Miki Basin Industrial Park
Environmental Assessment

Exhibit G

Traffic Impact Analysis Report

TRAFFIC IMPACT ANALYSIS REPORT
MIKI BASIN 200-ACRE INDUSTRIAL SUBDIVISION
LANAI CITY, LANAI, HAWAII

DRAFT FINAL

February 4, 2019

Prepared for:
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CONTINUING THE ENGINEERING PRACTICE FOUNDED BY H. A. R. AUSTIN IN 1934

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TRAFFIC IMPACT ANALYSIS REPORT

Miki Basin 200-Acre Industrial Subdivision

Lanai City, Lanai, Hawaii

1. INTRODUCTION

This report documents the findings of a traffic study conducted by Austin, Tsutsumi, and Associates, Inc. (ATA) to evaluate the traffic impacts resulting from the proposed Miki Basin 200-acre industrial subdivision (hereinafter referred to as the "Project") located in Lanai, Hawaii.

1.1 Project Description

The Project proposes to construct a 200-acre industrial subdivision on three (3) currently vacant parcels located south of Lanai Airport. The current site plan includes 100 acres of light industrial and 100 acres of heavy industrial land uses. Access to the Project will be provided via Miki Road. It is our understanding that if approved, the 200-acre industrial subdivision will develop gradually over a 30-year period. Thus, full build-out of the Project is anticipated by year 2050.

See Figure 1.1 for Project Location. See Figure 1.2 for the Project site plan.

1.2 Study Methodology

This study will address the following:

- Assess existing traffic operating conditions during the weekday AM and PM peak hours of traffic within the study area.
- Traffic Projections for Base Year 2050 (without the Project).
- Estimate the vehicular trips that will be generated by the Project.
- Traffic projections for the Project for Future Year 2050 (with Project).
- Recommendations for roadway improvements or other mitigative measures, as appropriate, to reduce or eliminate the adverse impacts resulting from traffic generated by the Project.

1.3 Analysis Methodology

Level of Service (LOS) is a qualitative measure used to describe the conditions of traffic flow at intersections, with values ranging from free-flow conditions at LOS A to congested conditions at LOS F. The Highway Capacity Manual (HCM), 6th Edition, includes methods for calculating volume to capacity ratios, delays, and corresponding LOS that were used in this study. See Appendix A for LOS Criteria.

Analyses for the study intersections were performed using the traffic analysis software Synchro, which is able to prepare reports based on the methodologies described in the HCM. These reports contain control delay results as based on intersection lane geometry, signal timing, and hourly traffic volumes. Based on the vehicular delay at each intersection, a LOS is assigned to each approach and intersection movement as a qualitative measure of performance. These results, as confirmed or refined by field observations, constitute the technical analysis that will form the basis of the recommendations outlined in this report.

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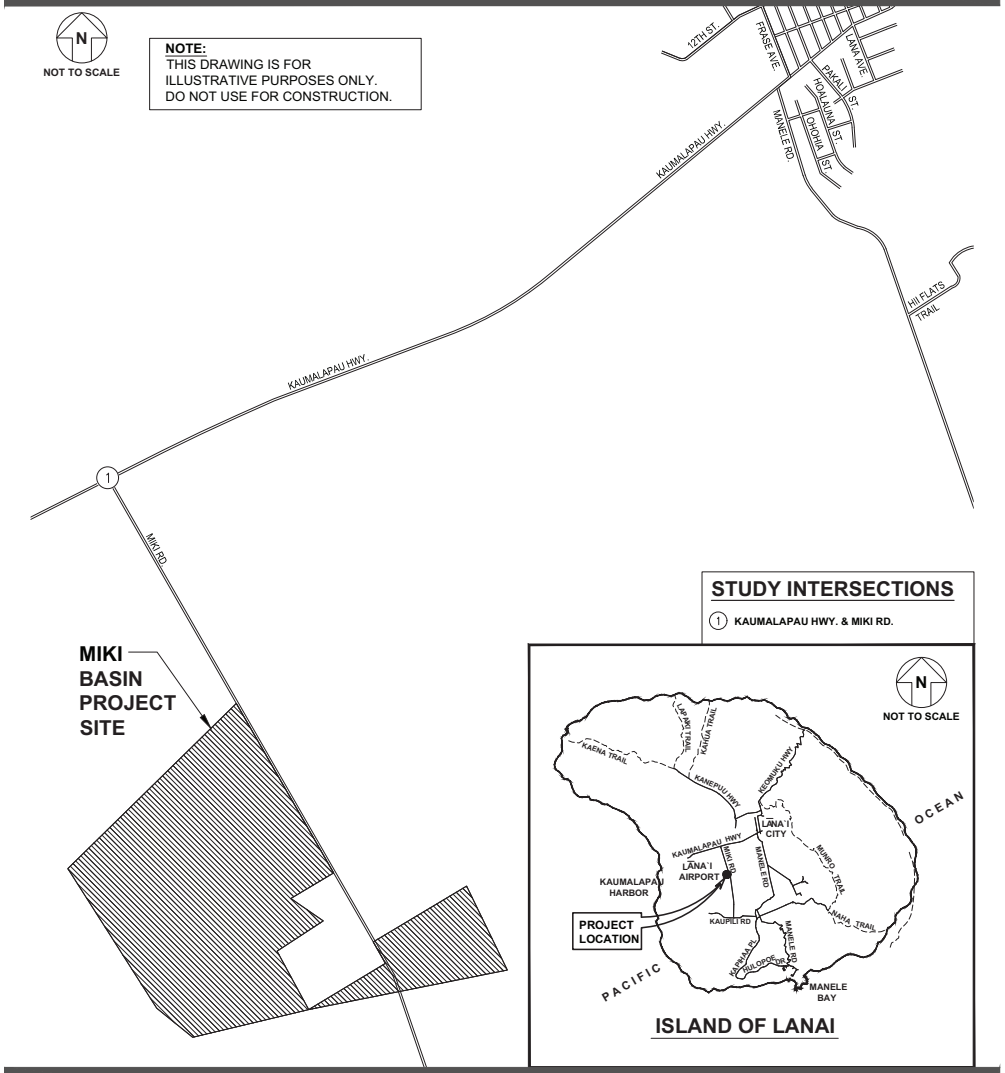

FIGURE 1.1 LOCATION MAP

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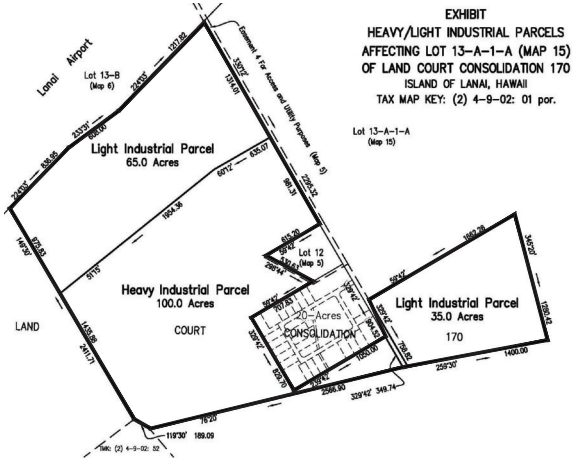

FIGURE 1.2 SITE PLAN

2. EXISTING CONDITIONS

2.1 Roadway System

The following are brief descriptions of the existing roadways studied within the vicinity of the Project:

Kaumalapau Highway is generally an east-west, two-way, two-lane state-owned roadway that runs perpendicular to Miki Road. This roadway begins to the west at the Fuel Depot and terminates to the east at its intersection with Lanai Avenue/Queens Street. The speed limit along Kaumalapau Highway is 45 miles per hour (mph) near Miki Road.

Miki Road is generally a north-south, two-way privately owned roadway that begins to the north at its intersection with Kaumalapau Highway and extends approximately 2.95 miles to the south – primarily through undeveloped land. The roadway is only approximately 13-15 feet wide, and therefore requires vehicles to pull off to the unpaved shoulder when encountering approaching vehicles traveling in the opposite direction.

2.2 Existing Traffic Volumes

12-hour traffic count data was taken between 6:00 AM and 6:00 PM at the Kaumalapau Highway/Miki Road intersection between Wednesday, October 24, 2018 and Friday, October 26, 2018. The Wednesday AM and PM peak hours were the heaviest days in terms of traffic generation, and were therefore used as the basis for the intersection analyses contained within this report. The AM and PM hours of traffic were determined to be 6:30-7:30 AM and 1:00-2:00 PM, respectively. Traffic count data is provided in Appendix B.

2.3 Existing Observations and Analysis

2.3.1 Intersection Analysis

The study intersection currently operates at LOS B or better during the AM and PM Peak hours of traffic. No significant delays or queuing were observed at any of the intersections during the peak hours of traffic. See Figure 2.1 and Table 4.2 for traffic volumes and LOS. LOS worksheets are provided in Appendix C.

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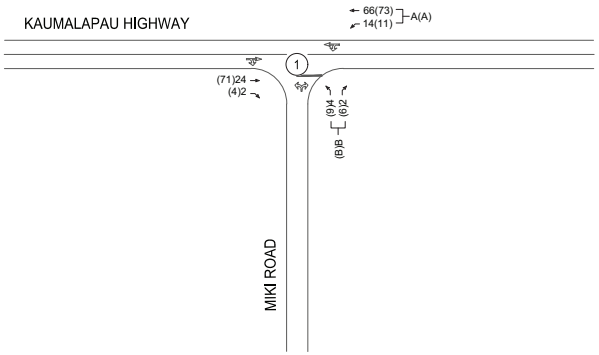
DATE OF COUNTS:
OCTOBER 24, 2018 TO
OCTOBER 26, 2018

AM PEAK HOUR:
6:30 AM - 7:30 AM

PM PEAK HOUR:
1:00 PM - 2:00 PM



LEGEND

##(##) - AM(PM) VEHICLE VOLUMES

X(X) - AM(PM) LOS

(X) - UNSIGNALIZED INTERSECTION X

FIGURE 2.1 EXISTING LANE CONFIGURATION, VOLUMES AND LOS

3. BASE YEAR 2050 TRAFFIC CONDITIONS

The Year 2050 was selected to reflect the Project completion year. The Base Year 2050 scenario represents the traffic conditions within the study area without the Project. Traffic projections were formulated by applying a defacto growth rate to the existing 2018 traffic count volumes as well as trips generated by known future developments in the vicinity of the Project.

3.1 Growth Rate

As of 2010, the population on the island of Lanai was about 3,100 residents. According to the Lanai Community Plan Update published by the County of Maui Planning Department in December 2013, the anticipated growth of Lanai's economy may require its population to nearly double in size to about 6,000 residents. This planning document was published as a guide for decision making and implementation through 2030. In order for Lanai's population to reach 6,000 by year 2030, the island would experience an average growth rate of approximately 4.7 percent per year. Therefore, this growth rate was applied along Kaumalapau Highway to represent the anticipated growth by year 2030.

The Population and Economic Projections for the State of Hawaii to 2045, published by the Hawaii Department of Business, Economic Development, and Tourism (DBEDT) in June 2018, was used to estimate the anticipated growth of Lanai's population between year 2030 and year 2050. According to DBEDT population forecasts, the population growth rate will decrease to less than 1.0 percent per year between 2025 and 2045. To be conservative, an average growth rate of 1.0 percent per year was applied along Kaumalapau Highway to represent the anticipated growth between year 2030 and year 2050.

3.2 Background Projects

The following background project was added to Base Year 2050 projections.

1. Miki Basin Heavy Industrial Area – 14-acre expansion to the existing 6 acres of the Miki Industrial Complex.

This project is anticipated to generate 43(43) trips per hour during the AM and PM peak hours of traffic, respectively.

3.3 Planned Roadway Projects

The Lanai Community Plan Update identified two proposed private roadway connections near the Project site. One roadway will travel parallel to Miki Road, east of the Project site connecting Kaumalapau Highway and Manele Road. The other roadway will travel between Miki Road and the proposed road, described in the previous sentence. To be conservative, it is assumed that these proposed private roadways will not provide access to the Project site, which would require all Project traffic to travel along Miki Road.

3.4 Base Year 2050 Analysis

Under Base Year 2050 conditions, the study intersection is forecast to operate similarly to existing conditions with all intersection movements expected to operate at LOS B or better during the AM and PM peak hours of traffic. See Figure 3.1 and Table 4.2 for traffic volumes and LOS. LOS worksheets are provided in Appendix C.

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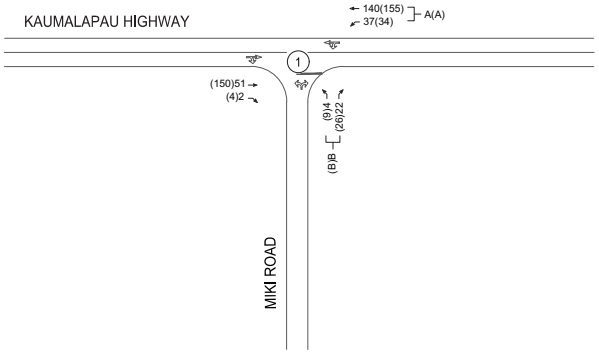

LEGEND

##(##) - AM(PM) VEHICLE VOLUMES

X(X) - AM(PM) LOS

(X) - UNSIGNALIZED INTERSECTION X

FIGURE 3.1

BASE YEAR LANE CONFIGURATION, VOLUMES AND LOS

4. FUTURE YEAR 2050 TRAFFIC CONDITIONS

The Future Year 2050 scenario represents the traffic conditions within the Project study area with the full build-out of the Project.

4.1 Project Description

The Project proposes to construct a 200-acre industrial subdivision on three (3) currently vacant parcels located south of Lanai Airport. The current site plan includes 100 acres of light industrial and 100 acres of heavy industrial zoning. Access to the project will be provided by Miki Road.

It is assumed that at least two driveway access points to the Project site will be provided along Miki Road. As shown in Figure 4.1, Project Driveway 1 provides access to the light and heavy industrial areas west of Miki Road and Project Driveway 2 provides access to the light industrial area east of Miki Road. For the purposes of this analysis Project Driveway 2 was assumed to align with the existing driveway west of Miki Road. However, it is important to note that a final decision on the location or number of Project driveways has not been made.

4.2 Travel Demand Estimations

4.2.1 Trip Generation

Assuming a floor-to-area ratio (FAR) of 0.3, which is consistent with other industrial developments within the Maui County, the proposed rezone would yield about 60 acres of industrial land use (30 acres of light industrial and 30 acres of heavy industrial). The Institute of Transportation Engineers (ITE) publishes trip rates, Trip Generation Manual, 10th Edition, based upon historical data from similar land uses. These trip rates/formulae and their associated directional distributions were used to estimate the increase in the number of vehicular trips generated by the proposed Project. The rates selected were based on the land use description. Table 4.1 shows the projected traffic generated by the Project during the AM and PM peak hours.

Table 4.1: Project Trip Generation

Land Use	Independent Variable	Weekday AM Peak Hour			Weekday PM Peak Hour		
		Enter (vph)	Exit (vph)	Total (vph)	Enter (vph)	Exit (vph)	Total (vph)
General Light Industrial (ITE Code 110)	1,306,800 SF GFA	263	36	299	28	190	218
Manufacturing (ITE Code 140)	100 Acres	119	13	132	58	78	136
Total		**382**	**49**	**431**	**86**	**268**	**354**

The Project is anticipated to generate 431 trips during the AM peak hour of traffic and 354 trips during the PM peak hour of traffic.

4.2.2 Trip Distribution & Assignment

Approximately 75 percent of the trips were assumed to originate from and be destined towards the east and the remaining 25 percent of the trips were assumed to originate from and be destined towards the west. Figure 4.1 illustrates the Project-generated trip distribution.

As mentioned above, it was assumed that two driveways to the Project site would be provided – one east and one west of Miki Road. The trips were distributed between the two driveways based on the proportion of Project area located on each side of Miki Road.

4.3 Future Year 2050 Analysis

Upon completion of the Project, all intersection movements are forecast to operate at LOS C or better during the AM and PM peak hours of traffic, with the exception of the northbound left-turn lane which is anticipated to operate at LOS D off Miki Road. Miki Road is privately-owned; the levels of service for the proposed uses on such are acceptable and not significant. An exclusive northbound left-turn lane is recommended to reduce the northbound right-turn vehicle delay. A westbound left-turn deceleration lane is recommended based upon the left-turn lane Warrant as discussed in section 4.3.2.

See Figure 4.2 and Table 4.2 for traffic volumes and LOS. LOS worksheets are provided in Appendix C.

Table 4.2: Existing, Base Year 2050, and Future Year 2050 LOS

Intersection	Existing Conditions						Base Year 2050						Future Year 2050					
	AM			PM			AM			PM			AM			PM		
	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS
Kaumalapau Highway/Miki Road																		
NB LT/RT	10.1	0.01	B	10.1	0.01	B	11.2	0.01	B	12.2	0.02	B	28.4	0.10	D	22.3	0.33	C
NB RT	n/a						n/a						9.3	0.07	A	12.4	0.39	B
WB LT	7.3	0.01	A	7.4	0.01	A	7.4	0.03	A	7.7	0.03	A	8.4	0.25	A	8.0	0.10	A
Miki Road/Project Driveway 1																		
NB LT/TH	n/a						n/a						0.0	0.00	A	0.0	0.00	A
EB LT													11.7	0.08	B	12.7	0.34	B
Miki Road/Project Driveway 2																		
EB LT/TH/RT	n/a						n/a						0.0	0.00	A	0.0	0.00	A
WB LT/TH/RT													0.0	0.00	A	0.0	0.00	A

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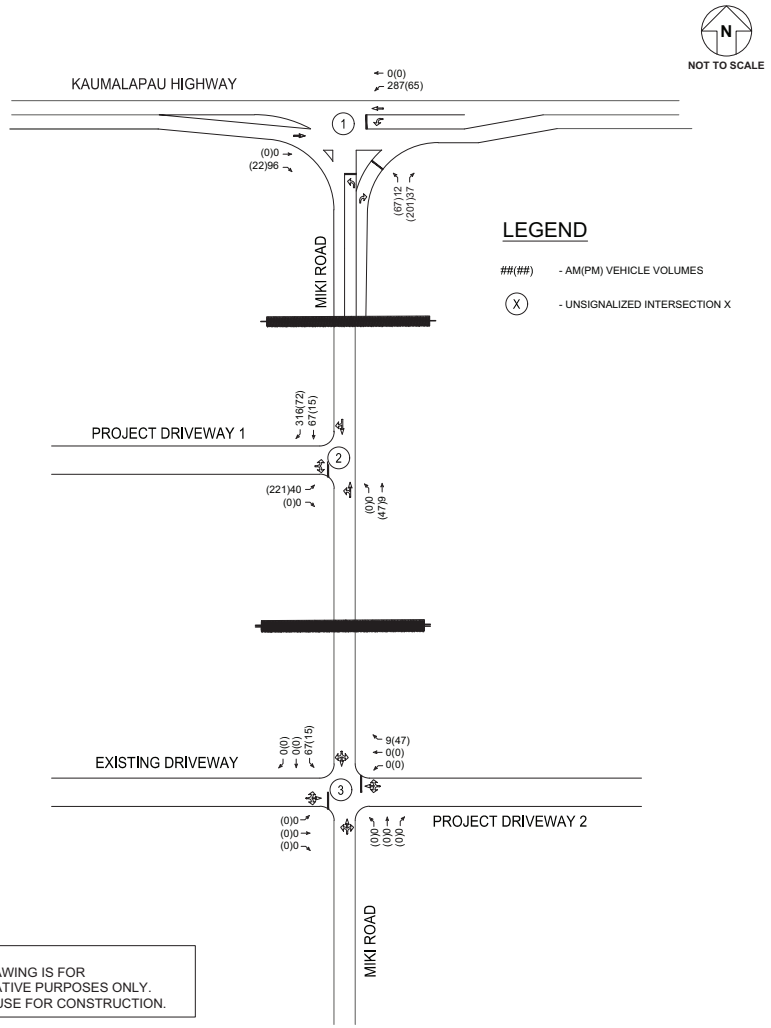

FIGURE 4.1 PROJECT-GENERATED TRIPS

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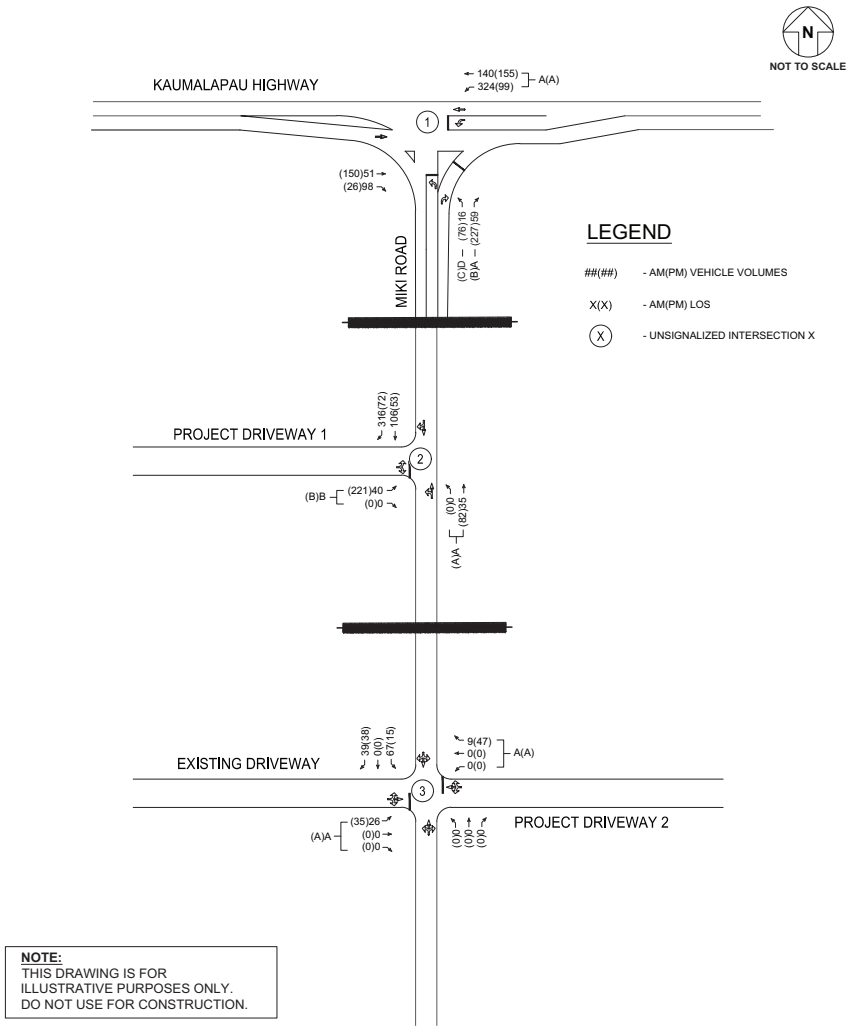

FIGURE 4.2

FUTURE YEAR LANE CONFIGURATION, VOLUMES AND LOS

4.3.1 Signal Warrant Analysis

Although a full traffic signal warrant analysis was not performed as part of this report, the Kaumalapau Highway/Miki Road intersection is not anticipated to warrant a traffic signal by Year 2050 with the Project. Refer to Appendix D for signal warrant analysis.

4.3.2 Left-turn Lane Warrant

Westbound Left-Turn Lane

At the time of this writing, the A Policy on Geometric Design of Highways and Streets ("Green Book", 2011) was the most recent version adopted by the Hawaii Department of Transportation. Based upon the following chart from NCHRP Report 279, which is referenced by the Green Book, a westbound left-turn lane is warranted at this intersection for Future Year 2050 with the Project. The westbound left-turn percentages are roughly 70 and 40 percent, respectively for the AM and PM peak hours of traffic as plotted below in Figure 4.3.

4.3.3 Intersection Geometry

The current intersection geometry provides a single, approximately 13-foot wide bi-directional lane at its southern Miki Road approach, which is inadequate to accommodate vehicles traveling side-by-side. As a result of the significant anticipated increase in travel demand, large design vehicle (lowboy with crane), and the 45 mph posted speed along Kaumalapau Highway in the vicinity of Miki Road, widening to two lanes is recommended between the Project site and Kaumalapau Highway with intersection geometries capable of accommodating turning movements by the design vehicle.

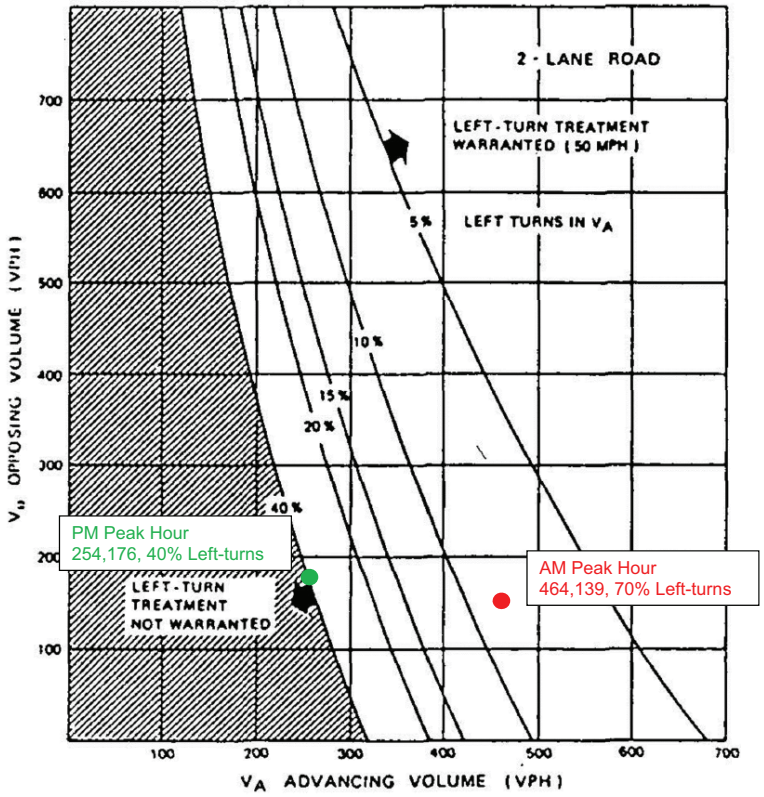

Figure 4.3: Left-Turn Warrant (NCHRP 279)

5. CONCLUSIONS AND RECOMMENDATIONS

The Project proposes to construct a 200-acre industrial subdivision along Miki Road, south of Lanai Airport. The Project is anticipated to generate approximately 431(354) trips during the AM(PM) peak hours of traffic by its 2050 estimated completion.

Upon completion of the Project, all intersection movements are forecast to operate at LOS D or better during the AM and PM peak hours of traffic.

The following geometric modifications are recommended:

- Widen Miki Road between its intersection with Kaumalapau Highway to the Project Driveway(s). Miki Street is currently estimated to be 13 feet wide, and should be widened to accommodate the design vehicle (lowboy with crane) and full side-by-side bidirectional travel with intersection geometries capable of accommodating turning movements.
- Provide an exclusive northbound left-turn lane.
- Provide an exclusive westbound left-turn deceleration lane.

6. REFERENCES

1. Transportation Research Board, Highway Capacity Manual, 6th Edition.
2. County of Maui Planning Department, Lanai Community Plan Update, 2013.
3. State of Hawaii Department of Business, Economic Development and Tourism, Population and Economic Projections for the State of Hawaii to 2045, 2018.
4. Austin, Tsutsumi, and Associates, Inc., Traffic Assessment for Miki Basin Heavy Industrial Area, 2013.I
5. Institute of Transportation Engineers, Trip Generation, 10th Edition, 2017.
6. A Policy on Geometric Design of Highways and Streets, AASHTO, 2011.
7. Neuman, Timothy R., NCHRP 279 – Intersection Channelization Design Guide, 1985.

APPENDICES

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APPENDIX A

LEVEL OF SERVICE CRITERIA

ENCLOSURE B – LEVEL OF SERVICE (LOS) CRITERIA

VEHICULAR LEVEL OF SERVICE FOR SIGNALIZED INTERSECTIONS (HCM 6th Edition)

Level of service for vehicles at signalized intersections is directly related to delay values and is assigned on that basis. Level of Service is a measure of the acceptability of delay values to motorists at a given intersection. The criteria are given in the table below.

Level-of Service Criteria for Signalized Intersections

Level of Service	Control Delay per Vehicle (sec./veh.)
A	< 10.0
B	>10.0 and ≤ 20.0
C	>20.0 and ≤ 35.0
D	>35.0 and ≤ 55.0
E	>55.0 and ≤ 80.0
F	> 80.0

Delay is a complex measure, and is dependent on a number of variables, including the quality of progression, the cycle length, the green ratio, and the v/c ratio for the lane group or approach in question.

VEHICULAR LEVEL OF SERVICE CRITERIA FOR UNSIGNALIZED INTERSECTIONS (HCM 6th Edition)

The level of service criteria for vehicles at unsignalized intersections is defined as the average control delay, in seconds per vehicle.

LOS delay threshold values are lower for two-way stop-controlled (TWSC) and all-way stop-controlled (AWSC) intersections than those of signalized intersections. This is because more vehicles pass through signalized intersections, and therefore, drivers expect and tolerate greater delays. While the criteria for level of service for TWSC and AWSC intersections are the same, procedures to calculate the average total delay may differ.

Level of Service Criteria for Two-Way Stop-Controlled Intersections

Level of Service	Average Control Delay (sec/veh)
A	≤ 10
B	>10 and ≤15
C	>15 and ≤25
D	>25 and ≤35
E	>35 and ≤50
F	> 50

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APPENDIX B

TRAFFIC COUNT DATA

Miki Road_Kaumalapau Highway

	KAUMALAPAU HWY EASTBOUND		KAUMALAPAU HWY WESTBOUND		MIKI RD NORTHBOUND			
Start Time	Thru	Right	Left	Thru	Left	Right	Int. Total	
6:00	1	0	3	15	0	0	19	100
6:15	3	2	3	12	0	0	20	104
6:30	1	0	5	18	0	0	24	112
6:45	11	1	3	22	0	0	37	108
7:00	8	1	3	9	2	0	23	93
7:15	4	0	3	17	2	2	28	93
7:30	4	1	1	13	0	1	20	89
7:45	6	2	1	9	1	3	22	98
8:00	3	0	3	15	2	0	23	100
8:15	9	0	1	10	2	2	24	107
8:30	11	2	1	13	0	2	29	105
8:45	5	2	3	12	2	0	24	103
9:00	18	2	2	6	2	0	30	103
9:15	9	1	0	9	1	2	22	110
9:30	10	0	2	9	1	5	27	127
9:45	13	0	0	11	0	0	24	135
10:00	13	0	4	18	1	1	37	154
10:15	16	0	0	19	0	4	39	161
10:30	7	2	3	22	0	1	35	156
10:45	20	1	2	14	1	5	43	158
11:00	25	1	2	14	2	0	44	154
11:15	17	1	1	9	1	5	34	149
11:30	29	1	0	5	0	2	37	146
11:45	14	2	2	18	1	2	39	138
12:00	12	1	4	17	1	4	39	138
12:15	11	0	4	14	1	1	31	146
12:30	9	1	2	10	3	4	29	160
12:45	11	3	2	20	0	3	39	169
13:00	17	0	4	22	1	3	47	174
13:15	21	0	4	17	2	1	45	174
13:30	14	1	0	18	4	1	38	168
13:45	19	3	3	16	2	1	44	168
14:00	20	2	3	19	1	2	47	161
14:15	16	2	3	14	1	3	39	158
14:30	17	2	3	12	2	2	38	138
14:45	21	2	2	9	2	1	37	134
15:00	25	2	1	11	3	2	44	119
15:15	7	3	0	4	1	4	19	102
15:30	24	1	2	3	0	4	34	110
15:45	8	0	2	8	1	3	22	91
16:00	14	1	1	9	0	2	27	84
16:15	10	1	6	5	1	4	27	73
16:30	7	0	0	5	0	3	15	56
16:45	9	0	0	2	1	3	15	53
17:00	7	0	0	5	3	1	16	49
17:15	6	0	0	3	0	1	10	
17:30	3	0	0	8	0	1	12	
17:45	2	1	0	8	0	0	11	
24-Oct	**567**	**48**	**94**	**578**	**51**	**91**	**1429**	

AM Peak Hour

PM Peak Hour

Miki Road_Kaumalapau Highway								
	KAUMALAPAU HWY EASTBOUND		KAUMALAPAU HWY WESTBOUND		MIKI RD NORTHBOUND			
Start Time	Thru	Right	Left	Thru	Left	Right	Int. Total	
6:00	0	0	2	6	0	0	8	80
6:15	5	0	2	10	0	0	17	85
6:30	2	0	5	23	0	0	30	91
6:45	4	0	6	15	0	0	25	85
7:00	2	0	3	3	1	4	13	90
7:15	5	0	2	14	1	1	23	103
7:30	3	1	4	15	0	1	24	108
7:45	5	0	5	15	1	4	30	126
8:00	10	0	2	10	1	3	26	125
8:15	6	1	2	13	2	4	28	134
8:30	15	1	2	21	0	3	42	143
8:45	8	2	2	14	0	3	29	143
9:00	15	1	0	17	1	1	35	144
9:15	8	1	5	21	0	2	37	145
9:30	22	1	1	15	0	3	42	135
9:45	10	2	4	11	0	3	30	126
10:00	15	0	2	12	2	5	36	120
10:15	12	1	2	9	1	2	27	107
10:30	12	1	2	13	0	5	33	119
10:45	7	2	1	11	1	2	24	125
11:00	8	1	2	10	0	2	23	132
11:15	20	1	4	11	2	1	39	141
11:30	19	0	2	14	0	4	39	130
11:45	17	0	1	10	0	3	31	123
12:00	12	0	6	11	0	3	32	124
12:15	12	0	3	9	0	4	28	117
12:30	10	0	3	15	1	3	32	124
12:45	8	0	2	17	0	5	32	123
13:00	8	0	3	12	0	2	25	117
13:15	14	1	1	19	0	0	35	137
13:30	11	1	3	11	2	3	31	138
13:45	7	1	3	11	0	4	26	132
14:00	19	1	3	18	0	4	45	151
14:15	17	0	5	9	1	4	36	144
14:30	8	0	0	14	0	3	25	139
14:45	22	1	5	15	2	0	45	155
15:00	22	2	1	9	0	4	38	143
15:15	13	1	2	14	0	1	31	127
15:30	20	2	1	9	1	8	41	111
15:45	20	0	1	11	0	1	33	90
16:00	9	0	2	5	1	5	22	77
16:15	10	0	1	3	0	1	15	70
16:30	6	1	2	10	0	1	20	64
16:45	11	0	0	4	0	5	20	54
17:00	7	0	0	5	1	2	15	44
17:15	3	0	0	5	1	0	9	
17:30	4	1	0	5	0	0	10	
17:45	4	0	2	4	0	0	10	
25-Oct	**507**	**28**	**112**	**558**	**23**	**119**	**1347**	

Miki Road_Kaumalapau Highway								
	KAUMALAPAU HWY EASTBOUND		KAUMALAPAU HWY WESTBOUND		MIKI RD NORTHBOUND			
Start Time	Thru	Right	Left	Thru	Left	Right	Int. Total	
6:00	1	0	0	3	0	0	4	63
6:15	0	0	0	15	0	0	15	76
6:30	1	0	3	20	0	0	24	79
6:45	2	0	5	10	0	3	20	84
7:00	6	0	2	9	0	0	17	87
7:15	2	1	3	11	1	0	18	97
7:30	9	3	1	11	4	1	29	106
7:45	4	0	4	12	0	3	23	105
8:00	10	1	1	9	0	6	27	125
8:15	9	1	2	10	3	2	27	132
8:30	5	1	2	20	0	0	28	141
8:45	11	2	3	21	2	4	43	146
9:00	8	0	2	20	1	3	34	145
9:15	13	0	4	17	0	2	36	148
9:30	14	1	4	12	0	2	33	139
9:45	27	2	2	7	1	3	42	141
10:00	17	1	1	13	2	3	37	136
10:15	10	0	2	12	1	2	27	130
10:30	13	0	0	15	0	7	35	141
10:45	15	1	4	16	0	1	37	134
11:00	12	3	1	13	0	2	31	125
11:15	22	0	2	9	1	4	38	122
11:30	16	0	0	7	0	5	28	111
11:45	10	0	2	12	1	3	28	113
12:00	9	0	2	15	0	2	28	114
12:15	16	0	2	7	0	2	27	127
12:30	10	0	4	15	0	1	30	123
12:45	8	0	3	12	5	1	29	113
13:00	13	3	3	20	0	2	41	113
13:15	10	1	2	9	0	1	23	107
13:30	5	0	2	12	0	1	20	106
13:45	14	0	1	10	2	2	29	115
14:00	13	2	5	13	0	2	35	114
14:15	10	1	0	7	0	4	22	108
14:30	16	0	3	7	1	2	29	123
14:45	8	0	11	8	0	1	28	154
15:00	14	0	4	8	0	3	29	147
15:15	14	0	1	18	0	4	37	136
15:30	30	0	1	20	0	9	60	118
15:45	7	1	1	9	0	3	21	68
16:00	10	0	0	5	1	2	18	56
16:15	8	0	0	10	1	0	19	44
16:30	5	1	1	3	0	0	10	39
16:45	3	0	3	3	0	0	9	43
17:00	1	1	0	2	0	2	6	44
17:15	4	0	0	4	0	6	14	
17:30	7	0	0	5	1	1	14	
17:45	7	0	0	3	0	0	10	
26-Oct	**479**	**27**	**99**	**529**	**28**	**107**	**1269**	

APPENDIX C

LEVEL OF SERVICE CALCULATIONS

AUSTIN, TSUTSUMI & ASSOCIATES, INC.
CIVIL ENGINEERS • SURVEYORS

APPENDIX C

LEVEL OF SERVICE CALCULATIONS

- Existing Conditions

Intersection	
Int Delay, s/veh	1.3

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	24	2	14	66	4	2
Future Vol, veh/h	24	2	14	66	4	2
Conflicting Peds, #/hr	0	1	1	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	Free
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	74	74	74	74	74	74
Heavy Vehicles, %	10	55	4	8	55	20
Mvmt Flow	32	3	19	89	5	3

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	36	0	162	-
Stage 1	-	-	-	-	35	-
Stage 2	-	-	-	-	127	-
Critical Hdwy	-	-	4.14	-	6.95	-
Critical Hdwy Stg 1	-	-	-	-	5.95	-
Critical Hdwy Stg 2	-	-	-	-	5.95	-
Follow-up Hdwy	-	-	2.236	-	3.995	-
Pot Cap-1 Maneuver	-	-	1562	-	720	0
Stage 1	-	-	-	-	867	0
Stage 2	-	-	-	-	783	0
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1561	-	710	-
Mov Cap-2 Maneuver	-	-	-	-	710	-
Stage 1	-	-	-	-	855	-
Stage 2	-	-	-	-	783	-

Approach	EB	WB	NB
HCM Control Delay, s	0	1.3	10.1
HCM LOS			B

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	710	-	-	1561	-
HCM Lane V/C Ratio	0.008	-	-	0.012	-
HCM Control Delay (s)	10.1	-	-	7.3	0
HCM Lane LOS	B	-	-	A	A
HCM 95th %tile Q(veh)	0	-	-	0	-

Intersection	
Int Delay, s/veh	1

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	71	4	11	73	9	6
Future Vol, veh/h	71	4	11	73	9	6
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	Free
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	93	93	93	93	93	93
Heavy Vehicles, %	11	56	7	10	46	11
Mvmt Flow	76	4	12	78	10	6

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	80	0	180	-
Stage 1	-	-	-	-	78	-
Stage 2	-	-	-	-	102	-
Critical Hdwy	-	-	4.17	-	6.86	-
Critical Hdwy Stg 1	-	-	-	-	5.86	-
Critical Hdwy Stg 2	-	-	-	-	5.86	-
Follow-up Hdwy	-	-	2.263	-	3.914	-
Pot Cap-1 Maneuver	-	-	1487	-	719	0
Stage 1	-	-	-	-	845	0
Stage 2	-	-	-	-	823	0
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1487	-	713	-
Mov Cap-2 Maneuver	-	-	-	-	713	-
Stage 1	-	-	-	-	838	-
Stage 2	-	-	-	-	823	-

Approach	EB	WB	NB
HCM Control Delay, s	0	1	10.1
HCM LOS			B

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	713	-	-	1487	-
HCM Lane V/C Ratio	0.014	-	-	0.008	-
HCM Control Delay (s)	10.1	-	-	7.4	0
HCM Lane LOS	B	-	-	A	A
HCM 95th %tile Q(veh)	0	-	-	0	-

APPENDIX C

LEVEL OF SERVICE CALCULATIONS

- Base Year 2050 without Project Conditions

Intersection	
Int Delay, s/veh	1.3

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	51	2	37	140	4	22
Future Vol, veh/h	51	2	37	140	4	22
Conflicting Peds, #/hr	0	1	1	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	Free
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	10	55	4	8	55	20
Mvmt Flow	55	2	40	152	4	24

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	58	0	289	-
Stage 1	-	-	-	-	57	-
Stage 2	-	-	-	-	232	-
Critical Hdwy	-	-	4.14	-	6.95	-
Critical Hdwy Stg 1	-	-	-	-	5.95	-
Critical Hdwy Stg 2	-	-	-	-	5.95	-
Follow-up Hdwy	-	-	2.236	-	3.995	-
Pot Cap-1 Maneuver	-	-	1533	-	603	0
Stage 1	-	-	-	-	846	0
Stage 2	-	-	-	-	697	0
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1532	-	585	-
Mov Cap-2 Maneuver	-	-	-	-	585	-
Stage 1	-	-	-	-	821	-
Stage 2	-	-	-	-	697	-

Approach	EB	WB	NB
HCM Control Delay, s	0	1.5	11.2
HCM LOS			B

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	585	-	-	1532	-
HCM Lane V/C Ratio	0.007	-	-	0.026	-
HCM Control Delay (s)	11.2	-	-	7.4	0
HCM Lane LOS	B	-	-	A	A
HCM 95th %tile Q(veh)	0	-	-	0.1	-

Intersection	
Int Delay, s/veh	1.1

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	150	4	34	155	9	26
Future Vol, veh/h	150	4	34	155	9	26
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	Free
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	93	93	93	93	93	93
Heavy Vehicles, %	11	56	7	10	46	11
Mvmt Flow	161	4	37	167	10	28

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	165	0	404	-
Stage 1	-	-	-	-	163	-
Stage 2	-	-	-	-	241	-
Critical Hdwy	-	-	4.17	-	6.86	-
Critical Hdwy Stg 1	-	-	-	-	5.86	-
Critical Hdwy Stg 2	-	-	-	-	5.86	-
Follow-up Hdwy	-	-	2.263	-	3.914	-
Pot Cap-1 Maneuver	-	-	1383	-	526	0
Stage 1	-	-	-	-	770	0
Stage 2	-	-	-	-	706	0
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1383	-	511	-
Mov Cap-2 Maneuver	-	-	-	-	511	-
Stage 1	-	-	-	-	748	-
Stage 2	-	-	-	-	706	-

Approach	EB	WB	NB
HCM Control Delay, s	0	1.4	12.2
HCM LOS			B

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	511	-	-	1383	-
HCM Lane V/C Ratio	0.019	-	-	0.026	-
HCM Control Delay (s)	12.2	-	-	7.7	0
HCM Lane LOS	B	-	-	A	A
HCM 95th %tile Q(veh)	0.1	-	-	0.1	-

AUSTIN, TSUTSUMI & ASSOCIATES, INC.
CIVIL ENGINEERS • SURVEYORS

APPENDIX C

LEVEL OF SERVICE CALCULATIONS

- Future Year 2050 with Project Conditions

Intersection	
Int Delay, s/veh	5.4

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	51	98	324	140	16	59
Future Vol, veh/h	51	98	324	140	16	59
Conflicting Peds, #/hr	0	1	1	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	900	-	350	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	10	55	4	8	55	20
Mvmt Flow	55	107	352	152	17	64

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	163	0	966	110
Stage 1	-	-	-	-	110	-
Stage 2	-	-	-	-	856	-
Critical Hdwy	-	-	4.14	-	6.95	6.4
Critical Hdwy Stg 1	-	-	-	-	5.95	-
Critical Hdwy Stg 2	-	-	-	-	5.95	-
Follow-up Hdwy	-	-	2.236	-	3.995	3.48
Pot Cap-1 Maneuver	-	-	1404	-	228	897
Stage 1	-	-	-	-	798	-
Stage 2	-	-	-	-	339	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1403	-	171	896
Mov Cap-2 Maneuver	-	-	-	-	171	-
Stage 1	-	-	-	-	597	-
Stage 2	-	-	-	-	339	-

Approach	EB	WB	NB
HCM Control Delay, s	0	5.9	13.4
HCM LOS			B

Minor Lane/Major Mvmt	NBLn1	NBLn2	EBT	EBR	WBL	WBT
Capacity (veh/h)	171	896	-	-	1403	-
HCM Lane V/C Ratio	0.102	0.072	-	-	0.251	-
HCM Control Delay (s)	28.4	9.3	-	-	8.4	-
HCM Lane LOS	D	A	-	-	A	-
HCM 95th %tile Q(veh)	0.3	0.2	-	-	1	-

Intersection	
Int Delay, s/veh	0.9

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	40	0	0	35	106	316
Future Vol, veh/h	40	0	0	35	106	316
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	50	50	50	50	50	50
Mvmt Flow	43	0	0	38	115	343

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	325	287	458	0	-	0
Stage 1	287	-	-	-	-	-
Stage 2	38	-	-	-	-	-
Critical Hdwy	6.9	6.7	4.6	-	-	-
Critical Hdwy Stg 1	5.9	-	-	-	-	-
Critical Hdwy Stg 2	5.9	-	-	-	-	-
Follow-up Hdwy	3.95	3.75	2.65	-	-	-
Pot Cap-1 Maneuver	581	651	891	-	-	-
Stage 1	664	-	-	-	-	-
Stage 2	874	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	581	651	891	-	-	-
Mov Cap-2 Maneuver	581	-	-	-	-	-
Stage 1	664	-	-	-	-	-
Stage 2	874	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	11.7	0	0
HCM LOS	B		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	891	-	581	-	-
HCM Lane V/C Ratio	-	-	0.075	-	-
HCM Control Delay (s)	0	-	11.7	-	-
HCM Lane LOS	A	-	B	-	-
HCM 95th %tile Q(veh)	0	-	0.2	-	-

Intersection	
Int Delay, s/veh	0

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕			↕	
Traffic Vol, veh/h	26	0	0	0	0	9	0	0	0	67	0	39
Future Vol, veh/h	26	0	0	0	0	9	0	0	0	67	0	39
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	28	0	0	0	0	10	0	0	0	73	0	42

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	172	167	21	167	188	0	42	0	0	0	0	0
Stage 1	167	167	-	0	0	-	-	-	-	-	-	-
Stage 2	5	0	-	167	188	-	-	-	-	-	-	-
Critical Hdwy	7.12	6.52	6.22	7.12	6.52	6.22	4.12	-	-	4.12	-	-
Critical Hdwy Stg 1	6.12	5.52	-	6.12	5.52	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.12	5.52	-	6.12	5.52	-	-	-	-	-	-	-
Follow-up Hdwy	3.518	4.018	3.318	3.518	4.018	3.318	2.218	-	-	2.218	-	-
Pot Cap-1 Maneuver	791	726	1056	797	707	-	1567	-	-	-	-	-
Stage 1	835	760	-	-	-	-	-	-	-	-	-	-
Stage 2	1017	-	-	835	745	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	-	726	1056	797	707	-	1567	-	-	-	-	-
Mov Cap-2 Maneuver	-	726	-	797	707	-	-	-	-	-	-	-
Stage 1	835	760	-	-	-	-	-	-	-	-	-	-
Stage 2	1017	-	-	835	745	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s			0	
HCM LOS	-	-		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1567	-	-	-	-	-	-	-
HCM Lane V/C Ratio	-	-	-	-	-	-	-	-
HCM Control Delay (s)	0	-	-	-	-	-	-	-
HCM Lane LOS	A	-	-	-	-	-	-	-
HCM 95th %tile Q(veh)	0	-	-	-	-	-	-	-

Intersection	
Int Delay, s/veh	7.4

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↱		↰	↑	↰	↱
Traffic Vol, veh/h	150	26	99	155	76	227
Future Vol, veh/h	150	26	99	155	76	227
Conflicting Peds, #/hr	0	1	1	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	900	-	350	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	74	74	74	74	74	74
Heavy Vehicles, %	10	55	4	8	55	20
Mvmt Flow	203	35	134	209	103	307

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	239	0	699	222
Stage 1	-	-	-	-	222	-
Stage 2	-	-	-	-	477	-
Critical Hdwy	-	-	4.14	-	6.95	6.4
Critical Hdwy Stg 1	-	-	-	-	5.95	-
Critical Hdwy Stg 2	-	-	-	-	5.95	-
Follow-up Hdwy	-	-	2.236	-	3.995	3.48
Pot Cap-1 Maneuver	-	-	1316	-	336	775
Stage 1	-	-	-	-	704	-
Stage 2	-	-	-	-	528	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1315	-	301	774
Mov Cap-2 Maneuver	-	-	-	-	301	-
Stage 1	-	-	-	-	631	-
Stage 2	-	-	-	-	528	-

Approach	EB	WB	NB
HCM Control Delay, s	0	3.1	15.3
HCM LOS			C

Minor Lane/Major Mvmt	NBLn1	NBLn2	EBT	EBR	WBL	WBT
Capacity (veh/h)	301	774	-	-	1315	-
HCM Lane V/C Ratio	0.341	0.396	-	-	0.102	-
HCM Control Delay (s)	23	12.7	-	-	8	-
HCM Lane LOS	C	B	-	-	A	-
HCM 95th %tile Q(veh)	1.5	1.9	-	-	0.3	-

Intersection	
Int Delay, s/veh	6.6

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	221	0	0	82	53	72
Future Vol, veh/h	221	0	0	82	53	72
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	50	50	50	50	50	50
Mvmt Flow	240	0	0	89	58	78

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	186	97	136	0	-	0
Stage 1	97	-	-	-	-	-
Stage 2	89	-	-	-	-	-
Critical Hdwy	6.9	6.7	4.6	-	-	-
Critical Hdwy Stg 1	5.9	-	-	-	-	-
Critical Hdwy Stg 2	5.9	-	-	-	-	-
Follow-up Hdwy	3.95	3.75	2.65	-	-	-
Pot Cap-1 Maneuver	705	843	1200	-	-	-
Stage 1	820	-	-	-	-	-
Stage 2	827	-	-	-	-	-
Platoon blocked, %					-	-
Mov Cap-1 Maneuver	705	843	1200	-	-	-
Mov Cap-2 Maneuver	705	-	-	-	-	-
Stage 1	820	-	-	-	-	-
Stage 2	827	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	12.7	0	0
HCM LOS	B		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1200	-	705	-	-
HCM Lane V/C Ratio	-	-	0.341	-	-
HCM Control Delay (s)	0	-	12.7	-	-
HCM Lane LOS	A	-	B	-	-
HCM 95th %tile Q(veh)	0	-	1.5	-	-

Intersection	
Int Delay, s/veh	0

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	35	0	0	0	0	47	0	0	0	15	0	38
Future Vol, veh/h	35	0	0	0	0	47	0	0	0	15	0	38
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	38	0	0	0	0	51	0	0	0	16	0	41

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	79	53	21	53	73	0	41	0	0	0	0	0
Stage 1	53	53	-	0	0	-	-	-	-	-	-	-
Stage 2	26	0	-	53	73	-	-	-	-	-	-	-
Critical Hdwy	7.12	6.52	6.22	7.12	6.52	6.22	4.12	-	-	4.12	-	-
Critical Hdwy Stg 1	6.12	5.52	-	6.12	5.52	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.12	5.52	-	6.12	5.52	-	-	-	-	-	-	-
Follow-up Hdwy	3.518	4.018	3.318	3.518	4.018	3.318	2.218	-	-	2.218	-	-
Pot Cap-1 Maneuver	910	838	1056	946	817	-	1568	-	-	-	-	-
Stage 1	960	851	-	-	-	-	-	-	-	-	-	-
Stage 2	992	-	-	960	834	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	-	838	1056	946	817	-	1568	-	-	-	-	-
Mov Cap-2 Maneuver	-	838	-	946	817	-	-	-	-	-	-	-
Stage 1	960	851	-	-	-	-	-	-	-	-	-	-
Stage 2	992	-	-	960	834	-	-	-	-	-	-	-

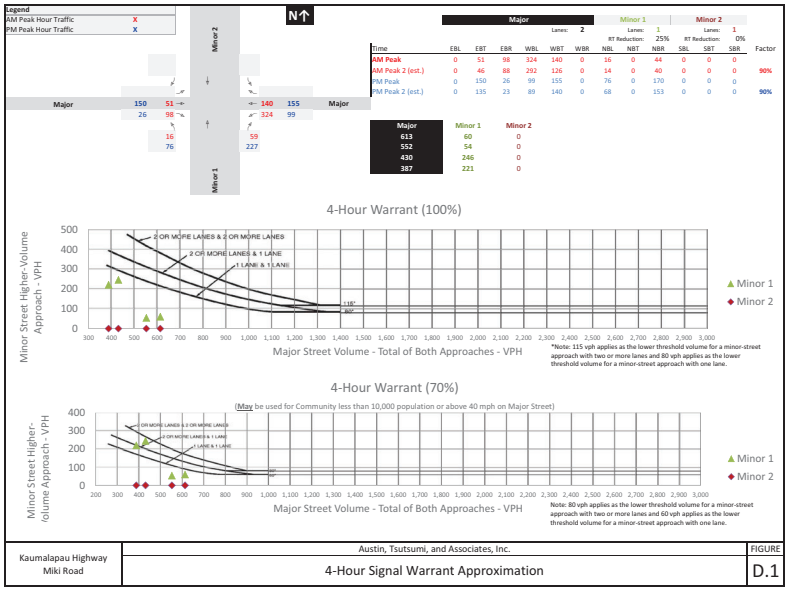
Approach	EB	WB	NB	SB
HCM Control Delay, s			0	
HCM LOS	-	-		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1568	-	-	-	-	-	-	-
HCM Lane V/C Ratio	-	-	-	-	-	-	-	-
HCM Control Delay (s)	0	-	-	-	-	-	-	-
HCM Lane LOS	A	-	-	-	-	-	-	-
HCM 95th %tile Q(veh)	0	-	-	-	-	-	-	-

AUSTIN, TSUTSUMI & ASSOCIATES, INC.
CIVIL ENGINEERS • SURVEYORS

APPENDIX D

TRAFFIC SIGNAL WARRANT



Kaumalapau Highway Miki Road	Austin, Tsutsumi, and Associates, Inc.	FIGURE
	4-Hour Signal Warrant Approximation	D.1