vehicle-miles of travel, VMT15	228	veh-mi
Peak-hour vehicle-miles of travel, VMT60	866	veh-mi
Peak 15-min total travel time, TT15	5.2	veh-h
Capacity from ATS, CdATS	0	veh/h
Capacity from PTSF, CdPTSF	1700	veh/h
Directional Capacity	1700	veh/h

-----Passing Lane Analysis-----

Total length of analysis segment, Lt	1.0	mi
Length of two-lane highway upstream of the passing lane, Lu	-	mi
Length of passing lane including tapers, Lpl	-	mi
Average travel speed, ATSD (from above)	43.6	mi/h
Percent time-spent-following, PTSFd (from above)	86.9	
Level of service, LOSd (from above)	E	

-----Average Travel Speed with Passing Lane-----

Downstream length of two-lane highway within effective length of passing lane for average travel speed, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, Ld	-	mi
Adj. factor for the effect of passing lane on average speed, fpl	-	
Average travel speed including passing lane, ATSpl	-	
Percent free flow speed including passing lane, PFFSpl	0.0	%

-----Percent Time-Spent-Following with Passing Lane-----

Downstream length of two-lane highway within effective length of passing lane for percent time-spent-following, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, Ld	-	mi
Adj. factor for the effect of passing lane on percent time-spent-following, fpl	-	
Percent time-spent-following including passing lane, PTSFpl	-	%

-----Level of Service and Other Performance Measures with Passing Lane-----

Level of service including passing lane, LOSpl	A	
Peak 15-min total travel time, TT15	-	veh-h

-----Bicycle Level of Service-----

Posted speed limit, Sp	55
Percent of segment with occupied on-highway parking	0
Pavement rating, P	5
Flow rate in outside lane, vOL	911.6
Effective width of outside lane, We	15.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	4.77
Bicycle LOS	E

Notes:

1. Note that the adjustment factor for level terrain is 1.00, as level terrain is one of the base conditions. For the purpose of grade adjustment, specific downgrade segments are treated as level terrain.
2. If v_i (v_d or v_o) $\geq 1,700$ pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for $v > 200$ veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

HCS7 Basic Freeway Report

Project Information

Analyst	Transpo Group	Date	4/16/2018
Agency	WSDOT	Analysis Year	Future With Project
Jurisdiction		Time Period Analyzed	PM Peak
Project Description	With Project (SR 705 North of I-5)		

Geometric Data

Number of Lanes (N), ln	3	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	75.4	Total Ramp Density (TRD), ramps/mi	1.50
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	70.9
Right-Side Lateral Clearance, ft	8		

Adjustment Factors

Driver Population	All Familiar	Final Speed Adjustment Factor (SAF)	1.000
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	1.000
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

Demand and Capacity

Volume (V), veh/h	3573	Heavy Vehicle Adjustment Factor (f _{HV})	0.980
Peak Hour Factor (PHF)	0.95	Flow Rate (v _P), pc/h/ln	1279
Total Trucks, %	2.00	Capacity (c), pc/h/ln	2400
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c _{adj}), pc/h/ln	2400
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.53
Passenger Car Equivalent (E _T)	2.000		

Speed and Density

Lane Width Adjustment (f _{LW})	0.0	Average Speed (S), mi/h	70.7
Right-Side Lateral Clearance Adj. (f _{RLC})	0.0	Density (D), pc/mi/ln	18.1
Total Ramp Density Adjustment	4.5	Level of Service (LOS)	C
Adjusted Free-Flow Speed (FFS _{adj}), mi/h	70.9		

HCS7 Basic Freeway Report

Project Information

Analyst	Transpo Group	Date	4/16/2018
Agency	WSDOT	Analysis Year	Future With Project
Jurisdiction		Time Period Analyzed	PM Peak
Project Description	With Project PM Peak Period (I-5 @ S 48th St)		

Geometric Data

Number of Lanes (N), ln	4	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	75.4	Total Ramp Density (TRD), ramps/mi	1.00
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	72.2
Right-Side Lateral Clearance, ft	10		

Adjustment Factors

Driver Population	All Familiar	Final Speed Adjustment Factor (SAF)	1.000
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	1.000
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

Demand and Capacity

Volume (V), veh/h	7952	Heavy Vehicle Adjustment Factor (f _{HV})	0.980
Peak Hour Factor (PHF)	0.97	Flow Rate (v _p), pc/h/ln	2091
Total Trucks, %	2.00	Capacity (c), pc/h/ln	2400
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c _{adj}), pc/h/ln	2400
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.87
Passenger Car Equivalent (E _T)	2.000		

Speed and Density

Lane Width Adjustment (f _{LW})	0.0	Average Speed (S), mi/h	61.3
Right-Side Lateral Clearance Adj. (f _{RLC})	0.0	Density (D), pc/mi/ln	34.1
Total Ramp Density Adjustment	3.2	Level of Service (LOS)	D
Adjusted Free-Flow Speed (FFS _{adj}), mi/h	72.2		

HCS7 Basic Freeway Report

Project Information

Analyst	Transpo Group	Date	4/16/2018
Agency	WSDOT	Analysis Year	Future With Project
Jurisdiction		Time Period Analyzed	PM Peak
Project Description	With Project (SR 512 East of I-5 Interchange)		

Geometric Data

Number of Lanes (N), ln	4	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	75.4	Total Ramp Density (TRD), ramps/mi	1.00
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	72.2
Right-Side Lateral Clearance, ft	10		

Adjustment Factors

Driver Population	All Familiar	Final Speed Adjustment Factor (SAF)	1.000
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	1.000
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

Demand and Capacity

Volume (V), veh/h	4602	Heavy Vehicle Adjustment Factor (f _{HV})	0.980
Peak Hour Factor (PHF)	0.95	Flow Rate (v _p), pc/h/ln	1236
Total Trucks, %	2.00	Capacity (c), pc/h/ln	2400
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c _{adj}), pc/h/ln	2400
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.51
Passenger Car Equivalent (E _T)	2.000		

Speed and Density

Lane Width Adjustment (f _{LW})	0.0	Average Speed (S), mi/h	72.0
Right-Side Lateral Clearance Adj. (f _{RLC})	0.0	Density (D), pc/mi/ln	17.2
Total Ramp Density Adjustment	3.2	Level of Service (LOS)	B
Adjusted Free-Flow Speed (FFS _{adj}), mi/h	72.2		

Phone: _____ Fax: _____
 E-Mail: _____

-----Directional Two-Lane Highway Segment Analysis-----

Analyst Transpo Group
 Agency/Co. WSDOT
 Date Performed 4/16/2018
 Analysis Time Period PM Peak
 Highway SR507
 From/To South of SR 7
 Jurisdiction
 Analysis Year Future With Project
 Description With Proj SR 507 south of SR 7

-----Input Data-----

Highway class	Class 2		Peak hour factor, PHF	0.95	
Shoulder width	3.0	ft	% Trucks and buses	2	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	1.0	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Level		% Recreational vehicles	0	%
Grade: Length	-	mi	% No-passing zones	100	%
Up/down	-	%	Access point density	1	/mi

Analysis direction volume, Vd 1233 veh/h
 Opposing direction volume, Vo 433 veh/h

-----Average Travel Speed-----

Direction	Analysis(d)	Opposing (o)
PCE for trucks, ET	1.0	1.2
PCE for RVs, ER	1.0	1.0
Heavy-vehicle adj. factor,(note-5) fHV	1.000	0.996
Grade adj. factor,(note-1) fg	1.00	1.00
Directional flow rate,(note-2) vi	1298 pc/h	458 pc/h

Free-Flow Speed from Field Measurement:

Field measured speed,(note-3) S FM - mi/h
 Observed total demand,(note-3) V - veh/h

Estimated Free-Flow Speed:

Base free-flow speed,(note-3) BFFS 65.0 mi/h
 Adj. for lane and shoulder width,(note-3) fLS 2.6 mi/h
 Adj. for access point density,(note-3) fA 0.3 mi/h

Free-flow speed, FFSd 62.2 mi/h

Adjustment for no-passing zones, fnp 3.0 mi/h
 Average travel speed, ATSD 45.5 mi/h
 Percent Free Flow Speed, PFFS 73.2 %

-----Percent Time-Spent-Following-----

Direction	Analysis(d)	Opposing (o)	
PCE for trucks, ET	1.0	1.0	
PCE for RVs, ER	1.0	1.0	
Heavy-vehicle adjustment factor, fHV	1.000	1.000	
Grade adjustment factor,(note-1) fg	1.00	1.00	
Directional flow rate,(note-2) vi	1298 pc/h	456 pc/h	
Base percent time-spent-following,(note-4) BPTSFd	81.3 %		
Adjustment for no-passing zones, fnp	18.4		
Percent time-spent-following, PTSFd	94.9 %		

-----Level of Service and Other Performance Measures-----

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.76	
Peak 15-min vehicle-miles of travel, VMT15	324	veh-mi
Peak-hour vehicle-miles of travel, VMT60	1233	veh-mi
Peak 15-min total travel time, TT15	7.1	veh-h
Capacity from ATS, CdATS	0	veh/h
Capacity from PTSF, CdPTSF	1700	veh/h
Directional Capacity	1700	veh/h

-----Passing Lane Analysis-----

Total length of analysis segment, Lt	1.0	mi
Length of two-lane highway upstream of the passing lane, Lu	-	mi
Length of passing lane including tapers, Lpl	-	mi
Average travel speed, ATSD (from above)	45.5	mi/h
Percent time-spent-following, PTSFd (from above)	94.9	
Level of service, LOSd (from above)	E	

-----Average Travel Speed with Passing Lane-----

Downstream length of two-lane highway within effective length of passing lane for average travel speed, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, Ld	-	mi
Adj. factor for the effect of passing lane on average speed, fpl	-	
Average travel speed including passing lane, ATSpl	-	
Percent free flow speed including passing lane, PFFSpl	0.0	%

-----Percent Time-Spent-Following with Passing Lane-----

Downstream length of two-lane highway within effective length of passing lane for percent time-spent-following, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, Ld	-	mi
Adj. factor for the effect of passing lane on percent time-spent-following, fpl	-	
Percent time-spent-following including passing lane, PTSFpl	-	%

-----Level of Service and Other Performance Measures with Passing Lane-----

Level of service including passing lane, LOSpl	A	
Peak 15-min total travel time, TT15	-	veh-h

-----Bicycle Level of Service-----

Posted speed limit, Sp	55
Percent of segment with occupied on-highway parking	0
Pavement rating, P	5
Flow rate in outside lane, vOL	1297.9
Effective width of outside lane, We	15.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	4.95
Bicycle LOS	E

Notes:

1. Note that the adjustment factor for level terrain is 1.00, as level terrain is one of the base conditions. For the purpose of grade adjustment, specific downgrade segments are treated as level terrain.
2. If v_i (v_d or v_o) $\geq 1,700$ pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for $v > 200$ veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.