To: Clyde Shimizu and Mark Garrity

From: Chris Wellander and David Shelton

CC: Steve Hogan, Hong Li

Date: August 7, 2009

Subject: Pearl Highlands Ramp Impacts Analysis

Introduction

This memorandum summarizes the results of analysis conducted to determine potential traffic impacts of the proposed Pearl Highlands rail station on the existing H-1/H-2 interchange and nearby highways.

Impacts to SB H-2 Off-ramp

As shown in Appendix A, a new ramp is proposed to provide direct auto and bus access from southbound H-2 to the Pearl Highlands station park-and-ride and transit center. The 2030 volumes on this ramp are anticipated to be approximately 240 vehicles in the AM peak hour and 40 vehicles in the PM peak hour. The new ramp would diverge from the existing southbound off-ramp from H-2 to eastbound H-1 and Waipahu Street (the split to these two destinations occurs after the diverge of the new ramp). The existing southbound H2 to H1 ramp exits H2 as a drop lane as opposed to a diverge and has an approximate capacity of 2000 vehicles per hour according to the Highway Capacity Manual. With a 2030 no-build volume of 415 vehicles in the AM peak hour, the capacity of the off-ramp from H-2 would be sufficient to handle demand. The additional 240 vehicles accessing the new ramp would bring the total volume on the off-ramp to 655 vehicles, which should still be handled adequately. In the PM peak hour, the 2030 no-build volume of 950 vehicles would be increased to 990 with the anticipated volumes accessing the LRT station. In conclusion, no significant traffic impact to the existing off-ramp or mainline traffic is anticipated to occur with construction of the proposed direct access ramp.

Impacts to NB H-2 On-ramp from WB Kamehameha Highway

As shown in Appendix A, construction of the rail project is anticipated to result in an increase in the 2030 volume during the PM peak hour on the on-ramp from westbound Kamehameha Highway to northbound H-2. As shown in Appendix B, an analysis of this ramp merge in HCS indicated that, without construction of the rail project (no-build), ramp operations are expected to be LOS F in 2030 during the PM peak hour. This is due to a combination of high traffic volumes (3,545 vehicles on the mainline merging with 860 entering vehicles from the Kamehameha on-ramp), a relatively sharp on-ramp angle (approximately 25:1), and a relatively steep upgrade directly after the ramp merge. The rail project would result in an addition of approximately 200 vehicles to the Kamehameha on-ramp and a reduction of approximately 300 vehicles on the H-2 mainline, resulting in a net reduction of approximately 100 cars at the merge junction. With the rail project, this merge is expected

to continue to operate at LOS F. As a result of the net reduction in traffic, the impact of the project on this merge would not be significant.

Impacts to Farrington Highway Weave Section

As shown in Appendix A, construction of the light rail project is anticipated to result in a slight net increase in 2030 volumes during the PM peak hour on westbound Farrington Highway between Waiawa Drive and Kamehameha Highway. This section of Farrington Highway currently experiences periods of congestion due in large part to a weave pattern involving vehicles that exit westbound H-1 at the Waipahu off-ramp, enter westbound Farrington Highway via a left-side on-ramp, weave across two lanes of traffic, and then exit to northbound Kamehameha Highway via a right-side off-ramp. An analysis of this weave in HCS indicated that the additional volumes resulting from the project would not have a significant impact on the weave section. Assuming a worst cast scenario in which all of the volumes on the on-ramp to Kamehameha Highway weave across from the H-1 off-ramp, 2030 no build is expected to operate at LOS E (see Appendix B). With the additional vehicles exiting the LRT station and entering the traffic stream on Farrington Highway, the weave section is still expected to operate at LOS E. Additional analysis, including field work traffic surveys to determine the actual percentage of weaving vehicles, is required to better determine the expected impact to this weave. Finally, a new traffic signal proposed for the intersection of Waiawa Drive and Farrington Highway is expected to provide additional gaps and opportunities for weaving vehicles to make their maneuver.

Appendix A – Volume Diagrams

2030 AM
(xxxx) without LRT project
xxxx with LRT project
(3545)
3450
(5440)
5440
(415)
655
(365)
365
(50)
50
(1260)
1260
(5025)
4785
(515)
470
(1770)
1720
(1555)
1505
(2070)
1975
85
115
15
330
40
15
20
240
345
35
(620)
530
(1715)
1665
(55)
400
(860)
860
(7000)
6800
(420)
420
(1060)
970
Kamehameha Hwy
Farrington Hwy
Ala Ike
Cane Haul Rd
Leeward Community College

2030 PM
(xxxx) without LRT project
xxxx with LRT project
(6205)
6105
(3750)
3750
(950)
990
(515)
515
(435)
435
(1800)
1800
(2800)
2760
(860)
1060
(3545)
3245
(3125)
3550
(2265)
2490
15
55
40
15
55
290
85
95
70
240
(1400)
1420
(3450)
3150
(95)
165
(1975)
1935
(1055)
1015
(2320)
2340
(11,100)
10,100
Kamehameha Hwy
Farrington Hwy
Ala Ike
Cane Haul Rd
Leeward Community College

Appendix B – HCS Analysis Resuits

Merge Analysis: On-ramp from Kam Hwy w/ WB H1 to NB H2 – 2030 No Build PM Peak

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	Ryan Avery	Freeway/Dir of Travel	H2
Agency or Company	PB	Junction	Kamehameha Hwy
Date Performed	7/24/2009	Jurisdiction	Honolulu
Analysis Time Period	PM Peak	Analysis Year	2030

Project Description No-Build

Inputs

Upstream Adj Ramp	Terrain: Grade	Downstream Adj Ramp
☐ Yes ☐ On		☐ Yes ☐ On
☐ No ☐ Off		☐ No ☐ Off
L_{up} = ft		L_{down} = 1200 ft
V_u = veh/h	S_{FF} = 55.0 mph S_{FR} = 45.0 mph Sketch (show lanes, L_U, L_D, V_R, V_F)	V_D = 1800 veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Ru	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3545	0.95	Grade	2	0	0.980	1.00	3806
Ramp	860	0.95	Level	2	0	0.990	1.00	914
UpStream								
DownStream	1800	0.95	Grade	2	0	0.990	1.00	1914

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 (Exhibit 25-5)

V_{12} = 3806 pc/h

V_3 or V_{av34} 0 pc/h (Equation 25-4 or 25-5)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 25-8)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4720	Exhibit 25-7		Yes

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4720	Exhibit 25-7	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 = 39.9 (pc/mi/ln)

LOS = F (Exhibit 25-4)

Speed Determination

M_S = 0.730 (Exhibit 25-19)

S_R = 45.5 mph (Exhibit 25-19)

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

S = 45.5 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 (Exhibit 25-12)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 25-15 or 25-16)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 25-18)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 25-14		
$V_{FO} = V_F - V_R$		Exhibit 25-14		
V_R		Exhibit 25-3		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 25-14		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086 V_{12} - 0.0009 L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 25-4)

Speed Determination

D_s = (Exhibit 25-19)

S_R = mph (Exhibit 25-19)

S_0 = mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

Merge Analysis: On-ramp from Kam Hwy w/ WB H1 to NB H2 – 2030 Build PM Peak

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	Ryan Avery	Freeway/Dir of Travel	H2
Agency or Company	PB	Junction	Kamehameha Hwy
Date Performed	7/28/2009	Jurisdiction	Honolulu
Analysis Time Period	PM Peak	Analysis Year	2030

Project Description: Build

Inputs

Upstream Adj Ramp: ☐ Yes ☐ On ☐ No ☐ Off

L_{up} = ft

V_u = veh/h

Terrain: Grade

S_{FF} = 55.0 mph S_{FR} = 45.0 mph

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

Downstream Adj Ramp: ☐ Yes ☐ On ☐ No ☐ Off

L_{down} = 1200 ft

V_D = 1800 veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3245	0.95	Grade	2	0	0.980	1.00	3484
Ramp	1060	0.95	Level	2	0	0.990	1.00	1127
UpStream								
DownStream	1800	0.95	Grade	2	0	0.962	1.00	1971

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 (Exhibit 25-5)

V_{12} = 3484 pc/h

V_3 or V_{av34} 0 pc/h (Equation 25-4 or 25-5)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12b} = pc/h (Equation 25-8)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4611	Exhibit 25-7		Yes

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4611	Exhibit 25-7	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 = 38.9 (pc/mi/ln)

LOS = F (Exhibit 25-4)

Speed Determination

M_S = 0.684 (Exhibit 25-19)

S_R = 45.1 mph (Exhibit 25-19)

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

S = 45.1 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 (Exhibit 25-12)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 25-15 or 25-16)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12b} = pc/h (Equation 25-18)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 25-14		
$V_{FO} = V_F - V_R$		Exhibit 25-14		
V_R		Exhibit 25-3		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 25-14		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086 V_{12} - 0.0009 L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 25-4)

Speed Determination

D_s = (Exhibit 25-19)

S_R = mph (Exhibit 25-19)

S_0 = mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

Merge Analysis: On-ramp from Kam Hwy w/ WB H1 to NB H2 – 2030 Build PM Peak With Re-striped Bridge and Subsequent Merge (i.e., extended acceleration lane)

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	Ryan Avery	Freeway/Dir of Travel	H2
Agency or Company	PB	Junction	Kamehameha Hwy
Date Performed	7/28/2009	Jurisdiction	Honolulu
Analysis Time Period	PM Peak	Analysis Year	2030

Project Description: Build - Long Acceleration Lane

Inputs

Upstream Adj Ramp
☐ Yes ☐ On
☐ No ☐ Off
L_{up} = ft
V_u = veh/h

Terrain: Grade

S_{FF} = 55.0 mph S_{FR} = 45.0 mph
Sketch (show lanes, L_A, L_D, V_R, V_F)

Downstream Adj Ramp
☐ Yes ☐ On
☐ No ☐ Off
L_{down} = 1200 ft
V_D = 1800 veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Ru	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3245	0.95	Grade	2	0	0.980	1.00	3484
Ramp	1060	0.95	Level	2	0	0.990	1.00	1127
UpStream								
DownStream	1800	0.95	Grade	2	0	0.962	1.00	1971

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 (Exhibit 25-5)
V_{12} = 3484 pc/h
V_3 or V_{av34} 0 pc/h (Equation 25-4 or 25-5)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} = pc/h (Equation 25-8)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4611	Exhibit 25-7		Yes

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4611	Exhibit 25-7	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 = 34.0 (pc/mi/ln)
LOS = F (Exhibit 25-4)

Speed Determination

M_S = 0.614 (Exibit 25-19)
S_R = 47.0 mph (Exhibit 25-19)
S_0 = N/A mph (Exhibit 25-19)
S = 47.0 mph (Exhibit 25-14)

Diverge Areas

Estimation of v_{12}

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

L_{ED} = (Equation 25-8 or 25-9)
P_{FD} = using Equation (Exhibit 25-12)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 25-15 or 25-16)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} = pc/h (Equation 25-18)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 25-14		
$V_{FO} = V_F - V_R$		Exhibit 25-14		
V_R		Exhibit 25-3		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 25-14		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086 V_{12} - 0.0009 L_D$

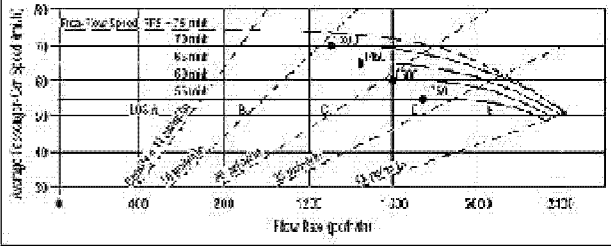
D_R = (pc/mi/ln)
LOS = (Exhibit 25-4)

Speed Determination

D_s = (Exhibit 25-19)
S_R = mph (Exhibit 25-19)
S_0 = mph (Exhibit 25-19)
S = mph (Exhibit 25-15)

Freeway Segment Analysis: On-ramp from Kam Hwy w/ WB H1 to NB H2 – 2030 Build PM Peak With Re-striped Bridge (11-ft lanes and 3-ft shoulder) and Subsequent Widened ML to Three Lanes (i.e., convert ramp to add-lane)

BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information		Site Information	
Analyst	*Ryan Avery*	Highway/Direction of Travel	*H-2*
Agency or Company	*Parsons Brinckerhoff*	From/To	*H-1 Exit to Kamehameha On-Ramp*
Date Performed	*7/28/2009*	Jurisdiction	*Honolulu*
Analysis Time Period	*PM Peak*	Analysis Year	*2030*

Project Description Re-stripe bridge

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs					
Volume, V	*4305*	veh/h	Peak-Hour Factor, PHF	*0.95*	
AADT		veh/day	% Trucks and Buses, P_T	*2*	
Peak-Hr Prop. of AADT, K			% RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Grade*	
DDHV = AADT × K × D		veh/h	Grade 4.00 % Length	*0.50 mi*	
Driver type adjustment	*1.00*		Up/Down %	*4.00*	

Calculate Flow Adjustments				
f_p	*1.00*		E_R	*2.5*
E_T	*2.0*		$f_{HV} = 1/[1+P_T(E_T-1)+P_R(E_R-1)]$	*0.980*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width	*11.0*	ft	f_{LW}	*1.9*	mi/h
Rt-Shoulder Lat. Clearance	*3.0*	ft	f_{LC}	*1.2*	mi/h
Interchange Density	*0.50*	i/mi	f_{ID}	*0.0*	mi/h
Number of Lanes, N	*3*		f_N	*3.0*	mi/h
FFS (measured)		mi/h	FFS	*55.0*	mi/h
Base free-flow Speed, BFFS	*61.1*	mi/h			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF × N × f_{HV} × f_p)	*1541*	pc/h/ln	Design LOS	
S	*55.0*	mi/h	v_p = (V or DDHV) / (PHF × N × f_{HV} × f_p)	pc/h
D = v_p / S	*28.0*	pc/mi/ln	S	mi/h
LOS	*D*		D = v_p / S	pc/mi/ln
			Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 23-8, 23-10	f_{LW} - Exhibit 23-4
V - Hourly volume	D - Density	E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 23-12	f_N - Exhibit 23-6
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7
DDHV - Directional design hour volume			

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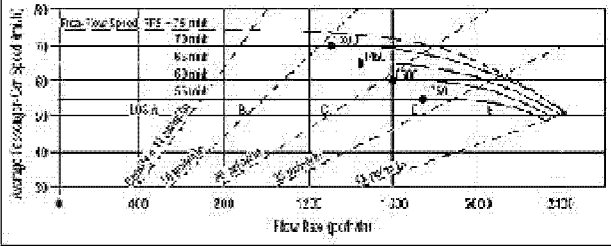
Freeway Segment Analysis: On-ramp from Kam Hwy w/ WB H1 to NB H2 – 2030 Build PM Peak With Widened Bridge (12-ft lanes and 6-ft shoulder) and Subsequent Widened ML to Three Lanes (i.e., convert ramp to add-lane)

BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information		Site Information	
Analyst	*Ryan Avery*	Highway/Direction of Travel	*H-2*
Agency or Company	*Parsons Brinckerhoff*	From/To	*H-1 Exit to Kamehameha On-Ramp*
Date Performed	*7/28/2009*	Jurisdiction	*Honolulu*
Analysis Time Period	*PM Peak*	Analysis Year	*2030*
Project Description			

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs				
Volume, V	*4305*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	% Trucks and Buses, P_T	*2*
Peak-Hr Prop. of AADT, K			% RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Grade*
DDHV = AADT × K × D		veh/h	Grade 4.00 % Length	*0.50 mi*
Driver type adjustment	*1.00*		Up/Down %	*4.00*

Calculate Flow Adjustments			
f_p	*1.00*	E_R	*2.5*
E_T	*2.0*	$f_{HV} = 1/[1+P_T(E_T-1)+P_R(E_R-1)]$	*0.980*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width	*12.0*	ft	f_{LW}	*0.0*	mi/h
Rt-Shoulder Lat. Clearance	*6.0*	ft	f_{LC}	*0.0*	mi/h
Interchange Density	*0.50*	I/mi	f_{ID}	*0.0*	mi/h
Number of Lanes, N	*3*		f_N	*3.0*	mi/h
FFS (measured)		mi/h	FFS	*57.0*	mi/h
Base free-flow Speed, BFFS	*60.0*	mi/h			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF × N × f_{HV} × f_p)	*1541*	pc/h/ln	Design LOS	
S	*57.0*	mi/h	v_p = (V or DDHV) / (PHF × N × f_{HV} × f_p)	pc/h
D = v_p / S	*27.0*	pc/mi/ln	S	mi/h
LOS	*D*		D = v_p / S	pc/mi/ln
			Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 23-8, 23-10	f_{LW} - Exhibit 23-4
V - Hourly volume	D - Density	E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 23-12	f_N - Exhibit 23-6
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7
DDHV - Directional design hour volume			

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Weave Analysis: On-ramp from WB H-1 to NB Kam Hwy Across WB Farrington Hwy – 2030 No Build PM Peak

FREEWAY WEAVING WORKSHEET

General Information

Analyst	Ryan Avery
Agency/Company	PB
Date Performed	7/24/2009
Analysis Time Period	PM

Site Information

Freeway/Dir of Travel	WB Farrington Highway
Weaving Seg Location	H1 to Kamhameha Highway
Jurisdiction	Honolulu
Analysis Year	2030

Inputs

Freeway free-flow speed, S_{FF} (mi/h)	45
Weaving number of lanes, N	3
Weaving seg length, L (ft)	1700
Terrain	Level

Weaving type	C
Volume ratio, VR	0.73
Weaving ratio, R	0.43

Conversions to pc/h Under Base Conditions

(pc/h)	V	PHF	Truck %	RV %	E_T	E_R	f_{HV}	f_p	v
V_{o1}	920	0.95	2	0	1.5	1.2	0.990	1.00	978
V_{o2}	0	0.95	2	0	1.5	1.2	0.990	1.00	0
V_{w1}	1055	0.95	2	0	1.5	1.2	0.990	1.00	1121
V_{w2}	1400	0.95	2	0	1.5	1.2	0.990	1.00	1488
V_{nw}				2609	V_{nw}				978
V									3587

Weaving and Non-Weaving Speeds

	Unconstrained		Constrained	
	Weaving (i = w)	Non-Weaving (i = nw)	Weaving (i = w)	Non-Weaving (i = nw)
a (Exhibit 24-6)	0.08	0.0020		
b (Exhibit 24-6)	2.30	6.00		
c (Exhibit 24-6)	0.80	1.10		
d (Exhibit 24-6)	0.60	0.60		
Weaving intensity factor, Ui	0.94	1.49		
Weaving and non-weaving speeds, Si (mi/h)	33.05	29.07		

Number of lanes required for unconstrained operation, Nw 1.88
Maximum number of lanes, Nw (max) 3.00

☐ If Nw < Nw(max) unconstrained operation ☐ if Nw > Nw (max) constrained operation

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment speed, S (mi/h)	31.86
Weaving segment density, D (pc/mi/ln)	37.53
Level of service, LOS	E
Capacity of base condition, c_b (pc/h)	4980
Capacity as a 15-minute flow rate, c (veh/h)	4931
Capacity as a full-hour volume, c_h (veh/h)	4684

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.

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Weave Analysis: On-ramp from WB H-1 to NB Kam Hwy Across WB Farrington Hwy – 2030 Build PM Peak

FREEWAY WEAVING WORKSHEET

General Information

Analyst	Ryan Avery
Agency/Company	PB
Date Performed	7/24/2009
Analysis Time Period	PM

Site Information

Freeway/Dir of Travel	WB Farrington Highway
Weaving Seg Location	H-1 to Kamhameha Highway
Jurisdiction	Honolulu
Analysis Year	2030

Inputs

Freeway free-flow speed, S_{ff} (mi/h)	45	Weaving type	C
Weaving number of lanes, N	3	Volume ratio, VR	0.73
Weaving seg length, L (ft)	1700	Weaving ratio, R	0.42
Terrain	Level		

Conversions to pc/h Under Base Conditions

(pc/h)	V	PHF	Truck %	RV %	E_T	E_R	f_{HV}	f_p	v
V_{o1}	920	0.95	2	0	1.5	1.2	0.990	1.00	978
V_{o2}	0	0.95	2	0	1.5	1.2	0.990	1.00	0
V_{w1}	1015	0.95	2	0	1.5	1.2	0.990	1.00	1079
V_{w2}	1420	0.95	2	0	1.5	1.2	0.990	1.00	1509
V_{nw}				2588	V_{nw}				978
V									3566

Weaving and Non-Weaving Speeds

	Unconstrained		Constrained	
	Weaving (i = w)	Non-Weaving (i = nw)	Weaving (i = w)	Non-Weaving (= nw)
a (Exhibit 24-6)	0.08	0.0020		
b (Exhibit 24-6)	2.30	6.00		
c (Exhibit 24-6)	0.80	1.10		
d (Exhibit 24-6)	0.60	0.60		
Weaving intensity factor, Ui	0.93	1.47		
Weaving and non-weaving speeds, Si (mi/h)	33.11	29.17		

Number of lanes required for unconstrained operation, Nw 1.88
Maximum number of lanes, Nw (max) 3.00

☐ If Nw < Nw(max) unconstrained operation ☐ If Nw > Nw (max) constrained operation

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment speed, S (mi/h)	31.93
Weaving segment density, D (pc/mi/n)	37.23
Level of service, LOS	E
Capacity of base condition, c_b (pc/h)	4980
Capacity as a 15-minute flow rate, c (veh/h)	4931
Capacity as a full-hour volume, c_h (veh/h)	4684

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.

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