APPENDIX D

TRAFFIC INDEX DETERMINATION

Project: Kapolei Interchange Complex Phase 3
Kapolei, Oahu, Hawaii

Street Name: State Harbor Access Road

(1) Design Period (years) — 50

(2) Current Average Daily Traffic (ADT) Per Direction — 3401

(3) Future Average Daily Traffic (ADT) Per Direction — 27244

(4) Average ADT Per Direction Over Design Period — 15322.5

(5) Design Lane Factor — 1

Number of Lanes In One Direction	Design Lane Factor
1	1
2	1
3	0.8
4	0.75

(6) 24-Hour Truck Traffic, T_{24} (%) — 17

Truck Traffic Distribution :

2-axle	=	27.30%
3-axle	=	16.70%
4-axle	=	18.30%
5-axle	=	30.60%
6-axle	=	4.30%
7-axle	=	2.80%

(7) Average Daily Truck Traffic Per Direction, ADTT — 2605

(8) Equivalent 18-kip Single Axle Loads, ESAL

2-axle : % of 2-axle trucks x No. trucks x 597	=	424537
3-axle : % of 3-axle trucks x No. trucks x 525	=	228378
4-axle : % of 4-axle trucks x No. trucks x 1162	=	553906
5-axle : % of 5-axle trucks x No. trucks x 1462	=	1165326
6-axle : % of 6-axle trucks x No. trucks x 1174	=	217123
Annual ESAL :	=	2589269
Total ESAL For Design Period	=	129463449

TRAFFIC INDEX (TI) = 9 (ESAL/1,000,000)EXP(0.119) — 16.05

SAY 16.0

Project: Kapolei Interchange Complex Phase 3
Kapolei, Oahu, Hawaii

Street: State Harbor Access Road

Design Parameters

Traffic Index	16.0
R value of ACB	90
R value of AB	80
R value of ASB	60
R value of Subgrade	4

Pavement Section using Asphalt Concrete Base and Aggregate Base

Trial Thickness of AC + ACB 15.5 Inches

(1) **Asphalt Concrete (AC)**

GE required					0.512	
GE with Tolerance =	0.512	+	0.240	=	0.752	
Gf of AC					1.906	
GE/Gf	=	4.73		SAY	5.00	Inches
				USE	4.50	Inches

(2) **Asphalt Concrete Base (ACB)**

GE required	=			1.024	
GE of AC	=			0.475	
GE required of ACB	=			0.549	
Gf of ACB				1.81	
GE/Gf	=	3.64	SAY	4.00	Inches
			USE	11.00	Inches

(3) **Calculate New Gf of AC**

Thickness of AC + Thickness of ACB				1.292	
New Gf of AC				1.906	

(4) **Aggregate Base (AB)**

GE required	=			2.048	
GE of AC	=			0.475	
GE of ACB	=			1.660	
GE required of AB	=			-0.086	
Gf of AB	=			1.100	
GE/Gf	=	-0.94	SAY	0.00	
			USE	6.00	Inches

(5) **Aggregate Subbase (ASB)**

GE required	=			4.915	
GE of AC	=			0.475	
GE of ACB	=			1.660	
GE of AB	=			0.550	
GE required of ASB	=			2.231	
GE less tolerance	=			1.991	
Gf of ASB	=			1.000	
GE/Gf	=	23.89	SAY	24.00	Inches
			USE	24.00	Inches

Design Pavement Section

4.5	**Inches**	**AC**
11.0	**Inches**	**ACB**
6.0	**Inches**	**AB**
24.0	**Inches**	**ASB**
45.5	**Inches**	**Total Thickness**

Kapolei Interchange Complex Phase 3
Kapolei, Oahu, Hawaii

Design Period = 50 years (One-Way Traffic)

	2 Axles		3 Axles		4 Axles		5 Axles		6 Axles		TOTAL	Axle/1000
Single Axle	ADTT= 711		ADTT= 435		ADTT= 477		ADTT= 797		ADTT= 185		ADTT= 2605	
Loads (kips)	Factors	Repetition	Factors	Repetition	Factors	Repetition	Factors	Repetition	Factors	Repetition	REPETITIONS	
20-22	172.5	122648	306.25	133219	1773	845721	3,788.50	3019435	3221.75	596024	4717046	99.22006
22-24	120.25	85498	44.75	19466	2232.5	1064903	1077.25	858568	5773.5	1068098	3096532	65.13359
24-26	87	61857	18.75	8156	1515.75	723013	85	67745	1085.25	200771	1061542	22.32887
26-28	16.75	11909	14	6090	575.25	274394	15	11955			304349	6.40178
28-30	16.75	11909	13.5	5873	573	273321	15	11955			303058	6.37463
30-32			12.25	5329	107	51039					56368	1.18566
32-34			12.25	5329	105	50085					55414	1.16559
34-36			12.25	5329	105	50085					55414	1.16559
Tandem Axle Loads (kips)												
30-32			1268.5	551798	1015.25	484274	454.75	362436	1085.25	200771	1599279	33.63981
32-34			926	402810	733	349641	520.25	414639			1167090	
34-36			261.5	113753	935.25	446114	332.75	265202			825069	41.90379
36-38			261.5	113753	313.5	149540	464.5	370207			633499	
38-40			167	72645	209.75	100051	188.25	150035			322731	20.11368
40-42			74	32190	139.5	66541.5	100.25	79899			178631	
42-44					139.5	66541.5	64	51008			117550	6.22996
44-46					68	32436	82.75	65952			98388	
46-48			9.5	4133			62.5	49813			53945	3.20422
48-50			9.5	4133			62.5	49813			53945	1.13470

Project: Kapolei Interchange Complex Phase 3
Engineer: G. Seki
Input Data:
Subgrade / Subbase K 150.0 PCI
Modulus of Rupture MR 650.0 PSI
Avg. Daily Truck Traffic (2 way) ADTT 5210.00
Design Life 50 years
Doweled Joints
No Concrete Shoulders
Load Safety Factor 1.3
Estimated Pavement Thickness 10.5 IN

A X L E L O A D S
Axles per 1000 Trucks

Single		Tandem	
36	1.17	48	4.34
34	1.17	44	3.20
32	1.19	40	6.23
30	6.37	36	41.90
28	6.40	32	33.64
26	22.33	28	0.00
24	65.13	24	0.00
22	99.22	20	0.00
20	0.00	16	0.00
18	0.00	12	0.00

Design Thickness = 12.0 Inches

Load Repetitions ---Fatigue Analysis----- ----Erosion Analysis---

SAL	*LSF	Axle/ 1000	Expected Reps	Stress Ratio	Allowable Reps	Fatigue Consump	Power	Allowable Reps	Erosion
36	46.8	1.17	55623.	0.544	147762.	37.64	31.835	2473087.	2.25
34	44.2	1.17	55623.	0.516	387021.	14.37	28.396	3541586.	1.57
32	41.6	1.19	56574.	0.487	1533827.	3.69	25.154	5258963.	1.08
30	39.0	6.37	302838.	0.458	17595160.	1.72	22.108	8186901.	3.70
28	36.4	6.40	304264.	0.430	**********	0.00	19.258	13596357.	2.24
26	33.8	22.33	1061596.	0.401	**********	0.00	16.606	24829495.	4.28
24	31.2	65.13	3096362.	0.372	**********	0.00	14.149	52978309.	5.84
22	28.6	99.22	4717043.	0.342	**********	0.00	11.889	154261746.	3.06
20	26.0	0.00	0.	0.313	**********	0.00	9.826	**********	0.00
18	23.4	0.00	0.	0.284	**********	0.00	7.959	**********	0.00

TAL	*LSF	Axle/ 1000	Expected Reps	Stress Ratio	Allowable Reps	Fatigue Consump	Power	Allowable Reps	Erosion
48	62.4	4.34	206329.	0.363	**********	0.00	24.506	5740022.	3.59
44	57.2	3.20	152132.	0.335	**********	0.00	20.591	10575904.	1.44
40	52.0	6.23	296182.	0.306	**********	0.00	17.018	22357090.	1.32
36	46.8	41.90	1991978.	0.277	**********	0.00	13.784	60902698.	3.27
32	41.6	33.64	1599288.	0.248	**********	0.00	10.891	324880408.	0.49
28	36.4	0.00	0.	0.219	**********	0.00	8.339	**********	0.00
24	31.2	0.00	0.	0.189	**********	0.00	6.126	**********	0.00
20	26.0	0.00	0.	0.160	**********	0.00	4.254	**********	0.00
16	20.8	0.00	0.	0.129	**********	0.00	2.723	**********	0.00
12	15.6	0.00	0.	0.099	**********	0.00	1.532	**********	0.00

Total Fatigue Used = 57.43 Erosion Damage = 34.13

11.5 Inch Thickness Inadequate, Fatigue Used= 173.04 Erosion Damage = 56.67

ECONOMIC JUSTIFICATION

PROJECT: Kapolei Interchange Complex Phase 3
Kapolei, Oahu, Hawaii

	Unit Prices:	**In-Place Costs**
1	Asphalt Concrete Pavement (AC) - per ton	$ 230.00
2	Asphalt Concrete Base (ACB) - per ton	$ 225.00
3	Asphalt Treated Permeable Base (ATPB) - per ton	$ 225.00
4	Cement Treated Permeable Base (CTPB) - per cubic yard	$ 200.00
5	Untreated Permeable Base (UTPB) - per cubic yard	$ 100.00
6	Aggregate Base (AB) - per cubic yard	$ 85.00
7	Aggregate Subbase (ASB) - per cubic yard	$ 75.00
8	Portland Cement Concrete Pavement (PCC) - per cubic yard	$ 450.00
9	Roadway Excavation - per cubic yard	$ 50.00
10	Cold Planing of Existing AC - per cubic yard	$ 72.00
11	AC Overlay - per ton	$ 230.00
12	Retexturing of Concrete Pavement - per square yard	$ 40.00

Assumptions/Limitations:

1. The new pavement sections are based on the current HDOT design guidelines

2. HDOT Conversion Factors:

Asphalt Concrete Pavement (Mix IV):	2.07 Tons/cubic yard
Asphalt Concrete Base:	2.12 Tons/cubic yard
Asphalt Treated Permeable Base:	2.19 Tons/cubic yard

3. Assume cold-plane and overlay 2.0 inches of AC every 7 to 8 years for AC pavement with untreated bases
   Assume cold-plane and overlay 2.0 inches of AC every 10 to 12 years for AC pavement with treated bases

4. Economic analysis based on excavated pavement sections.

5. Assume rate of inflation at 6 percent per year.

6. Assume rate of discount at 6 percent per year.

PAVEMENT COST COMPARISON	
OPTION	**TOTAL COST**
A	$ 454.42 per square yard
B	$ 290.00 per square yard

A. AC Pavement Section with ACB over ASB

New Pavement Section: 4.5" AC, 11" ACB, 6" AB, 24" ASB (45.5" Roadway Excavation)

Initial Cost

Items	Thickness (inches)	Quantity (cy/sy)	Unit Price	Cost Per Square Yard
AC	4.5	0.13	$ 230.00	$ 59.51
ACB	11	0.31	$ 225.00	$ 145.75
ATPB	0	0.00	$ 225.00	$ -
CTPB	0	0.00	$ 200.00	$ -
UTPB	0	0.00	$ 100.00	$ -
AB	6	0.17	$ 85.00	$ 14.17
ASB	24	0.67	$ 75.00	$ 50.00
Roadway Excavation	45.5	1.26	$ 50.00	$ 63.19
			Total Initial Cost	$ 332.62

Maintenance Cost

Year	Items	Thickness (inches)	Quantity (cy/sy)	Present Unit Price	Inflated Unit Price	Inflated Cost Per Sq. Yd.	Present Cost Per Sq. Yd.
10	Cold-Planing	2.0	0.06	$ 72.00	$ 128.94	$ 7.16	$ 4.00
	AC Overlay	2.0	0.06	$ 230.00	$ 411.89	$ 47.37	$ 26.45
20	Cold-Planing	2.0	0.06	$ 72.00	$ 230.91	$ 12.83	$ 4.00
	AC Overlay	2.0	0.06	$ 230.00	$ 737.64	$ 84.83	$ 26.45
30	Cold-Planing	2.0	0.06	$ 72.00	$ 413.53	$ 22.97	$ 4.00
	AC Overlay	2.0	0.06	$ 230.00	$ 1,321.00	$ 151.92	$ 26.45
40	Cold-Planing	2.0	0.06	$ 72.00	$ 740.57	$ 41.14	$ 4.00
	AC Overlay	2.0	0.06	$ 230.00	$ 2,365.72	$ 272.06	$ 26.45
Number of Overlay =	4		**Total Maint. Cost**				$ 121.80
OPTION A:			**TOTAL COST**				**$ 454.42**

B. PCC Pavement with ASB

New Pavement Section: 12.0" PCC, 24.0" ASB (36.0" Roadway Excavation)

Initial Cost

Items	Thickness (inches)	Quantity (cy/sy)	Unit Price	Cost Per Square Yard
PCC	12	0.33	$ 450.00	$ 150.00
ACB	0	0.00	$ 225.00	$ -
ATPB	0	0.00	$ 225.00	$ -
CTPB	0	0.00	$ 200.00	$ -
UTPB	0	0.00	$ 100.00	$ -
AB	0	0.00	$ 85.00	$ -
ASB	24	0.67	$ 75.00	$ 50.00
Roadway Excavation	36	1.00	$ 50.00	$ 50.00

Maintenance Cost $ 40.00

OPTION B : **Total Cost** $ 290.00