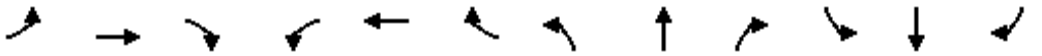
Appendix A

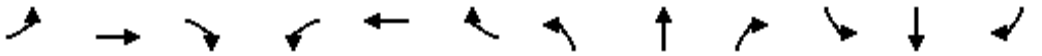
Alternative G Modified

Interchange Evaluation Worksheets



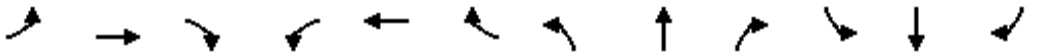
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	260	0	325	65	0	70	630	55	60	50	40	255
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	9.0		9.0	9.0		9.0	9.0	8.5	9.0	9.0	8.5	9.0
Lane Util. Factor	0.97		1.00	1.00		1.00	0.97	1.00	1.00	1.00	1.00	1.00
Frt	1.00		0.85	1.00		0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95		1.00	0.95		1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433		1583	1770		1583	3433	1863	1583	1770	1863	1583
Flt Permitted	0.95		1.00	0.95		1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433		1583	1770		1583	3433	1863	1583	1770	1863	1583
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	274	0	342	68	0	74	663	58	63	53	42	268
RTOR Reduction (vph)	0	0	250	0	0	54	0	0	35	0	0	19
Lane Group Flow (vph)	274	0	92	68	0	20	663	58	28	53	42	249
Turn Type	Prot		custom	Prot		custom	Prot		custom	Prot		custom
Protected Phases	1			1			5	6		5	6	
Permitted Phases			5			5			1 6			1 6
Actuated Green, G (s)	13.7		24.2	13.7		24.2	24.2	25.6	47.8	24.2	25.6	47.8
Effective Green, g (s)	13.7		24.2	13.7		24.2	24.2	25.6	39.3	24.2	25.6	39.3
Actuated g/C Ratio	0.15		0.27	0.15		0.27	0.27	0.28	0.44	0.27	0.28	0.44
Clearance Time (s)	9.0		9.0	9.0		9.0	9.0	8.5		9.0	8.5	
Vehicle Extension (s)	3.0		3.0	3.0		3.0	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	523		426	269		426	923	530	691	476	530	691
v/s Ratio Prot	c0.08			0.04			c0.19	0.03		0.03	0.02	
v/s Ratio Perm			0.06			0.01			0.02			c0.16
v/c Ratio	0.52		0.22	0.25		0.05	0.72	0.11	0.04	0.11	0.08	0.36
Uniform Delay, d1	35.1		25.5	33.6		24.4	29.8	23.8	14.5	24.8	23.6	17.0
Progression Factor	0.90		1.06	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	1.0		0.3	0.5		0.0	2.7	0.4	0.0	0.1	0.3	0.3
Delay (s)	32.6		27.2	34.1		24.4	32.5	24.2	14.6	24.9	23.9	17.3
Level of Service	C		C	C		C	C	C	B	C	C	B
Approach Delay (s)		29.6			29.1			30.5			19.2	
Approach LOS		C			C			C			B	

Intersection Summary			
HCM Average Control Delay	27.9	HCM Level of Service	C
HCM Volume to Capacity ratio	0.54		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	27.0
Intersection Capacity Utilization	50.0%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			



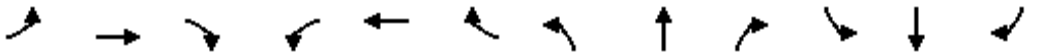
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	385	0	795	115	0	90	640	105	105	135	80	405
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0		5.0	5.0		5.0	5.0	5.0	5.0	5.0	5.0	5.0
Lane Util. Factor	0.97		1.00	1.00		1.00	0.97	1.00	1.00	1.00	1.00	1.00
Frt	1.00		0.85	1.00		0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95		1.00	0.95		1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433		1583	1770		1583	3433	1863	1583	1770	1863	1583
Flt Permitted	0.95		1.00	0.95		1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433		1583	1770		1583	3433	1863	1583	1770	1863	1583
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	405	0	837	121	0	95	674	111	111	142	84	426
RTOR Reduction (vph)	0	0	358	0	0	60	0	0	53	0	0	71
Lane Group Flow (vph)	405	0	479	121	0	35	674	111	58	142	84	355
Turn Type	Prot		custom	Prot		custom	Prot		custom	Prot		custom
Protected Phases	1			1			5	6		5	6	
Permitted Phases			5			5			1 6			1 6
Actuated Green, G (s)	20.1		32.9	20.1		32.9	32.9	22.0	47.1	32.9	22.0	47.1
Effective Green, g (s)	20.1		32.9	20.1		32.9	32.9	22.0	47.1	32.9	22.0	47.1
Actuated g/C Ratio	0.22		0.37	0.22		0.37	0.37	0.24	0.52	0.37	0.24	0.52
Clearance Time (s)	5.0		5.0	5.0		5.0	5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0		3.0	3.0		3.0	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	767		579	395		579	1255	455	828	647	455	828
v/s Ratio Prot	c0.12			0.07			0.20	0.06		0.08	0.05	
v/s Ratio Perm			c0.30			0.02			0.04			c0.22
v/c Ratio	0.53		0.83	0.31		0.06	0.54	0.24	0.07	0.22	0.18	0.43
Uniform Delay, d1	30.8		26.0	29.1		18.5	22.5	27.3	10.6	19.7	26.9	13.2
Progression Factor	0.94		0.88	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.7		9.5	0.4		0.0	0.4	1.3	0.0	0.2	0.9	0.4
Delay (s)	29.7		32.4	29.6		18.6	23.0	28.6	10.7	19.9	27.8	13.5
Level of Service	C		C	C		B	C	C	B	B	C	B
Approach Delay (s)		31.5			24.7			22.1			16.8	
Approach LOS		C			C			C			B	

Intersection Summary			
HCM Average Control Delay	25.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.64		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	75.6%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	735	0	355	95	0	195	180	60	50	145	60	555
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	9.0		9.0	9.0		9.0	9.0	8.5	9.0	9.0	8.5	9.0
Lane Util. Factor	0.97		1.00	1.00		1.00	0.97	1.00	1.00	0.97	1.00	1.00
Frt	1.00		0.85	1.00		0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95		1.00	0.95		1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433		1583	1770		1583	3433	1863	1583	3433	1863	1583
Flt Permitted	0.95		1.00	0.95		1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433		1583	1770		1583	3433	1863	1583	3433	1863	1583
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	774	0	374	100	0	205	189	63	53	153	63	584
RTOR Reduction (vph)	0	0	300	0	0	85	0	0	26	0	0	0
Lane Group Flow (vph)	774	0	74	100	0	120	189	63	27	153	63	584
Turn Type	Prot		custom	Prot		custom	Prot		custom	Prot		custom
Protected Phases	1			1			5	6		5	6	
Permitted Phases			5			5			1 6			1 5 6
Actuated Green, G (s)	27.9		17.8	27.9		17.8	17.8	17.8	54.2	17.8	17.8	90.0
Effective Green, g (s)	27.9		17.8	27.9		17.8	17.8	17.8	45.7	17.8	17.8	81.5
Actuated g/C Ratio	0.31		0.20	0.31		0.20	0.20	0.20	0.51	0.20	0.20	0.91
Clearance Time (s)	9.0		9.0	9.0		9.0	9.0	8.5		9.0	8.5	
Vehicle Extension (s)	3.0		3.0	3.0		3.0	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	1064		313	549		313	679	368	804	679	368	1433
v/s Ratio Prot	c0.23			0.06			0.06	0.03		0.04	0.03	
v/s Ratio Perm			0.05			0.08			0.02			c0.37
v/c Ratio	0.73		0.24	0.18		0.38	0.28	0.17	0.03	0.23	0.17	0.41
Uniform Delay, d1	27.7		30.4	22.7		31.3	30.6	30.0	11.1	30.3	30.0	0.6
Progression Factor	1.00		1.00	0.93		0.73	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	2.5		0.4	0.1		0.7	0.2	1.0	0.0	0.2	1.0	0.2
Delay (s)	30.2		30.8	21.3		23.4	30.9	31.0	11.1	30.5	31.0	0.8
Level of Service	C		C	C		C	C	C	B	C	C	A
Approach Delay (s)		30.4			22.7			27.5			8.9	
Approach LOS		C			C			C			A	

Intersection Summary			
HCM Average Control Delay	22.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.49		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	59.3%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	720	0	345	90	0	190	570	85	150	250	85	930
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	9.0		9.0	9.0		9.0	9.0	8.5	9.0	9.0	8.5	9.0
Lane Util. Factor	0.97		1.00	1.00		1.00	0.97	1.00	1.00	0.97	1.00	1.00
Frt	1.00		0.85	1.00		0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95		1.00	0.95		1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433		1583	1770		1583	3433	1863	1583	3433	1863	1583
Flt Permitted	0.95		1.00	0.95		1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433		1583	1770		1583	3433	1863	1583	3433	1863	1583
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	758	0	363	95	0	200	600	89	158	263	89	979
RTOR Reduction (vph)	0	0	234	0	0	40	0	0	103	0	0	0
Lane Group Flow (vph)	758	0	129	95	0	160	600	89	55	263	89	979
Turn Type	Prot		custom	Prot		custom	Prot		custom	Prot		custom
Protected Phases	1			1			5	6		5	6	
Permitted Phases			5			5			1 6			1 5 6
Actuated Green, G (s)	21.0		31.9	21.0		31.9	31.9	10.6	40.1	31.9	10.6	90.0
Effective Green, g (s)	21.0		31.9	21.0		31.9	31.9	10.6	31.6	31.9	10.6	81.5
Actuated g/C Ratio	0.23		0.35	0.23		0.35	0.35	0.12	0.35	0.35	0.12	0.91
Clearance Time (s)	9.0		9.0	9.0		9.0	9.0	8.5		9.0	8.5	
Vehicle Extension (s)	3.0		3.0	3.0		3.0	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	801		561	413		561	1217	219	556	1217	219	1433
v/s Ratio Prot	c0.22			0.05			0.17	0.05		0.08	0.05	
v/s Ratio Perm			0.08			0.10			0.04			c0.62
v/c Ratio	0.95		0.23	0.23		0.29	0.49	0.41	0.10	0.22	0.41	0.68
Uniform Delay, d1	33.9		20.4	28.0		20.9	22.7	36.8	19.6	20.3	36.8	1.1
Progression Factor	1.00		1.00	0.52		1.65	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	19.7		0.2	0.3		0.3	0.3	5.5	0.1	0.1	5.5	1.4
Delay (s)	53.7		20.6	14.7		34.7	23.0	42.3	19.7	20.4	42.3	2.4
Level of Service	D		C	B		C	C	D	B	C	D	A
Approach Delay (s)		43.0			28.2			24.4			8.6	
Approach LOS		D			C			C			A	

Intersection Summary			
HCM Average Control Delay	24.7	HCM Level of Service	C
HCM Volume to Capacity ratio	0.70		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	88.4%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	SEH Inc.	Freeway/Dir of Travel	US 160 Eastbound
Agency or Company		Junction	Grandview Ramp A
Date Performed	11/13/2009	Jurisdiction	
Analysis Time Period		Analysis Year	Year 2025

Project Description: US 160 FEIS Grandview Section - Year 2025 Analysis

Inputs

Upstream Adj Ramp	Terrain	Downstream Adj Ramp
☐ Yes ☐ On		☐ Yes ☐ On
☐ No ☐ Off		☐ No ☐ Off
L_{up} = ft	S_{FF} = 60.0 mph S_{FR} = 40.0 mph	L_{down} = ft
Vu = veh/h	Sketch (show lanes, L_A, L_D,V_R,V_f)	VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	2700	0.95	Rolling	5	0	0.930	1.00	3055
Ramp	795	0.95	Rolling	2	0	0.971	1.00	862
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM}= using Equation

V_{12}= pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}		See Exhibit 25-7	
V_{R12}		4600:All	

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = (pc/ mi /ln)

LOS = (Exhibit 25-4)

Speed Estimation

M_S = (Exibit 25-19)

S_R= mph (Exhibit 25-19)

S_0= mph (Exhibit 25-19)

S= mph (Exhibit 25-14)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} =0.644 using Equation 5

V_{12} = 2274 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$V_{Fl}=V_F$	3055	6900	No
V_{12}	2274	4400:All	No
$V_{FO} = V_F - V_R$	2193	6900	No
V_R	862	2100	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = 14.8 (pc/ mi /ln)

LOS= B (Exhibit 25-4)

Speed Estimation

D_s = 0.441 (Exhibit 25-19)

S_R= 52.1 mph (Exhibit 25-19)

S_0= 65.8 mph (Exhibit 25-19)

S = 55.0 mph (Exhibit 25-15)

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	SEH Inc.	Freeway/Dir of Travel	US 160 Eastbound
Agency or Company		Junction	Grandview Ramp A
Date Performed	11/13/2009	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	Year 2025
Project Description	US 160 FEIS Grandview Section - Year 2025 Analysis		

Inputs

Upstream Adj Ramp	Terrain	Downstream Adj Ramp
☐ Yes ☐ On		☐ Yes ☐ On
☐ No ☐ Off		☐ No ☐ Off
L_{up} = ft	S_{FF} = 60.0 mph S_{FR} = 40.0 mph	L_{down} = ft
Vu = veh/h	Sketch (show lanes, L_A, L_D,V_R,V_f)	VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	4265	0.95	Rolling	5	0	0.930	1.00	4826
Ramp	1540	0.95	Rolling	2	0	0.971	1.00	1670
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM}= using Equation

V_{12}= pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}		See Exhibit 25-7	
V_{R12}		4600:All	

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

D_R = (pc/ mi /ln)

LOS = (Exhibit 25-4)

Speed Estimation

M_S = (Exibit 25-19)

S_R= mph (Exhibit 25-19)

S_0= mph (Exhibit 25-19)

S= mph (Exhibit 25-14)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} =0.563 using Equation 5

V_{12} = 3445 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$V_{Fl}=V_F$	4826	6900	No
V_{12}	3445	4400:All	No
$V_{FO} = V_F - V_R$	3156	6900	No
V_R	1670	2100	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$

D_R = 24.9 (pc/ mi /ln)

LOS= C (Exhibit 25-4)

Speed Estimation

D_s = 0.513 (Exhibit 25-19)

S_R= 50.8 mph (Exhibit 25-19)

S_0= 64.3 mph (Exhibit 25-19)

S = 54.0 mph (Exhibit 25-15)

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst2	SEH Inc.	Freeway/Dir of Travel	US 160 Eastbound
Agency or Company		Junction	Granview Ramp B
Date Performed	11/13/2009	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	Year 2025

Project Description US 160 FEIS Grandview Section - Year 2025 Analysis

Inputs

Upstream Adj Ramp	Terrain Rolling	Downstream Adj Ramp
☐ Yes ☐ On		☐ Yes ☐ On
☐ No ☐ Off		☐ No ☐ Off
L_{up} = ft		L_{down} = ft
V_u = veh/h	S_{FF} = 60.0 mph S_{FR} = 40.0 mph Sketch (show lanes, L_A, L_D,V_R,V_f)	V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	1905	0.95	Rolling	5	0	0.930	1.00	2156
Ramp	595	0.95	Rolling	2	0	0.971	1.00	645
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM}= 1.000 using Equation 0

V_{12}= 2156 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}	2801	See Exhibit 25-7	No
V_{R12}	2801	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

D_R = 23.3 (pc/ m/ln)

LOS = C (Exhibit 25-4)

Speed Estimation

M_S = 0.337 (Exibit 25-19)

S_R= 53.9 mph (Exhibit 25-19)

S_0= N/A mph (Exhibit 25-19)

S= 53.9 mph (Exhibit 25-14)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = using Equation

V_{12} = pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$V_{FI}=V_F$		See Exhibit 25-14	
V_{12}		4400:All	
$V_{FO} = V_F - V_R$		See Exhibit 25-14	
V_R		See Exhibit 25-3	

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$

D_R = (pc/ m/ln)

LOS= (Exhibit 25-4)

Speed Estimation

D_s = (Exhibit 25-19)

S_R= mph (Exhibit 25-19)

S_0= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst2	SEH Inc.	Freeway/Dir of Travel	US 160 Eastbound
Agency or Company		Junction	Grandview Ramp B
Date Performed	11/13/2009	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	Year 2025

Project Description US 160 FEIS Grandview Section - Year 2025 Analysis

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{up} = ft

V_u = veh/h

Terrain Rolling

S_{FF} = 60.0 mph S_{FR} = 40.0 mph

Sketch (show lanes, L_A, L_D,V_R,V_f)

Downstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	$v=V/PHF\ f_{HV}\ f_p$
Freeway	2725	0.95	Rolling	5	0	0.930	1.00	3084
Ramp	465	0.95	Rolling	2	0	0.971	1.00	504
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM}= 1.000 using Equation 0

V_{12}= 3084 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}	3588	See Exhibit 25-7	No
V_{R12}	3588	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = 29.5 (pc/ m/ln)

LOS = D (Exhibit 25-4)

Speed Estimation

M_S = 0.414 (Exibit 25-19)

S_R= 52.5 mph (Exhibit 25-19)

S_0= N/A mph (Exhibit 25-19)

S= 52.5 mph (Exhibit 25-14)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = using Equation

V_{12} = pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$V_{FI}=V_F$		See Exhibit 25-14	
V_{12}		4400:All	
$V_{FO} = V_F - V_R$		See Exhibit 25-14	
V_R		See Exhibit 25-3	

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = (pc/ m/ln)

LOS= (Exhibit 25-4)

Speed Estimation

D_s = (Exhibit 25-19)

S_R= mph (Exhibit 25-19)

S_0= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst2	SEH Inc.	Freeway/Dir of Travel	US 160 Westbound
Agency or Company		Junction	Grandview Ramp C
Date Performed	11/13/2009	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	Year 2025

Project Description US 160 FEIS Grandview Section - Year 2025 Analysis

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{up} = ft

V_u = veh/h

Terrain Rolling

S_{FF} = 60.0 mph S_{FR} = 40.0 mph

Sketch (show lanes, L_A, L_D,V_R,V_f)

Downstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	$v=V/PHF\ f_{HV}\ f_p$
Freeway	1750	0.95	Rolling	5	0	0.930	1.00	1980
Ramp	945	0.95	Rolling	2	0	0.971	1.00	1025
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM}= 1.000 using Equation 0

V_{12}= 1980 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}	3005	See Exhibit 25-7	No
V_{R12}	3005	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = 16.5 (pc/ m/ln)

LOS = B (Exhibit 25-4)

Speed Estimation

M_S = 0.248 (Exibit 25-19)

S_R= 55.5 mph (Exhibit 25-19)

S_0= N/A mph (Exhibit 25-19)

S= 55.5 mph (Exhibit 25-14)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = using Equation

V_{12} = pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$V_{FI}=V_F$		See Exhibit 25-14	
V_{12}		4400:All	
$V_{FO} = V_F - V_R$		See Exhibit 25-14	
V_R		See Exhibit 25-3	

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = (pc/ m/ln)

LOS= (Exhibit 25-4)

Speed Estimation

D_s = (Exhibit 25-19)

S_R= mph (Exhibit 25-19)

S_0= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst2	SEH Inc.	Freeway/Dir of Travel	US 160 Westbound
Agency or Company		Junction	Grandview Ramp C
Date Performed	11/13/2009	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	Year 2025

Project Description US 160 FEIS Grandview Section - Year 2025 Analysis

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{up} = ft

V_u = veh/h

Terrain Rolling

S_{FF} = 60.0 mph S_{FR} = 40.0 mph

Sketch (show lanes, L_A, L_D,V_R,V_f)

Downstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	$v=V/PHF\ f_{HV}\ f_p$
Freeway	3135	0.95	Rolling	5	0	0.930	1.00	3547
Ramp	565	0.95	Rolling	2	0	0.971	1.00	613
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM}= 1.000 using Equation 0

V_{12}= 3547 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}	4160	See Exhibit 25-7	No
V_{R12}	4160	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = 25.7 (pc/ m/ln)

LOS = C (Exhibit 25-4)

Speed Estimation

M_S = 0.419 (Exibit 25-19)

S_R= 52.5 mph (Exhibit 25-19)

S_0= N/A mph (Exhibit 25-19)

S= 52.5 mph (Exhibit 25-14)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = using Equation

V_{12} = pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$V_{FI}=V_F$		See Exhibit 25-14	
V_{12}		4400:All	
$V_{FO} = V_F - V_R$		See Exhibit 25-14	
V_R		See Exhibit 25-3	

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = (pc/ m/ln)

LOS= (Exhibit 25-4)

Speed Estimation

D_s = (Exhibit 25-19)

S_R= mph (Exhibit 25-19)

S_0= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst2	SEH Inc.	Freeway/Dir of Travel	US 160 Westbound
Agency or Company		Junction	Grandview Ramp e
Date Performed	11/13/2009	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	Year 2025

Project Description US 160 FEIS Grandview Section - Year 2025 Analysis

Inputs

Upstream Adj Ramp

☑ Yes ☑ On

☐ No ☐ Off

L_{up} = 1700 ft

V_u = 945 veh/h

Terrain Rolling

S_{FF} = 60.0 mph S_{FR} = 40.0 mph

Sketch (show lanes, L_A, L_D,V_R,V_f)

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	$v=V/PHF\ f_{HV}\ f_p$
Freeway	2695	0.95	Rolling	5	0	0.930	1.00	3050
Ramp	385	0.95	Rolling	2	0	0.971	1.00	417
UpStream	945	0.95	Rolling	2	0	0.971	1.00	1025
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM}= 0.594 using Equation 1

V_{12}= 1813 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}	3467	See Exhibit 25-7	No
V_{R12}	2230	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = 18.9 (pc/ m/ln)

LOS = B (Exhibit 25-4)

Speed Estimation

M_S = 0.309 (Exibit 25-19)

S_R= 54.4 mph (Exhibit 25-19)

S_0= 57.3 mph (Exhibit 25-19)

S= 55.4 mph (Exhibit 25-14)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = using Equation

V_{12} = pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$V_{FI}=V_F$		See Exhibit 25-14	
V_{12}		4400:All	
$V_{FO} = V_F - V_R$		See Exhibit 25-14	
V_R		See Exhibit 25-3	

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = (pc/ m/ln)

LOS= (Exhibit 25-4)

Speed Estimation

D_s = (Exhibit 25-19)

S_R= mph (Exhibit 25-19)

S_0= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst2	SEH Inc.	Freeway/Dir of Travel	US 160 Westbound
Agency or Company		Junction	Grandview Ramp E
Date Performed	11/13/2009	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	Year 2025

Project Description US 160 FEIS Grandview Section - Year 2025 Analysis

Inputs

Upstream Adj Ramp

☑ Yes ☑ On

☐ No ☐ Off

L_{up} = 1700 ft

V_u = 565 veh/h

Terrain Rolling

S_{FF} = 60.0 mph S_{FR} = 40.0 mph

Sketch (show lanes, L_A, L_D,V_R,V_f)

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	$v=V/PHF\ f_{HV}\ f_p$
Freeway	3700	0.95	Rolling	5	0	0.930	1.00	4187
Ramp	590	0.95	Rolling	2	0	0.971	1.00	640
UpStream	565	0.95	Rolling	2	0	0.971	1.00	613
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM}= 0.594 using Equation 1

V_{12}= 2488 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}	4827	See Exhibit 25-7	No
V_{R12}	3128	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = 25.8 (pc/ m/ln)

LOS = C (Exhibit 25-4)

Speed Estimation

M_S = 0.362 (Exibit 25-19)

S_R= 53.5 mph (Exhibit 25-19)

S_0= 55.7 mph (Exhibit 25-19)

S= 54.2 mph (Exhibit 25-14)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = using Equation

V_{12} = pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$V_{FI}=V_F$		See Exhibit 25-14	
V_{12}		4400:All	
$V_{FO} = V_F - V_R$		See Exhibit 25-14	
V_R		See Exhibit 25-3	

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = (pc/ m/ln)

LOS= (Exhibit 25-4)

Speed Estimation

D_s = (Exhibit 25-19)

S_R= mph (Exhibit 25-19)

S_0= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

HCS2000: Basic Freeway Segments Release 4.1f

Operational Analysis

Analyst:	SEH Inc.
Agency or Company:	
Date Performed:	11/13/2009
Analysis Time Period:	AM Peak
Freeway/Direction:	Eastbound
From/To:	West of US 550
Jurisdiction:	
Analysis Year:	Year 2025

Description: US 160 FEIS Grandview Section - Year 2025 Analysis

Flow Inputs and Adjustments

Volume, V	2700	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	711	v
Trucks and buses	5	%
Recreational vehicles	0	%
Terrain type:	Rolling	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	2.5	
Recreational vehicle PCE, ER	2.0	
Heavy vehicle adjustment, fHV	0.930	
Driver population factor, fp	1.00	
Flow rate, vp	1018	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	60.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1018	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	3	
Density, D	17.0	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

Operational Analysis

Analyst:	SEH Inc.
Agency or Company:	
Date Performed:	11/13/2009
Analysis Time Period:	PM Peak
Freeway/Direction:	Eastbound
From/To:	West of US 550
Jurisdiction:	
Analysis Year:	Year 2025

Description: US 160 FEIS Grandview Section - Year 2025 Analysis

Flow Inputs and Adjustments

Volume, V	4265	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1122	v
Trucks and buses	5	%
Recreational vehicles	0	%
Terrain type:	Rolling	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	2.5	
Recreational vehicle PCE, ER	2.0	
Heavy vehicle adjustment, fHV	0.930	
Driver population factor, fp	1.00	
Flow rate, vp	1609	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	60.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1609	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	3	
Density, D	26.8	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

Operational Analysis

Analyst:	SEH Inc.
Agency or Company:	
Date Performed:	11/13/2009
Analysis Time Period:	AM Peak
Freeway/Direction:	Westbound
From/To:	West of US 550
Jurisdiction:	
Analysis Year:	Year 2025

Description: US 160 FEIS Grandview Section - Year 2025 Analysis

Flow Inputs and Adjustments

Volume, V	3080	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	811	v
Trucks and buses	5	%
Recreational vehicles	0	%
Terrain type:	Rolling	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	2.5	
Recreational vehicle PCE, ER	2.0	
Heavy vehicle adjustment, fHV	0.930	
Driver population factor, fp	1.00	
Flow rate, vp	1162	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	60.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1162	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	3	
Density, D	19.4	pc/mi/ln
Level of service, LOS	C	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

Operational Analysis

Analyst:	SEH Inc.
Agency or Company:	
Date Performed:	11/13/2009
Analysis Time Period:	PM Peak
Freeway/Direction:	Westbound
From/To:	West of US 550
Jurisdiction:	
Analysis Year:	Year 2025

Description: US 160 FEIS Grandview Section - Year 2025 Analysis

Flow Inputs and Adjustments

Volume, V	4290	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1129	v
Trucks and buses	5	%
Recreational vehicles	0	%
Terrain type:	Rolling	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	2.5	
Recreational vehicle PCE, ER	2.0	
Heavy vehicle adjustment, fHV	0.930	
Driver population factor, fp	1.00	
Flow rate, vp	1618	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	60.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1618	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	3	
Density, D	27.0	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	SEH Inc.	Freeway/Dir of Travel	US 160 Eastbound
Agency or Company		Junction	CR 233 Off Ramp
Date Performed	11/13/2009	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	Year 2025
Project Description	US 160 FEIS Grandview Section - Year 2025 Analysis		

Inputs

Upstream Adj Ramp	Terrain	Downstream Adj Ramp
☐ Yes ☐ On		☐ Yes ☐ On
☐ No ☐ Off		☐ No ☐ Off
L_{up} = ft	S_{FF} = 60.0 mph S_{FR} = 40.0 mph	L_{down} = ft
Vu = veh/h	Sketch (show lanes, L_A, L_D,V_R,V_f)	VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	2500	0.95	Rolling	5	0	0.930	1.00	2829
Ramp	1090	0.95	Rolling	2	0	0.971	1.00	1182
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM}= using Equation

V_{12}= pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}		See Exhibit 25-7	
V_{R12}		4600:All	

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = (pc/ mi /ln)

LOS = (Exhibit 25-4)

Speed Estimation

M_S = (Exibit 25-19)

S_R= mph (Exhibit 25-19)

S_0= mph (Exhibit 25-19)

S= mph (Exhibit 25-14)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} =1.000 using Equation 0

V_{12} = 2829 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$V_{Fl}=V_F$	2829	4600	No
V_{12}	2829	4400:All	No
$V_{FO} = V_F - V_R$	1647	4600	No
V_R	1182	2100	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = 25.9 (pc/ mi /ln)

LOS= C (Exhibit 25-4)

Speed Estimation

D_s = 0.469 (Exhibit 25-19)

S_R= 51.6 mph (Exhibit 25-19)

S_0= N/A mph (Exhibit 25-19)

S = 51.6 mph (Exhibit 25-15)

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	SEH Inc.	Freeway/Dir of Travel	US 160 Eastbound
Agency or Company		Junction	CR 233 Off Ramp
Date Performed	11/13/2009	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	Year 2025
Project Description	US 160 FEIS Grandview Section - Year 2025 Analysis		

Inputs

Upstream Adj Ramp	Terrain	Downstream Adj Ramp
☐ Yes ☐ On		☐ Yes ☐ On
☐ No ☐ Off		☐ No ☐ Off
L_{up} = ft	S_{FF} = 60.0 mph S_{FR} = 40.0 mph	L_{down} = ft
Vu = veh/h	Sketch (show lanes, L_A, L_D,V_R,V_f)	VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	3190	0.95	Rolling	5	0	0.930	1.00	3610
Ramp	1065	0.95	Rolling	2	0	0.971	1.00	1155
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM}= using Equation

V_{12}= pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}		See Exhibit 25-7	
V_{R12}		4600:All	

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

D_R = (pc/ mi /ln)

LOS = (Exhibit 25-4)

Speed Estimation

M_S = (Exibit 25-19)

S_R= mph (Exhibit 25-19)

S_0= mph (Exhibit 25-19)

S= mph (Exhibit 25-14)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} =1.000 using Equation 0

V_{12} = 3610 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$V_{Fl}=V_F$	3610	4600	No
V_{12}	3610	4400:All	No
$V_{FO} = V_F - V_R$	2455	4600	No
V_R	1155	2100	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$

D_R = 32.6 (pc/ mi /ln)

LOS= D (Exhibit 25-4)

Speed Estimation

D_s = 0.467 (Exhibit 25-19)

S_R= 51.6 mph (Exhibit 25-19)

S_0= N/A mph (Exhibit 25-19)

S = 51.6 mph (Exhibit 25-15)

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst2	SEH Inc.	Freeway/Dir of Travel	US 160 Eastbound
Agency or Company		Junction	CR 223 On Ramp
Date Performed	11/13/2009	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	Year 2025

Project Description US 160 FEIS Grandview Section - Year 2025 Analysis

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{up} = ft

V_u = veh/h

Terrain Rolling

S_{FF} = 60.0 mph S_{FR} = 40.0 mph

Sketch (show lanes, L_A, L_D,V_R,V_f)

Downstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	$v=V/PHF\ f_{HV}\ f_p$
Freeway	1410	0.95	Rolling	5	0	0.930	1.00	1596
Ramp	195	0.95	Rolling	2	0	0.971	1.00	211
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM}= 1.000 using Equation 0

V_{12}= 1596 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}	1807	See Exhibit 25-7	No
V_{R12}	1807	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = 15.7 (pc/ m/ln)

LOS = B (Exhibit 25-4)

Speed Estimation

M_S = 0.297 (Exibit 25-19)

S_R= 54.7 mph (Exhibit 25-19)

S_0= N/A mph (Exhibit 25-19)

S= 54.7 mph (Exhibit 25-14)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = using Equation

V_{12} = pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$V_{FI}=V_F$		See Exhibit 25-14	
V_{12}		4400:All	
$V_{FO} = V_F - V_R$		See Exhibit 25-14	
V_R		See Exhibit 25-3	

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = (pc/ m/ln)

LOS= (Exhibit 25-4)

Speed Estimation

D_s = (Exhibit 25-19)

S_R= mph (Exhibit 25-19)

S_0= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst2	SEH Inc.	Freeway/Dir of Travel	US 160 Eastbound
Agency or Company		Junction	CR 223 On Ramp
Date Performed	11/13/2009	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	Year 2025

Project Description US 160 FEIS Grandview Section - Year 2025 Analysis

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{up} = ft

V_u = veh/h

Terrain Rolling

S_{FF} = 60.0 mph S_{FR} = 40.0 mph

Sketch (show lanes, L_A, L_D,V_R,V_f)

Downstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	$v=V/PHF\ f_{HV}\ f_p$
Freeway	2125	0.95	Rolling	5	0	0.930	1.00	2405
Ramp	400	0.95	Rolling	2	0	0.971	1.00	434
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM}= 1.000 using Equation 0

V_{12}= 2405 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}	2839	See Exhibit 25-7	No
V_{R12}	2839	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = 23.7 (pc/ m/ln)

LOS = C (Exhibit 25-4)

Speed Estimation

M_S = 0.340 (Exibit 25-19)

S_R= 53.9 mph (Exhibit 25-19)

S_0= N/A mph (Exhibit 25-19)

S= 53.9 mph (Exhibit 25-14)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = using Equation

V_{12} = pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$V_{FI}=V_F$		See Exhibit 25-14	
V_{12}		4400:All	
$V_{FO} = V_F - V_R$		See Exhibit 25-14	
V_R		See Exhibit 25-3	

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = (pc/ m/ln)

LOS= (Exhibit 25-4)

Speed Estimation

D_s = (Exhibit 25-19)

S_R= mph (Exhibit 25-19)

S_0= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	SEH Inc.	Freeway/Dir of Travel	US 160 Westbound
Agency or Company		Junction	CR 233 Off Ramp
Date Performed	11/13/2009	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	Year 2025
Project Description	US 160 FEIS Grandview Section - Year 2025 Analysis		

Inputs

Upstream Adj Ramp	Terrain	Downstream Adj Ramp
☐ Yes ☐ On		☐ Yes ☐ On
☐ No ☐ Off		☐ No ☐ Off
L_{up} = ft	S_{FF} = 60.0 mph S_{FR} = 40.0 mph	L_{down} = ft
Vu = veh/h	Sketch (show lanes, L_A, L_D,V_R,V_f)	VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	1685	0.95	Rolling	5	0	0.930	1.00	1907
Ramp	290	0.95	Rolling	2	0	0.971	1.00	314
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM}= using Equation

V_{12}= pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}		See Exhibit 25-7	
V_{R12}		4600:All	

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = (pc/ mi /ln)

LOS = (Exhibit 25-4)

Speed Estimation

M_S = (Exibit 25-19)

S_R= mph (Exhibit 25-19)

S_0= mph (Exhibit 25-19)

S= mph (Exhibit 25-14)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} =1.000 using Equation 0

V_{12} = 1907 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$V_{Fl}=V_F$	1907	4600	No
V_{12}	1907	4400:All	No
$V_{FO} = V_F - V_R$	1593	4600	No
V_R	314	2100	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = 18.0 (pc/ mi /ln)

LOS= B (Exhibit 25-4)

Speed Estimation

D_s = 0.391 (Exhibit 25-19)

S_R= 53.0 mph (Exhibit 25-19)

S_0= N/A mph (Exhibit 25-19)

S = 53.0 mph (Exhibit 25-15)

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	SEH Inc.	Freeway/Dir of Travel	US 160 Westbound
Agency or Company		Junction	CR 233 Off Ramp
Date Performed	11/13/2009	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	Year 2025
Project Description	US 160 FEIS Grandview Section - Year 2025 Analysis		

Inputs

Upstream Adj Ramp	Terrain	Downstream Adj Ramp
☐ Yes ☐ On		☐ Yes ☐ On
☐ No ☐ Off		☐ No ☐ Off
L_{up} = ft	S_{FF} = 60.0 mph S_{FR} = 40.0 mph	L_{down} = ft
Vu = veh/h	Sketch (show lanes, L_A, L_D,V_R,V_f)	VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	2290	0.95	Rolling	5	0	0.930	1.00	2591
Ramp	280	0.95	Rolling	2	0	0.971	1.00	304
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM}= using Equation

V_{12}= pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}		See Exhibit 25-7	
V_{R12}		4600:All	

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

D_R = (pc/ mi /ln)

LOS = (Exhibit 25-4)

Speed Estimation

M_S = (Exibit 25-19)

S_R= mph (Exhibit 25-19)

S_0= mph (Exhibit 25-19)

S= mph (Exhibit 25-14)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} =1.000 using Equation 0

V_{12} = 2591 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$V_{Fl}=V_F$	2591	4600	No
V_{12}	2591	4400:All	No
$V_{FO} = V_F - V_R$	2287	4600	No
V_R	304	2100	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$

D_R = 23.8 (pc/ mi /ln)

LOS= C (Exhibit 25-4)

Speed Estimation

D_s = 0.390 (Exhibit 25-19)

S_R= 53.0 mph (Exhibit 25-19)

S_0= N/A mph (Exhibit 25-19)

S = 53.0 mph (Exhibit 25-15)

HCS2000: Basic Freeway Segments Release 4.1f

Operational Analysis

Analyst:	SEH Inc.
Agency or Company:	
Date Performed:	11/13/2009
Analysis Time Period:	AM Peak
Freeway/Direction:	Eastbound
From/To:	US 550 to CR 233
Jurisdiction:	
Analysis Year:	Year 2025

Description: US 160 FEIS Grandview Section - Year 2025 Analysis

Flow Inputs and Adjustments

Volume, V	2500	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	658	v
Trucks and buses	5	%
Recreational vehicles	0	%
Terrain type:	Rolling	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	2.5	
Recreational vehicle PCE, ER	2.0	
Heavy vehicle adjustment, fHV	0.930	
Driver population factor, fp	1.00	
Flow rate, vp	1414	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	4.5	mi/h
Free-flow speed, FFS	60.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1414	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	2	
Density, D	23.6	pc/mi/ln
Level of service, LOS	C	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

Operational Analysis

Analyst:	SEH Inc.
Agency or Company:	
Date Performed:	11/13/2009
Analysis Time Period:	PM Peak
Freeway/Direction:	Eastbound
From/To:	US 550 to CR 233
Jurisdiction:	
Analysis Year:	Year 2025

Description: US 160 FEIS Grandview Section - Year 2025 Analysis

Flow Inputs and Adjustments

Volume, V	3190	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	839	v
Trucks and buses	5	%
Recreational vehicles	0	%
Terrain type:	Rolling	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	2.5	
Recreational vehicle PCE, ER	2.0	
Heavy vehicle adjustment, fHV	0.930	
Driver population factor, fp	1.00	
Flow rate, vp	1805	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	4.5	mi/h
Free-flow speed, FFS	60.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1805	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	59.6	mi/h
Number of lanes, N	2	
Density, D	30.3	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

Operational Analysis

Analyst:	SEH Inc.
Agency or Company:	
Date Performed:	11/13/2009
Analysis Time Period:	AM Peak
Freeway/Direction:	Westbound
From/To:	CR 233 to US 550
Jurisdiction:	
Analysis Year:	Year 2025
Description:	

Flow Inputs and Adjustments

Volume, V	2130	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	561	v
Trucks and buses	5	%
Recreational vehicles	0	%
Terrain type:	Rolling	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	2.5	
Recreational vehicle PCE, ER	2.0	
Heavy vehicle adjustment, fHV	0.930	
Driver population factor, fp	1.00	
Flow rate, vp	1205	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	4.5	mi/h
Free-flow speed, FFS	60.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1205	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	2	
Density, D	20.1	pc/mi/ln
Level of service, LOS	C	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

Operational Analysis

Analyst:	SEH Inc.
Agency or Company:	
Date Performed:	11/13/2009
Analysis Time Period:	PM Peak
Freeway/Direction:	Westbound
From/To:	CR 233 to US 550
Jurisdiction:	
Analysis Year:	Year 2025

Description: US 160 FEIS Grandview Section - Year 2025 Analysis

Flow Inputs and Adjustments

Volume, V	3510	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	924	v
Trucks and buses	5	%
Recreational vehicles	0	%
Terrain type:	Rolling	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	2.5	
Recreational vehicle PCE, ER	2.0	
Heavy vehicle adjustment, fHV	0.930	
Driver population factor, fp	1.00	
Flow rate, vp	1986	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	4.5	mi/h
Free-flow speed, FFS	60.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1986	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	58.1	mi/h
Number of lanes, N	2	
Density, D	34.2	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Freeway Weaving Release 4.1f

Operational Analysis

Analyst:	SEH Inc.
Agency/Co.:	
Date Performed:	11/13/2009
Analysis Time Period:	AM Peak
Freeway/Dir of Travel:	US 160 Westbound
Weaving Location:	CR 233 On US 550 Off
Jurisdiction:	
Analysis Year:	Year 2025

Description: US 160 FEIS Grandview Section - Year 2025 Analysis

Inputs

Freeway free-flow speed, SFF	60	mph
Weaving number of lanes, N	3	
Weaving segment length, L	2070	ft
Terrain type	Rolling	
Grade		%
Length		mi
Weaving type	A	Multilane or C-D
Volume ratio, VR	0.49	
Weaving ratio, R	0.33	

Conversion to pc/h Under Base Conditions

	Non-Weaving V A-C	Non-Weaving V B-D	Weaving V A-D	Weaving V B-C	
Volume, V	1053	38	342	697	veh/h
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	
Peak 15-min volume, v15	277	10	90	183	v
Trucks and buses	5	5	5	5	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	2.5	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	2.0	
Heavy vehicle adjustment, fHV	0.930	0.930	0.930	0.930	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	1191	42	386	788	pc/h

Weaving and Non-Weaving Speeds

	Weaving	Non-Weaving
a (Exhibit 24-6)	0.15	0.00
b (Exhibit 24-6)	2.20	4.00
c (Exhibit 24-6)	0.97	1.30
d (Exhibit 24-6)	0.80	0.75
Weaving intensity factor, Wi	1.22	0.19
Weaving and non-weaving speeds, Si	37.47	57.00
Number of lanes required for unconstrained operation, Nw (Exhibit 24-7)		1.62
Maximum number of lanes, Nw (max) (Exhibit 24-7)		1.40
Type of operation is		Constrained

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S	45.45	mph
Weaving segment density, D	17.65	pc/mi/ln
Level of service, LOS	B	
Capacity of base condition, cb	4948	pc/h
Capacity as a 15-minute flow rate, c	4603	pc/h
Capacity as a full-hour volume, ch	4373	pc/h

Limitations on Weaving Segments

	Analyzed	If Max Exceeded Maximum	See Note Note
Weaving flow rate, Vw	1174	2800	a
Average flow rate (pcphpl)	802	2300	b
Volume ratio, VR	0.49	0.45	c
Weaving ratio, R	0.33	N/A	d
Weaving length (ft)	2070	2500	e

Notes:

a. Weaving segments longer than 2500 ft. are treated as isolated merge and diverge areas using the procedures of Chapter 25, "Ramps and Ramp Junctions".
b. Capacity constrained by basic freeway capacity.
c. Capacity occurs under constrained operating conditions.
d. Three-lane Type A segments do not operate well at volume ratios greater than 0.45. Poor operations and some local queuing are expected in such cases.
e. Four-lane Type A segments do not operate well at volume ratios greater than 0.35. Poor operations and some local queuing are expected in such cases.
f. Capacity constrained by maximum allowable weaving flow rate: 2,800 pc/h (Type A), 4,000 (Type B), 3,500 (Type C).
g. Five-lane Type A segments do not operate well at volume ratios greater than 0.20. Poor operations and some local queuing are expected in such cases.
h. Type B weaving segments do not operate well at volume ratios greater than 0.80. Poor operations and some local queuing are expected in such cases.
i. Type C weaving segments do not operate well at volume ratios greater than 0.50. Poor operations and some local queuing are expected in such cases.

HCS2000: Freeway Weaving Release 4.1f

Operational Analysis

Analyst:	SEH Inc.
Agency/Co.:	
Date Performed:	11/13/2009
Analysis Time Period:	PM Peak
Freeway/Dir of Travel:	US 160 Westbound
Weaving Location:	CR 233 On US 550 Off
Jurisdiction:	
Analysis Year:	Year 2025

Description: US 160 FEIS Grandview Section - Year 2025 Analysis

Inputs

Freeway free-flow speed, SFF	60	mph
Weaving number of lanes, N	3	
Weaving segment length, L	2070	ft
Terrain type	Rolling	
Grade		%
Length		mi
Weaving type	A	Multilane or C-D
Volume ratio, VR	0.51	
Weaving ratio, R	0.19	

Conversion to pc/h Under Base Conditions

	Non-Weaving V A-C	Non-Weaving V B-D	Weaving V A-D	Weaving V B-C	
Volume, V	1673	38	337	1462	veh/h
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	
Peak 15-min volume, v15	440	10	89	385	v
Trucks and buses	5	5	5	5	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	2.5	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	2.0	
Heavy vehicle adjustment, fHV	0.930	0.930	0.930	0.930	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	1893	42	381	1654	pc/h

Weaving and Non-Weaving Speeds

	Weaving	Non-Weaving
a (Exhibit 24-6)	0.15	0.00
b (Exhibit 24-6)	2.20	4.00
c (Exhibit 24-6)	0.97	1.30
d (Exhibit 24-6)	0.80	0.75
Weaving intensity factor, Wi	2.06	0.39
Weaving and non-weaving speeds, Si	31.32	50.97
Number of lanes required for unconstrained operation, Nw (Exhibit 24-7)		1.77
Maximum number of lanes, Nw (max) (Exhibit 24-7)		1.40
Type of operation is		Constrained

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S	38.57	mph
Weaving segment density, D	34.31	pc/mi/ln
Level of service, LOS	D	
Capacity of base condition, cb	4948	pc/h
Capacity as a 15-minute flow rate, c	4603	pc/h
Capacity as a full-hour volume, ch	4373	pc/h

Limitations on Weaving Segments

	Analyzed	If Max Exceeded Maximum	See Note Note
Weaving flow rate, Vw	2035	2800	a
Average flow rate (pcphpl)	1323	2300	b
Volume ratio, VR	0.51	0.45	c
Weaving ratio, R	0.19	N/A	d
Weaving length (ft)	2070	2500	e

Notes:

a. Weaving segments longer than 2500 ft. are treated as isolated merge and diverge areas using the procedures of Chapter 25, "Ramps and Ramp Junctions".
b. Capacity constrained by basic freeway capacity.
c. Capacity occurs under constrained operating conditions.
d. Three-lane Type A segments do not operate well at volume ratios greater than 0.45. Poor operations and some local queuing are expected in such cases.
e. Four-lane Type A segments do not operate well at volume ratios greater than 0.35. Poor operations and some local queuing are expected in such cases.
f. Capacity constrained by maximum allowable weaving flow rate: 2,800 pc/h (Type A), 4,000 (Type B), 3,500 (Type C).
g. Five-lane Type A segments do not operate well at volume ratios greater than 0.20. Poor operations and some local queuing are expected in such cases.
h. Type B weaving segments do not operate well at volume ratios greater than 0.80. Poor operations and some local queuing are expected in such cases.
i. Type C weaving segments do not operate well at volume ratios greater than 0.50. Poor operations and some local queuing are expected in such cases.

HCS2000: Basic Freeway Segments Release 4.1f

Operational Analysis

Analyst:	SEH Inc.
Agency or Company:	
Date Performed:	11/13/2009
Analysis Time Period:	AM Peak
Freeway/Direction:	Eastbound
From/To:	CR 233 to SH 172
Jurisdiction:	
Analysis Year:	Year 2025

Description: US 160 FEIS Grandview Section - Year 2025 Analysis

Flow Inputs and Adjustments

Volume, V	1605	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	422	v
Trucks and buses	5	%
Recreational vehicles	0	%
Terrain type:	Rolling	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	2.5	
Recreational vehicle PCE, ER	2.0	
Heavy vehicle adjustment, fHV	0.930	
Driver population factor, fp	1.00	
Flow rate, vp	908	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	4.5	mi/h
Free-flow speed, FFS	60.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	908	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	2	
Density, D	15.1	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

Operational Analysis

Analyst:	SEH Inc.
Agency or Company:	
Date Performed:	11/13/2009
Analysis Time Period:	PM Peak
Freeway/Direction:	Eastbound
From/To:	CR 233 to SH 172
Jurisdiction:	
Analysis Year:	Year 2025

Description: US 160 FEIS Grandview Section - Year 2025 Analysis

Flow Inputs and Adjustments

Volume, V	2525	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	664	v
Trucks and buses	5	%
Recreational vehicles	0	%
Terrain type:	Rolling	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	2.5	
Recreational vehicle PCE, ER	2.0	
Heavy vehicle adjustment, fHV	0.930	
Driver population factor, fp	1.00	
Flow rate, vp	1429	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	4.5	mi/h
Free-flow speed, FFS	60.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1429	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	2	
Density, D	23.8	pc/mi/ln
Level of service, LOS	C	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

Operational Analysis

Analyst:	SEH Inc.
Agency or Company:	
Date Performed:	11/13/2009
Analysis Time Period:	AM Peak
Freeway/Direction:	Westbound
From/To:	SH 172 to CR 233
Jurisdiction:	
Analysis Year:	Year 2025

Description: US 160 FEIS Grandview Section - Year 2025 Analysis

Flow Inputs and Adjustments

Volume, V	1685	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	443	v
Trucks and buses	5	%
Recreational vehicles	0	%
Terrain type:	Rolling	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	2.5	
Recreational vehicle PCE, ER	2.0	
Heavy vehicle adjustment, fHV	0.930	
Driver population factor, fp	1.00	
Flow rate, vp	953	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	4.5	mi/h
Free-flow speed, FFS	60.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	953	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	2	
Density, D	15.9	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

Operational Analysis

Analyst:	SEH Inc.
Agency or Company:	
Date Performed:	11/13/2009
Analysis Time Period:	PM Peak
Freeway/Direction:	Westbound
From/To:	SH 172 to CR 233
Jurisdiction:	
Analysis Year:	Year 2025

Description: US 160 FEIS Grandview Section - Year 2025 Analysis

Flow Inputs and Adjustments

Volume, V	2290	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	603	v
Trucks and buses	5	%
Recreational vehicles	0	%
Terrain type:	Rolling	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	2.5	
Recreational vehicle PCE, ER	2.0	
Heavy vehicle adjustment, fHV	0.930	
Driver population factor, fp	1.00	
Flow rate, vp	1296	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	4.5	mi/h
Free-flow speed, FFS	60.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1296	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	2	
Density, D	21.6	pc/mi/ln
Level of service, LOS	C	

Overall results are not computed when free-flow speed is less than 55 mph.

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	SEH Inc.	Freeway/Dir of Travel	US 160 Eastbound
Agency or Company		Junction	SH 172 Off Ramp
Date Performed	11/13/2009	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	Year 2025
Project Description	US 160 FEIS Grandview Section - Year 2025 Analysis		

Inputs

Upstream Adj Ramp	Terrain	Downstream Adj Ramp
☐ Yes ☐ On		☐ Yes ☐ On
☐ No ☐ Off		☐ No ☐ Off
L_{up} = ft	S_{FF} = 60.0 mph S_{FR} = 40.0 mph	L_{down} = ft
Vu = veh/h	Sketch (show lanes, L_A, L_D,V_R,V_f)	VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	1605	0.95	Rolling	5	0	0.930	1.00	1816
Ramp	585	0.95	Rolling	2	0	0.971	1.00	634
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM}= using Equation

V_{12}= pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}		See Exhibit 25-7	
V_{R12}		4600:All	

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = (pc/ mi /ln)

LOS = (Exhibit 25-4)

Speed Estimation

M_S = (Exibit 25-19)

S_R= mph (Exhibit 25-19)

S_0= mph (Exhibit 25-19)

S= mph (Exhibit 25-14)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} =1.000 using Equation 0

V_{12} = 1816 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$V_{FI}=V_F$	1816	4600	No
V_{12}	1816	4400:All	No
$V_{FO} = V_F - V_R$	1182	4600	No
V_R	634	2100	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = 17.2 (pc/ mi /ln)

LOS= B (Exhibit 25-4)

Speed Estimation

D_s = 0.420 (Exhibit 25-19)

S_R= 52.4 mph (Exhibit 25-19)

S_0= N/A mph (Exhibit 25-19)

S = 52.4 mph (Exhibit 25-15)

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	SEH Inc.	Freeway/Dir of Travel	US 160 Eastbound
Agency or Company		Junction	SH 172 Off Ramp
Date Performed	11/13/2009	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	Year 2025
Project Description	US 160 FEIS Grandview Section - Year 2025 Analysis		

Inputs

Upstream Adj Ramp	Terrain	Downstream Adj Ramp
☐ Yes ☐ On		☐ Yes ☐ On
☐ No ☐ Off		☐ No ☐ Off
L_{up} = ft	S_{FF} = 60.0 mph S_{FR} = 40.0 mph	L_{down} = ft
Vu = veh/h	Sketch (show lanes, L_A, L_D,V_R,V_f)	VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	2525	0.95	Rolling	5	0	0.930	1.00	2857
Ramp	1180	0.95	Rolling	2	0	0.971	1.00	1279
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM}= using Equation

V_{12}= pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}		See Exhibit 25-7	
V_{R12}		4600:All	

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = (pc/ mi /ln)

LOS = (Exhibit 25-4)

Speed Estimation

M_S = (Exibit 25-19)

S_R= mph (Exhibit 25-19)

S_0= mph (Exhibit 25-19)

S= mph (Exhibit 25-14)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} =1.000 using Equation 0

V_{12} = 2857 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$V_{Fl}=V_F$	2857	4600	No
V_{12}	2857	4400:All	No
$V_{FO} = V_F - V_R$	1578	4600	No
V_R	1279	2100	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = 26.1 (pc/ mi /ln)

LOS= C (Exhibit 25-4)

Speed Estimation

D_s = 0.478 (Exhibit 25-19)

S_R= 51.4 mph (Exhibit 25-19)

S_0= N/A mph (Exhibit 25-19)

S = 51.4 mph (Exhibit 25-15)

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst2	SEH Inc.	Freeway/Dir of Travel	US 160 Eastbound
Agency or Company		Junction	SH 172 On Ramp
Date Performed	11/13/2009	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	Year 2025

Project Description US 160 FEIS Grandview Section - Year 2025 Analysis

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{up} = ft

V_u = veh/h

Terrain Rolling

S_{FF} = 60.0 mph S_{FR} = 40.0 mph

Sketch (show lanes, L_A, L_D,V_R,V_f)

Downstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	$v=V/PHF\ f_{HV}\ f_p$
Freeway	1020	0.95	Rolling	5	0	0.930	1.00	1154
Ramp	110	0.95	Rolling	2	0	0.971	1.00	119
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM}= 1.000 using Equation 0

V_{12}= 1154 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}	1273	See Exhibit 25-7	No
V_{R12}	1273	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = 11.6 (pc/ m/ln)

LOS = B (Exhibit 25-4)

Speed Estimation

M_S = 0.287 (Exibit 25-19)

S_R= 54.8 mph (Exhibit 25-19)

S_0= N/A mph (Exhibit 25-19)

S= 54.8 mph (Exhibit 25-14)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = using Equation

V_{12} = pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$V_{FI}=V_F$		See Exhibit 25-14	
V_{12}		4400:All	
$V_{FO} = V_F - V_R$		See Exhibit 25-14	
V_R		See Exhibit 25-3	

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = (pc/ m/ln)

LOS= (Exhibit 25-4)

Speed Estimation

D_s = (Exhibit 25-19)

S_R= mph (Exhibit 25-19)

S_0= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst2	SEH Inc.	Freeway/Dir of Travel	US 160 Eastbound
Agency or Company		Junction	SH 172 On Ramp
Date Performed	11/13/2009	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	Year 2025

Project Description US 160 FEIS Grandview Section - Year 2025 Analysis

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{up} = ft

V_u = veh/h

Terrain Rolling

S_{FF} = 60.0 mph S_{FR} = 40.0 mph

Sketch (show lanes, L_A, L_D,V_R,V_f)

Downstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	$v=V/PHF\ f_{HV}\ f_p$
Freeway	1345	0.95	Rolling	5	0	0.930	1.00	1522
Ramp	240	0.95	Rolling	2	0	0.971	1.00	260
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM}= 1.000 using Equation 0

V_{12}= 1522 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}	1782	See Exhibit 25-7	No
V_{R12}	1782	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = 15.5 (pc/ m/ln)

LOS = B (Exhibit 25-4)

Speed Estimation

M_S = 0.296 (Exibit 25-19)

S_R= 54.7 mph (Exhibit 25-19)

S_0= N/A mph (Exhibit 25-19)

S= 54.7 mph (Exhibit 25-14)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = using Equation

V_{12} = pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$V_{FI}=V_F$		See Exhibit 25-14	
V_{12}		4400:All	
$V_{FO} = V_F - V_R$		See Exhibit 25-14	
V_R		See Exhibit 25-3	

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = (pc/ m/ln)

LOS= (Exhibit 25-4)

Speed Estimation

D_s = (Exhibit 25-19)

S_R= mph (Exhibit 25-19)

S_0= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	SEH Inc.	Freeway/Dir of Travel	US 160 Westbound
Agency or Company		Junction	SH 172 Off Ramp
Date Performed	11/13/2009	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	Year 2025
Project Description	US 160 FEIS Grandview Section - Year 2025 Analysis		

Inputs

Upstream Adj Ramp	Terrain	Downstream Adj Ramp
☐ Yes ☐ On		☐ Yes ☐ On
☐ No ☐ Off		☐ No ☐ Off
L_{up} = ft	S_{FF} = 60.0 mph S_{FR} = 40.0 mph	L_{down} = ft
Vu = veh/h	Sketch (show lanes, L_A, L_D,V_R,V_f)	VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	935	0.95	Rolling	5	0	0.930	1.00	1058
Ramp	135	0.95	Rolling	2	0	0.971	1.00	146
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM}= using Equation

V_{12}= pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}		See Exhibit 25-7	
V_{R12}		4600:All	

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

D_R = (pc/ mi /ln)

LOS = (Exhibit 25-4)

Speed Estimation

M_S = (Exibit 25-19)

S_R= mph (Exhibit 25-19)

S_0= mph (Exhibit 25-19)

S= mph (Exhibit 25-14)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} =1.000 using Equation 0

V_{12} = 1058 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$V_{Fl}=V_F$	1058	4600	No
V_{12}	1058	4400:All	No
$V_{FO} = V_F - V_R$	912	4600	No
V_R	146	2100	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$

D_R = 10.7 (pc/ mi /ln)

LOS= B (Exhibit 25-4)

Speed Estimation

D_s = 0.376 (Exhibit 25-19)

S_R= 53.2 mph (Exhibit 25-19)

S_0= N/A mph (Exhibit 25-19)

S = 53.2 mph (Exhibit 25-15)

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	SEH Inc.	Freeway/Dir of Travel	US 160 Westbound
Agency or Company		Junction	SH 172 Off Ramp
Date Performed	11/13/2009	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	Year 2025
Project Description	US 160 FEIS Grandview Section - Year 2025 Analysis		

Inputs

Upstream Adj Ramp	Terrain	Downstream Adj Ramp
☐ Yes ☐ On		☐ Yes ☐ On
☐ No ☐ Off		☐ No ☐ Off
L_{up} = ft		L_{down} = ft
Vu = veh/h	S_{FF} = 60.0 mph S_{FR} = 40.0 mph Sketch (show lanes, L_A, L_D,V_R,V_f)	VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	1450	0.95	Rolling	5	0	0.930	1.00	1641
Ramp	205	0.95	Rolling	2	0	0.971	1.00	222
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM}= using Equation

V_{12}= pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}		See Exhibit 25-7	
V_{R12}		4600:All	

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

D_R = (pc/ mi /ln)

LOS = (Exhibit 25-4)

Speed Estimation

M_S = (Exibit 25-19)

S_R= mph (Exhibit 25-19)

S_0= mph (Exhibit 25-19)

S= mph (Exhibit 25-14)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} =1.000 using Equation 0

V_{12} = 1641 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$V_{Fl}=V_F$	1641	4600	No
V_{12}	1641	4400:All	No
$V_{FO} = V_F - V_R$	1419	4600	No
V_R	222	2100	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$

D_R = 15.7 (pc/ mi /ln)

LOS= B (Exhibit 25-4)

Speed Estimation

D_s = 0.383 (Exhibit 25-19)

S_R= 53.1 mph (Exhibit 25-19)

S_0= N/A mph (Exhibit 25-19)

S = 53.1 mph (Exhibit 25-15)

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst2	SEH Inc.	Freeway/Dir of Travel	US 160 Westbound
Agency or Company		Junction	SH 172 On Ramp
Date Performed	11/13/2009	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	Year 2025

Project Description US 160 FEIS Grandview Section - Year 2025 Analysis

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{up} = ft

V_u = veh/h

Terrain Rolling

S_{FF} = 60.0 mph S_{FR} = 40.0 mph

Sketch (show lanes, L_A, L_D,V_R,V_f)

Downstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	$v=V/PHF\ f_{HV}\ f_p$
Freeway	800	0.95	Rolling	5	0	0.930	1.00	905
Ramp	885	0.95	Rolling	2	0	0.971	1.00	960
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM}= 1.000 using Equation 0

V_{12}= 905 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}	1865	See Exhibit 25-7	No
V_{R12}	1865	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = 15.8 (pc/ m/ln)

LOS = B (Exhibit 25-4)

Speed Estimation

M_S = 0.298 (Exibit 25-19)

S_R= 54.6 mph (Exhibit 25-19)

S_0= N/A mph (Exhibit 25-19)

S= 54.6 mph (Exhibit 25-14)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = using Equation

V_{12} = pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$V_{FI}=V_F$		See Exhibit 25-14	
V_{12}		4400:All	
$V_{FO} = V_F - V_R$		See Exhibit 25-14	
V_R		See Exhibit 25-3	

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = (pc/ m/ln)

LOS= (Exhibit 25-4)

Speed Estimation

D_s = (Exhibit 25-19)

S_R= mph (Exhibit 25-19)

S_0= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst2	SEH Inc.	Freeway/Dir of Travel	US 160 Westbound
Agency or Company		Junction	SH 172 On Ramp
Date Performed	11/13/2009	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	Year 2025

Project Description US 160 FEIS Grandview Section - Year 2025 Analysis

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{up} = ft

V_u = veh/h

Terrain Rolling

S_{FF} = 60.0 mph S_{FR} = 40.0 mph

Sketch (show lanes, L_A, L_D,V_R,V_f)

Downstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	$v=V/PHF\ f_{HV}\ f_p$
Freeway	1245	0.95	Rolling	5	0	0.930	1.00	1409
Ramp	1045	0.95	Rolling	2	0	0.971	1.00	1133
UpStream								
DownStream								

Merge Areas | Diverge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM}= 1.000 using Equation 0

V_{12}= 1409 pc/h

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = using Equation

V_{12} = pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}	2542	See Exhibit 25-7	No
V_{R12}	2542	4600:All	No

Capacity Checks

	Actual	Maximum	LOS F?
$V_{FI}=V_F$		See Exhibit 25-14	
V_{12}		4400:All	
$V_{FO} = V_F - V_R$		See Exhibit 25-14	
V_R		See Exhibit 25-3	

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = 21.0 (pc/ m/ln)

LOS = C (Exhibit 25-4)

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = (pc/ m/ln)

LOS= (Exhibit 25-4)

Speed Estimation

M_S = 0.323 (Exibit 25-19)

S_R= 54.2 mph (Exhibit 25-19)

S_0= N/A mph (Exhibit 25-19)

S= 54.2 mph (Exhibit 25-14)

Speed Estimation

D_s = (Exhibit 25-19)

S_R= mph (Exhibit 25-19)

S_0= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

Appendix B

Alternative G Modified

At-Grade Intersection Evaluation Worksheets

Preferred Alternative (G Modified) Analysis

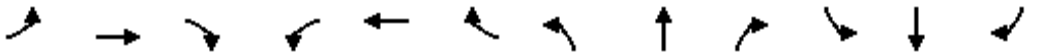
(At-Grade, Signalized Intersections)

Apendix B - US 160 Analysis - Peak Hour LOS Results (Signalized Intersections)

Intersection and Approaches	2025 Traffic Volumes with Current Laneage					Year 2025 Traffic Volumes with 3 Lanes				
	Number of Lanes	AM Peak Hour		PM Peak Hour		Number of Lanes	AM Peak Hour		PM Peak Hour	
		Delay[(a)]	LOS	Delay[(a)]	LOS		Delay[(a)]	LOS	Delay[(a)]	LOS
SIGNAL CONTROL										
US 550 & US 160	-	**142.2**	**F**	**241.3**	**F**	-	**72.3**	**E**	**116.9**	**F**
Eastbound Left	2	*223.3*	*F*	*295.3*	*F*	*2*	*137.9*	*F*	*218.5*	*F*
Eastbound Through	2	*158.8*	*F*	*241.3*	*F*	*3*	*61.4*	*E*	*67.3*	*E*
Eastbound Right	1	*0.3*	*A*	*2.7*	*A*	*1*	*0.3*	*A*	*2.7*	*A*
Westbound Left	2	*164.4*	*F*	*110.5*	*F*	*2*	*127.2*	*F*	*123.2*	*F*
Westbound Through	2	*175.5*	*F*	*403.7*	*F*	*3*	*91.0*	*F*	*205.6*	*F*
Westbound Right	1	*28.5*	*C*	*39.7*	*D*	*1*	*34.3*	*C*	*55.3*	*E*
Northbound Left	2	*215.2*	*F*	*317.5*	*F*	*2*	*111.4*	*F*	*214.9*	*F*
Northbound Through	1	*46.0*	*D*	*62.4*	*E*	*1*	*40.3*	*D*	*65.2*	*E*
Northbound Right	1	*0.5*	*A*	*0.3*	*A*	*1*	*0.5*	*A*	*0.3*	*A*
Southbound Left	1	*72.6*	*E*	*88.7*	*F*	*1*	*72.0*	*E*	*69.2*	*E*
Southbound Through	1	*59.2*	*E*	*61.1*	*E*	*1*	*59.2*	*E*	*61.1*	*E*
Southbound Right	1	*0.4*	*A*	*0.7*	*A*	*1*	*0.4*	*A*	*0.7*	*A*

Notes:

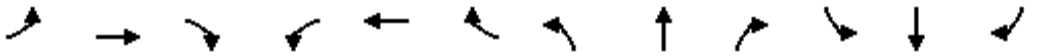
a) Delay measured as seconds per vehicle



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	480	1905	315	240	1750	140	945	70	485	110	55	385
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	5.0	4.0	4.0	5.0	5.0	4.0	5.0	4.0	4.0	5.0	4.0
Lane Util. Factor	0.97	0.95	1.00	0.97	0.95	1.00	0.97	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	3539	1583	3433	3539	1583	3433	1863	1583	1770	1863	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	3539	1583	3433	3539	1583	3433	1863	1583	1770	1863	1583
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	505	2005	332	253	1842	147	995	74	511	116	58	405
RTOR Reduction (vph)	0	0	0	0	0	62	0	0	0	0	0	0
Lane Group Flow (vph)	505	2005	332	253	1842	85	995	74	511	116	58	405
Turn Type	Prot		Free	Prot		Perm	Prot		Free	Prot		Free
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases			Free			8			Free			Free
Actuated Green, G (s)	17.0	68.5	151.0	10.0	61.5	61.5	33.0	36.5	151.0	18.0	21.5	151.0
Effective Green, g (s)	17.0	68.5	151.0	10.0	61.5	61.5	33.0	36.5	151.0	18.0	21.5	151.0
Actuated g/C Ratio	0.11	0.45	1.00	0.07	0.41	0.41	0.22	0.24	1.00	0.12	0.14	1.00
Clearance Time (s)	4.0	5.0		4.0	5.0	5.0	4.0	5.0		4.0	5.0	
Lane Grp Cap (vph)	386	1605	1583	227	1441	645	750	450	1583	211	265	1583
v/s Ratio Prot	c0.15	c0.57		0.07	0.52		c0.29	0.04		0.07	0.03	
v/s Ratio Perm			0.21			0.05			c0.32			0.26
v/c Ratio	1.31	1.25	0.21	1.11	1.28	0.13	1.33	0.16	0.32	0.55	0.22	0.26
Uniform Delay, d1	67.0	41.2	0.0	70.5	44.8	28.0	59.0	45.2	0.0	62.7	57.3	0.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	156.3	117.5	0.3	93.9	130.7	0.4	156.2	0.8	0.5	9.9	1.9	0.4
Delay (s)	223.3	158.8	0.3	164.4	175.5	28.5	215.2	46.0	0.5	72.6	59.2	0.4
Level of Service	F	F	A	F	F	C	F	D	A	E	E	A
Approach Delay (s)		151.7			164.6			137.8			20.8	
Approach LOS		F			F			F			C	

Intersection Summary			
HCM Average Control Delay	142.2	HCM Level of Service	F
HCM Volume to Capacity ratio	1.08		
Actuated Cycle Length (s)	151.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	107.4%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	480	2725	1060	240	3135	135	565	70	295	170	85	590
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	5.0	4.0	4.0	5.0	5.0	4.0	5.0	4.0	4.0	5.0	4.0
Lane Util. Factor	0.97	0.95	1.00	0.97	0.95	1.00	0.97	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	3539	1583	3433	3539	1583	3433	1863	1583	1770	1863	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	3539	1583	3433	3539	1583	3433	1863	1583	1770	1863	1583
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	505	2868	1116	253	3300	142	595	74	311	179	89	621
RTOR Reduction (vph)	0	0	0	0	0	33	0	0	0	0	0	0
Lane Group Flow (vph)	505	2868	1116	253	3300	109	595	74	311	179	89	621
Turn Type	Prot		Free	Prot		Perm	Prot		Free	Prot		Free
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases			Free			8			Free			Free
Actuated Green, G (s)	15.0	83.5	150.0	10.0	78.5	78.5	17.0	19.5	150.0	19.0	21.5	150.0
Effective Green, g (s)	15.0	83.5	150.0	10.0	78.5	78.5	17.0	19.5	150.0	19.0	21.5	150.0
Actuated g/C Ratio	0.10	0.56	1.00	0.07	0.52	0.52	0.11	0.13	1.00	0.13	0.14	1.00
Clearance Time (s)	4.0	5.0		4.0	5.0	5.0	4.0	5.0		4.0	5.0	
Lane Grp Cap (vph)	343	1970	1583	229	1852	828	389	242	1583	224	267	1583
v/s Ratio Prot	c0.15	0.81		0.07	c0.93		c0.17	0.04		0.10	0.05	
v/s Ratio Perm			c0.70			0.07			0.20			0.39
v/c Ratio	1.47	1.46	0.70	1.10	1.78	0.13	1.53	0.31	0.20	0.80	0.33	0.39
Uniform Delay, d1	67.5	33.2	0.0	70.0	35.8	18.3	66.5	59.1	0.0	63.6	57.8	0.0
Progression Factor	1.00	1.00	1.00	0.81	1.45	2.17	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	227.8	208.0	2.7	53.7	352.0	0.0	251.0	3.2	0.3	25.0	3.3	0.7
Delay (s)	295.3	241.3	2.7	110.5	403.7	39.7	317.5	62.4	0.3	88.7	61.1	0.7
Level of Service	F	F	A	F	F	D	F	E	A	F	E	A
Approach Delay (s)		188.0			369.7			197.6			24.5	
Approach LOS		F			F			F			C	

Intersection Summary					
HCM Average Control Delay	241.3	HCM Level of Service	F		
HCM Volume to Capacity ratio	1.51				
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	13.0		
Intersection Capacity Utilization	134.8%	ICU Level of Service	H		
Analysis Period (min)	15				

c Critical Lane Group