APPENDIX Q

Traffic Impact
Analysis Report

TRAFFIC IMPACT ANALYSIS REPORT FOR

PUUNENE HEAVY INDUSTRIAL SUBDIVISION

TMK: (2) 3-8-008:019

IN PUUNENE, MAUI, HAWAII

Prepared For

CMBY 2011 INVESTMENT, LLC

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1. INTRODUCTION

Phillip Rowell and Associates has been retained to prepare a Traffic Impact Analysis Report for the proposed heavy industrial subdivision in Puunene, Maui, Hawaii. This introductory chapter discusses the location of the project, the proposed development, and the study methodology.

Project Location and Description

1. The project is located approximately 1.4 miles east of Mokulele Highway in the vicinity of the Old Puunene Airport. **Figure 1** indicates the approximate location on the Island of Maui.

2. The total project area of the subdivision is 86 acres. Approximately 66 acres will be developed as industrial lots, while the remaining area will be roadway right-of-way and a drainage reserve. The current plan is to subdivide the project into 28 lots. A proposed development plan is provided as **Appendix A**.

3. Access to and egress from the project will be via Kama'aina Road, which intersects Mokulele Highway adjacent to the Maui Humane Society at the intersection of Mokulele Highway at Mehameha Loop, South Firebreak Road and Lower Kihei Road. A schematic drawing of this access route is referred to as Alternate 1 on **Figure 2**. The Applicant has submitted a request for an easement between Mokulele Highway and the proposed project's entrance. If the Applicant does not obtain this easement, an alternate easement will be obtained. The alternate alignment, referred to as Alternate 2, is also shown on **Figure 2**. If the Alternate 2 alignment is used, the project's access will be located eastward as shown.

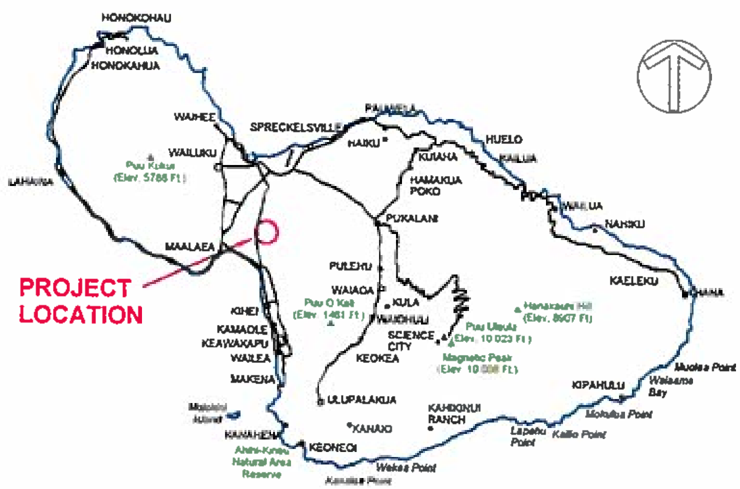


Figure 1
PROJECT LOCATION ON MAUI

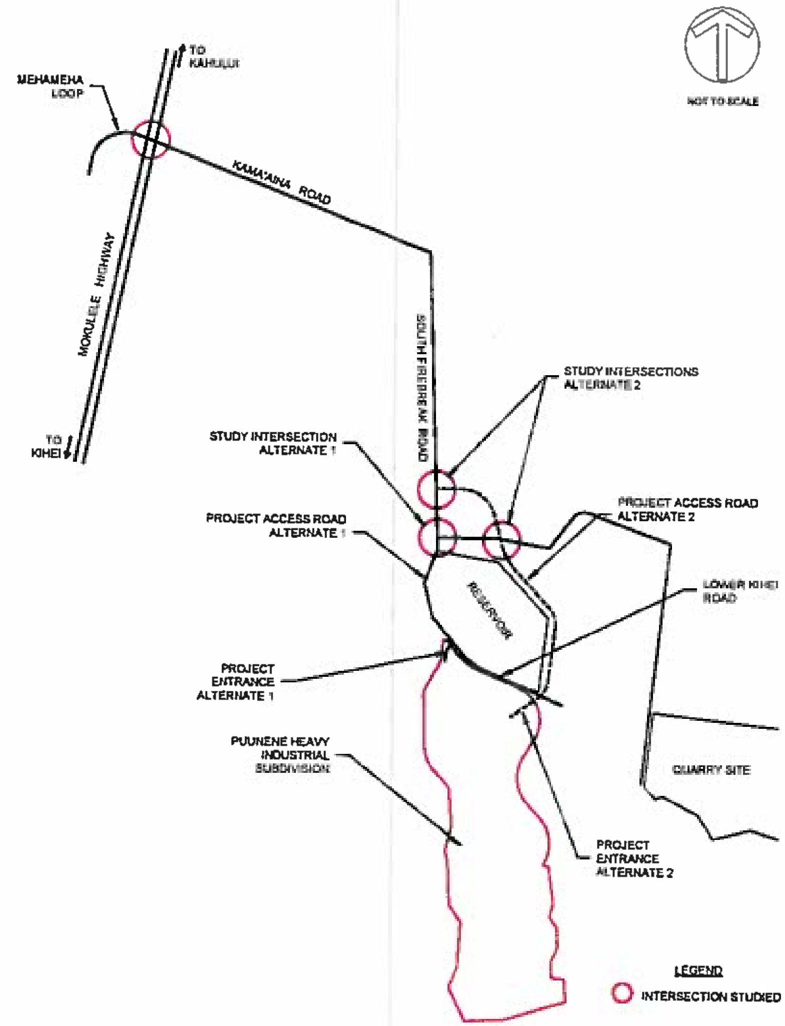


Figure 2
SCHEMATIC DRAWING OF ACCESS ROUTES TO PROJECT

4. The project will have no right of access to Maui Raceway Park roads. Additionally, there will be a drainage swell between the project lots and the property line adjacent to the park. This will prevent any traffic connection between the project and the park.

5. Since the current plan is to subdivide the property, there is no estimate as to when development of the lots will be completed. Therefore, 2015 is used as the project completion date.

Study Methodology

The following is a summary list of the tasks performed:

1. A field reconnaissance was performed to identify existing roadway cross-sections, intersection lane configurations, traffic control devices, and surrounding land uses.

2. Existing weekday peak hour traffic volumes were obtained for the intersection of Mokulele Highway at Kama'aina Road. Since existing and proposed traffic using Kama'aina Road is industrial related, traffic data included the number of heavy vehicles. Existing levels-of-service were determined using the methodology described in the *2000 Highway Capacity Manual.*

3. A list of related development projects within and adjacent to the study area that will impact traffic conditions at the study intersections was compiled.

4. Future background traffic volumes without traffic generated by the study project were estimated. A level-of-service analysis was performed to determine traffic operating conditions and levels-of-service as a result of background growth and traffic generated by other known future development projects.

5. Peak hour traffic that the proposed project will generate was estimated using trip generation analysis procedures recommended by the Institute of Transportation Engineers. Project generated traffic was distributed and assigned to the adjacent roadway network.

6. A level-of-service analysis for future traffic conditions with traffic generated by the study project was performed.

7. The impacts of traffic generated by the proposed project were quantified and summarized.

8. Improvements or modifications necessary to mitigate the traffic impacts of the project and to provide adequate access to and egress from the site were identified and analyzed.

9. A report documenting the conclusions of the analyses performed and recommendations was prepared.

Order of Presentation

Chapter 2 describes existing traffic conditions, the Level-of-Service (LOS) concept and the results of the Level-of-Service analysis of existing conditions.

Chapter 3 describes the process used to estimate 2015 background traffic volumes and the resulting background traffic projections. Background conditions are defined as future background traffic conditions without traffic generation by the study project.

Chapter 4 describes the methodology used to estimate the traffic characteristics of the proposed project, including 2015 background plus project traffic projections.

Chapter 5 describes the traffic impacts of the proposed project, conclusions of the impact analysis and recommended mitigation measures.

2. ANALYSIS OF EXISTING CONDITIONS

This chapter presents the existing traffic conditions on the roadways adjacent to the proposed project. The level-of-service (LOS) concept and the results of the LOS analysis for existing conditions are also presented. The purpose of this analysis is to identify existing deficiencies and to establish the base conditions for the determination of the impacts of the project which are described in a subsequent chapter.

Existing Streets and Intersection Controls

All traffic will access and egress the project via the intersection of Mokulele Highway at Kama'aina Road and Mehameha Loop. The north and south approaches are Mokulele Highway. The east approach is Kama'aina Road and the west approach is Mehameha Loop. Kama'aina Road, along with South Firebreak Road, connects Mokulele Highway with the Hawaiian Cement Quarry and the west leg connects with the Maui Humane Society facility. A schematic of this intersection is provided as Figure 3.

Mokulele Highway is a four-lane, divided highway with a north-south orientation connecting Kahului to the north with Kihei to the south. The posted speed limit is 45 miles per hour. There is a separate bike path along the east side of the highway.

The intersection of Mokulele Highway at Kama'aina Road is a four-legged, signalized intersection. The northbound and southbound approaches of Mokulele Highway both have separate left turn and right turn deceleration and turn storage lanes. Northbound and southbound left turn lanes are protected. The eastbound (Mehameha Loop) and westbound (Kama'aina Road) approaches are one lane each.

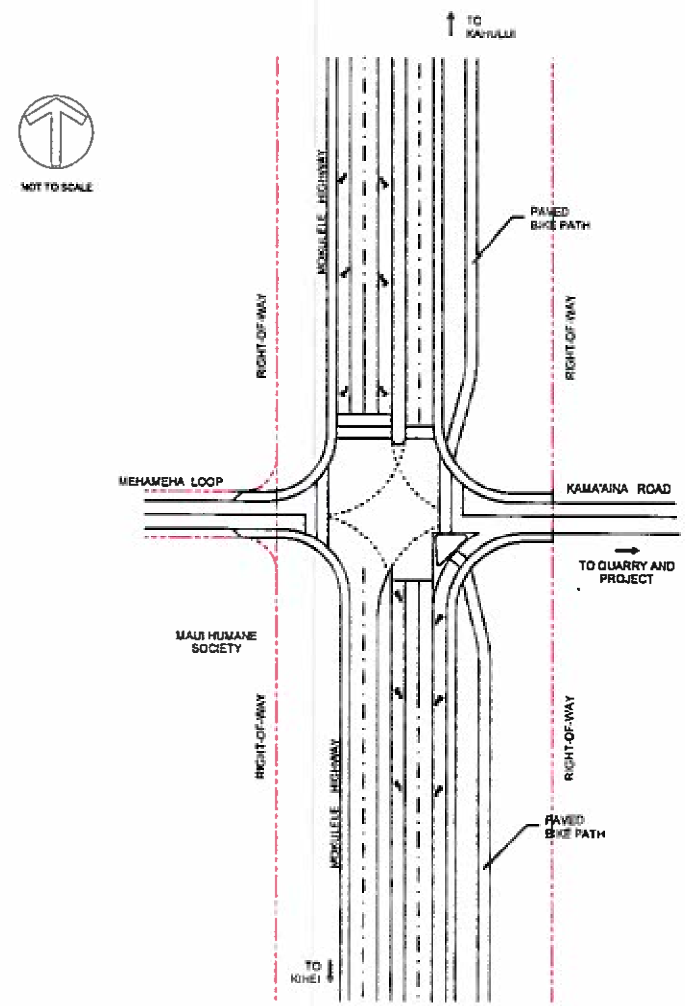


Figure 3
SCHEMATIC DRAWING OF INTERSECTION OF MOKULELE HIGHWAY AT KAMA'AINA ROAD AND MEHAMEHA LOOP

Existing Peak Hour Traffic Volumes

The intersection of Mokulele Highway at Kama'aina Road was counted from 6:30 AM to 9:00 AM on Friday, August 12, 2011 and from 3:00 PM to 6:00 PM on Thursday, August 11, 2011. Since Kama'aina Road provides access to the quarry and is heavily used by heavy trucks, the number of heavy vehicles was also counted. A heavy vehicle is defined by the *Highway Capacity Manual* as "a vehicle with more than four wheels touching the pavement during normal operation."[1] Heavy vehicles have a significant impact on the capacity of an intersection as a result of the vehicles operating characteristics. The percentage of heavy vehicles is therefore a critical input to the capacity analysis of this intersection.

The results of the traffic counts are summarized as Figure 4. Shown are the peak hour volumes of heavy vehicles, other vehicles and total vehicles. Also shown are the percentages of heavy vehicles of each traffic movement.

The traffic count summary worksheets are provided as Appendix B.

The morning peak hour is from 7:15 AM to 8:15 AM. This is consistent with traffic counts completed in 2010 at the intersection of Mokulele Highway at North Kihei Road, which is the next signalized intersection south of this intersection. The total morning peak hour volume along Mokulele Highway is approximately 2,200 vehicles per hour. The direction split is 50/50. Left and right turns are minimal. Traffic turning into and out of Kama'aina Road is largely heavy vehicles. The percentages of westbound left and right turns from Kama'aina Road that are heavy vehicles are 80% and 67%, respectively. 48% of the southbound left turns and 17% of the northbound right turns into Kama'aina Road are heavy vehicles also.

The afternoon peak hour along Mokulele Highway is from 3:30 PM to 4:30 PM. The total afternoon peak hour traffic volume is approximately 2,380 vehicles per hour. The directional split is also 50/50. 100% of the southbound left turns, 73% of the westbound left turns are heavy vehicles and 84% of the northbound right turns are heavy vehicles.

The peak hour volumes along Mehameha Loop are approximately 35 vehicles per hour during the morning peak hour and 40 vehicles per hour during the afternoon peak hour. There were no heavy vehicles along Mehameha Loop during the peak hours.

The peak hour volumes along Kama'aina Road are 57 vehicles per hour during the morning peak hour and 36 during the afternoon peak hour. During the morning peak hour, 25% of the vehicles along Kama'aina Road are heavy vehicles. During the afternoon peak hour, 22% of the vehicles are heavy vehicles.

Existing Public Transportation

The Maui Public Bus system operates the Kihei Islander bus route (Route 10) along Mokulele Highway at one hour intervals between 5:30 AM and 9:30 PM. This route connects Kahului and Kihei. There are no bus stops along Mokulele Highway. Therefore, there is no bus service available to the project site.

[1] Transportation Research Board, *Highway Capacity Manual*, Washington, D.C., page 5-7.

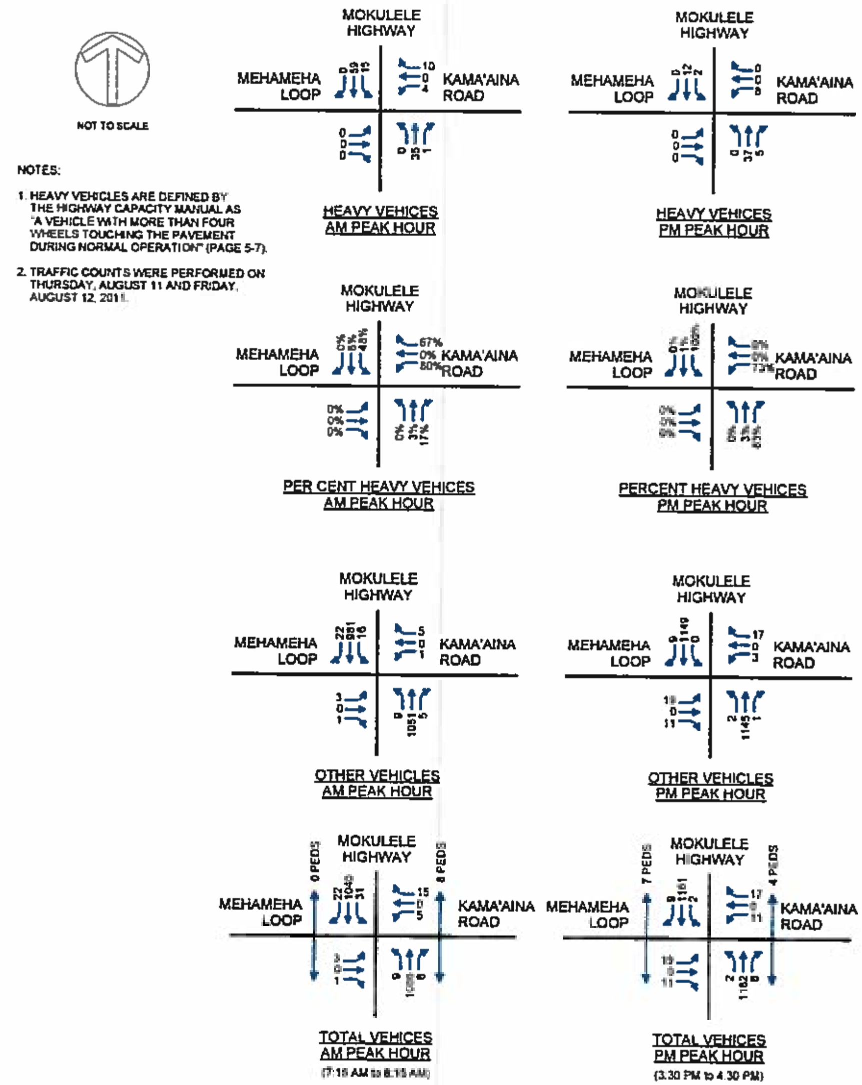


Figure 4
EXISTING PEAK HOUR TRAFFIC VOLUMES

Level-of-Service Concept

Signalized Intersections

"Level-of-Service" is a term which denotes any of an infinite number of combinations of traffic operating conditions that may occur on a given lane or roadway when it is subjected to various traffic volumes. Level-of-service (LOS) is a qualitative measure of the effect of a number of factors which include space, speed, travel time, traffic interruptions, freedom to maneuver, safety, driving comfort and convenience.

There are six levels-of-service, A through F, which relate to the driving conditions from best to worst, respectively. The characteristics of traffic operations for each level-of-service are summarized in Table 1. In general, LOS A represents free-flow conditions with no congestion. LOS F, on the other hand, represents severe congestion with stop-and-go conditions. Level-of-service D is typically considered acceptable for peak hour conditions in urban areas.[2]

Corresponding to each level-of-service shown in the table is a volume/capacity ratio. This is the ratio of either existing or projected traffic volumes to the capacity of the intersection. Capacity is defined as the maximum number of vehicles that can be accommodated by the roadway during a specified period of time. The capacity of a particular roadway is dependent upon its physical characteristics such as the number of lanes, the operational characteristics of the roadway (one-way, two-way, turn prohibitions, bus stops, etc.), the type of traffic using the roadway (trucks, buses, etc.) and turning movements.

Table 1 Level-of-Service Definitions for Signalized Intersections[1]

Level of Service	Interpretation	Volume-to-Capacity Ratio[2]	Stopped Delay (Seconds)
A, B	Uncongested operations; all vehicles clear in a single cycle.	0.000-0.700	<20.0
C	Light congestion; occasional backups on critical approaches	0.701-0.800	20.1-35.0
D	Congestion on critical approaches but intersection functional. Vehicles must wait through more than one cycle during short periods. No long standing lines formed.	0.801-0.900	35.1-55.0
E	Severe congestion with some standing lines on critical approaches. Blockage of intersection may occur if signal does not provide protected turning movements.	0.901-1.000	55.1-80.0
F	Total breakdown with stop-and-go operation	>1.001	>80.0

Notes:
(1) Source: *Highway Capacity Manual*, 2000.
(2) This is the ratio of the calculated critical volume to Level-of-Service E Capacity.

[2] Institute of Transportation Engineers, *Transportation Impact Analyses for Site Development*, Washington, D.C., 2006, page 56 - 60

Unsignalized Intersections

Like signalized intersections, the operating conditions of intersections controlled by stop signs can be classified by a level-of-service from A to F. However, the method for determining level-of-service for unsignalized intersections is based on the use of gaps in traffic on the major street by vehicles crossing or turning through that stream. Specifically, the capacity of the controlled legs of an intersection is based on two factors: 1) the distribution of gaps in the major street traffic stream, and 2) driver judgement in selecting gaps through which to execute a desired maneuver. The criteria for level-of-service at an unsignalized intersection is therefore based on delay of each turning movement. Table 2 summarizes the definitions for level-of-service and the corresponding delay

Table 2 Level-of-Service Definitions for Unsignalized Intersections[1]

Level-of-Service	Expected Delay to Minor Street Traffic	Delay (Seconds)
A	Little or no delay	<10.0
B	Short traffic delays	10.1 to 15.0
C	Average traffic delays	15.1 to 25.0
D	Long traffic delays	25.1 to 35.0
E	Very long traffic delays	35.1 to 50.0
F	See note (2) below	>50.1

Notes:
(1) Source: *Highway Capacity Manual*, 2000.
(2) When demand volume exceeds the capacity of the lane, extreme delays will be encountered with queuing which may cause severe congestion affecting other traffic movements in the intersection. This condition usually warrants improvement of the intersection.

Methodology for Level-of-Service Analysis

1. Synchro 6 was used to perform the level-of-service analysis. Synchro 6 is based on the *Highway Capacity Manual*.
2. The percentage of heavy vehicles as shown previously (Figure 4) was input for the appropriate lane group.
3. The *Highway Capacity Manual* defines level-of-service by delay.

Level-of-Service Analysis of Existing Conditions

The existing levels-of-service of the intersection of Mokulele Highway at Kama'aina Road and Mehameha Loop are summarized in **Table 3**. The volume-to-capacity ratios, delays and levels-of-service of the overall intersection and each lane group as reported by *Synchro* are shown.

Table 3 2011 Levels-of-Service - Mokulele Highway at Kama'aina Road & Mehameha Loop

	AM Peak Hour			PM Peak Hour		
	7:15 AM to 8:15 AM			3:30 PM to 4:30 PM		
Intersection and Movement	V/C	Delay [1]	LOS [2]	V/C	Delay	LOS
Overall Intersection	*0.50*	*5.9*	*A*	*0.50*	*5.0*	*A*
Eastbound Left ,Thru & Right	0.10	37.1	D	0.25	36.2	D
Westbound Left, Thru & Right	0.25	39.4	D	0.30	37.3	D
Northbound Left	0.48	50.9	D	0.16	41.1	D
Northbound Thru	0.46	5.0	A	0.49	3.9	A
Northbound Right	0.01	2.9	A	0.01	2.1	A
Southbound Left	0.56	47.7	D	0.31	51.2	D
Southbound Thru	0.41	3.5	A	0.45	3.7	A
Southbound Right	0.03	2.2	A	0.01	2.1	A

NOTES:
(1) Delay is in seconds per vehicle.
(2) LOS denotes Level-of-Service calculated using the operations method described in *Highway Capacity Manual*. Level-of-Service is based on delay.
(3) See Appendix C for Level-of-Service Analysis Worksheets

Existing Deficiencies

We have used the Institute of Transportation Engineers standard that Level-of-Service D is the minimum acceptable Level-of-Service and that the criteria is applicable to the overall intersection rather than each controlled lane group. Minor movements, such as left turns, and minor side street approaches may operate at Level-of-Service E or F for short periods of time during the peak hours so that the overall intersection and major movements along the major highway will operate at Level-of-Service D, or better. All volume-to-capacity ratios must be 1.00 or less.

Using this standard, no deficiencies were identified at the intersection of Mokulele Highway at Kama'aina Road at Mehameha Loop. The overall intersection operates at Level-of-Service A during both morning and afternoon peak hours. The eastbound approach, the westbound approach, the northbound left turn lane and the southbound left turn lane are shown as operating at Level-of-Service D. The levels-of-service shown are based on the calculated delay of the lane group. However, the volume-to-capacity ratio is low. This indicates that the long delay is because vehicles must wait for the signal to go through the rest of the traffic signal cycle resulting in a longer delay than desirable. As previously noted, Level-of-Service D is considered an acceptable level-of-service.

3. PROJECTED BACKGROUND TRAFFIC CONDITIONS

The purpose of this chapter is to discuss anticipated 2015 background conditions without project generated traffic. Background traffic conditions are defined as future traffic projections <u>without</u> traffic generated by the proposed project under study.

Future traffic growth consists of two components. The first is ambient background growth that is a result of regional growth and cannot be attributed to a specific project. This growth also considers traffic associated with minor, or small, projects for which no traffic data, or traffic study, are available. The second component is estimated traffic that will be generated by other major development projects in the vicinity of the proposed project. Included in the assessment of future background conditions are roadway improvements that are part of the related projects.

A level-of-service of future (2015) background traffic conditions is then performed, existing deficiencies identified and appropriate mitigation measures identified and assessed where needed. The purpose of this process is the identify roadway improvements required to mitigate unacceptable conditions as a result of background traffic growth and traffic generated by related projects in the area so that improvements can be assessed against the appropriate project.

Design Year for Traffic Forecasts

The design, or horizon, year of a project is the future year for which background traffic conditions are estimated. The design year is typically several years after completion of the study project. The year 2015 is used in this study to be compatible with the traffic studies for other major projects within and adjacent to the study area.

Background Traffic Growth

The *Maui Long Range Transportation Plan*[3] concluded that traffic on Maui would increase an average of 1.6% per year from 1990 to 2020. This growth rate was used to estimate the background growth between 2011 and 2015, which is the design year for this project. The growth factor was calculated using the following formula:

$$F = (1 + i)^n$$

where F = Growth Factor
i = Average annual growth rate, or 0.016
n = Growth period, or 4 years

It should be noted that some traffic studies for projects in Kihei have used a growth factor of 2.0% rather that 1.6% used in the study. We have checked with the other consultants and verified that this is the result of rounding.

This growth factor was applied to the northbound and southbound through traffic movements along Mokulele Highway.

Related Projects

The second component in estimating background traffic volumes is traffic resulting from other proposed projects in the vicinity. Related projects are defined as those projects that are under construction or have been approved for construction and would significantly impact traffic in the study area. Related projects may be development projects or roadway improvements. The following related projects were identified.

Kaiwahine Village

The proposed Kaiwahine Subdivision is located at the east end of Kaiwahine Street and will consist of 120 multi-family units. The traffic assignments for the subdivision were obtained from the traffic study for the project[4].

Maui Lu Resort

Maui Lu Resort is located in the northeast quadrant of the intersection of South Kihei Road at Kaonoulu Street. The existing resort will be demolished and a 400 unit timeshare will be constructed. Each timeshare unit will have one lock off unit which may be used as a separate hotel room. As part of the Maui Lu project, the intersection of South Kihei Road at Kaonoulu Street will be signalized and a separate southbound to eastbound left turn lane will also be constructed. The traffic assignments for the project were obtained from the traffic study for the project[5].

[3] Kaku Associates, *Maui Long Range Land Transportation Plan*, October 1996

[4] Phillip Rowell and Associates, *TIAR for Kaiwahine Village*, July 15, 2010

[5] Phillip Rowell and Associates, *TIAR for Maui Lu Resort*, March 7, 2007

Kihei Residential Subdivision

The Kihei Residential Subdivision will be located along the east side of Piilani Highway between Kaiwahine Street and North Kihei Road. The project will consist of 400 single family units, 200 multifamily units, 2,000 square feet of commercial floor area and 7,000 square feet of office floor area. The traffic assignments for the project were obtained from the traffic study for the project[6].

Primary access to and egress from this project is via the intersection of Piilani Highway at Kaiwahine Street. The TIAR includes improvements at this intersection to accommodate project generated traffic. These improvements are:

1. Modify the eastbound approach of Uwapo Road to provide separate left, through and right turn lanes.
2. Modify the westbound approach of Kaiwahine Street to provide two left turn lanes, one through lane and one right turn only lane.
3. Modify the southbound approach of Piilani Highway to provide two separate left turn lanes.

Kihei High School

The proposed Kihei High School will be located along the east side of Piilani Highway across from the Piilani Subdivision. According to the Environmental Impact Statement Preparation Notice (EISPN), the school will have a capacity of 1600 students for grades 9 through 12.

As described in the EISPN, access and egress will be via the intersection of Piilani Highway at Kulanihakoi Road, which will be modified with an extension of Kulanihakoi Road across Piilani Highway. Right turns only will be allowed into and out of the school site and the intersection will be unsignalized.

The number of trips that the high school will generate was estimated for a 1600-student high school using Institute of Transportation Engineers trip generation data. These trips were assigned based on the traffic circulation patterns described in the EISPN.

Kenolio 6 Affordable Housing Project

The Kenolio 6 Affordable Housing Project is located between Piilani Highway and Kenolio Road in the southwest quadrant of the intersection of Kaonoulu Street at Piilani Highway. The project is a 124 unit multi-family affordable housing development.

Access to and egress from the project will be via two driveways along the east side of Kenolio Road.

The traffic assignments for the project were obtained from the traffic study for the project [7].

[6] Austin, Tsutsumi & Associates, *TIAR for Kihei Residential Project*, May 22, 2007

[7] Phillip Rowell and Associates, *TIAR for Kenolio 6 Affordable Housing Project*, May 27, 2010

Piilani Promenade

The project is located along the mauka (east) side of Piilani Highway opposite Kaonoulu Street in the Kihei area of Maui. The extension of Kaonoulu Street will divide the project into two parcels. The north parcel is referred to as the Maui Outlet Center and will consist of 290,000 leasable square feet of retail and commercial uses. The south parcel is referred to as the Maui Retail Center and will consist of 410,000 leasable square feet of retail floor area. This includes 38,000 square feet for an outdoor garden area.

The traffic assignments for the project were obtained from the traffic study for the project [8]. As part of the project, the intersection of Piilani Highway at Kaonoulu Street will be signalized.

The projects that were identified as related projects and the estimated number of peak hour trips generated by each are summarized in Table 4. The approximate locations of these projects are shown in Figure 5. Traffic assignments at the intersection of Mokulele Highway at Kama'aina Road and Mehameha Loop for the related projects are shown as Figure 6.

It was assumed that traffic volumes into and out of the Maui Humane Society facility and the Hawaiian Cement quarry would not change.

2015 Background Traffic Projections

2015 background traffic projections were calculated by expanding existing traffic volumes by the appropriate growth rates and then superimposing traffic generated by related projects. The 2015 background peak hour traffic projections at the intersection of Mokulele Highway at Kama'aina Road and Mehameha Loop are shown in Figure 7.

Table 4 Trip Generation Summary of Related Projects

			AM Peak Hour			PM Peak Hour		
	Related Project	Description	In	Out	Total	In	Out	Total
A	Kawahine Village	120 Multi-Family	19	47	66	49	31	80
B	Maui Lu Resort	400 Timeshares + 400 Lock Off Units (Maximum)	245	140	385	205	230	435
C	Kihei Residential	400 Single Family 200 Multi-Family 2,000 SF Commercial 7,000 SF Office	213	403	616	405	332	737
D	Kihei High School	1600 Students Grades 9 thru 12	455	200	655	105	120	225
E	Kenolio 6 Affordable Housing Project	124 Multi-Family	20	48	68	51	32	83
F	Piilani Promenade	700,000 SF Retail	422	268	690	1,391	1,507	2,898
	TOTALS		1,374	1,106	2,480	2,206	2,252	4,458

[8] Phillip Rowell and Associates, *TIAR for Piilani Promenade*, June 7, 2011

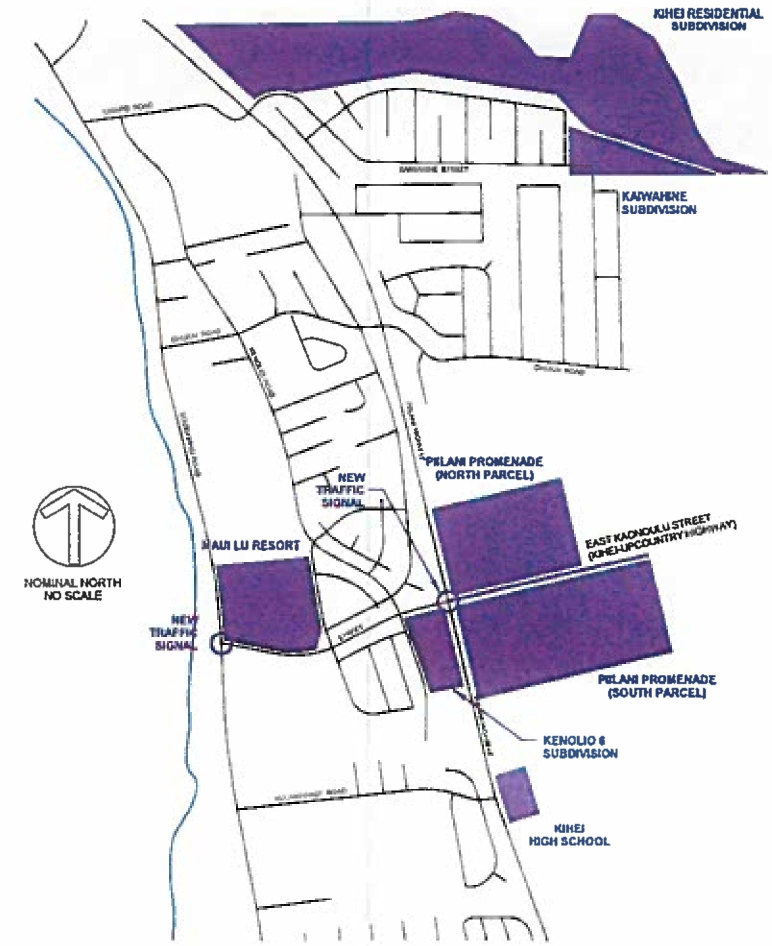


Figure 5
LOCATIONS OF RELATED PROJECTS

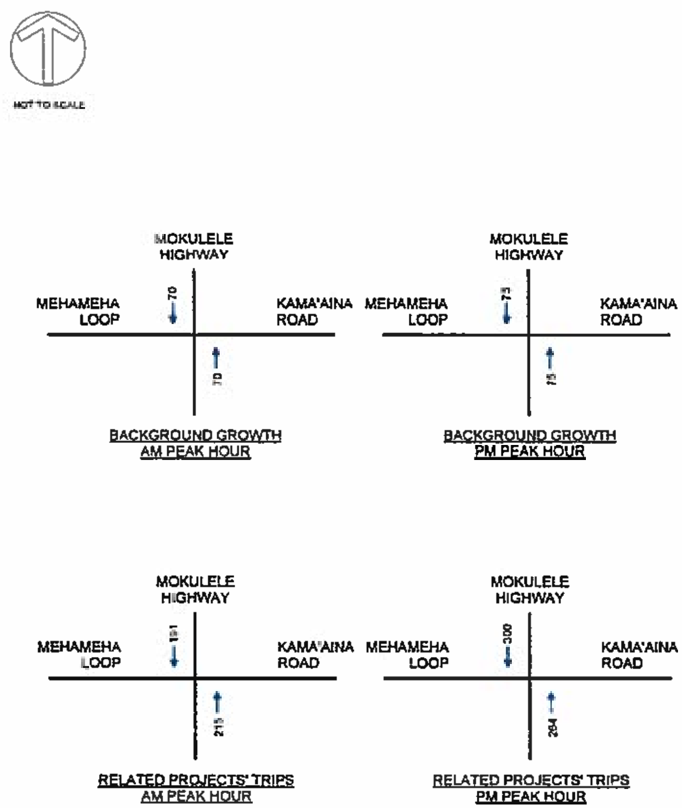


Figure 6
BACKGROUND GROWTH AND RELATED PROJECTS' TRIPS

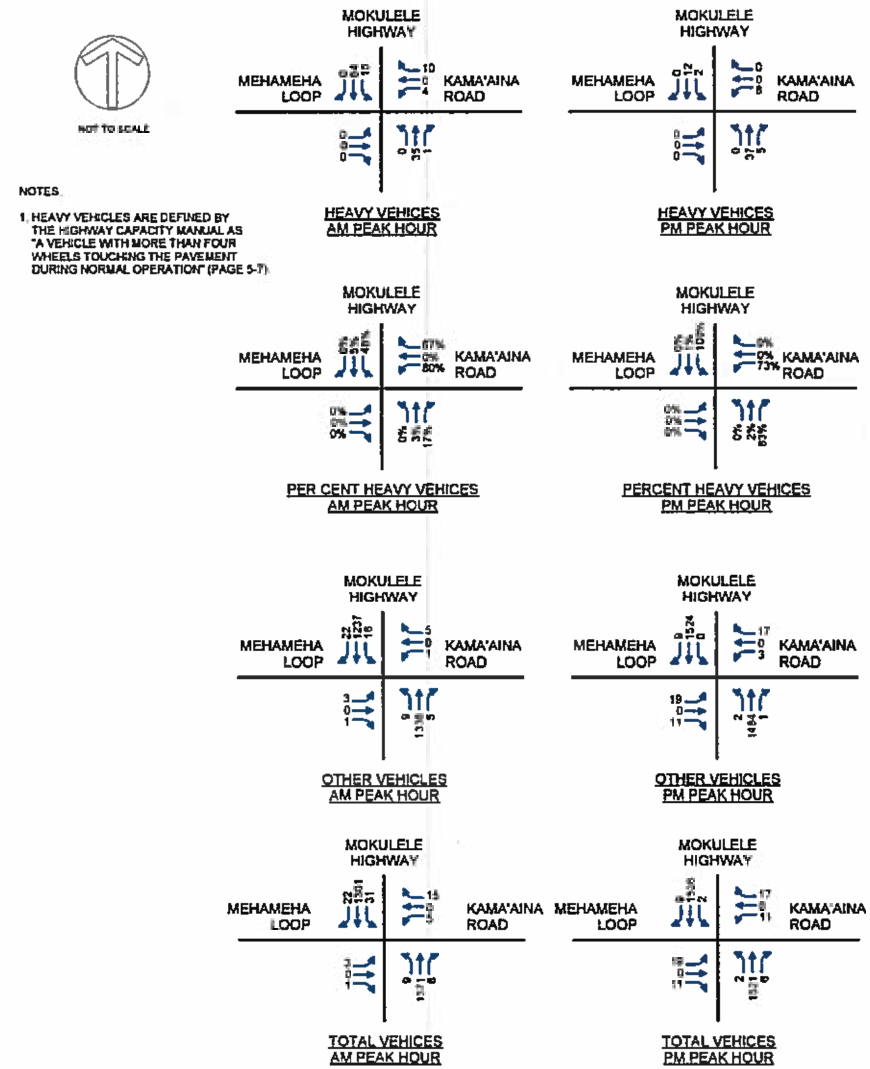


Figure 7
2015 BACKGROUND TRAFFIC PROJECTIONS

2015 Background Levels-of-Service

Table 5 summarizes the results of the level-of-service analysis of the intersection of Mokulele Highway at Kama'aina Road for 2015 background conditions without project generated traffic. Volume-to-capacity ratios, delays and levels-of-service of the overall intersection and each lane group as reported by *Synchro* are shown.

Table 5 2015 Background Levels-of-Service - Mokulele Highway at Kama'aina Road & Mehameha Loop

Intersection and Movement	AM Peak Hour			PM Peak Hour		
	V/C	Delay [1]	LOS [2]	V/C	Delay	LOS
Overall Intersection	*0.59*	*6.3*	*A*	*0.59*	*5.6*	*A*
Eastbound Left, Thru & Right	0.10	37.1	D	0.25	36.2	D
Westbound Left, Thru & Right	0.24	39.3	D	0.30	37.3	D
Northbound Left	0.41	46.7	D	0.16	41.1	D
Northbound Thru	0.56	5.8	A	0.59	4.7	A
Northbound Right	0.01	2.9	A	0.01	2.1	A
Southbound Left	0.56	47.6	D	0.31	51.2	D
Southbound Thru	0.52	4.3	A	0.59	4.7	A
Southbound Right	0.03	2.2	A	0.01	2.1	A

NOTES:
(1) Delay is in seconds per vehicle.
(2) LOS denotes Level-of-Service calculated using the operations method described in *Highway Capacity Manual*. Level-of-Service is based on delay
(3) See Appendix D for Level-of Service Analysis Worksheets

Mitigation Required for 2015 Background Conditions

The results are consistent with the results and conclusions of the level-of-service analysis of existing conditions. The overall intersection operates at Level-of-Service A during both morning and afternoon peak hours. The eastbound approach, the westbound approach, the northbound left turn lane and the southbound left turn lane are shown as operating at Level-of-Service D. The levels-of-service shown are based on the calculated delay of the lane group. However, the volume-to-capacity ratio is low. This indicates that the long delay is because vehicles must wait for the signal to go through the rest of the traffic signal cycle resulting in a longer delay than desirable. As previously noted, Level-of-Service D is considered an acceptable level-of-service.

No mitigation is required for 2015 background conditions.

4. PROJECT-RELATED TRAFFIC CONDITIONS

This chapter discusses the methodology used to identify the traffic-related impacts of the proposed project. This chapter presents the generation, distribution and assignment of project generated traffic and the background plus project traffic projections. The result of the level-of-service analysis of background plus project conditions is presented in the following chapter.

Methodology

Future traffic volumes generated by the project were estimated using the procedures described in the *Trip Generation Handbook*[9] and data provided in *Trip Generation*[10]. This method used trip generation rates or formulas to estimate the number of trips that the project will generate during the peak hours.

Trip Generation of Proposed Development

Trip generation equations for industrial parks (Land Use Code 130) were used to estimate the number of peak hour trips generated by the project. These rates are based on the number of acres to be developed.

The area used to estimated the number of trips the project will generate was the net area to be developed, 65.92 acres. The area is the total project area minus the drainage reserve and roadway right-of-way as shown:

[9] Institute of Transportation Engineers, *Trip Generation Handbook*, Washington, D.C., 1998, p. 7-12

[10] Institute of Transportation Engineers, *Trip Generation*, Washington, D.C., 2003

Acres	Use
65.92	Lots
9.10	Drainage Reserve
10.98	Road Right-of-Ways
86.00	Total Area

The results of the trip generation calculations are shown as Table 6. The project will generate 392 inbound and 80 outbound trips during the morning peak hour. During the afternoon peak hour, the project will generate 99 inbound and 372 outbound trips.

Table 6 Trip Generation Calculations

Time Period	Direction	Industrial Park (LU Code 130) Equation or %	Acres	Trips
AM Peak Hour	Total	Ln (T) = 0.78Ln(A)+2.89	65.92	472
	In	83%		392
	Out	17%		80
PM Peak Hour	Total	Ln (T) = 0.72Ln(A)+3.14		471
	In	21%		99
	Out	79%		372

Trip Distribution and Assignments

The project-related trips were distributed along the anticipated approach and departure routes from the project site based on the distribution of population as reported in the *Maui Long Range Land Transportation Plan*. The distribution of population in 2015 was estimated by interpolating between the 1990 and 2020 population estimates provided in the appendices of the Plan. Accordingly, 62% of the project trips were distributed as approaching from and departing to the north. The remaining 38% of the project trips were distributed as approaching from and departing to the south.

The project will have no right of access to Maui Raceway Park roads. Additionally, there will be a drainage swell between the project lots and the property line adjacent to the park. This will prevent any traffic connection between the project and the park. Accordingly, all traffic was assigned to us the intersection of Mokulele Highway at Kama'aina Road and Mehameha Loop.

Based on observations at the Central Maui Baseyard that is located north of the study project and the Consolidated Baseyard on Waiko Road, it was assumed that 25% of the vehicles generated by the project will be heavy vehicles.

The project morning and afternoon peak hour trip assignments at the intersection of Mokulele Highway at Kama'aina Road and Mehameha Loop are shown in Figure 8.

2015 Background Plus Project Projections

Background plus project traffic conditions are defined as 2015 background traffic conditions plus project related traffic. The 2015 background plus project traffic projections were estimated by superimposing the peak hourly traffic generated by the proposed project on the 2015 background peak hour traffic volumes presented in Chapter 3. The 2015 background plus the project traffic projections at the intersection of Mokulele Highway at Kama'aina Road and Mehameha Loop are shown on Figure 9.

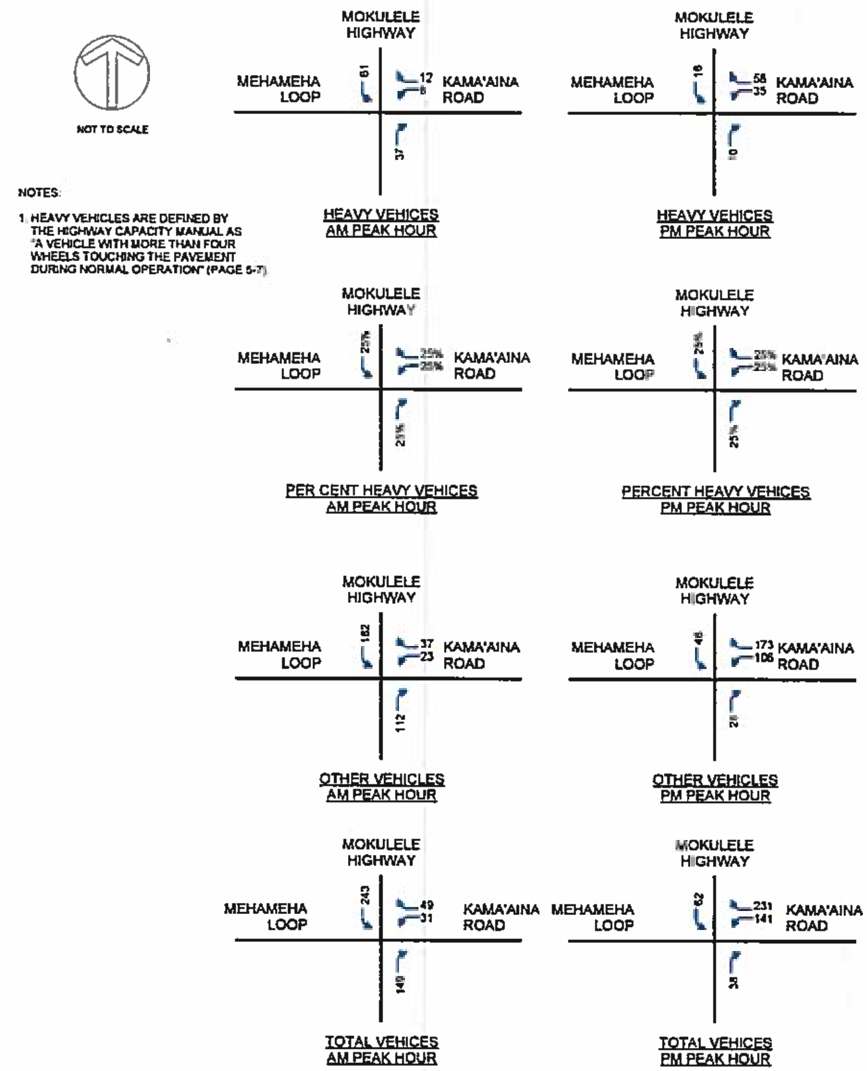


Figure 8
PROJECT TRIP ASSIGNMENTS

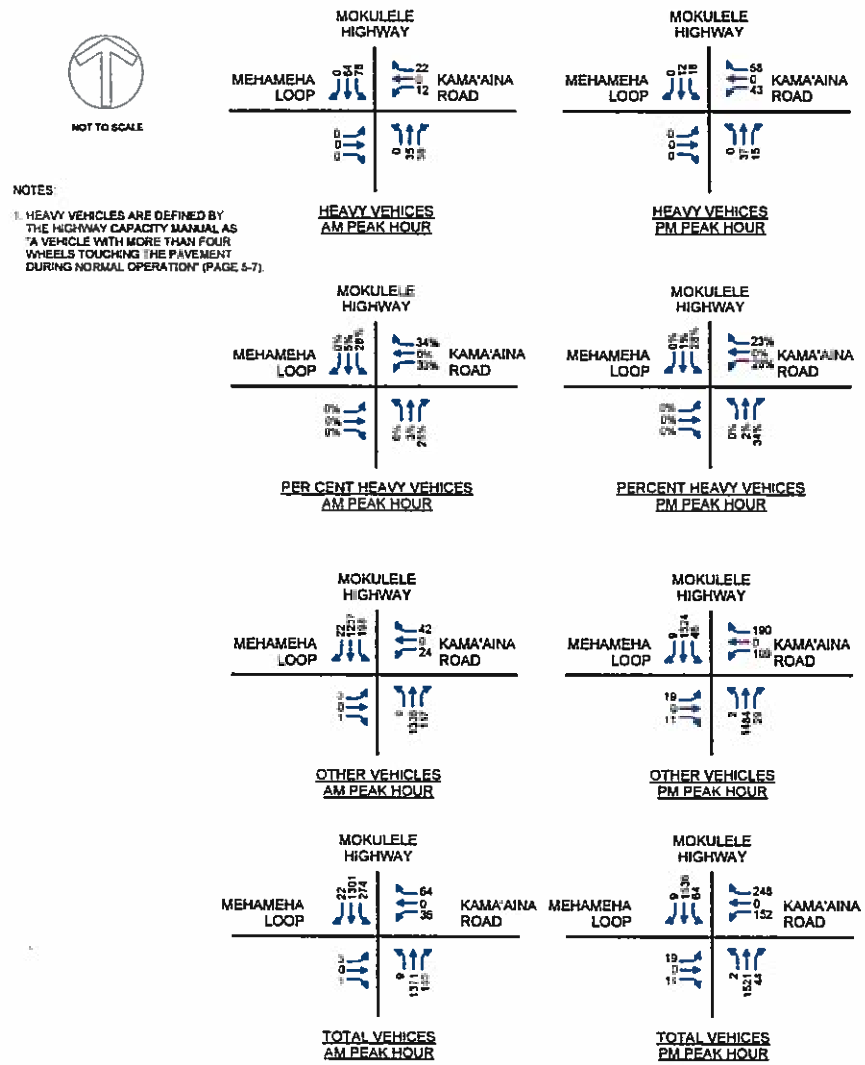


Figure 9
2015 BACKGROUND PLUS PROJECT TRAFFIC PROJECTIONS

5. TRAFFIC IMPACT ANALYSIS

The impact of the project was assessed by analyzing the changes in traffic volumes and levels-of-service at the study intersections. These impacts are discussed in this chapter. Intersection traffic movements that do not meet the standard for acceptable levels-of-service are identified and improvements that will result is acceptable levels-of-service are identified and assessed.

This chapter also describes anticipated traffic operating conditions at the project's driveways along Kama'aina Road.

Changes in Total Intersection Volumes

An analysis of the project's share of 2015 background plus project intersection approach volumes at the intersection of Mokulele Highway at Kama'aina Road is summarized in Table 7. The table summarizes the project's share of total 2015 peak hour approach volumes. Also shown are the percentage of 2015 background plus project traffic that is the result of background growth and traffic generated by related projects. As shown, project generated traffic will represent 14.6% of the morning peak hour traffic and 13.2% of the afternoon peak hour traffic.

An analysis of the project's pro rata share of the increase of traffic volumes between 2010 and 2015 is summarized in Table 8. This table summarizes the growth between 2010 and 2015 and indicates the percentage of growth resulting from background growth and related projects, and the percentage growth resulting from project generated traffic.

Table 7 Analysis of Project's Share of Total Intersection Approach Volumes [1]

Intersection	Period	Existing	2015 Background	2015 Background Plus Project	Background Growth		Project Traffic	
					Trips	Percent of Total Traffic [2]	Trips	Percent of Total Traffic [2]
Mokulele Hwy at Kama'aina Road	AM	2218	2764	3236	546	16.9%	472	14.6%
	PM	2420	3134	3606	714	19.8%	472	13.1%

Notes:
(1) Volumes shown are total intersection approach volumes or projections.
(2) Percentage of total 2015 background plus project traffic.

Table 8 Analysis of Project's Share of Total Intersection Approach Volumes Growth [1]

Intersection	Period	Existing	2015 Background	Background Plus Project	Background Growth [2]		Project Trips [3]	
					Volume	% of 2010 to 2015 Growth	Volume [4]	% of 2010 to 2015 Growth
Mokulele Hwy at Kama'aina Road	AM	2218	2764	3236	546	53.6%	472	46.4%
	PM	2420	3134	3606	714	60.2%	472	39.8%

Notes:
(1) Volumes shown are total intersection approach volumes or projections.
(2) Background versus existing.
(3) Background plus project versus background.
(4) Project generated traffic.

2015 Background Plus Project Level-of-Service Analysis

The level-of-service analysis was performed for background and background plus project conditions. The incremental difference between the two conditions quantifies the impact of the project. The results of the Level-of-Service analysis of the intersection of Mokulele Highway at Kama'aina Road and Mehameha Loop are summarized in Table 9.

Table 9 2015 Background Plus Project Levels-of-Service - Mokulele Hwy at Kama'aina Rd

Intersection and Movement	AM Peak Hour						PM Peak Hour					
	Without Project			With Project			Without Project			With Project		
	V/C	Delay [1]	LOS [2]	V/C	Delay	LOS	V/C	Delay	LOS	V/C	Delay	LOS
Overall Intersection	*0.59*	*6.3*	*A*	*0.85*	*17.1*	*B*	*0.59*	*5.6*	*A*	*1.07*	*32.6*	*C*
Eastbound Left ,Thru & Right	0.10	37.1	D	0.06	34.8	C	0.25	38.2	D	0.07	20.1	C
Westbound Left, Thru & Right	0.24	39.3	D	0.45	38.9	D	0.30	37.3	D	1.01	78.7	E
Northbound Left	0.41	46.7	D	0.53	57.6	E	0.16	41.1	D	0.22	46.3	D
Northbound Thru	0.56	5.6	A	0.79	19.7	B	0.59	4.7	A	0.91	27.0	C
Northbound Right	0.01	2.9	A	0.13	10.6	B	0.01	2.1	A	0.04	10.6	B
Southbound Left	0.56	47.6	D	0.89	53.7	D	0.31	51.2	D	1.06	166.3	F
Southbound Thru	0.52	4.3	A	0.53	5.2	A	0.59	4.7	A	0.84	20.7	C
Southbound Right	0.03	2.2	A	0.03	2.7	A	0.01	2.1	A	0.01	8.8	A

NOTES:
(1) Delay is in seconds per vehicle.
(2) LOS denotes Level-of-Service calculated using the operations method described in *Highway Capacity Manual*. Level-of-Service is based on delay.
(3) See Appendix E for Level-of-Service Analysis Worksheets.

The findings of the level-of-service analysis are:

1. The northbound left will operate at Level-of-Service E during the morning peak hour. However, the volume-to-capacity ratio is 0.53, which means that the long delay is the result of the signal timing. No mitigation is required.

2. During the afternoon peak hour, the westbound approach will operate at Level-of-Service E, the southbound left will operate at Level-of-Service F and the overall intersection will operate at Level-of-Service C, but the volume-to-capacity ratio is 1.07. As the volume-to-capacity ratios for these movements are greater than 1.00, mitigation is required.

Mitigation Measures - Mokulele Highway at Kama'aina Road & Mehameha Loop

An assessment of modifying the westbound approach to provide a separate right turn lane is summarized in Table 10. With this improvement, all controlled movements will operate at Level-of-Service D, or better, the overall intersection will operate at Level-of-Service B and all volume-to-capacity ratios are less than 1.00.

Table 10 Mitigation Analysis - Mokulele Highway at Kama'aina Road & Mehameha Loop

Intersection and Movement	AM Peak Hour						PM Peak Hour					
	Without Mitigation			With Mitigation			Without Mitigation			With Mitigation		
	V/C	Delay [1]	LOS [2]	V/C	Delay	LOS	V/C	Delay	LOS	V/C	Delay	LOS
Overall Intersection	*0.85*	*17.1*	*B*	*0.78*	*16.0*	*B*	*1.07*	*32.6*	*C*	*0.79*	*17.3*	*B*
Eastbound Left ,Thru & Right	0.06	34.8	C	0.08	36.2	D	0.07	20.1	C	0.10	24.0	C
Westbound Left, Thru & Right	0.45	38.9	D				1.01	78.7	E			
Westbound Left & Thru				0.54	44.9	D				0.80	46.2	D
Westbound Right				0.00	41.1	D				0.00	36.1	D
Northbound Left	0.53	57.6	E	0.52	53.9	D	0.22	46.3	D	0.18	39.3	D
Northbound Thru	0.79	19.7	B	0.76	17.5	B	0.91	27.0	C	0.80	15.7	B
Northbound Right	0.13	10.6	B	0.13	9.7	A	0.04	10.6	B	0.04	7.0	A
Southbound Left	0.89	53.7	D	0.89	54.1	D	1.06	166.3	F	0.72	54.7	D
Southbound Thru	0.53	5.2	A	0.52	4.4	A	0.84	20.7	C	0.72	11.3	B
Southbound Right	0.03	2.7	A	0.03	2.3	A	0.01	8.8	A	0.01	5.1	A

NOTES:
(1) Delay is in seconds per vehicle.
(2) LOS denotes Level-of-Service calculated using the operations method described in *Highway Capacity Manual*. Level-of-Service is based on delay.
(3) See Appendix F for Level-of-Service Analysis Worksheets.

Because of the large number of heavy trucks entering and exiting the project via the intersection of Mokulele Highway at Kama'aina Road, the need for an acceleration lane for traffic turning from westbound Kama'aina Road to northbound Mokulele Highway was assessed. A review of information provided in *A Policy on Geometric Design of Highways and Streets*, published by the American Association of State Highway and Transportation Officials (AASHTO), concluded that there are general guidelines regarding the need for an acceleration lane, but no warrants. It should be noted that an acceleration lane was not provided at this intersection or the exit from the Central Maui Baseyard, which is north of this intersection along Mokulele Highway, when Mokulele Highway was recently widened.

The projected number of heavy vehicles that would use an acceleration lane at this location is significantly higher than estimated for background without project conditions. The number of heavy vehicles is expected to increase from 10 to 22 vehicles per hour during the morning peak hour and from zero to 58 vehicles during the afternoon peak hour. Given this significant increase and the impacts that heavy vehicles have on the capacity of intersections and roadways, it is recommended that an acceleration lane be provided for vehicles turning right from westbound Kama'aina Road to northbound Mokulele Highway.

Levels-of-Service of Unsignalized Intersections

The results of the level-of-service analysis are summarized in Table 11.

Table 11 2015 Levels-of-Service of Unsignalized Intersection

Intersection and Movement	AM Peak Hour With Project Delay [2]	AM Peak Hour With Project LOS [3]	PM Peak Hour With Project Delay	PM Peak Hour With Project LOS
S. Firebreak Rd at Quarry Access Rd (Alternate 1)	*1.1*	*A*	*1.0*	*A*
Westbound Left & Right	9.6	A	11.6	B
Southbound Left & Thru	1.0	A	0.9	A
S. Firebreak Rd at Project Access Rd (Alternate 2)	*7.9*	*A*	*8.7*	*A*
Westbound Left & Right	9.0	A	11.4	B
Southbound Left & Thru	8.0	A	7.0	A
Quarry Access Rd at Project Access Rd (Alternate 2)	*12.3*	*B*	*11.6*	*B*
Eastbound Left, Thru & Right	9.4	A	8.7	A
Westbound Left, Thru & Right	9.7	A	9.1	A
Northbound Left, Thru & Right	8.7	A	12.7	B
Southbound Left, Thru & Right	13.4	B	8.8	A

NOTES.
(1) Denotes volume-to-capacity ratio. Volume-to-capacity ratios are not calculated for the unsignalized intersections.
(2) Delay is in seconds per vehicle.
(3) LOS denotes Level-of-Service calculated using the operations method described in Highway Capacity Manual. Level-of-Service is based on delay.
(4) See Appendix G for Level-of-Service Analysis Worksheets.

Alternate 1

For Alternate 1, the only unsignalized intersection with controlled lane groups is the intersection of South Firebreak Road at Quarry Access Road. At this intersection, all project related traffic will continue south to the industrial subdivision while all quarry related traffic will use the Quarry Access Road. It was assumed that the Quarry Access Road approach is the STOP sign controlled approach. Refer to Figure 10.

All controlled lane groups will operate at Level-of-Service A or B. This implies good operating conditions and minimal delays.

Alternate 2

For Alternate 2, two intersections have controlled lane groups: South Firebreak Road at the Project Access Road and the Quarry Access Road at the Project Access Road. At the intersection of South Firebreak Road at the Project Access Road, all project related traffic will turn onto the Project Access Road and all quarry related traffic will continue to use the south leg of the intersection. It was assumed that the Project Access Road approach is the STOP sign controlled approach. At the intersection of the Quarry Access Road at the Project Access Road, all northbound and southbound traffic is project related while all eastbound and westbound traffic is quarry related. Refer to Figure 11. It was assumed that all approaches are STOP sign controlled and that no turns will be allowed at this intersection.

All controlled lane groups movements will operate at Level-of-Service A or B. This implies good operating conditions and minimal delays.

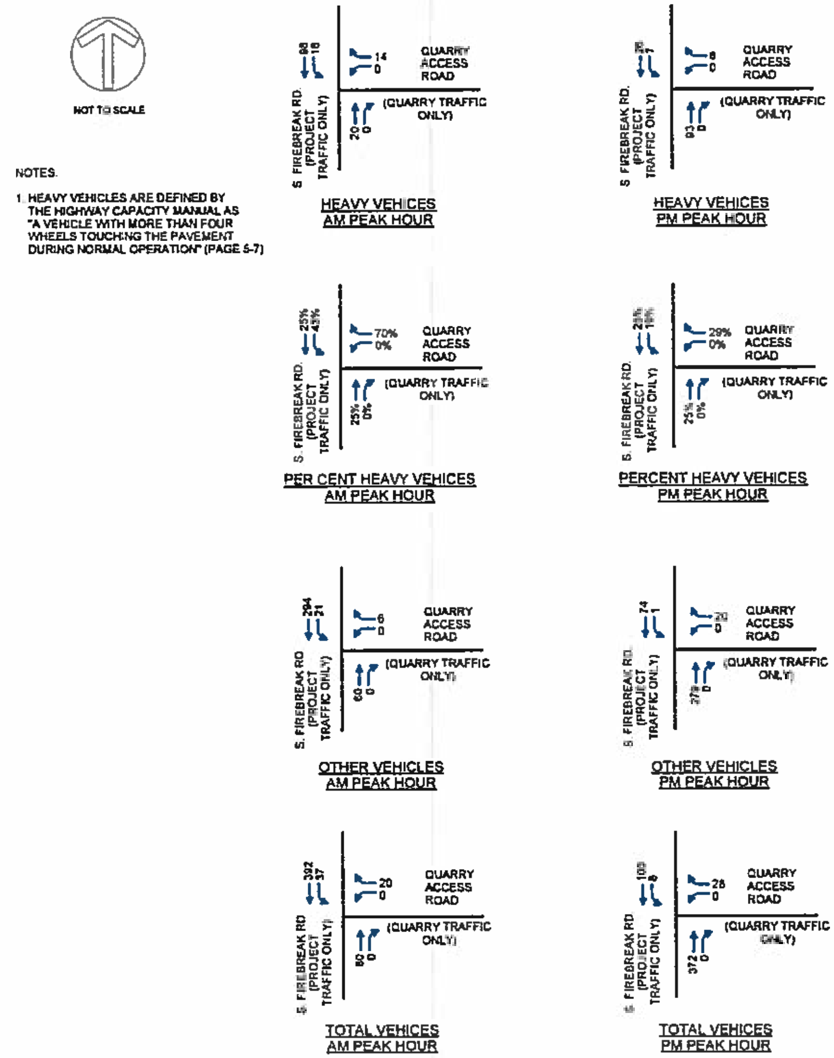


Figure 10
2015 BACKGROUND PLUS PROJECT TRAFFIC PROJECTIONS AT UNSIGNALIZED INTERSECTIONS (ALTERNATE 1)

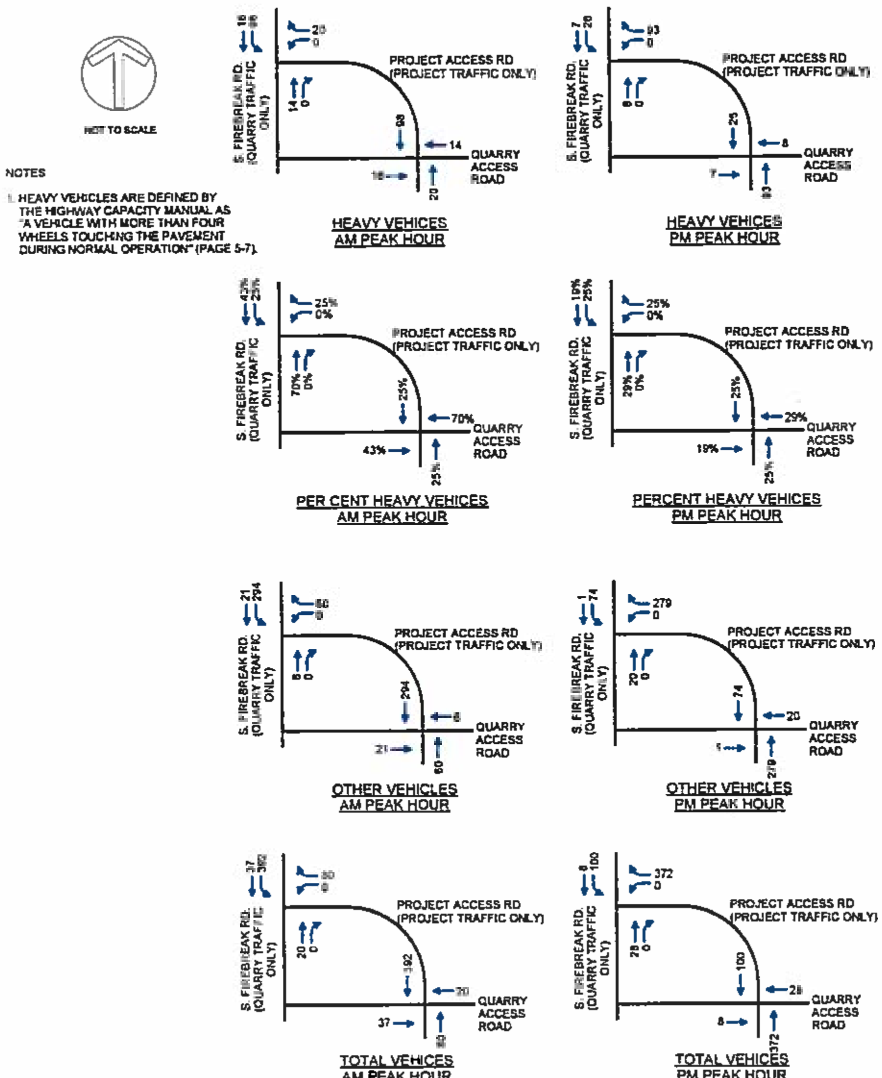


Figure 11
2015 BACKGROUND PLUS PROJECT TRAFFIC PROJECTIONS AT UNSIGNALIZED INTERSECTIONS (ALTERNATE 2)

Required Left Turn Storage Lane Lengths

The left turn storage lengths required to accommodate estimated traffic volumes were calculated using guidelines in *A Policy on Geometric Design of Highways and Streets* published by the American Association of State Highway and Transportation Officials. There are separate policies for signalized and unsignalized intersections, but as the subject intersection is signalized, only the policy relative to signalized intersections is provided. The policy and assumptions used are as follows:

1. For signalized intersections, the length of the left turn storage lane should be "1.5 to 2.0 times the average number of vehicles that would store per cycle, which is predicted on the design volume."

2. The average length required per vehicle is 25 feet.

3. As a minimum, a left turn storage lane should accommodate two vehicles, one automobile size vehicle and one truck. A length of 60 feet has been typically used as a minimum.

4. A traffic signal cycle length of 90 seconds was used. This is longer than the cycle length currently in use. Since the length of the left turn storage lane is directly related to the signal cycle length, using a longer cycle length will insure that queues do not exceed the capacity of the storage lane if the traffic signal timing is modified at a future date.

Using the above criteria, the left turn storage lane requirements were calculated and the results are summarized in Table 12. Also shown are the storage lane length recommended.

Table 12 Left Turn Storage Lane Requirements

Intersection	Approach & Time Period		Design Volume	Cycle Length (Seconds)	Cycles per Hour	Average Vehicles per Cycle	Recommended Length (1) Minimum Veh	Minimum Ft	Desirable Veh	Desirable Ft	Recommendation
Mokulele Hwy at Kama'aina Road	NB	AM	5	90	40	0	0	0	0	0	Retain 60 ft storage lane
		PM	2	90	40	0	0	0	0	0	
	SB	AM	274	90	40	7	11	275	14	350	Increase length of left turn storage lane from 60 to 350 ft
		PM	64	90	40	2	3	75	4	100	

NOTE:
(1) Minimum queue length is 1.5 times average number of vehicles. Desirable queue length is 2.0 times average number of vehicles.

The existing and recommended turn lanes and storage lane lengths at the intersection of Mokulele Highway at Kama'aina Road are summarized as Table 13. The turn lanes consist of three components: the taper, the deceleration length and the storage length. The deceleration length is a function of the design speed of the roadway. It is the length required for a driver to safely decelerate from the travel speed of the roadway to a stop condition at the beginning of the storage area. The storage length calculations are described above.

Table 13 Assessment of Deceleration Lane Requirements

Intersection	Approach & Movement		Existing [1] Taper (feet)	Existing [1] Deceleration Length (feet)	Existing [1] Storage (feet)	Recommended Taper (feet)	Recommended Deceleration Length (feet)	Recommended Storage (feet)
Mokulele Hwy at Kama'aina Road	NB	Left	180	510	60	180	510	60
		Right	180	475	60	180	475	60
	SB	Left	180	485	60	180	485	350
		Right	180	430	60	180	430	60

NOTE:
(1) Existing lengths were obtained from construction plans of the subject intersection. Plans are dated June 2005.

Summary Mitigation Measures and Recommendations

Table 14 is a summary of mitigation required at the intersection of Mokulele Highway at Kama'aina Road. A drawing of these mitigation improvements prepared by the project's civil engineer is presented as Appendix I.

Table 14 Summary of Recommended Mitigation for 2015 Background Conditions

Intersection	Mitigation Required to Mitigate Existing (2011) Deficiencies	Mitigation Required to Mitigate Background Deficiencies	Mitigation Required to Mitigate Background Plus Project Deficiencies
Mokulele Hwy at Kama'aina Rd and Mehameha Loop	No mitigation required.	No mitigation required.	1. Modify westbound approach to provide a separate right turn lane. 2. Provide acceleration lane for westbound to northbound right turns. 3. Lengthen southbound left turn deceleration lane from 60 feet to 350 feet

In addition to the mitigation measures described above, the following is recommended:

1. The areas adjacent to Kama'aina Road, South Firebreak Road and Lower Kihei Road should be monitored to insure that the sugar cane growth does not impede sight distances and that visibility of traffic control devices is maintained.

2. Because of the increased traffic volumes along Kama'aina Road, South Firebreak Road and Lower Kihei Road as a result of the project, these roadways should be striped and signed per County of Maui Standards. The high proportion of traffic that will be heavy vehicles should be considered in the design and installation of traffic control devices, especially the longer stopping distances required for the heavy vehicles.

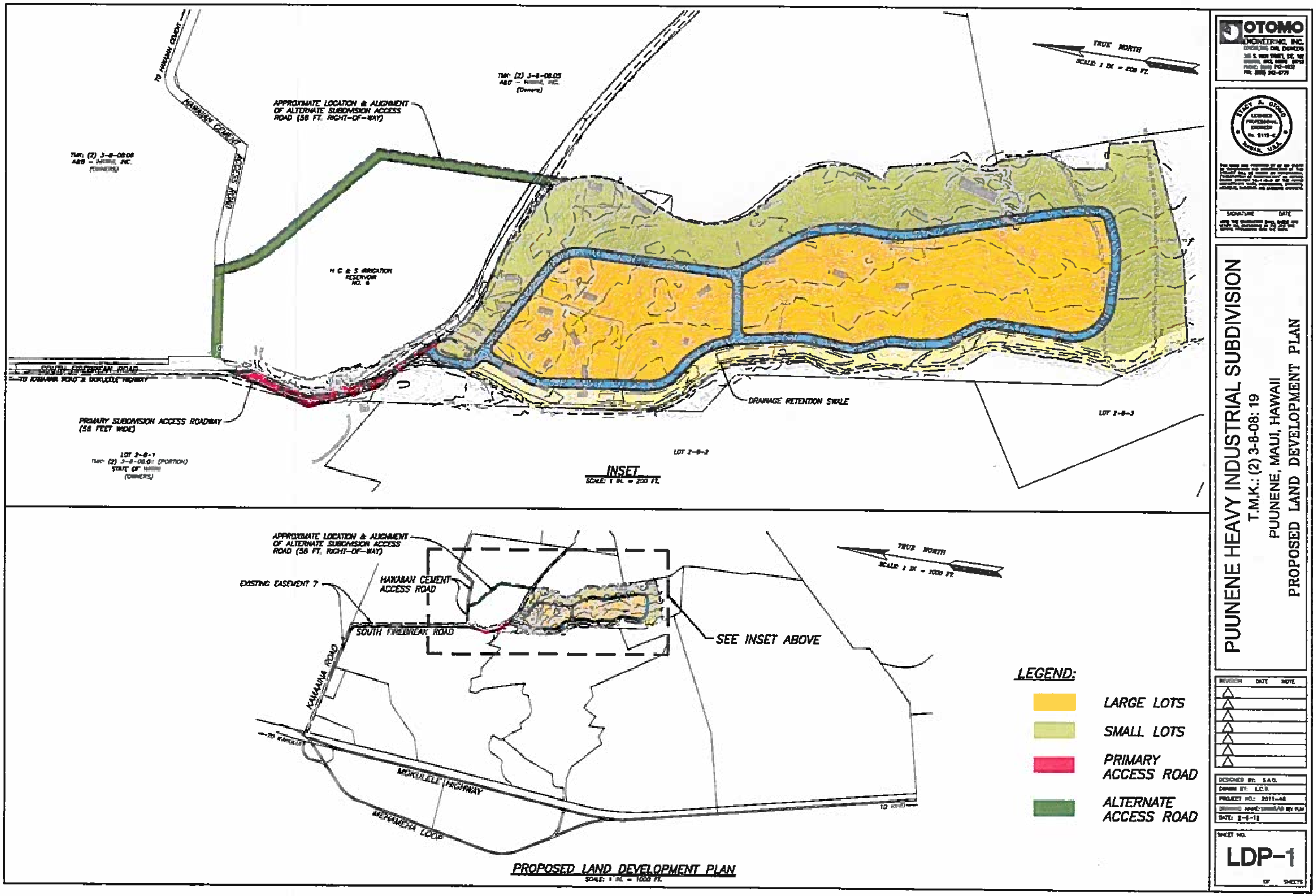
Early Consultation Letters and Responses

Letters were received from the following agencies in response to requests for early consultation comments:

1. State of Hawaii Department of Transportation
2. State of Hawaii Department of Business, Economic Development and Tourism Office of Planning
3. County of Maui Police Department
4. County of Maui Department of Planning

The letter from County of Maui Department of Planning did not contain any issues relative to the TIAR and the comments from Office of Planning advised to contact State of Hawaii Department of Transportation, which was done and a comment letter received. The comments from State of Hawaii Department of Transportation and County of Maui Police Department have been responded to. The comments and responses are provided as Appendix H.

Appendix A
Proposed Land Development Plan
(Provided by Otomo Engineering, Inc.)



PUUNENE HEAVY INDUSTRIAL SUBDIVISION
T.M.K.: (2) 3-8-08: 19
PUUNENE, MAUI, HAWAII
PROPOSED LAND DEVELOPMENT PLAN
OTOMO ENGINEERING, INC.
LDP-1
TRUE NORTH
SCALE: 1 IN. = 200 FT.
APPROXIMATE LOCATION & ALIGNMENT OF ALTERNATE SUBDIVISION ACCESS ROAD (56 FT. RIGHT-OF-WAY)
H C & S IRRIGATION RESERVOIR NO. 6
SOUTH FIREBREAK ROAD
TO KAMAAINA ROAD & MOKULELE HIGHWAY
PRIMARY SUBDIVISION ACCESS ROADWAY (56 FEET WIDE)
DRAINAGE RETENTION SWALE
LOT 2-8-3
LOT 2-8-2
INSET
SCALE: 1 IN. = 200 FT.
EXISTING EASEMENT 7
HAWAIIAN CEMENT ACCESS ROAD
SEE INSET ABOVE
KAMAAINA ROAD
MOKULELE HIGHWAY
MEHAMEHA LOOP
SCALE: 1 IN. = 1000 FT.
PROPOSED LAND DEVELOPMENT PLAN
SCALE: 1 IN. = 1000 FT.
LEGEND:
LARGE LOTS
SMALL LOTS
PRIMARY ACCESS ROAD
ALTERNATE ACCESS ROAD

Appendix B
Traffic Count Summary Worksheets

TRAFFIC COUNT SUMMARY WORKSHEET

PROJECT: PUUNENE HEAVY INDUSTRIAL SUBDIVISION
INTERSECTION: Mokulele Highway at Kamaaina Road and Mehameha Loop (TOTAL VEHICLES)
DAY & DATE: Friday, August 12, 2011
START TIME: 6:45 am
END TIME: 8:30 am

15-Minute Volumes Beginning at:

Interval	Start Time	North Approach 1	2	3	East Approach 4	5	6	South Approach 7	8	9	West Approach 10	11	12	Totals
1	6:45 am	3	180	11	5	0	2	0	193	1	0	0	0	395
2	7:00 am	1	210	12	6	0	1	2	243	1	0	0	0	476
3	7:15 am	1	251	5	4	0	0	1	284	0	1	0	0	547
4	7:30 am	4	273	10	4	0	2	1	300	4	0	0	0	598
5	7:45 am	6	275	7	5	0	0	0	272	2	0	0	1	568
6	8:00 am	11	241	9	2	0	3	4	230	3	0	0	2	505
7	8:15 am													0
8	8:30 am													0
9	8:45 am													0
10	9:00 am													0
11	9:15 am													0
12	9:30 am													0
13	9:45 am													0
14	10:00 am													0
	Maximum:	11	275	12	6	0	3	4	300	4	1	0	2	598

Hourly Volume of Each Movement

		1	2	3	4	5	6	7	8	9	10	11	12	Totals
6:45 am	7:45 am	9	914	38	19	0	5	4	1020	6	1	0	0	2016
7:00 am	8:00 am	12	1009	34	19	0	3	4	1099	7	1	0	1	2189
7:15 am	8:15 am	22	1040	31	15	0	5	6	1086	9	1	0	3	2218
7:30 am	8:30 am													
7:45 am	8:45 am													
8:00 am	9:00 am													
8:15 am	9:15 am													
8:30 am	9:30 am													
8:45 am	9:45 am													
9:00 am	10:00 am													
9:15 am	10:15 am													
Peak Hour Volume		22	1040	31	15	0	5	6	1086	9	1	0	3	2218
Peak Hour Factor:		0.50	0.95	0.65	0.63	0.00	0.42	0.38	0.91	0.56	0.25	0.00	0.38	0.93

	North Approach	East Approach	South Approach	West Approach
Total Arrivals	1093	20	1101	4
Total Departures	1104	37	1046	31
Total	2197	57	2147	35

TRAFFIC COUNT SUMMARY WORKSHEET

PROJECT: PUUNENE HEAVY INDUSTRIAL SUBDIVISION
INTERSECTION: Mokulele Highway at Kamaaina Road and Mehameha Loop (HEAVY VEHICLES)
DAY & DATE: Friday, August 12, 2011
START TIME: 6:45 am
END TIME: 8:30 am

15-Minute Volumes Beginning at:

Interval	Start Time	North Approach			East Approach			South Approach			West Approach			
		1	2	3	4	5	6	7	8	9	10	11	12	Totals
1	6:45 am	0	14	4	4	0	0	0	8	0	0	0	0	30
2	7:00 am	0	8	3	3	0	1	2	17	0	0	0	0	34
3	7:15 am	0	13	3	3	0	0	1	11	0	0	0	0	31
4	7:30 am	0	12	6	3	0	2	0	6	0	0	0	0	29
5	7:45 am	0	17	3	2	0	0	0	6	0	0	0	0	28
6	8:00 am	0	17	4	2	0	2	0	12	0	0	0	0	37
7	8:15 am													0
8	8:30 am													0
9	8:45 am													0
10	9:00 am													0
11	9:15 am													0
12	9:30 am													0
13	9:45 am													0
14	10:00 am													0
	Maximum:	0	17	6	4	0	2	2	17	0	0	0	0	37

Hourly Volume of Each Movement

		1	2	3	4	5	6	7	8	9	10	11	12	Totals
6:45 am	7:45 am	0	47	16	13	0	3	3	42	0	0	0	0	124
7:00 am	8:00 am	0	50	15	11	0	3	3	40	0	0	0	0	122
7:15 am	8:15 am	0	59	16	10	0	4	1	35	0	0	0	0	125
7:30 am	8:30 am													
7:45 am	8:45 am													
8:00 am	9:00 am													
8:15 am	9:15 am													
8:30 am	9:30 am													
8:45 am	9:45 am													
9:00 am	10:00 am													
9:15 am	10:15 am													
Peak Hour Volume		0	59	16	10	0	4	1	35	0	0	0	0	125
Peak Hour Factor:		0.00	0.87	0.67	0.63	0.00	0.50	0.13	0.51	0.00	0.00	0.00	0.00	0.84
Total Arrivals			75			14			36			0		
Total Departures			45			17			63			0		
Total			120			31			99			0		

TRAFFIC COUNT SUMMARY WORKSHEET

PROJECT: PUUNENE HEAVY INDUSTRIAL SUBDIVISION
INTERSECTION: Mokulele Highway at Kamaaina Road and Mehameha Loop (TOTAL VEHICLES)
DAY & DATE: Thursday, August 11, 2011
START TIME: 3:30 pm
END TIME: 5:30 pm

15-Minute Volumes Beginning at:

Interval	Start Time	North Approach			East Approach			South Approach			West Approach			
		1	2	3	4	5	6	7	8	9	10	11	12	Totals
1	3:30 pm	4	282	0	7	0	3	3	327	0	4	0	5	635
2	3:45 pm	4	313	1	3	0	5	0	247	1	4	0	4	582
3	4:00 pm	1	277	1	4	0	0	2	290	1	0	0	6	582
4	4:15 pm	0	289	0	3	0	3	1	318	0	3	0	4	621
5	4:30 pm	1	283	0	4	0	0	0	266	1	3	0	2	560
6	4:45 pm	1	311	0	2	0	1	0	237	2	2	0	4	560
7	5:00 pm	1	284	0	0	0	0	1	269	0	2	0	1	558
8	5:15 pm	0	308	0	1	0	1	0	291	0	1	0	1	603
9	5:30 pm													0
10	5:45 pm													0
11	6:00 pm													0
12	6:15 pm													0
13	6:30 pm													0
14	6:45 pm													0
	Maximum:	4	313	1	7	0	5	3	327	2	4	0	6	635

Hourly Volume of Each Movement

		1	2	3	4	5	6	7	8	9	10	11	12	Totals
3:30 pm	4:30 pm	9	1161	2	17	0	11	6	1182	2	11	0	19	2420
3:45 pm	4:45 pm	6	1162	2	14	0	8	3	1121	3	10	0	16	2345
4:00 pm	5:00 pm	3	1160	1	13	0	4	3	1111	4	8	0	16	2323
4:15 pm	5:15 pm	3	1167	0	9	0	4	2	1090	3	10	0	11	2299
4:30 pm	5:30 pm	3	1186	0	7	0	2	1	1063	3	8	0	8	2281
4:45 pm	5:45 pm													
5:00 pm	6:00 pm													
5:15 pm	6:15 pm													
5:30 pm	6:30 pm													
5:45 pm	6:45 pm													
6:00 pm	7:00 pm													
Peak Hour Volume		9	1161	2	17	0	11	6	1182	2	11	0	19	2420
Peak Hour Factor:		0.56	0.93	0.50	0.61	0.00	0.55	0.50	0.90	0.25	0.69	0.00	0.79	0.95
Total Arrivals			1172			28			1190			30		
Total Departures			1218			8			1183			11		
Total			2390			36			2373			41		

TRAFFIC COUNT SUMMARY WORKSHEET

PROJECT: PUUNENE HEAVY INDUSTRIAL SUBDIVISION
INTERSECTION: Mokulele Highway at Kamaaina Road and Mehameha Loop (HEAVY VEHICLES)
DAY & DATE: Thursday, August 11, 2011
START TIME: 3:30 pm
END TIME: 5:30 pm

15-Minute Volumes Beginning at:

Interval	Start Time	North Approach 1	2	3	East Approach 4	5	6	South Approach 7	8	9	West Approach 10	11	12	Totals
1	3:30 pm	0	3	0	0	0	2	2	7	0	0	0	0	14
2	3:45 pm	0	2	1	0	0	3	0	11	0	0	0	0	17
3	4:00 pm	0	3	1	0	0	0	2	12	0	0	0	0	18
4	4:15 pm	0	4	0	0	0	3	1	7	0	0	0	0	15
5	4:30 pm	0	4	0	0	0	0	0	8	0	0	0	0	12
6	4:45 pm	0	2	0	0	0	0	0	9	0	0	0	0	11
7	5:00 pm	0	4	0	0	0	0	0	2	0	0	0	0	6
8	5:15 pm	0	2	0	0	0	0	0	4	0	0	0	0	6
9	5:30 pm													0
10	5:45 pm													0
11	6:00 pm													0
12	6:15 pm													0
13	6:30 pm													0
14	6:45 pm													0
	Maximum:	0	4	1	0	0	3	2	12	0	0	0	0	18

Hourly Volume of Each Movement

		1	2	3	4	5	6	7	8	9	10	11	12	Totals
3:30 pm	4:30 pm	0	12	2	0	0	8	6	37	0	0	0	0	64
3:45 pm	4:45 pm	0	13	2	0	0	6	3	38	0	0	0	0	62
4:00 pm	5:00 pm	0	13	1	0	0	3	3	36	0	0	0	0	56
4:15 pm	5:15 pm	0	14	0	0	0	3	1	26	0	0	0	0	44
4:30 pm	5:30 pm	0	12	0	0	0	0	0	23	0	0	0	0	35
4:45 pm	5:45 pm													
5:00 pm	6:00 pm													
5:15 pm	6:15 pm													
5:30 pm	6:30 pm													
5:45 pm	6:45 pm													
6:00 pm	7:00 pm													
Peak Hour Volume		0	12	2	0	0	8	5	37	0	0	0	0	64
Peak Hour Factor		0.00	0.75	0.50	0.00	0.00	0.67	0.63	0.77	0.00	0.00	0.00	0.00	0.89
Total Arrivals			14			8			42			0		
Total Departures			37			7			20			0		
Total			51			15			62			0		

Appendix C
Level-of-Service Worksheets for Existing Conditions

HCM Signalized Intersection Capacity Analysis
1: KAMA'AINA ROAD & MOKULELE HIGHWAY

11/30/2011

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0		4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor		1.00			1.00		1.00	0.95	1.00	1.00	0.95	1.00
Frt		0.95			0.92		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected		0.97			0.98		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)		1756			994		1805	3505	1380	1220	3406	1615
Flt Permitted		0.78			0.87		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)		1415			882		1805	3505	1380	1220	3406	1615
Volume (vph)	3	0	1	5	0	15	9	1086	6	31	1040	22
Peak-hour factor, PHF	0.38	0.92	0.25	0.42	0.92	0.75	0.56	0.91	0.38	0.78	0.95	0.50
Adj. Flow (vph)	8	0	4	12	0	20	16	1193	16	40	1095	44
RTOR Reduction (vph)	0	4	0	0	19	0	0	0	4	0	0	10
Lane Group Flow (vph)	0	8	0	0	13	0	16	1193	12	40	1095	34
Heavy Vehicles (%)	0%	0%	0%	80%	0%	67%	0%	3%	17%	48%	6%	0%
Turn Type	Perm			Perm			Prot		Perm	Prot		Perm
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4			8					2			6
Actuated Green, G (s)		5.0			5.0		1.5	60.7	60.7	4.8	64.0	64.0
Effective Green, g (s)		5.0			5.0		1.5	60.7	60.7	4.8	64.0	64.0
Actuated g/C Ratio		0.06			0.06		0.02	0.74	0.74	0.06	0.78	0.78
Clearance Time (s)		4.0			4.0		4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)		3.0			3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)		86			53		33	2579	1015	71	2642	1253
v/s Ratio Prot							0.01	c0.34		c0.03	c0.32	
v/s Ratio Perm		0.01			c0.04				0.01			0.03
v/c Ratio		0.10			0.25		0.48	0.46	0.01	0.56	0.41	0.03
Uniform Delay, d1		36.6			37.0		40.1	4.4	2.9	37.8	3.1	2.1
Progression Factor		1.00			1.00		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2		0.5			2.5		10.8	0.6	0.0	9.8	0.5	0.0
Delay (s)		37.1			39.4		50.9	5.0	2.9	47.7	3.5	2.2
Level of Service		D			D		D	A	A	D	A	A
Approach Delay (s)		37.1			39.4			5.5			5.0	
Approach LOS		D			D			A			A	

Intersection Summary			
HCM Average Control Delay	5.9	HCM Level of Service	A
HCM Volume to Capacity ratio	0.50		
Actuated Cycle Length (s)	82.5	Sum of lost time (s)	16.0
Intersection Capacity Utilization	40.0%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
1: KAMA'AINA ROAD & MOKULELE HIGHWAY

8/25/2011

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0		4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor		1.00			1.00		1.00	0.95	1.00	1.00	0.95	1.00
Frt		0.95			0.92		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected		0.97			0.98		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)		1745			1315		1805	3505	883	902	3574	1615
Flt Permitted		0.90			0.87		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)		1615			1166		1805	3505	883	902	3574	1615
Volume (vph)	19	0	11	11	0	17	2	1182	6	2	1161	9
Peak-hour factor, PHF	0.79	0.92	0.69	0.55	0.92	0.61	0.50	0.90	0.50	0.50	0.93	0.56
Adj. Flow (vph)	24	0	16	20	0	28	4	1313	12	4	1248	16
RTOR Reduction (vph)	0	15	0	0	26	0	0	0	3	0	0	4
Lane Group Flow (vph)	0	25	0	0	22	0	4	1313	9	4	1248	12
Heavy Vehicles (%)	0%	0%	0%	73%	0%	0%	0%	3%	83%	100%	1%	0%
Turn Type	Perm			Perm			Prot		Perm	Prot		Perm
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4			8					2			6
Actuated Green, G (s)		4.9			4.9		1.1	60.2	60.2	1.1	60.2	60.2
Effective Green, g (s)		4.9			4.9		1.1	60.2	60.2	1.1	60.2	60.2
Actuated g/C Ratio		0.06			0.06		0.01	0.77	0.77	0.01	0.77	0.77
Clearance Time (s)		4.0			4.0		4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)		3.0			3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)		101			73		25	2698	680	13	2751	1243
v/s Ratio Prot							0.00	c0.37		c0.00	0.35	
v/s Ratio Perm		0.02			c0.04				0.01			0.01
v/c Ratio		0.25			0.30		0.16	0.49	0.01	0.31	0.45	0.01
Uniform Delay, d1		34.9			35.0		38.1	3.3	2.1	38.2	3.2	2.1
Progression Factor		1.00			1.00		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2		1.3			2.3		3.0	0.6	0.0	13.0	0.5	0.0
Delay (s)		36.2			37.3		41.1	3.9	2.1	51.2	3.7	2.1
Level of Service		D			D		D	A	A	D	A	A
Approach Delay (s)		36.2			37.3			4.0			3.9	
Approach LOS		D			D			A			A	

Intersection Summary			
HCM Average Control Delay	5.0	HCM Level of Service	A
HCM Volume to Capacity ratio	0.50		
Actuated Cycle Length (s)	78.2	Sum of lost time (s)	12.0
Intersection Capacity Utilization	42.7%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Appendix D
Level-of-Service Worksheets for 2015 Background Conditions

HCM Signalized Intersection Capacity Analysis
1: KAMA'AINA ROAD & MOKULELE HIGHWAY

8/25/2011

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		✥			✥		↰	↑↑	↱	↰	↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0		4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor		1.00			1.00		1.00	0.95	1.00	1.00	0.95	1.00
Frt		0.95			0.92		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected		0.97			0.98		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)		1756			994		1805	3505	1380	1220	3438	1615
Flt Permitted		0.78			0.87		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)		1415			882		1805	3505	1380	1220	3438	1615
Volume (vph)	3	0	1	5	0	15	9	1371	6	31	1301	22
Peak-hour factor, PHF	0.38	0.92	0.25	0.42	0.92	0.75	0.58	0.95	0.38	0.78	0.95	0.50
Adj. Flow (vph)	8	0	4	12	0	20	16	1443	16	40	1369	44
RTOR Reduction (vph)	0	4	0	0	19	0	0	0	4	0	0	10
Lane Group Flow (vph)	0	8	0	0	13	0	16	1443	12	40	1369	34
Heavy Vehicles (%)	0%	0%	0%	80%	0%	67%	0%	3%	17%	48%	5%	0%
Turn Type	Perm			Perm			Prot		Perm	Prot		Perm
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4			8					2			6
Actuated Green, G (s)		5.0			5.0		1.8	60.6	60.6	4.8	63.6	63.6
Effective Green, g (s)		5.0			5.0		1.8	60.6	60.6	4.8	63.6	63.6
Actuated g/C Ratio		0.06			0.06		0.02	0.74	0.74	0.06	0.77	0.77
Clearance Time (s)		4.0			4.0		4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)		3.0			3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)		86			54		39	2578	1015	71	2654	1247
v/s Ratio Prot							0.01	c0.41		c0.03	c0.40	
v/s Ratio Perm		0.01			c0.04				0.01			0.03
v/c Ratio		0.10			0.24		0.41	0.56	0.01	0.56	0.52	0.03
Uniform Delay, d1		36.6			36.9		39.8	4.9	2.9	37.8	3.6	2.2
Progression Factor		1.00			1.00		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2		0.5			2.4		6.9	0.9	0.0	9.8	0.7	0.0
Delay (s)		37.1			39.3		46.7	5.8	2.9	47.6	4.3	2.2
Level of Service		D			D		D	A	A	D	A	A
Approach Delay (s)		37.1			39.3			6.2			5.4	
Approach LOS		D			D			A			A	

Intersection Summary			
HCM Average Control Delay	6.3	HCM Level of Service	A
HCM Volume to Capacity ratio	0.59		
Actuated Cycle Length (s)	82.4	Sum of lost time (s)	16.0
Intersection Capacity Utilization	47.9%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
1: KAMA'AINA ROAD & MOKULELE HIGHWAY 1/24/2012

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0		4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor		1.00			1.00		1.00	0.95	1.00	1.00	0.95	1.00
Frt		0.95			0.92		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected		0.97			0.98		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)		1745			1315		1805	3539	883	902	3574	1615
Flt Permitted		0.90			0.87		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)		1615			1166		1805	3539	883	902	3574	1615
Volume (vph)	19	0	11	11	0	17	2	1521	6	2	1536	9
Peak-hour factor, PHF	0.79	0.92	0.69	0.55	0.92	0.61	0.50	0.95	0.50	0.50	0.95	0.56
Adj. Flow (vph)	24	0	16	20	0	28	4	1601	12	4	1617	16
RTOR Reduction (vph)	0	15	0	0	26	0	0	0	3	0	0	4
Lane Group Flow (vph)	0	25	0	0	22	0	4	1601	9	4	1617	12
Heavy Vehicles (%)	0%	0%	0%	73%	0%	0%	0%	2%	83%	100%	1%	0%
Turn Type	Perm			Perm			Prot		Perm	Prot		Perm
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4			8					2			6
Actuated Green, G (s)		4.9			4.9		1.1	60.2	60.2	1.1	60.2	60.2
Effective Green, g (s)		4.9			4.9		1.1	60.2	60.2	1.1	60.2	60.2
Actuated g/C Ratio		0.06			0.06		0.01	0.77	0.77	0.01	0.77	0.77
Clearance Time (s)		4.0			4.0		4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)		3.0			3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)		101			73		25	2724	680	13	2751	1243
v/s Ratio Prot							0.00	0.45		c0.00	c0.45	
v/s Ratio Perm		0.02			c0.04				0.01			0.01
v/c Ratio		0.25			0.30		0.16	0.59	0.01	0.31	0.59	0.01
Uniform Delay, d1		34.9			35.0		38.1	3.8	2.1	38.2	3.8	2.1
Progression Factor		1.00			1.00		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2		1.3			2.3		3.0	0.9	0.0	13.0	0.9	0.0
Delay (s)		36.2			37.3		41.1	4.7	2.1	51.2	4.7	2.1
Level of Service		D			D		D	A	A	D	A	A
Approach Delay (s)		36.2			37.3			4.8			4.8	
Approach LOS		D			D			A			A	

Intersection Summary			
HCM Average Control Delay	5.6	HCM Level of Service	A
HCM Volume to Capacity ratio	0.59		
Actuated Cycle Length (s)	78.2	Sum of lost time (s)	12.0
Intersection Capacity Utilization	52.5%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Appendix E
Level-of-Service Worksheets for 2015 Background Plus Project Conditions

HCM Signalized Intersection Capacity Analysis
1: KAMA'AINA ROAD & MOKULELE HIGHWAY

9/1/2011

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0		4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor		1.00			1.00		1.00	0.95	1.00	1.00	0.95	1.00
Frt		0.95			0.91		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected		0.97			0.98		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)		1756			1276		1805	3505	1292	1410	3438	1615
Flt Permitted		0.80			0.88		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)		1445			1138		1805	3505	1292	1410	3438	1615
Volume (vph)	3	0	1	36	0	64	9	1371	155	274	1301	22
Peak-hour factor, PHF	0.38	0.92	0.25	0.90	0.92	0.90	0.56	0.95	0.90	0.90	0.95	0.50
Adj. Flow (vph)	8	0	4	40	0	71	16	1443	172	304	1369	44
RTOR Reduction (vph)	0	4	0	0	65	0	0	0	82	0	0	11
Lane Group Flow (vph)	0	8	0	0	46	0	16	1443	90	304	1369	33
Heavy Vehicles (%)	0%	0%	0%	33%	0%	34%	0%	3%	25%	28%	5%	0%
Turn Type	Perm			Perm			Prot		Perm	Prot		Perm
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4			8					2			6
Actuated Green, G (s)		7.6			7.6		1.4	43.5	43.5	20.2	62.3	62.3
Effective Green, g (s)		7.6			7.6		1.4	43.5	43.5	20.2	62.3	62.3
Actuated g/C Ratio		0.09			0.09		0.02	0.52	0.52	0.24	0.75	0.75
Clearance Time (s)		4.0			4.0		4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)		3.0			3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)		132			104		30	1830	675	342	2571	1208
v/s Ratio Prot							0.01	c0.41		c0.22	0.40	
v/s Ratio Perm		0.01			c0.10				0.13			0.03
v/c Ratio		0.06			0.45		0.53	0.79	0.13	0.89	0.53	0.03
Uniform Delay, d1		34.6			35.9		40.6	16.2	10.2	30.5	4.4	2.7
Progression Factor		1.00			1.00		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2		0.2			3.0		17.0	3.5	0.4	23.2	0.8	0.0
Delay (s)		34.8			38.9		57.6	19.7	10.6	53.7	5.2	2.7
Level of Service		C			D		E	B	B	D	A	A
Approach Delay (s)		34.8			38.9			19.1			13.7	
Approach LOS		C			D			B			B	

Intersection Summary			
HCM Average Control Delay	17.1	HCM Level of Service	B
HCM Volume to Capacity ratio	0.85		
Actuated Cycle Length (s)	83.3	Sum of lost time (s)	12.0
Intersection Capacity Utilization	68.9%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
1: KAMA'AINA ROAD & MOKULELE HIGHWAY

8/30/2011

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0		4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor		1.00			1.00		1.00	0.95	1.00	1.00	0.95	1.00
Frt		0.95			0.92		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected		0.97			0.98		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)		1745			1368		1805	3539	1205	1410	3574	1615
Flt Permitted		0.76			0.86		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)		1370			1196		1805	3539	1205	1410	3574	1615
Volume (vph)	19	0	11	152	0	248	2	1521	44	64	1536	9
Peak-hour factor, PHF	0.79	0.92	0.69	0.90	0.92	0.90	0.50	0.95	0.90	0.90	0.95	0.56
Adj. Flow (vph)	24	0	16	169	0	276	4	1601	49	71	1617	16
RTOR Reduction (vph)	0	11	0	0	74	0	0	0	25	0	0	7
Lane Group Flow (vph)	0	29	0	0	371	0	4	1601	24	71	1617	9
Heavy Vehicles (%)	0%	0%	0%	28%	0%	23%	0%	2%	34%	28%	1%	0%
Turn Type	Perm			Perm			Prot		Perm	Prot		Perm
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4			8					2			6
Actuated Green, G (s)		25.0			25.0		0.8	40.7	40.7	3.9	43.8	43.8
Effective Green, g (s)		25.0			25.0		0.8	40.7	40.7	3.9	43.8	43.8
Actuated g/C Ratio		0.31			0.31		0.01	0.50	0.50	0.05	0.54	0.54
Clearance Time (s)		4.0			4.0		4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)		3.0			3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)		420			366		18	1765	601	67	1918	867
v/s Ratio Prot							0.00	c0.45		c0.05	c0.45	
v/s Ratio Perm		0.03			c0.37				0.04			0.01
v/c Ratio		0.07			1.01		0.22	0.91	0.04	1.06	0.84	0.01
Uniform Delay, d1		20.1			28.3		40.1	18.7	10.5	38.8	16.0	8.8
Progression Factor		1.00			1.00		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2		0.1			50.4		6.2	8.3	0.1	127.4	4.7	0.0
Delay (s)		20.1			78.7		46.3	27.0	10.6	166.3	20.7	8.8
Level of Service		C			E		D	C	B	F	C	A
Approach Delay (s)		20.1			78.7			26.6			26.7	
Approach LOS		C			E			C			C	

Intersection Summary			
HCM Average Control Delay	32.6	HCM Level of Service	C
HCM Volume to Capacity ratio	1.07		
Actuated Cycle Length (s)	81.6	Sum of lost time (s)	16.0
Intersection Capacity Utilization	80.5%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Appendix F
Level-of-Service Worksheets for 2015 Background Plus Project Conditions with Mitigation

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor		1.00			1.00	1.00	1.00	0.95	1.00	1.00	0.95	1.00
Frt		0.95			1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected		0.97			0.95	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)		1756			1357	1205	1805	3505	1292	1410	3438	1615
Flt Permitted		0.78			0.75	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)		1424			1071	1205	1805	3505	1292	1410	3438	1615
Volume (vph)	3	0	1	36	0	64	9	1371	155	274	1301	22
Peak-hour factor, PHF	0.38	0.92	0.25	0.90	0.92	0.90	0.56	0.95	0.90	0.90	0.95	0.50
Adj. Flow (vph)	8	0	4	40	0	71	16	1443	172	304	1369	44
RTOR Reduction (vph)	0	4	0	0	0	71	0	0	79	0	0	10
Lane Group Flow (vph)	0	8	0	0	40	0	16	1443	93	304	1369	34
Heavy Vehicles (%)	0%	0%	0%	33%	0%	34%	0%	3%	25%	28%	5%	0%
Turn Type	Perm			Perm		NA	Prot		Perm	Prot		Perm
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4			8					2			6
Actuated Green, G (s)		5.7			5.7	0.0	1.4	44.7	44.7	19.9	63.2	63.2
Effective Green, g (s)		5.7			5.7	0.0	1.4	44.7	44.7	19.9	63.2	63.2
Actuated g/C Ratio		0.07			0.07	0.00	0.02	0.54	0.54	0.24	0.77	0.77
Clearance Time (s)		4.0			4.0		4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)		3.0			3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)		99			74	0	31	1904	702	341	2640	1240
v/s Ratio Prot							0.01	c0.41		c0.22	0.40	
v/s Ratio Perm		0.01			c0.04				0.13			0.03
v/c Ratio		0.08			0.54	0.00	0.52	0.76	0.13	0.89	0.52	0.03
Uniform Delay, d1		35.9			37.0	41.1	40.1	14.6	9.3	30.2	3.7	2.3
Progression Factor		1.00			1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2		0.4			7.8	0.0	13.7	2.9	0.4	24.0	0.7	0.0
Delay (s)		36.2			44.9	41.1	53.9	17.5	9.7	54.1	4.4	2.3
Level of Service		D			D	D	D	B	A	D	A	A
Approach Delay (s)		36.2			42.5			17.0			13.2	
Approach LOS		D			D			B			B	

Intersection Summary			
HCM Average Control Delay	16.0	HCM Level of Service	B
HCM Volume to Capacity ratio	0.78		
Actuated Cycle Length (s)	82.3	Sum of lost time (s)	12.0
Intersection Capacity Utilization	66.4%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
1: KAMA'AINA ROAD & MOKULELE HIGHWAY 8/30/2011

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor		1.00			1.00	1.00	1.00	0.95	1.00	1.00	0.95	1.00
Frt		0.95			1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected		0.97			0.95	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)		1745			1410	1313	1805	3539	1205	1410	3574	1615
Flt Permitted		0.80			0.73	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)		1445			1085	1313	1805	3539	1205	1410	3574	1615
Volume (vph)	19	0	11	152	0	248	2	1521	44	64	1536	9
Peak-hour factor, PHF	0.79	0.92	0.69	0.90	0.92	0.90	0.50	0.95	0.90	0.90	0.95	0.56
Adj. Flow (vph)	24	0	16	169	0	276	4	1601	49	71	1617	16
RTOR Reduction (vph)	0	13	0	0	0	276	0	0	21	0	0	6
Lane Group Flow (vph)	0	27	0	0	169	0	4	1601	28	71	1617	10
Heavy Vehicles (%)	0%	0%	0%	28%	0%	23%	0%	2%	34%	28%	1%	0%
Turn Type	Perm			Perm		NA	Prot		Perm	Prot		Perm
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4			8					2			6
Actuated Green, G (s)		14.1			14.1	0.0	0.9	41.1	41.1	5.1	45.3	45.3
Effective Green, g (s)		14.1			14.1	0.0	0.9	41.1	41.1	5.1	45.3	45.3
Actuated g/C Ratio		0.20			0.20	0.00	0.01	0.57	0.57	0.07	0.63	0.63
Clearance Time (s)		4.0			4.0		4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)		3.0			3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)		282			212	0	22	2012	685	99	2239	1012
v/s Ratio Prot							0.00	c0.45		c0.05	0.45	
v/s Ratio Perm		0.03			c0.16				0.04			0.01
v/c Ratio		0.10			0.80	0.00	0.18	0.80	0.04	0.72	0.72	0.01
Uniform Delay, d1		23.9			27.7	36.1	35.3	12.3	6.9	32.9	9.2	5.1
Progression Factor		1.00			1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2		0.1			18.5	0.0	4.0	3.4	0.1	21.8	2.1	0.0
Delay (s)		24.0			46.2	36.1	39.3	15.7	7.0	54.7	11.3	5.1
Level of Service		C			D	D	D	B	A	D	B	A
Approach Delay (s)		24.0			40.0			15.5			13.0	
Approach LOS		C			D			B			B	

Intersection Summary			
HCM Average Control Delay	17.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.79		
Actuated Cycle Length (s)	72.3	Sum of lost time (s)	12.0
Intersection Capacity Utilization	70.7%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Appendix G
Level-of-Service Worksheets for Project Entrances

HCM Unsignalized Intersection Capacity Analysis
2: QUARRY ACCESS ROAD & SOUTH FIREBREAK ROAD

9/18/2011

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	0	20	80	0	37	392
Peak Hour Factor	0.92	0.96	0.90	0.92	0.92	0.90
Hourly flow rate (vph)	0	21	89	0	40	436
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	605	89			89	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	605	89			89	
tC, single (s)	6.4	6.9			4.5	
tC, 2 stage (s)						
tF (s)	3.5	3.9			2.6	
p0 queue free %	100	97			97	
cM capacity (veh/h)	446	811			1284	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	21	89	476
Volume Left	0	0	40
Volume Right	21	0	0
cSH	811	1700	1284
Volume to Capacity	0.03	0.05	0.03
Queue Length 95th (ft)	2	0	2
Control Delay (s)	9.6	0.0	1.0
Lane LOS	A		A
Approach Delay (s)	9.6	0.0	1.0
Approach LOS	A		

Intersection Summary			
Average Delay	1.1		
Intersection Capacity Utilization	39.3%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
2: QUARRY ACCESS ROAD & SOUTH FIREBREAK ROAD

10/10/2011

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	0	28	372	0	8	100
Peak Hour Factor	0.92	0.70	0.90	0.92	0.67	0.90
Hourly flow rate (vph)	0	40	413	0	12	111
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	548	413			413	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	548	413			413	
tC, single (s)	6.4	6.5			4.3	
tC, 2 stage (s)						
tF (s)	3.5	3.6			2.4	
p0 queue free %	100	93			99	
cM capacity (veh/h)	492	585			1060	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	40	413	123
Volume Left	0	0	12
Volume Right	40	0	0
cSH	585	1700	1060
Volume to Capacity	0.07	0.24	0.01
Queue Length 95th (ft)	5	0	1
Control Delay (s)	11.6	0.0	0.9
Lane LOS	B		A
Approach Delay (s)	11.6	0.0	0.9
Approach LOS	B		

Intersection Summary			
Average Delay	1.0		
Intersection Capacity Utilization	29.6%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
2: INDUSTRIAL PARK ACCESS ROAD & SOUTH FIREBREAK ROAD
9/23/2011

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	Y		↱			↰
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	0	80	20	0	392	37
Peak Hour Factor	0.92	0.90	0.96	0.92	0.90	0.92
Hourly flow rate (vph)	0	89	21	0	436	40
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	932	21			21	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	932	21			21	
tC, single (s)	6.4	6.5			4.3	
tC, 2 stage (s)						
tF (s)	3.5	3.5			2.4	
p0 queue free %	100	91			70	
cM capacity (veh/h)	207	994			1458	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	89	21	476
Volume Left	0	0	436
Volume Right	89	0	0
cSH	994	1700	1458
Volume to Capacity	0.09	0.01	0.30
Queue Length 95th (ft)	7	0	32
Control Delay (s)	9.0	0.0	8.0
Lane LOS	A		A
Approach Delay (s)	9.0	0.0	8.0
Approach LOS	A		

Intersection Summary			
Average Delay	7.9		
Intersection Capacity Utilization	41.9%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
4: QUARRY ACCESS ROAD & INDUSTRIAL PARK ACCESS ROAD
9/23/2011

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑			↑			↑			↑	
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	0	37	0	0	20	0	0	80	0	0	392	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.93	0.70	0.92	0.90	0.92	0.92	0.90	0.92
Hourly flow rate (vph)	0	40	0	0	22	0	0	89	0	0	436	0

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	40	22	89	436
Volume Left (vph)	0	0	0	0
Volume Right (vph)	0	0	0	0
Hadj (s)	0.73	1.19	0.42	0.42
Departure Headway (s)	6.0	6.5	5.0	4.6
Degree Utilization, x	0.07	0.04	0.12	0.56
Capacity (veh/h)	549	506	690	761
Control Delay (s)	9.4	9.7	8.7	13.4
Approach Delay (s)	9.4	9.7	8.7	13.4
Approach LOS	A	A	A	B

Intersection Summary			
Delay	12.3		
HCM Level of Service	B		
Intersection Capacity Utilization	30.6%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
2: INDUSTRIAL PARKACCESS ROAD & SOUTH FIREBREAK ROAD

10/10/2011

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	0	372	28	0	100	8
Peak Hour Factor	0.92	0.90	0.70	0.92	0.90	0.67
Hourly flow rate (vph)	0	413	40	0	111	12
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	274	40			40	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	274	40			40	
tC, single (s)	6.4	6.5			4.3	
tC, 2 stage (s)						
tF (s)	3.5	3.5			2.4	
p0 queue free %	100	57			92	
cM capacity (veh/h)	660	969			1434	
Direction, Lane #	**WB 1**	**NB 1**	**SB 1**			
Volume Total	413	40	123			
Volume Left	0	0	111			
Volume Right	413	0	0			
cSH	969	1700	1434			
Volume to Capacity	0.43	0.02	0.08			
Queue Length 95th (ft)	54	0	6			
Control Delay (s)	11.4	0.0	7.0			
Lane LOS	B		A			
Approach Delay (s)	11.4	0.0	7.0			
Approach LOS	B					
Intersection Summary						
Average Delay			9.7			
Intersection Capacity Utilization			42 3%	ICU Level of Service		A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis
4: QUARRY ACCESS ROAD & INDUSTRIAL PARKACCESS ROAD

10/10/2011

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑			↑			↑			↑	
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	0	8	0	0	28	0	0	372	0	0	100	0
Peak Hour Factor	0.92	0.67	0.92	0.90	0.70	0.90	0.92	0.90	0.90	0.67	0.90	0.92
Hourly flow rate (vph)	0	12	0	0	40	0	0	413	0	0	111	0
Direction, Lane #	**EB 1**	**WB 1**	**NB 1**	**SB 1**								
Volume Total (vph)	12	40	413	111								
Volume Left (vph)	0	0	0	0								
Volume Right (vph)	0	0	0	0								
Hadj (s)	0.32	0.49	0.42	0.42								
Departure Headway (s)	5.6	5.7	4.6	4.9								
Degree Utilization, x	0.02	0.06	0.53	0.15								
Capacity (veh/h)	579	573	770	701								
Control Delay (s)	8.7	9.1	12.7	8.8								
Approach Delay (s)	8.7	9.1	12.7	8.8								
Approach LOS	A	A	B	A								
Intersection Summary												
Delay			11.6									
HCM Level of Service			B									
Intersection Capacity Utilization			29.6%		ICU Level of Service				A			
Analysis Period (min)			15									

Appendix H
Agency Early Consultation Comments and Responses

Responses to Comments from State of Hawaii Department of Transportation

Comment Letter Dated August 4, 2011

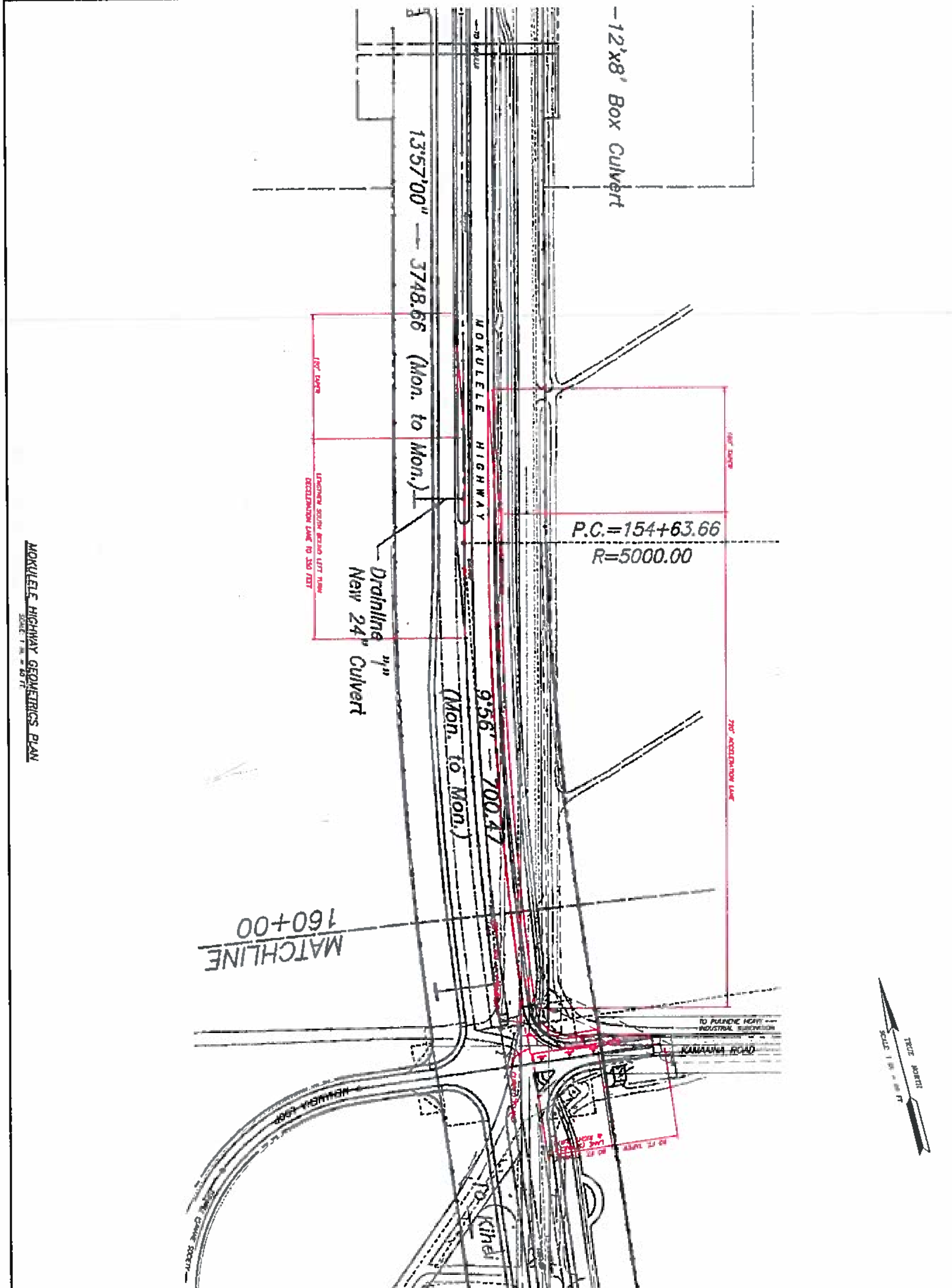
	Comment	Response
1.	A traffic assessment must be prepared for our review and approval. The assessment should determine the trips generated by the project, and any other relevant existing and future developments and trip-generators in the area, and the impact of those trips on the intersection of Kamaaina Road and Mokulele Highway and propose mitigation measures, as required. It should take into account ambient traffic from other existing uses that use Kamaaina Road.	Acknowledged. The TIAR projections include traffic generated by all known projects in the northern portion of Kihei in addition to traffic associated with the Hawaiian Cement quarry operations that use Kamaaina Road. The TIAR also contains recommendations to mitigate the project's traffic impacts at the intersection of Mokulele Highway at Kamaaina Road.
2.	Since there may be a possibility that some project traffic might use the Maui Raceway Park roadways as a shortcut to Mokulele Highway, the assessment should have a discussion of measures to be taken to minimize that possibility.	The project will have no right of access to Maui Raceway Park roads. Additionally, there will be a drainage swell between the project lots and the property line adjacent to the park. This will prevent any traffic connection between the project and the park. This in noted in the project description (Chapter 1) and the discussion of project trip distribution (Chapter 4).

Responses to Comments from County of Maui Police Department

Comment Letter Dated July 28, 2011

	Comment	Response
1.	At the entry/exit points of the property, proper lighting and line of sight will be critical of vehicular and pedestrian safety.	Acknowledged.
2.	Vehicles traveling east to west on Kamaaina Road (downhill) are required to stop at a posted stop sign, however the stop sign is very close to the sugar cane and will need to be further from the cane to be more visible. This section of the roadway is also used by Hawaiian Cement trucks and HC&S vehicles. Some of these vehicles such as loaded cement trucks and can hauling trucks are very large, heavy and require greater distances to stop.	The TIAR contains a recommendation regarding maintenance to sight distances and visibility of traffic control devices. The number of heavy vehicles was estimated and included on the analysis of the study intersections.

Appendix I
Engineer's Drawing of Proposed Mitigation Improvements at Intersection of Mokulele Highway at Kama'aina Road and Mehameha Loop



PUUNENE HEAVY INDUSTRIAL SUBDIVISION

T.M.K.: (2) 3-8-08: 19

PUUNENE, MAUI, HAWAII

MOKULELE HIGHWAY GEOMETRICS PLAN

OTOMO ENGINEERING, INC.

SHEET NO. 1