TRAFFIC IMPACT ANALYSIS REPORT FOR

EMMANUEL LUTHERAN CHURCH AND SCHOOL

IN WAIKAPU, MAUI, HAWAII

DRAFT REPORT

Prepared For

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1. INTRODUCTION

Phillip Rowell and Associates has been retained by Emmanuel Lutheran Church to prepare a traffic impact analysis for a proposed school and sanctuary in the Waikapu area of Maui. The approximate location of the project on the Island of Maui is shown in Figure 1.

This introductory chapter discusses the location of the project, the proposed development, and the study methodology.

Purpose and Objectives of Study

1. Determine and describe the traffic characteristics of the proposed project.
2. Quantify and document the traffic related impacts of the proposed project.
3. Identify and evaluate traffic related improvements required to provide adequate access to and egress from the proposed project and to mitigate the project's traffic impacts.

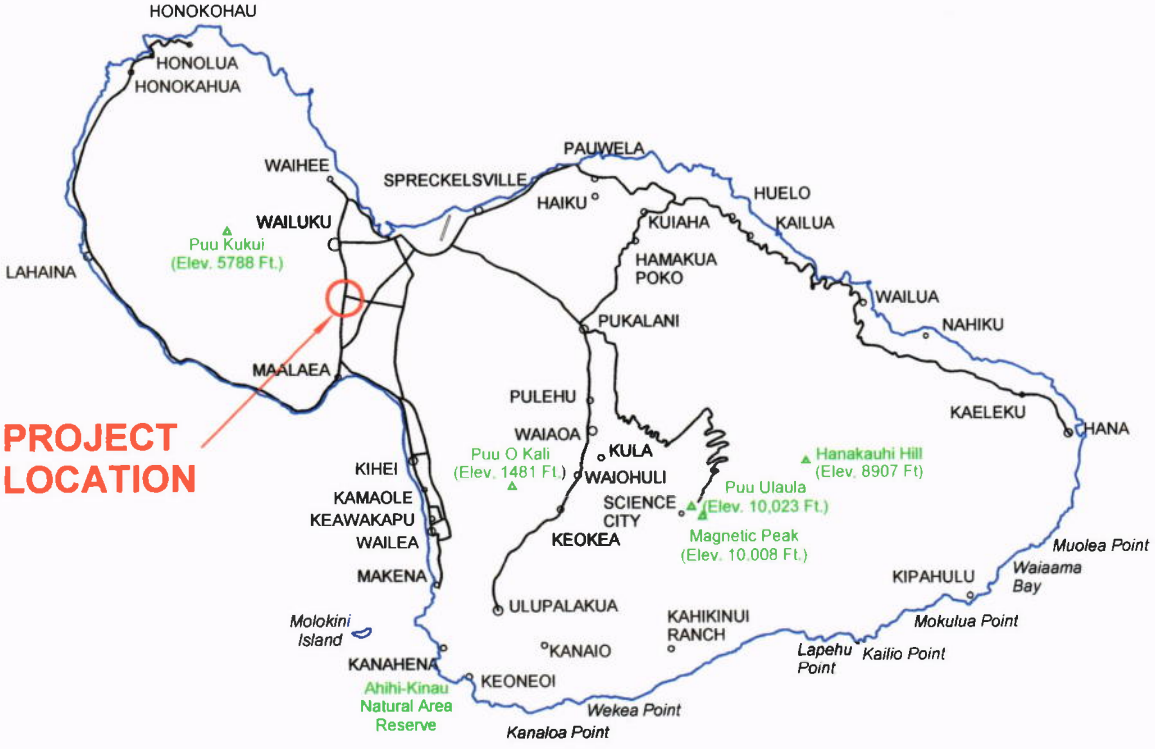

Figure 1
PROJECT LOCATION MAP

Project Location and Description

A preliminary site plan of the project is shown as Appendix A. The following is a summary of the project:

1. The project is located between Honoapiilani Highway and the extension of Waiale Road, south of Kuikahi Drive. The site is bounded by Honoapiilani Highway on the west, Kuikahi Drive on the north, Waiale Road on the east and the Waikapu Affordable Housing Project on the south.

2. The project will consist of a new K through 8 school and preschool. The students and staff will be relocated from the existing school located in Wailuku. Current enrollment of the preschool is 40. Maximum future enrollment is expected to be approximately 80. Current enrollment of the school is approximately 200. Enrollment is expected to increase to a maximum of 400 students.

3. The project will also consist of a new 4,000 square foot sanctuary.

4. Access will be via an existing driveway along the west side of Waiale Road, approximately midway between Kuikahi Drive and the north boundary of the Waikapu Affordable Housing Project.

An activity matrix of the proposed uses at the project, the days and the approximate number of persons attending each use is shown as Table 1.

Table 1 Activity Matrix for Proposed Church and School [1]

Event	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Preschool		80 People 7 AM to 5 PM	80 People 7 AM to 5 PM	80 People 7 AM to 5 PM	80 People 7 AM to 5 PM	80 People 7 AM to 5 PM	
Day School		400 People 7:300 AM to 3:30 PM	400 People 7:300 AM to 3:30 PM	400 People 7:300 AM to 3:30 PM	400 People 7:300 AM to 3:30 PM	400 People 7:300 AM to 3:30 PM	
After School		120 People 3:30 PM to 5:30 PM	120 People 3:30 PM to 5:30 PM	120 People 3:30 PM to 5:30 PM	120 People 3:30 PM to 5:30 PM	120 People 3:30 PM to 5:30 PM	
Early Church Service	225 People 8 AM to 9:15 AM						
Sunday School	75 to 90 People 9:30 AM to 10:30 AM						
Church Service	110 People 10:45 AM to 11:45 AM						
Lenten Service (Feb., March, & April)				60 to 80 People 6 PM to 8 PM			
Advent Service (December)				60 to 80 People 6 PM to 8 PM			
Board Meetings					10 to 50 People 5 PM to 8 PM		
Maintenance							12 People 8 AM to 3 PM
Weddings (On Demand)							10 to 60 People 10 AM to 7 PM
Other Education		40 People 7:30 AM to 3:30 PM	40 People 7:30 AM to 3:30 PM	40 People 7:30 AM to 3 :30 PM	40 People 7:30 AM to 3:30 PM	40 People 7:30 AM to 3:30 PM	
Church Events		15 People 7 PM to 9 PM		15 People 7 PM to 9 PM		15 People 7 PM to 9 PM	

Notes:
1. Source: Emmanuel Lutheran Church

Horizon Year

The design horizon year represents a date for which future background traffic projections were estimated. These projections include traffic generated by other planned projects within and adjacent to the study area and background traffic growth.

The year 2010 was used as the horizon year, even though scheduled completion is earlier. This year was selected to be consistent with the traffic studies for the related projects in the area.

Study Methodology

The following is a summary list of the tasks performed:

1. The study area and the scope of work were defined using criteria established by the Institute of Transportation Engineers[1] for small developments. Small developments are projects that generate between 100 and 500 peak hour trips. This was based on the results of a preliminary trip generation analysis that determined the proposed new office building would generate more than 100 trips during the peak hour. See Table 2.

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

3. Existing peak-hour traffic volumes for the study intersections were obtained and summarized.

4. Existing levels-of-service of the study intersections was determined using the methodology described in the *Highway Capacity Manual*.

5. A list of related development projects within and adjacent to the study area that will impact traffic conditions at the study intersections was compiled. This list included both development projects and anticipated highway improvement projects.

6. Future background traffic volumes at the study intersections without traffic generated by the study project were estimated.

7. Peak hour traffic that the proposed project will generate was estimated using trip generation analysis procedures recommended by the Institute of Transportation Engineers.

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

9. The impacts of traffic generated by the proposed project at the study intersections was quantified and summarized.

10. Locations that project generated traffic significantly impacts traffic operating conditions were identified.

11. Recommendations, improvements or modifications necessary to mitigate the traffic impacts of the project and to provide adequate access to and egress from the site were formulated.

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

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[1] Institute of Transportation Engineers, *Transportation and Land Development, Second Edition*, Washington, D.C., 2002, pages 3-1 thru 3-16.

Table 2 Suggested Requirements for Various Types of Traffic Impact Analyses[2]

	Trip Generation Threshold			
	Access Location & Design Review	Small Development: Traffic Impact Assessment	Medium Development: Traffic Impact Statement	Large Development: Regional Traffic Analysis
	T ≤ 100 Peak Hour Trips	100 < T ≤ 500 Peak Hour Trips	500 < T ≤ 1000 Peak Hour Trips	T > 1000 Peak Hour Trips
Pre-application meeting or discussion	✔	✔	✔	✔
Analysis of Roadway Issues				
Existing condition analysis within study area	✔	✔	✔	✔
Sight distance evaluation	✔	✔	✔	✔
Nearby driveway locations	?	✔	✔	✔
Existing traffic conditions at nearby intersections and driveways		✔	✔	✔
Future road improvements		?	✔	✔
Crash experience in proximity to site	?	✔	✔	✔
Trip generation of adjacent development		?	✔	✔
Trip distribution analysis		✔	✔	✔
Background traffic growth		?	✔	✔
Future conditions analysis at nearby intersections		?	✔	✔
Mitigation identification and evaluation		?	?	✔
Site Issues				
Traffic generation	✔	✔	✔	✔
Traffic distribution	?	✔	✔	✔
Evaluate number, location & spacing of access points	?	✔	✔	✔
Evaluate access design, queuing, etc.	✔	✔	✔	✔
Evaluate site circulation	✔	✔	✔	✔
Other Analyses				
Gap analysis for unsignalized locations		?	?	✔
TSM/TDM[2] Mitigation measures (car- or van-pooling, transit, etc.)- transit agency participation			?	✔
Effect on traffic signal progression, analysis of proposed signal locations			?	✔

Notes:
(1) Key: ✔ = required, ? = may be appropriate on a case-by-case basis
(2) Source: Institute of Transportation Engineers, *Transportation and Land Development*, Washington, D.C., 2002, p.3-6
(3) TSM/TDM = Transportation System Management/Transportation Demand Management
(4) A traffic signal should not be permitted

Study Area

The study area for this study is consistent with the study area for other traffic impact studies in Wailea and recent direction from the County of Maui Department of Public Works. The study area is shown on Figure 3. The study intersections are listed in Table 2.

Table 3 Study Intersections and Right-of-Way Control

Number	Intersection	Right-of-Way Control	Jurisdiction
1	Honoapiilani Highway at East Waiko Road	Unsignalized (1)	State
2	Honoapiilani Highway at Waiolu Road	Unsignalized	State
3	Honoapiilani Highway at Pilikana Street	Unsignalized (1)	State
4	Honoapiilani Highway at Kuikahi Drive	Signalized	State
5	Waiale Road at Kuikahi Drive	Unsignalized	County
6	Waiale Road at Road A (2)		
7	Waiale Road at Road C (2)		
8	Waiale Road at East Waiko Road (2)		

Notes:
(1) This intersection is currently unsignalized. Signals are to be installed as a condition of other development projects in the area.
(2) This intersection is being constructed as part of the Waikapu Affordable Housing project that is under construction.

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 2010 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 2010 background plus project traffic projections.

Chapter 5 describes the traffic impacts of the proposed project, identifies potential mitigation measures and summarizes the traffic impact study.

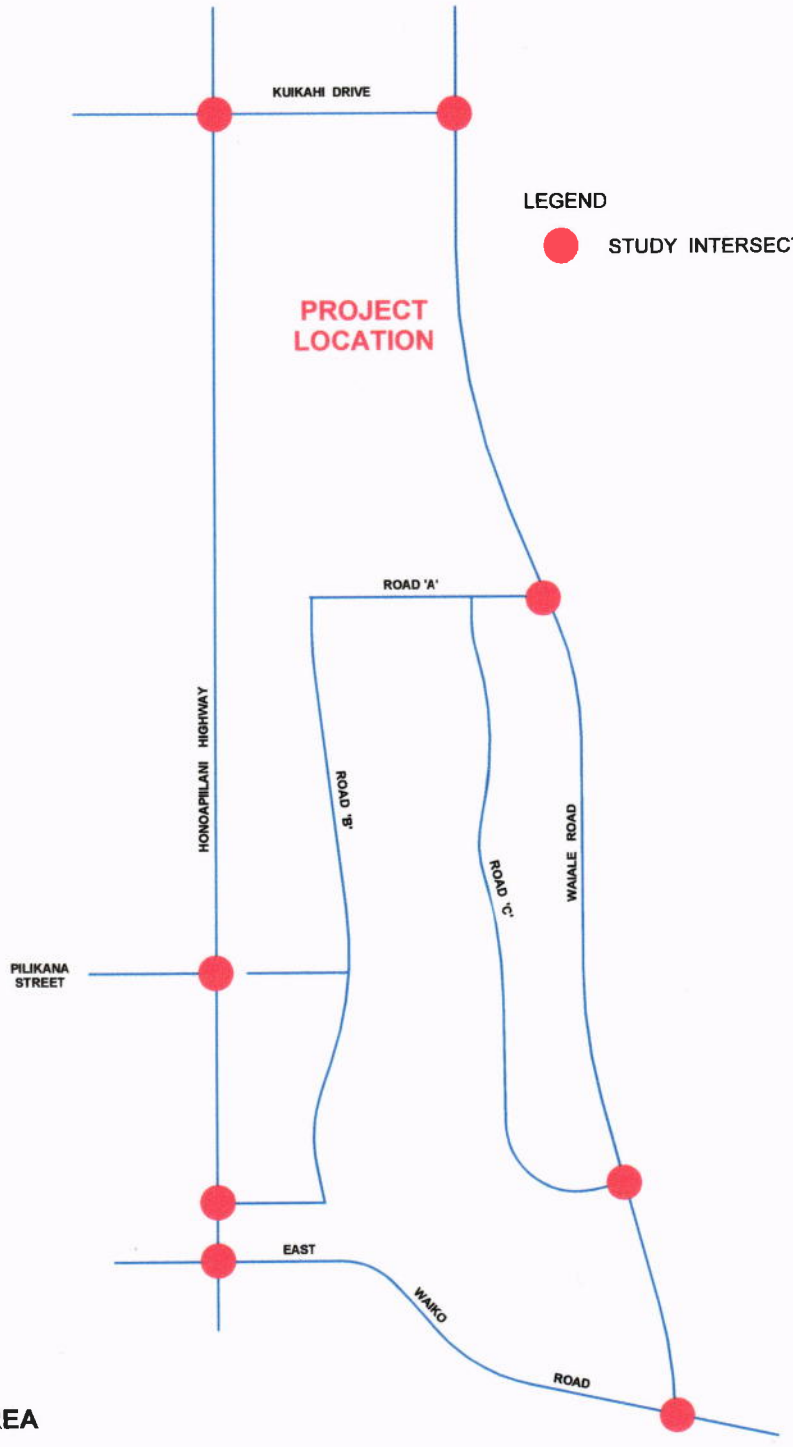

Figure 2
STUDY AREA

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 Level-of-Service analysis for existing conditions are also presented. The purpose of this analysis is to establish the base conditions for the determination of the impacts of the project which are described in a subsequent chapter.

Description of Existing Streets and Intersection Controls

The following is summary of the major roadways in the study area:

The following is a summary of the major roadways in the study area:

Honoapiilani Highway

Honoapiilani Highway is a major State highway connecting Wailuku and Maalaea. In the vicinity of the proposed project, the highway is a two-lane, two-way facility with separate left turn lanes. The posted speed limit is 45 miles per hour (mph).

East Waiko Road

East Waiko Road is a two-lane, two-way roadway intersecting Honoapiilani Highway approximately one quarter mile south of Pilikana Street. East Waiko Road serves residential development along both sides of Honoapiilani Highway. The intersection of Honoapiilani Highway at East Waiko Road is unsignalized.

Figure 3 is a schematic indicating the lane configurations and right-of-way controls of the study intersections.

Existing Peak Hour Traffic Volumes

The existing peak hour traffic volumes are shown in Figures 4, 5 and 6. The peak hour volumes were determined from traffic counts of the study intersections.

1. The traffic counts were performed during the first week of November and the first week of December, 2005.

2. The morning counts were performed between 6:30 AM and 9:00 AM. The afternoon counts were performed between 3:30 PM and 6:00 PM. Sunday counts were performed between 7:30 AM and 12:30 PM.

3. The traffic counts include buses, trucks and other large vehicles. Mopeds and Bicycles were not counted.

4. The traffic volumes shown are the peak hourly volume of each movement rather than the peak sum of all approach volumes.

5. The traffic volumes of adjacent intersections may not match the volumes shown for an adjacent intersection because the peak hours of the adjacent intersections may not coincide and there are driveways between the intersections.

6. Pedestrian activity was negligible.

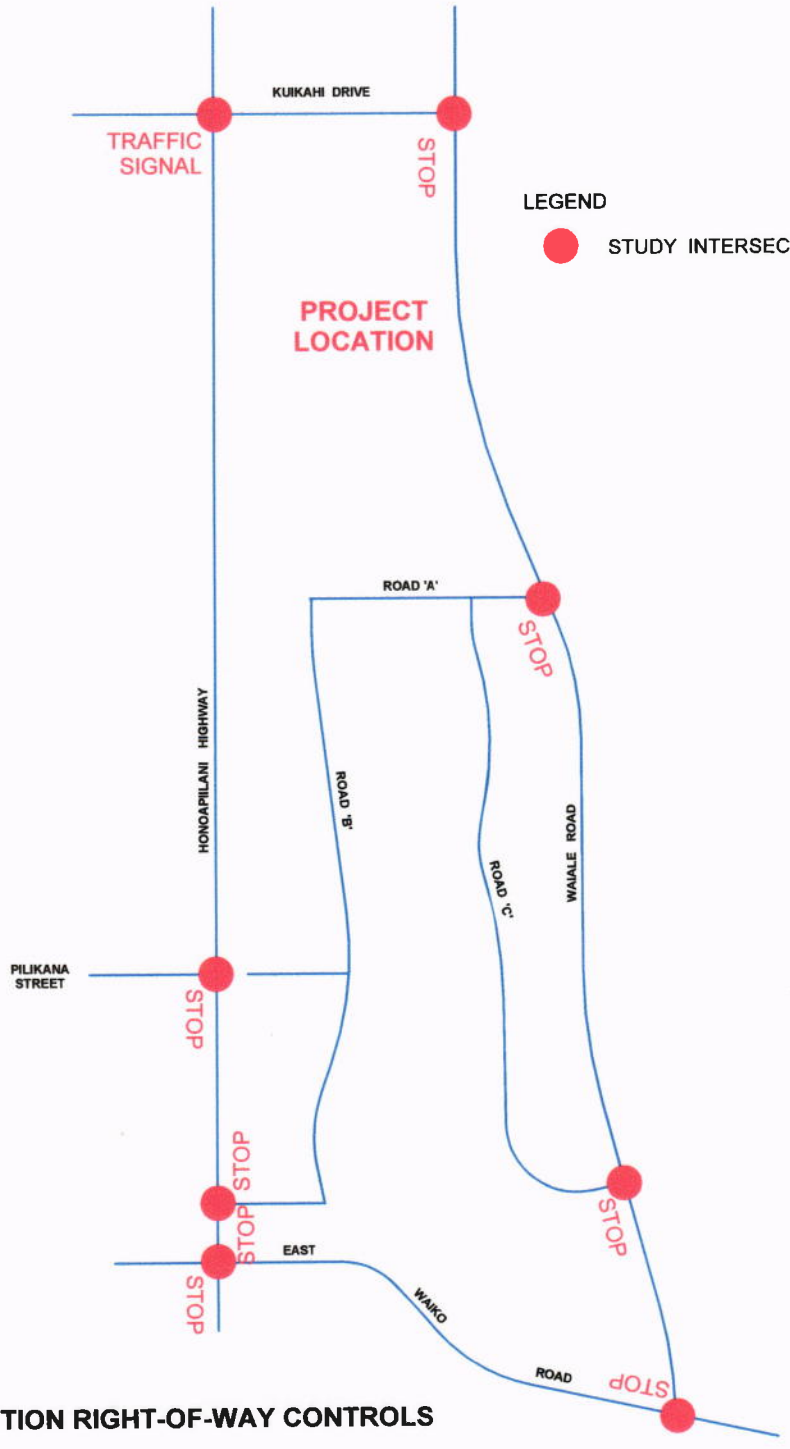

Figure 3
INTERSECTION RIGHT-OF-WAY CONTROLS

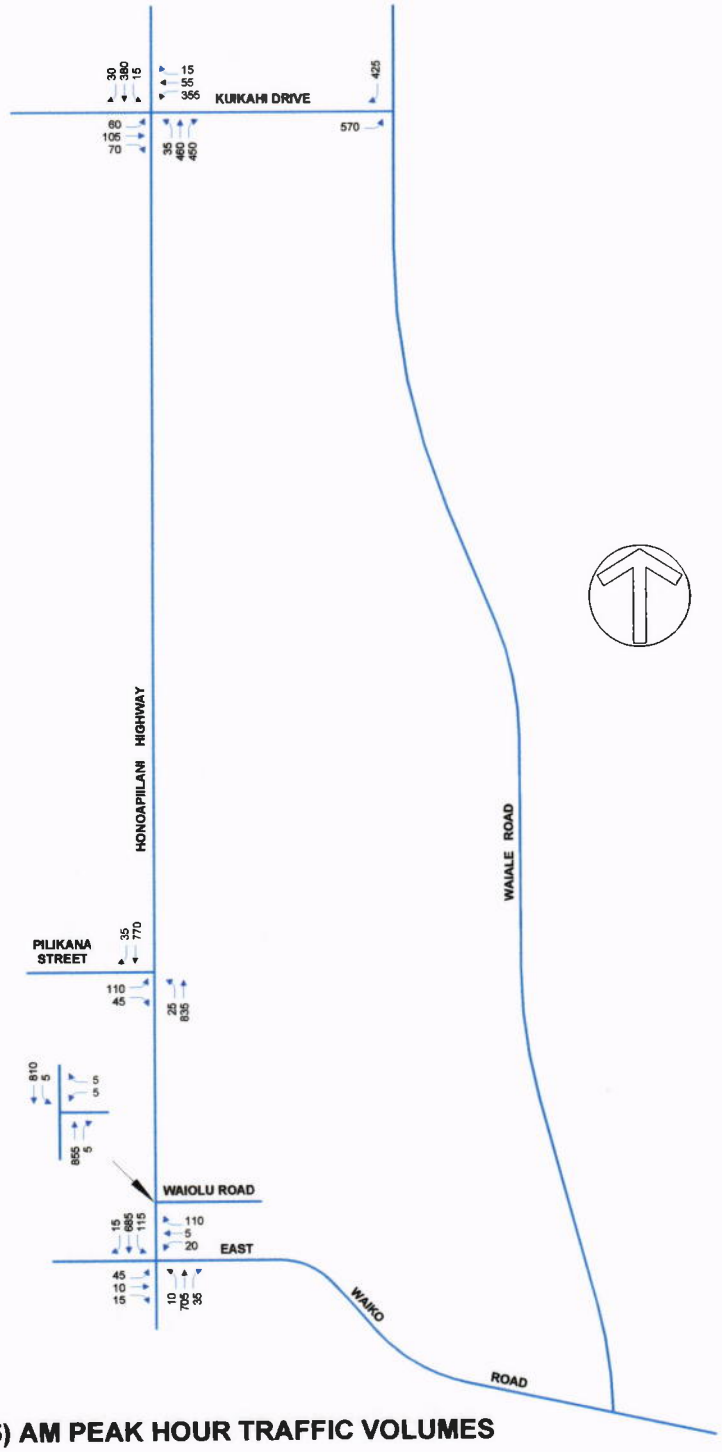

Figure 4
EXISTING (2005) AM PEAK HOUR TRAFFIC VOLUMES

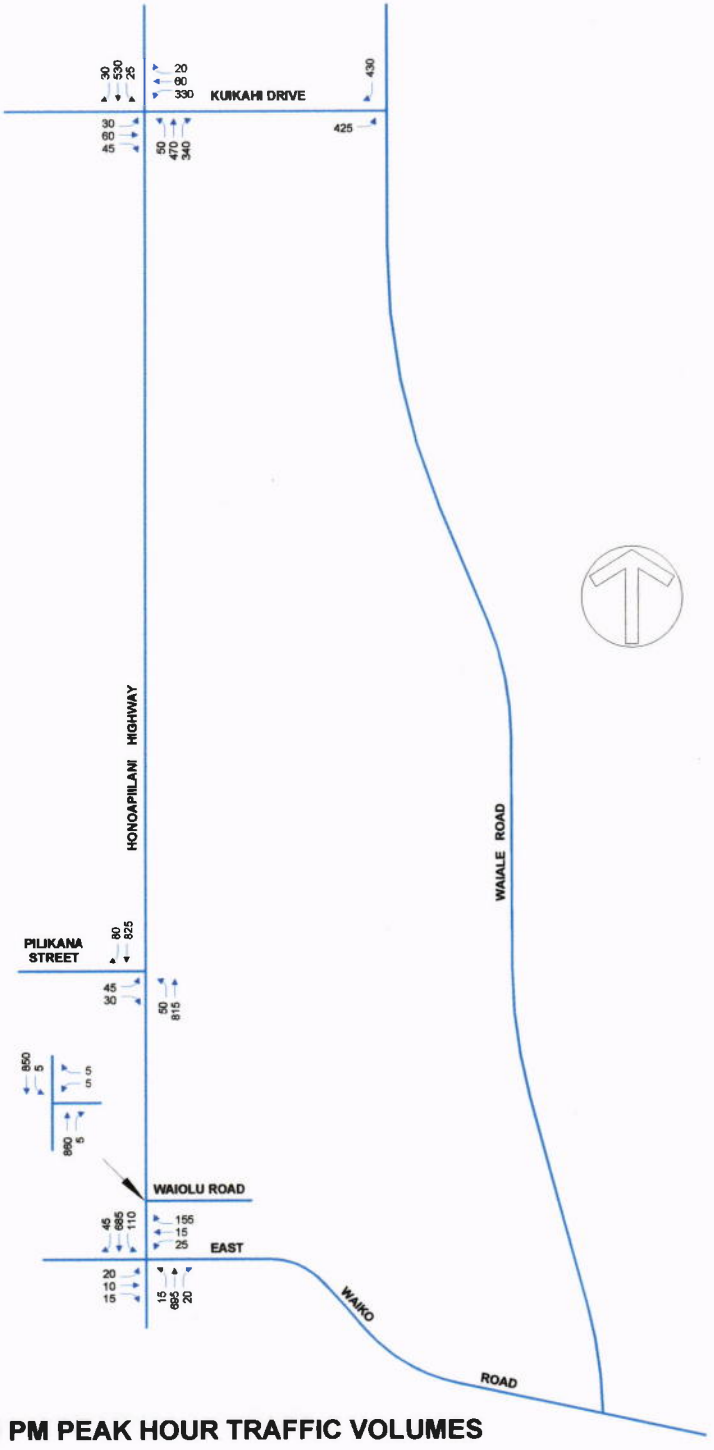

Figure 5
EXISTING (2005) PM PEAK HOUR TRAFFIC VOLUMES

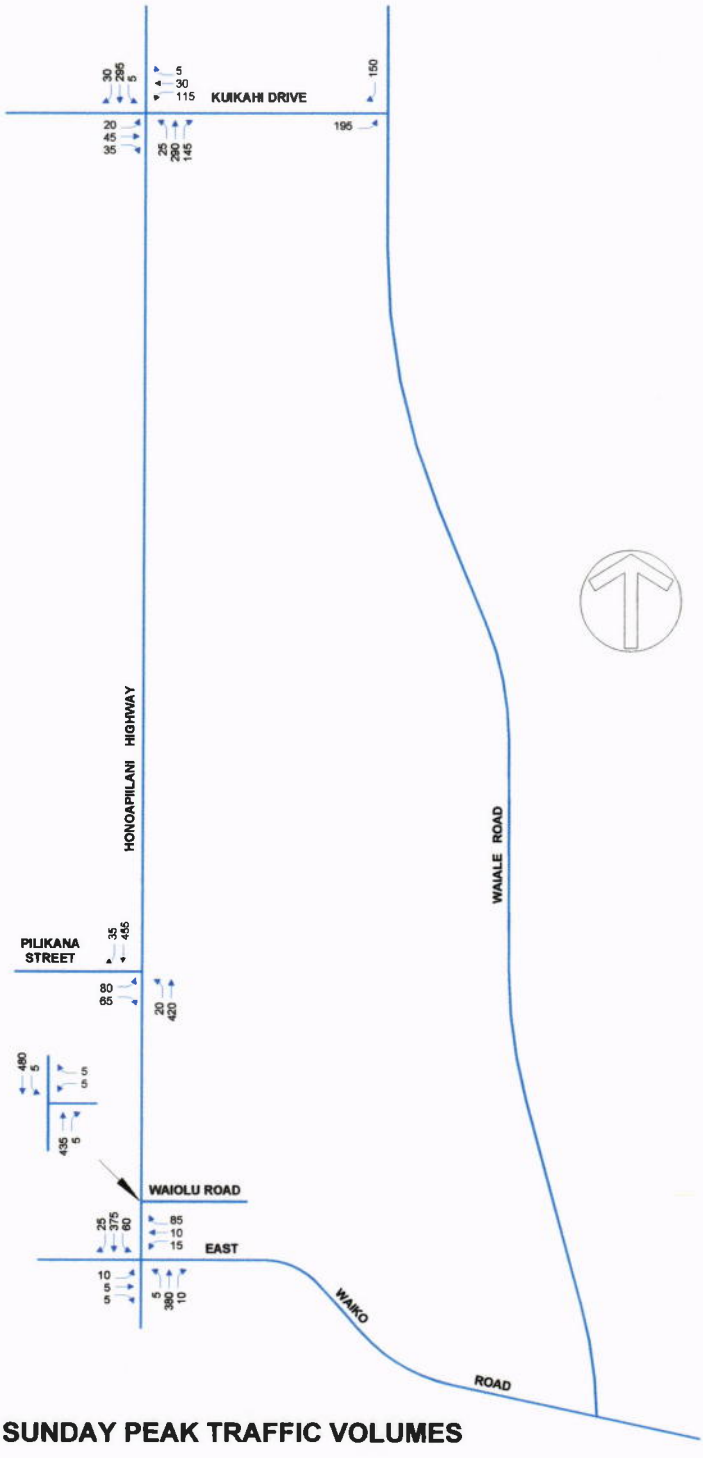

Figure 6
EXISTING (2005) SUNDAY PEAK TRAFFIC VOLUMES

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 (Level-of-Service) 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 4. In general, Level-of-Service A represents free-flow conditions with no congestion. Level-of-Service 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.

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 4 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.

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 5 summarizes the definitions for level-of-service and the corresponding delay.

Table 5 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.

Level-of-Service Analysis of Existing Conditions

Signalized Intersections

State Department of Transportation (Honolulu) requested the Synchro software package be used to performed level-of-service analyses. Accordingly, Synchro 6 was used to calculate the traffic signal timings. The timings were then downloaded into the Highway Capacity Software to calculate the levels-of-service of the signalized intersections. Both software packages are based on the *Highway Capacity Manual*.

The resulting levels-of-service of the signalized study intersection are summarized in Table 6. The results shown in the table are the volume-to-capacity ratios, delays and levels-of-service of all the controlled movements of the study intersection.

Table 6 Existing (2005) Levels-of-Service - Signalized Intersections

Intersection and Movement	AM Peak Hour			PM Peak Hour			Sunday Peak Hour		
	V/C[1]	Delay[2]	LOS[3]	V/C[1]	Delay[2]	LOS[3]	V/C[1]	Delay[2]	LOS[3]
Honoapiilani Hwy at Kuikahi Dr	0.60	36.9	D	0.61	35.4	D	0.32	20.7	C
Eastbound Left	0.21	40.7	D	0.12	37.7	D	0.06	19.4	B
Eastbound Thru	0.26	40.9	D	0.16	38.0	D	0.09	19.6	B
Eastbound Right	0.21	40.3	D	0.15	37.9	D	0.08	19.6	B
Westbound Left	0.54	23.4	C	0.55	26.0	C	0.23	14.2	B
Westbound Thru & Right	0.08	16.9	B	0.11	19.3	B	0.05	12.6	B
Northbound Left	0.19	51.8	D	0.22	46.0	D	0.10	26.9	C
Northbound Thru	0.77	46.1	D	0.72	37.4	D	0.50	22.8	C
Northbound Right	0.40	34.1	C	0.16	25.0	C	0.16	18.3	B
Southbound Left	0.08	50.0	D	0.11	44.1	D	0.02	26.0	C
Southbound Thru	0.64	40.1	D	0.81	42.5	D	0.51	23.0	C
Southbound Right	0.06	28.6	C	0.06	23.6	C	0.06	17.3	B

NOTES:
1. V/C denotes ratio of volume to capacity.
2. Delay is in seconds per vehicle.
3. LOS denotes Level-of-Service calculated using the operations method described in *Highway Capacity Manual*. LOS is based on delay.

Unsignalized Intersections

The results of the Level-of-Service analysis of the unsignalized intersections are summarized in Table 7. Shown are the control delays and Levels-of-Service of each movement. Volume-to-capacity ratios are not calculated for unsignalized intersections.

Table 7 Existing (2005) Levels-of-Service Analysis for Unsignalized Intersections[1]

Intersection and Movement	AM Peak Hour		PM Peak Hour		Sunday Peak Hour	
	Delay [1]	LOS [2]	Delay [1]	LOS [2]	Delay [1]	LOS [2]
Honoapiilani Highway at East Waiko Road						
Northbound Left	9.1	A	9.3	A	8.1	A
Southbound Left	10.0-	A	9.8	A	8.3	A
Westbound Left, Thru & Right	70.9	F	173.5	F	15.4	C
Eastbound Left & Thru	478.6	F	315.6	F	24.7	C
Eastbound Right	13.7	B	13.7	B	10.5	B
Honoapiilani Highway at Waiolu Road						
Southbound Left	9.9	A	9.9	A	8.3	A
Westbound Left & Right	19.1	C	19.5	C	14.8	B
Honoapiilani Highway at Pilikana Road						
Northbound Left	9.5	A	9.9	A	8.4	A
Eastbound Left	268.6	F	104.6	F	23.4	C
Eastbound Right	15.7	C	16.1	C	11.9	B
Waiale Road at Kuikahi Drive						
Northbound Left	(4)	(4)	(4)	(4)	(4)	(4)
Eastbound Left	(4)	(4)	(4)	(4)	(4)	(4)
Eastbound Right	(4)	(4)	(4)	(4)	(4)	(4)

NOTES:
(1) Delay 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) The calculated delay exceeds 999.9 seconds, which is the maximum delay that the model will calculate.
(4) Delays and levels-of-service were not calculated as only two movements are allowed at the intersection.

Conclusions of the Level-of-Service Analysis

1. At the intersection of Honoapiilani Highway at Kuikahi Drive, all traffic movements operate at Level-of-Service D, or better, during both peak periods.

2. To eastbound and westbound approaches of Waiko Road to Honoapiilani Highway operate at Level-of-Service F during both weekday peak hour and Level-of-Service C during the Sunday peak hour. Traffic signals are to be installed at this intersection as a condition of the Waikapu Affordable Housing Project.

3. All controlled movements at the intersection of Honoapiilani Highway at Waiolu Road operate at Level-of-Service C, or better, during weekdays and Sundays.

4. The eastbound left turns at the intersection of Honoapiilani Highway at Pilikana Street operate at Level-of-Service F during the weekday peak hour and Level-of-Service C during the Sunday peak hour. Traffic signals are to be installed as a condition of the Waiolani Mauka subdivision project. These signals are currently being designed.

5. Delays and levels-of-service are not shown for the intersection of Waiale Road at Kuikahi Drive as only two movements, the southbound to westbound right turn and the eastbound to northbound left turn, are allowed. The south leg of the intersection is the entrance to a parking lot for construction workers.

3. PROJECTED BACKGROUND TRAFFIC CONDITIONS

The purpose of this chapter is to discuss the assumptions and data used to estimate 2010 background traffic conditions. Background traffic conditions are defined as future traffic volumes without the proposed project.

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. The second component is estimated traffic that will be generated by other development projects in the vicinity of the proposed project.

Background Traffic Growth

Data provided in the *Maui Long Range Land Transportation Study* was used to estimated the background growth rate of traffic along Honoapiilani Highway. The AM and PM peak hour traffic estimates for 1990 and 2020 provided in the report were used to calculate separate growth rates for northbound and southbound peak hour traffic. This data and the calculations are shown in Table 8.

The higher growth rates for AM and PM peak hours were used to estimate the background growth of traffic along Honoapiilani Highway between 2005 and 2010. Therefore, 1.86% per year was used for the AM peak hour growth rate and 1.65% per year was used for the afternoon peak hour growth rate. As there were no Sunday peak hour projections provided in the *Maui Long Range Land Transportation Plan*, the growth rate calculated for the PM peak hour was used for the Sunday peak hour growth rate, 1.65% per year.

Table 8 Calculation of Background Growth Rate Along Honoapiilani Highway[1]

	AM Peak Hour		PM Peak Hour	
Year	Northbound	Southbound	Northbound	Southbound
1990	903	691	810	1,217
2020	1,401	1,201	1,324	1,845
Growth Rate [2]	1.47%	1.86%	1.65%	1.40%

Notes:
1. Source: Kaku & Associates, *Maui Long Range Land Transportation Study*, February 1997, p. 66
2. Compounded growth rate.

Related Projects

The second component in estimating future background traffic volumes is traffic resulting from other proposed projects in the vicinity. Related projects are defined as those projects that are likely to be constructed within or adjacent to the study project and would significantly impact traffic in the study area. Related projects may be development projects or roadway improvements.

The projects that were identified as related projects and the estimated number of peak hour trips generated by each are summarized in Table 9. The trip generation data was obtained from the traffic impact study for each project.

Table 9 Trip Generation Summary of Related Projects

		AM Peak Hour			PM Peak Hour			Sunday Peak Hour		
	Related Project	In	Out	Total	In	Out	Total	In	Out	Total
A	Waiolani Elua	5	15	20	20	10	30	15	10	25
B	Unnamed Project	10	20	30	25	15	40	20	15	35
C	Waikapu 28	30	85	115	90	55	145	65	55	120
D	Waikapu Affordable Housing Project	75	230	305	260	145	405	180	160	340
E	Kehalani (Remaining Development Approx 50%)	210	635	845	720	405	1,125	500	445	945
F	Pu'unani	105	265	370	290	165	455	200	180	380
TOTALS		**435**	**1,250**	**1,685**	**1,405**	**795**	**2,200**	**980**	**865**	**1,845**

Notes:
(1) All numbers are rounded to nearest five (5).

There are four roadway projects.

1. The intersection of Honoapiilani Highway at Pilikana Street is to be signalized. The warrants for a traffic signals are satisfied for existing conditions[3]. The developer of Waiolani Elua and Waikapu 28 has agreed to participate in this project.

2. The extension of Waiale Road from Kuikahi to East Waiko Road. The developer of the study project will participate the this project as it is an important element of the development.

3. Improvement of East Waiko Road between Kuihelani Highway and the industrial baseyard, which is just east of the proposed Waiale Road extension.

4. Signalization of the intersection of Honoapiilani Highway at East Waiko Road.

The approximate locations of the development projects and the approximate alignment of Waiale Road is shown in Figure 7.

2010 Background Traffic Projections

2010 background traffic projections were calculated by expanding existing traffic volumes by the appropriate growth rates and then superimposing traffic generated by related projects. The resulting 2010 background peak hour traffic volumes are shown in Figures 8, 9 and 10.

[3] Philip Rowell and Associates, *Traffic Impact Study for Waikapu 28 Subdivision*, October 2003.

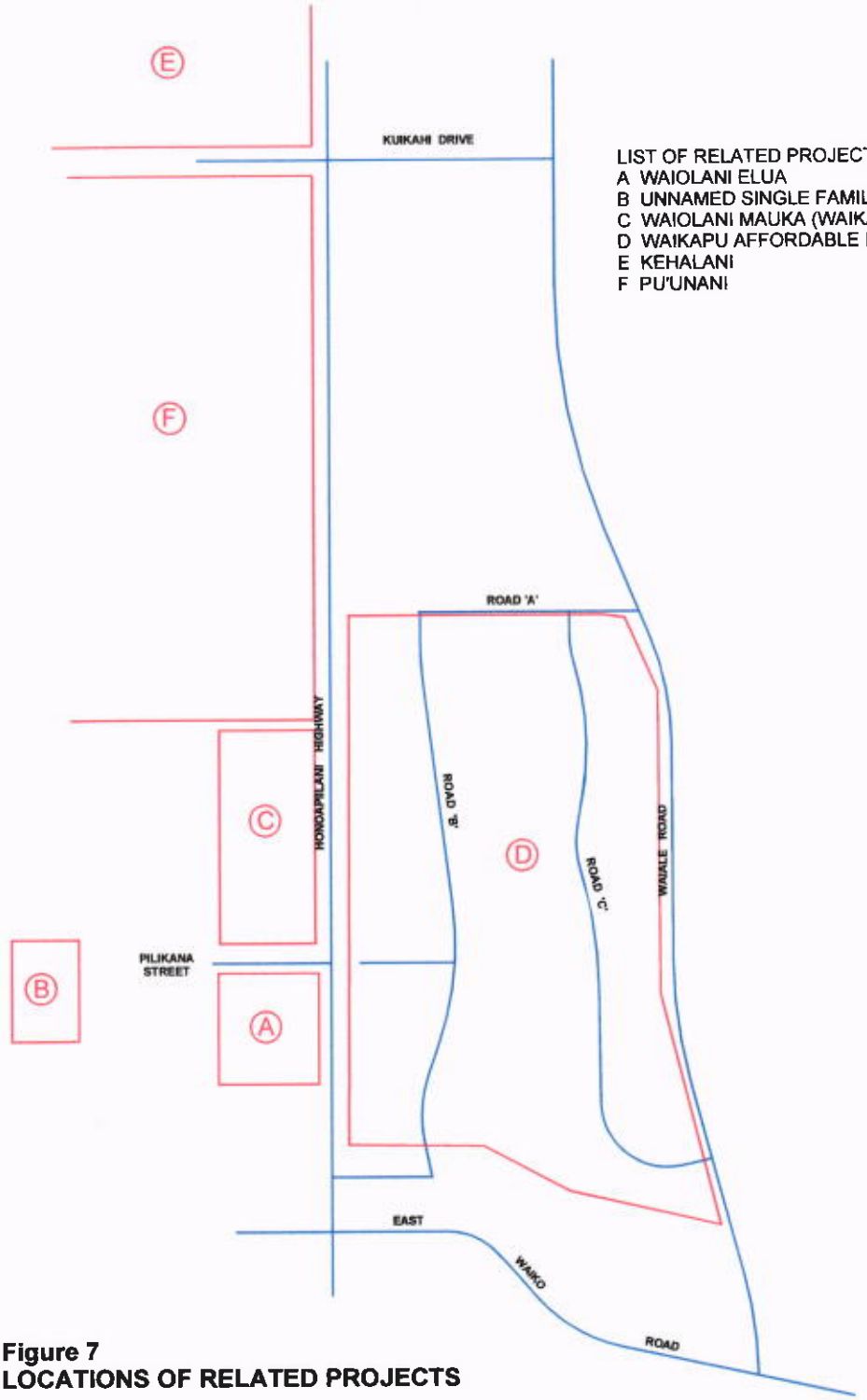

Figure 7
LOCATIONS OF RELATED PROJECTS

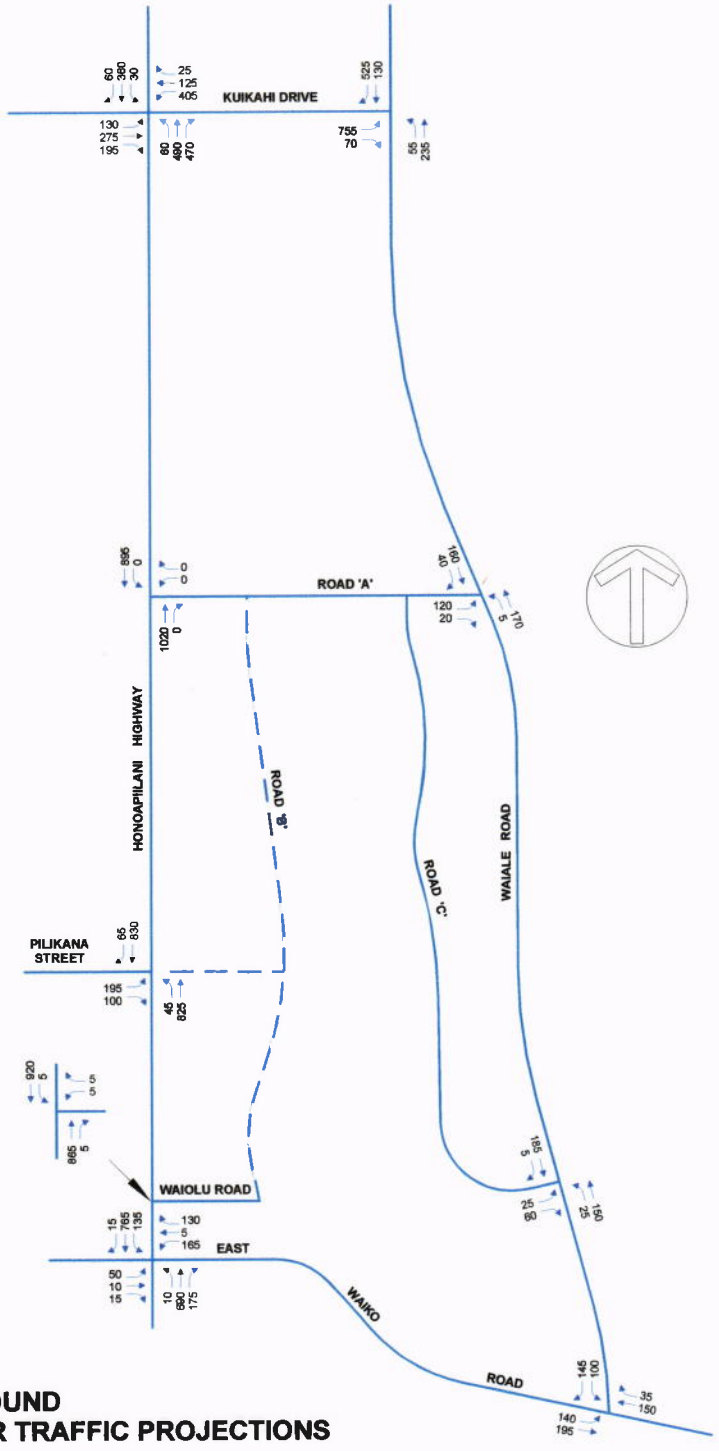

Figure 8
2010 BACKGROUND
AM PEAK HOUR TRAFFIC PROJECTIONS

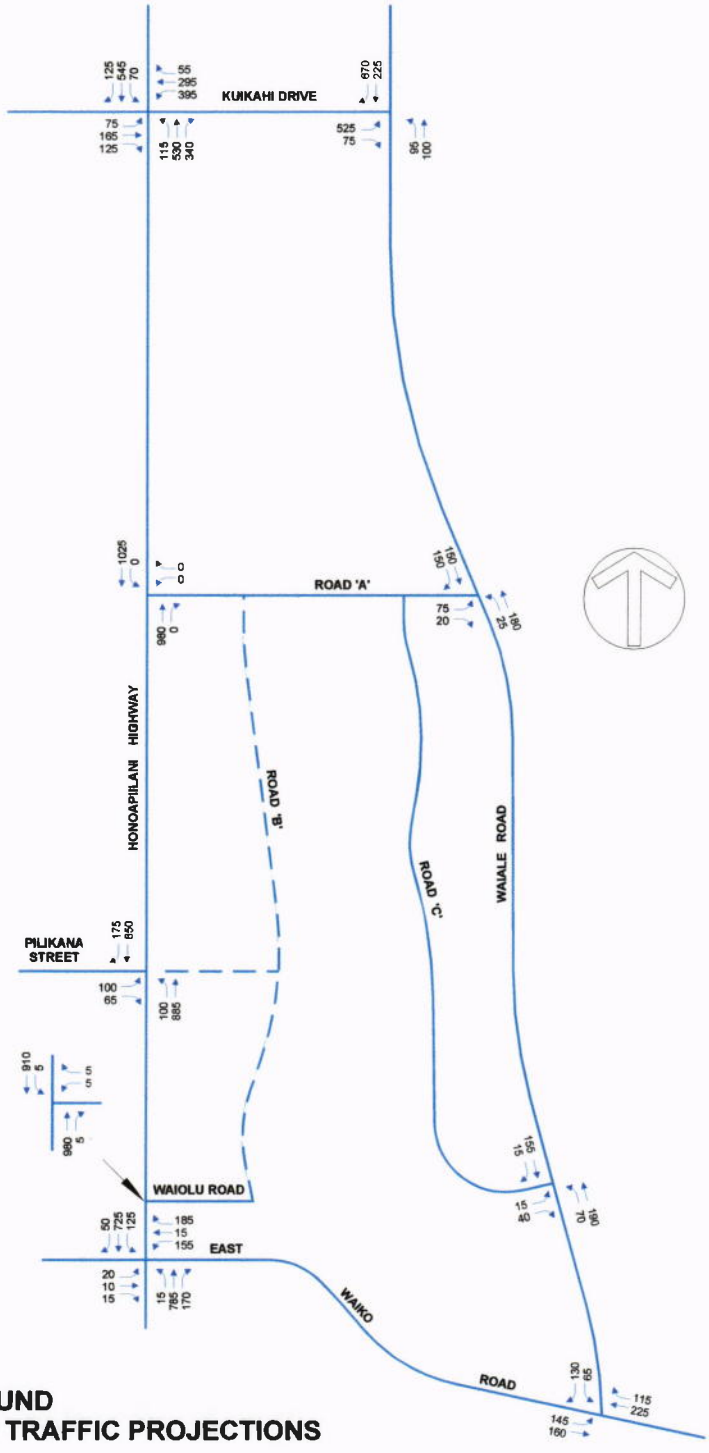

Figure 9
2010 BACKGROUND
PM PEAK HOUR TRAFFIC PROJECTIONS

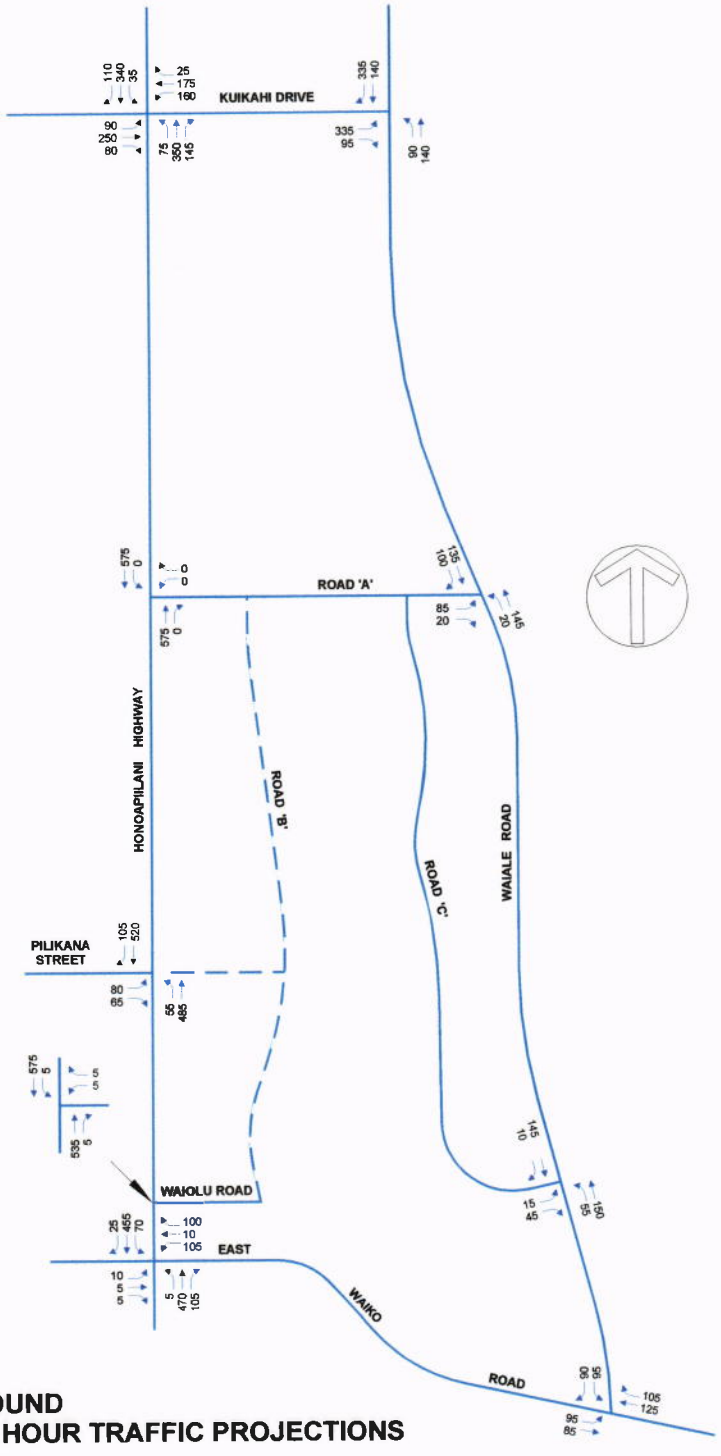

Figure 10
2010 BACKGROUND
SUNDAY PEAK HOUR TRAFFIC PROJECTIONS

4. PROJECT-RELATED TRAFFIC CONDITIONS

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.

Project Trip Generation Calculations

Future traffic volumes generated by a project were typically estimated using the procedures described in the *Trip Generation Handbook,*[4] published by the Institute of Transportation Engineers. This method uses trip generation rates to estimate the number of trips that a proposed project will generate during peak hours. The standard reference for trip generation data is *Trip Generation.*[5]

The proposed project consists of three components, the pre-school, the day-school and the church. Each component is discussed separately.

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

[5] Institute of Transportation Engineers, *Trip Generation, 7th Edition*, Washington, D.C., 2003

Pre-School

Trip Generation does not contain trip generation data for pre-schools. In order to determine the number of peak hour trips per student, a trip generation survey was performed for the existing pre-school is Wailuku. The number of vehicles dropping off and picking up pre-school students was counted and related to the number of pre-school students enrolled. This count was performed in May 2005. During the survey, there were 24 inbound and 24 outbound vehicle trips during the morning peak hour. There were 38 pre-school students enrolled at the time of the survey. Therefore, the morning peak hour trip generation rate is 1.26 trips per student and the directional distribution is 50/50.

During the afternoon peak hour, there were 15 inbound and 15 outbound trips. The afternoon peak hour trip generation rate is 0.78 and the directional distribution is 5/50.

The trip generation data is summarized in Table 10, along with the calculations for 80 pre-school students.

Day School

Trip Generation contains peak hour trip generation data for K through 8 private schools. The rates are based of the number of students enrolled. These rates were used to estimate the trip generated by the day school.

Church

Trip Generation contains peak hour trip generation data for churches. Rates are provided for weekday morning, weekday afternoon and Sunday peak hours. The rates are based on the gross square footage of the building. These rates were used to estimate the trip generated by the church building.

The trip generation analysis for the total project is summarized in Table 10. The trips shown are the peak hourly trips generated by the project, which typically coincide with the peak hour of the adjacent street.

Table 10 Trip Generation Analysis

Period & Direction		Pre-School			K-8 Day-School			Church			Totals
		Trips per Student or Percent		Trips	Trips per Student or Percent		Trips	Trips per TGSF or Percent		Trips	
AM Peak Hour	Total	1.26	80	100	0.90	400	360	1.28	5,000	10	470
	Inbound	50%		50	55%		200	50%		5	255
	Outbound	50%		50	45%		160	50%		5	215
PM Peak Hour	Total	0.78		60	0.61		245	1.41		10	315
	Inbound	50%		30	47%		115	59%		5	150
	Outbound	50%		30	53%		130	41%		5	165
Sunday Peak Hour	Total	(2)			(2)			11.76		60	60
	Inbound							50%		30	30
	Outbound							50%		30	30

Notes:
(1) All number are rounded to five (5).
(2) Pre-school and day-school are closed on Sunday.
(3) TGSF = Thousand Gross Square Feet

Trip Distribution and Assignments

The project-related trips were distributed along the anticipated approach routes to the project site based on the directional distribution of existing peak hour traffic along Wailea Alanui Drive, Wailea Iki Drive and Piilani Highway.

The project morning and afternoon peak hour trip assignments are shown in Figures 11, 12 and 13.

2010 Background Plus Project Projections

Background plus project traffic conditions are defined as 2010 background traffic conditions plus project related traffic. These projections were estimated by superimposing the peak hourly traffic generated by the proposed project on the 2010 background peak hour traffic volumes presented in Chapter 3.

The incremental difference between background and background plus project is the traffic impact of the project under study.

The traffic projections for 2010 background plus project conditions are shown on Figures 14, 15 and 16. The traffic projection worksheets are presented as Appendix B.

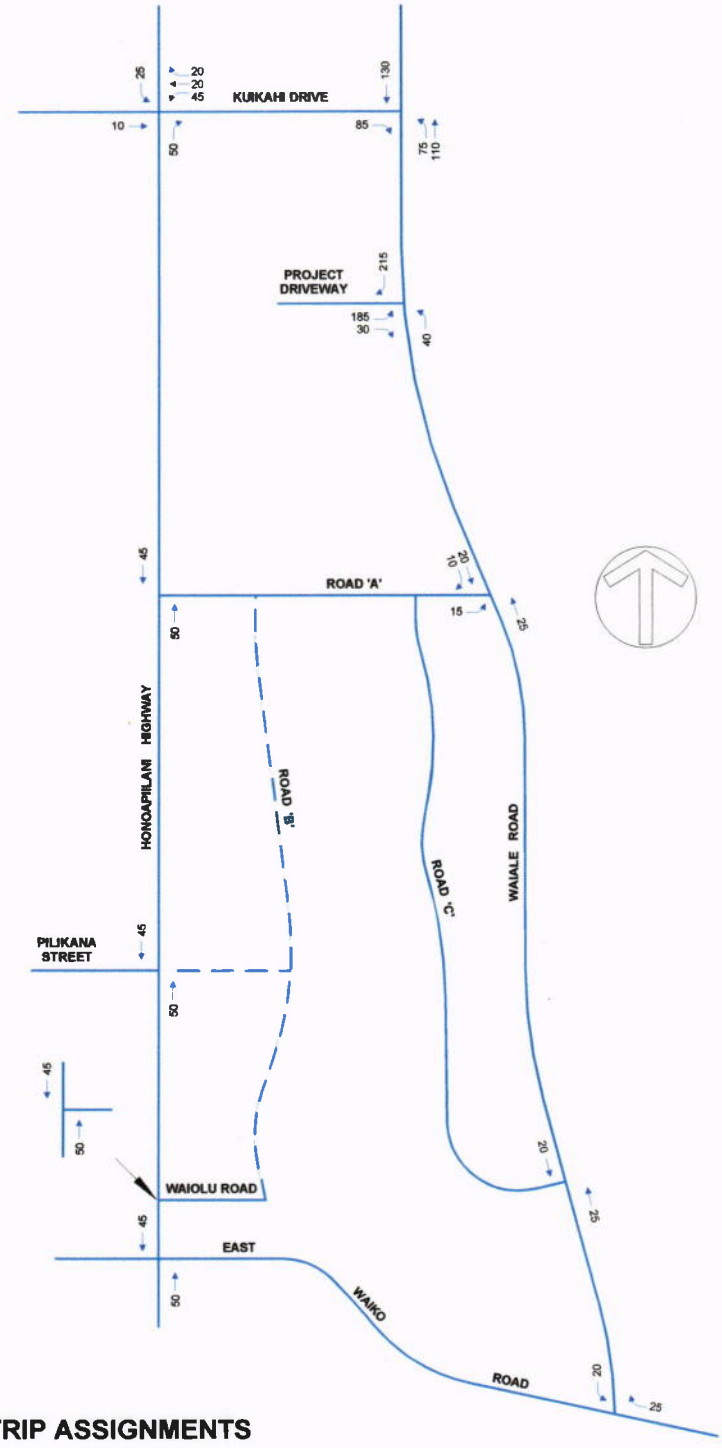

Figure 11
AM PROJECT TRIP ASSIGNMENTS

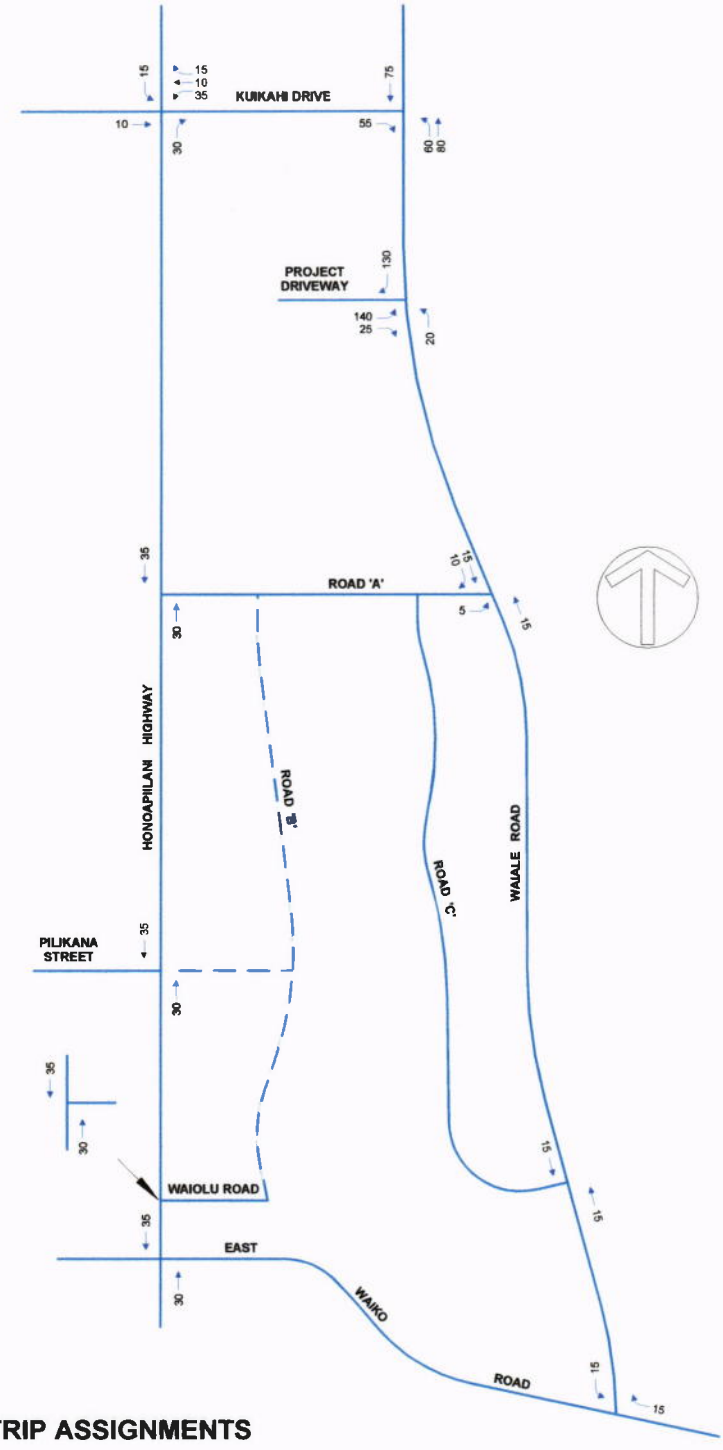

Figure 12
PM PROJECT TRIP ASSIGNMENTS

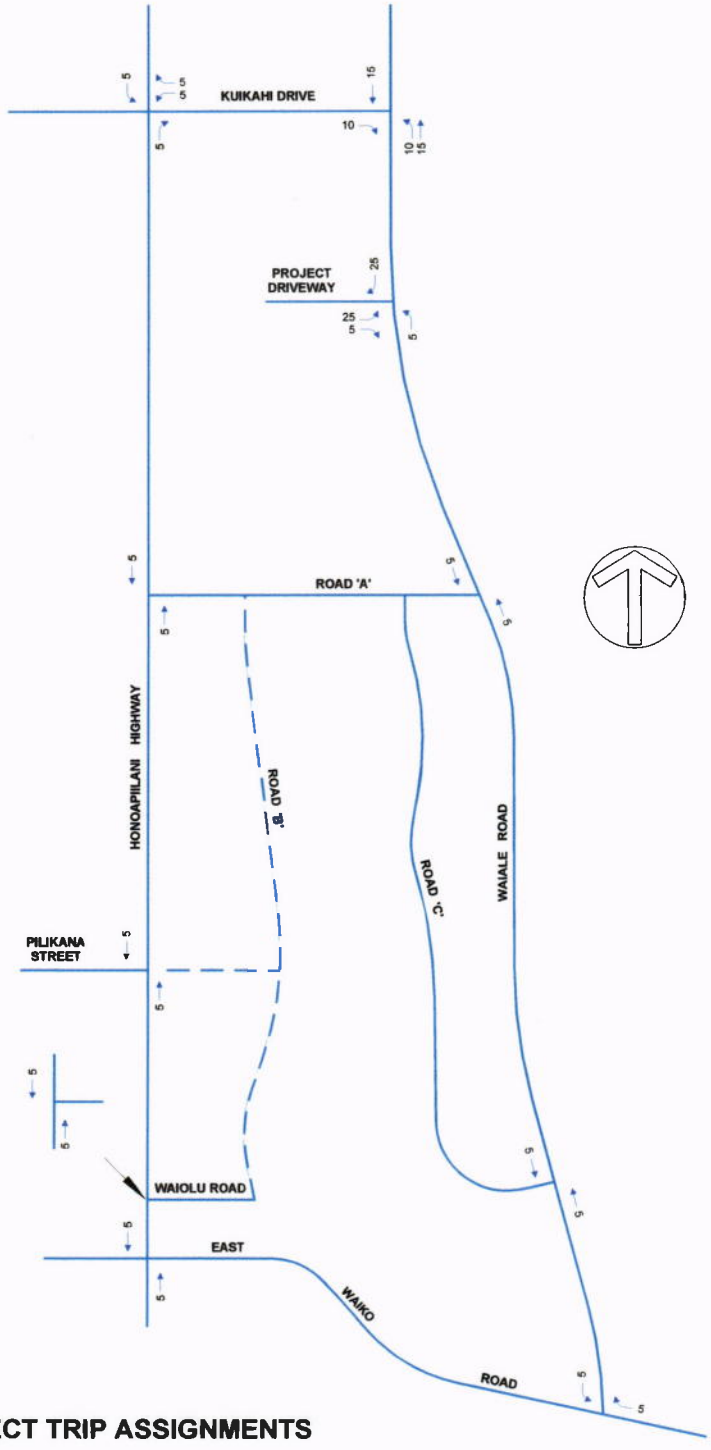

Figure 13
SUNDAY PROJECT TRIP ASSIGNMENTS

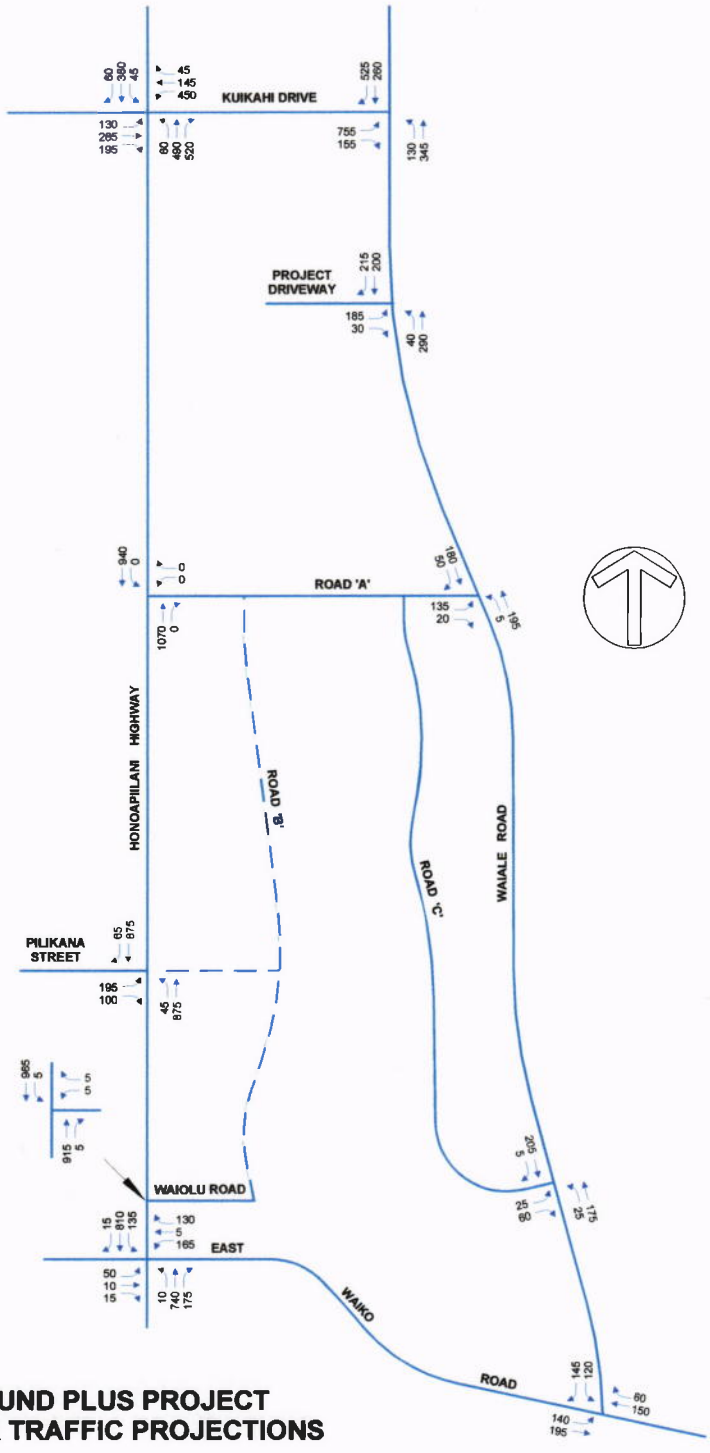

Figure 14
2010 BACKGROUND PLUS PROJECT
AM PEAK HOUR TRAFFIC PROJECTIONS

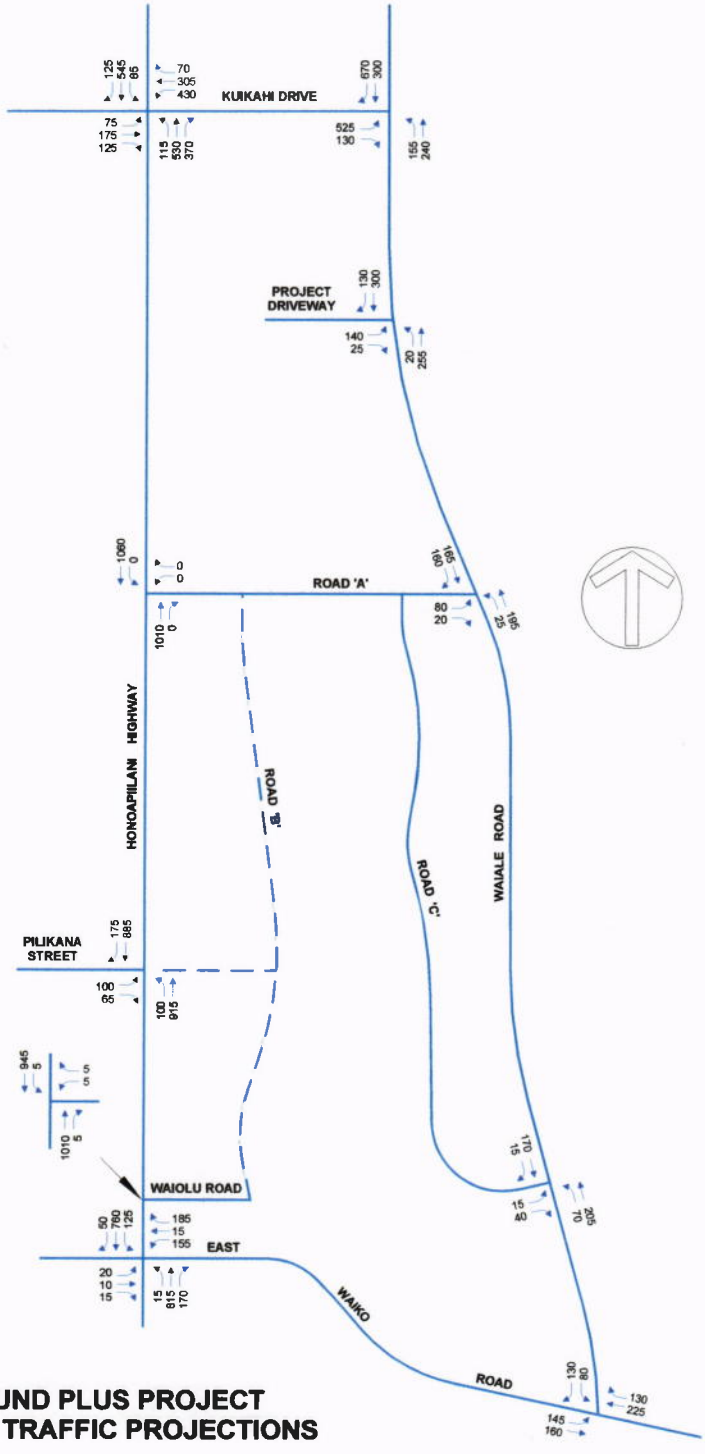

Figure 15
2010 BACKGROUND PLUS PROJECT
PM PEAK HOUR TRAFFIC PROJECTIONS

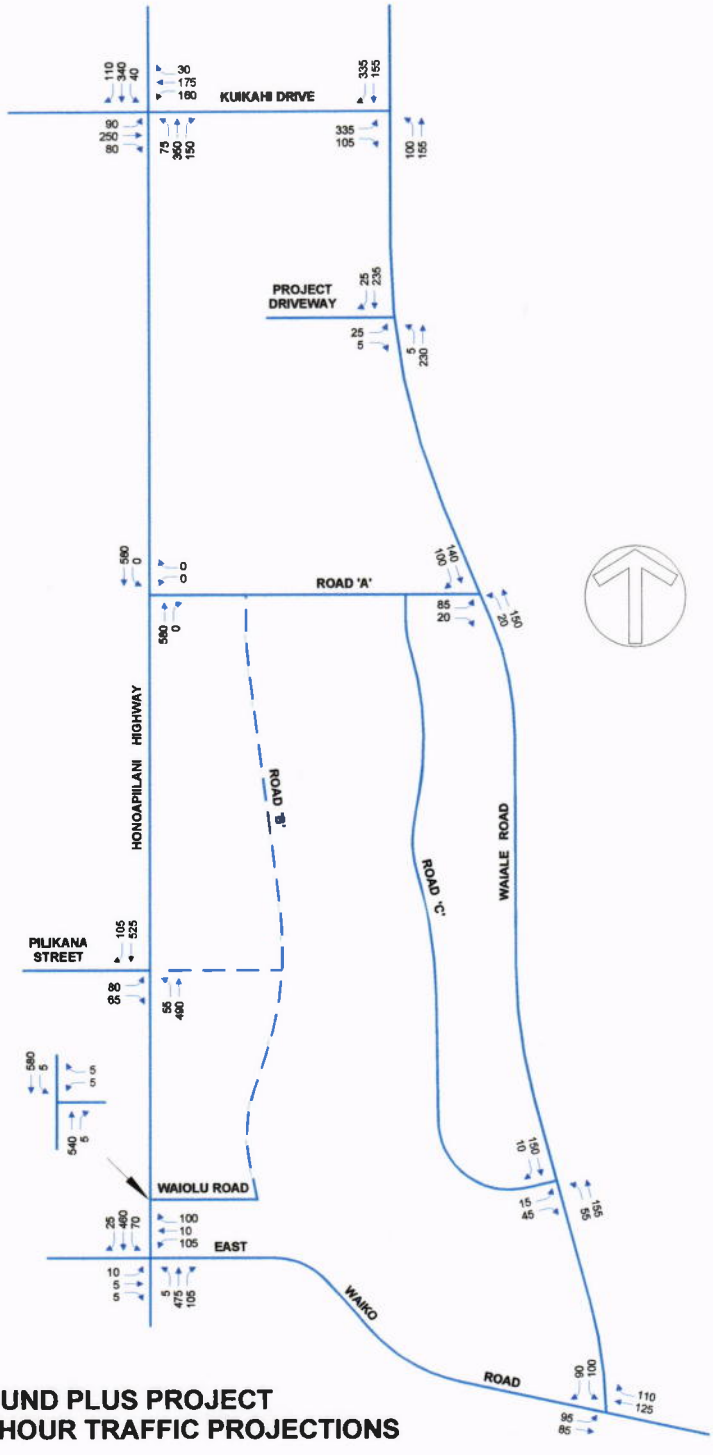

Figure 16
2010 BACKGROUND PLUS PROJECT
SUNDAY PEAK HOUR TRAFFIC PROJECTIONS

5. CONCLUSIONS AND RECOMMENDATIONS

The purpose of this chapter is to summarize the results of the level-of-service analysis, which identifies the project-related impacts. In addition, any mitigation measures necessary and feasible are identified and other access, egress and circulation issues are discussed.

The impact of the project was assessed by analyzing the changes in traffic volumes and levels-of-service at the study intersections.

Changes in Total Intersection Volumes

An analysis of the changes in traffic volumes at the study intersections is summarized in Table 11.

An analysis of the project's pro rata share of the increase of traffic volumes between 2005 and 2010 is summarized in Table 12 .

Table 11 Analysis of Changes of Total Intersection Approach Volumes [1]

Intersection	Period	Existing	2010 Background	2010 Background Plus Project	Percent Growth from Background Growth [2]	Percent Growth from Project Traffic [3]
Honoapiilani Highway at East Waiko Road	AM	1770	2165	2260	22.3%	4.4%
	PM	1810	2270	2335	25.4%	2.9%
	Sunday	985	1365	1375	38.6%	0.7%
Honoapiilani Highway at Waiolu Road	AM	1685	1805	1900	7.1%	5.3%
	PM	1730	1910	1975	10.4%	3.4%
	Sunday	935	1130	1140	20.9%	0.9%
Honoapiilani Highway at Pilikana Street	AM	1820	2060	2155	13.2%	4.6%
	PM	1845	2175	2240	17.9%	3.0%
	Sunday	990	1310	1320	32.3%	0.8%
Honoapiilani Highway at Kuikahi Drive	AM	2030	2625	2795	29.3%	6.5%
	PM	1990	2835	2950	42.5%	4.1%
	Sunday	1040	1830	1850	76.0%	1.1%
Waiale Road at East Waiko Road	AM	290	765	810	163.8%	5.9%
	PM	335	840	870	150.7%	3.6%
	Sunday	185	595	605	221.6%	1.7%
Waiale Road at Kuikahi Drive	AM	995	1770	2170	77.9%	22.6%
	PM	855	1750	2020	104.7%	15.4%
	Sunday	345	1135	1185	229.0%	4.4%

Notes:
(1) Volumes shown are total intersection approach volumes or projections.
(2) Background growth compared to existing volumes.
(3) Growth from project traffic compared to background plus project traffic projections.

Table 12 Analysis of Growth of Total Intersection Approach Volumes [1]

Intersection	Period	Existing	2010 Background	Background Plus Project	Background Growth [2]		Project Trips [3]	
					Volume	% of 2005 to 2010 Growth	Volume [4]	% of 2005 to 2010 Growth
Honoapiilani Highway at East Waiko Road	AM	1770	2165	2260	395	80.6%	95	19.4%
	PM	1810	2270	2335	460	87.6%	65	12.4%
	Sunday	985	1365	1375	380	97.4%	10	2.6%
Honoapiilani Highway at Waiolu Road	AM	1685	1805	1900	120	55.8%	95	44.2%
	PM	1730	1910	1975	180	73.5%	65	26.5%
	Sunday	935	1130	1140	195	95.1%	10	4.9%
Honoapiilani Highway at Pilikana Street	AM	1820	2060	2155	240	71.6%	95	28.4%
	PM	1845	2175	2240	330	83.5%	65	16.5%
	Sunday	990	1310	1320	320	97.0%	10	3.0%
Honoapiilani Highway at Kuikahi Drive	AM	2030	2625	2795	595	77.8%	170	22.2%
	PM	1990	2835	2950	845	88.0%	115	12.0%
	Sunday	1040	1830	1850	790	97.5%	20	2.5%
Waiale Road at East Waiko Road	AM	290	765	810	475	91.3%	45	8.7%
	PM	335	840	870	505	94.4%	30	5.6%
	Sunday	185	595	605	410	97.6%	10	2.4%
Waiale Road at Kuikahi Drive	AM	995	1770	2170	775	66.0%	400	34.0%
	PM	855	1750	2020	895	76.8%	270	23.2%
	Sunday	345	1135	1185	790	94.0%	50	6.0%

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

Methodology for Level-of-Service Analysis

1. As previously noted, State Department of Transportation (Honolulu) has requested the Synchro software package be used to performed level-of-service analyses. Accordingly, Synchro 6 was used to calculate the traffic signal timings. The timings were then downloaded into the Highway Capacity Software to calculate the levels-of-service of the signalized intersections. Both software packages are based on the methodology described in the *Highway Capacity Manual*.

2. In the past, the LA Department of Transportation standard was used to determine the significance of the impacts of project generated traffic. SDOT has consistently responded that they prefer to use the engineering judgement and discretion of their staff to assess the traffic impacts of a project and the effectiveness of possible mitigation measures, along with the standards of the Institute of Transportation Engineers . Accordingly, we have used the Institute of Transportation Engineers standard that a Level-of-Service D is the minimum acceptable level-of-service and that the criteria is applicable to the overall intersection as well as the controlled lane group. If project generated traffic causes the level-of-service to drop below Level-of-Service D (Levels-of-Service E or F), then mitigation should be provided to improve the level-of-service to Level-of-Service D or better. If the Level-of-Service is E or F without project generated traffic and project generated traffic causes the delay of increase, then mitigation should be provided to improve the delay to be equal to or less than the delay for background without project conditions.

3. As the *Highway Capacity Manual* defines level-of-service by delay, we have used the same definition.

Level-of-Service Analysis for Signalized Intersections

The level-of-service analysis of the signalized intersections was performed for background and background plus project conditions and then compared. The incremental difference of the volume-to-capacity ratios between the two conditions is the impact of the project. The assumptions used for the level-of-service analysis are:

1. The existing intersection configurations will be maintained.

2. The intersections of Honoapiilani Highway at East Waiko Road and Honoapiilani Highway at Pilikana Street are signalized.

3. Waiale Road is completed between Kuikahi Drive and East Waiko Road. There are two three new intersections along this section of Waiale Road (at East Waiko Road, at Road A and at Road C). All these intersections are unsignalized.

Signalized Intersections

The results of the level-of-service analysis of the signalized intersections are summarized in Table 13. The results for three intersections are shown. Shown are the volume-to-capacity ratios, average vehicle delays and levels-of-service. As previously noted, the intersections of Honoapiilani Highway at East Waiko Road and Honoapiilani Highway at Pilikana Street are signalized for 2010 background conditions. The intersection of Honoapiilani Highway at Kuikahi Drive is already signalized.

For all the signalized study intersections, all movements will operate at Level-of-Service D, or better. As Level-of-Service D is the minimum acceptable level-of-service, no mitigation of the signalized intersections is required.

Unsignalized Intersections

The results of the level-of-service analysis of the unsignalized intersections are summarized in Table 14. Shown are the average vehicle delays and levels-of-service of the controlled lane groups. Delays and levels-of-service are not calculated for the overall intersection of the uncontrolled movements of an unsignalized intersection.

With the exception of the intersection of Waiale Road at Kuikahi Drive, all controlled lane groups will operate a Level-of-Service C, or better, during all peak periods. At the intersection of Waiale Road at Kuikahi Drive, the eastbound to northbound left turn will operate at Level-of-Service F during both weekday peak periods, without and with the project. Mitigation will be required for this intersection to operate at an acceptable level-of-service.

Table 13 2012 Levels-of-Service - Signalized Intersections

	AM Peak Hour						PM Peak Hour						SUNDAY Peak Hour					
	Without Project			With Project			Without Project			With Project			Without Project			With Project		
Intersection, Approach and Movement	V/C[1]	Delay[2]	LOS[3]	V/C	Delay	LOS	V/C[1]	Delay[2]	LOS[3]	V/C	Delay	LOS	V/C[1]	Delay[2]	LOS[3]	V/C	Delay	LOS
Honoapiilani Hwy at E. Waiko Rd	0.91	32.4	C	0.94	38.0	D	0.95	37.7	D	0.97	41.2	D	0.63	18.3	B	0.64	18.4	B
Eastbound Left & Thru	0.17	23.7	C	0.17	23.7	C	0.24	46.2	D	0.24	46.2	D	0.04	18.2	B	0.04	18.2	B
Eastbound Right	0.03	21.9	C	0.03	21.9	C	0.11	43.4	D	0.11	43.4	D	0.01	18.0	B	0.01	18.0	B
Westbound Let, Thru & Right	0.78	41.7	D	0.78	41.7	D	0.86	54.4	D	0.86	54.4	D	0.54	25.9	C	0.54	25.9	C
Northbound Left	0.05	11.0	B	0.06	11.3	B	0.05	11.9	B	0.06	13.0	B	0.01	7.0	A	0.01	7.0	A
Northbound Thru & Right	0.96	42.0	D	1.02	54.9	D	0.98	44.3	D	1.01	51.9	D	0.70	19.2	B	0.70	19.4	B
Southbound Left	0.83	54.2	D	0.83	54.5	D	0.77	51.0	D	0.70	51.0	D	0.21	10.1	B	0.22	10.2	B
Southbound Thru	0.70	15.5	B	0.74	16.8	B	0.72	20.3	C	0.75	21.6	C	0.53	15.4	B	0.54	15.5	B
Southbound Right	0.02	7.0	A	0.02	7.0	A	0.06	10.1	B	0.06	10.1	B	0.04	10.0+	B	0.04	10.0+	B
Honoapiilani Hwy at Pilikana Rd	0.67	21.2	C	0.70	23.7	C	0.66	18.6	B	0.68	20.1	C	0.42	13.4	B	0.42	13.5	B
Eastbound Left	0.51	31.8	C	0.51	31.8	C	0.30	28.8	C	0.30	28.8	C	0.20	21.4	C	0.20	21.4	C
Eastbound Right	0.22	26.8	C	0.22	26.8	C	0.13	26.6	C	0.13	26.6	C	0.11	20.5	C	0.11	20.5	C
Northbound Left	0.19	32.3	C	0.19	32.3	C	0.40	34.5	C	0.40	34.5	C	0.19	24.6	C	0.19	24.6	C
Northbound Thru	0.68	11.1	B	0.72	12.2	B	0.70	10.3	B	0.73	10.9	B	0.42	6.9	A	0.42	7.0	A
Southbound Thru	0.88	28.0	C	0.92	33.3	C	0.87	25.2	C	0.90	28.5	C	0.62	16.9	B	0.63	17.0	B
Southbound Right	0.05	9.6	A	0.05	9.6	A	0.19	9.6	A	0.19	9.6	A	0.12	10.5	B	0.12	10.5	B
Honoapiilani Hwy at Kuikahi Dr	0.77	41.8	D	0.78	43.7	D	0.74	38.5	D	0.75	39.4	D	0.56	22.4	C	0.56	22.4	C
Eastbound Left	0.50	48.3	D	0.52	49.2	D	0.40	44.6	D	0.41	45.0	D	0.30	22.8	C	0.30	22.8	C
Eastbound Thru	0.67	52.0	D	0.70	53.3	D	0.45	43.2	D	0.48	43.8	D	0.50	25.1	C	0.50	25.1	C
Eastbound Right	0.58	49.4	D	0.58	49.4	D	0.41	42.9	D	0.41	42.9	D	0.19	20.8	C	0.19	20.8	C
Westbound Left	0.78	33.7	C	0.88	44.8	D	0.77	34.1	C	0.85	40.3	D	0.41	17.3	B	0.43	17.5	B
Westbound Thru & Right	0.18	18.0	B	0.23	18.6	B	0.47	24.8	C	0.51	25.6	C	0.28	14.8	B	0.29	14.9	B
Northbound Left	0.32	54.7	D	0.32	54.7	D	0.52	53.5	D	0.52	53.5	D	0.30	29.8	C	0.30	29.8	C
Northbound Thru	0.82	49.7	D	0.82	49.7	D	0.81	42.5	D	0.81	42.5	D	0.61	25.1	C	0.61	25.1	C
Northbound Right	0.43	35.0+	D	0.53	37.5	D	0.16	25.0	C	0.22	25.7	C	0.16	18.3	B	0.17	18.4	B
Southbound Left	0.16	51.4	D	0.24	52.9	D	0.32	47.8	D	0.38	49.4	D	0.14	27.4	C	0.16	27.7	C
Southbound Thru	0.60	39.0	D	0.60	39.0	D	0.83	44.2	D	0.83	44.2	D	0.59	24.7	C	0.59	24.7	C
Southbound Right	0.12	29.4	C	0.12	29.4	C	0.23	26.0	C	0.23	26.0	C	0.23	19.1	B	0.23	19.1	B

NOTES:

1. V/C denotes ratio of volume to capacity.
2. Delay is in seconds per vehicle.
3. LOS denotes Level-of-Service calculated using the operations method described in *Highway Capacity Manual*. LOS is based on delay.

Table 14 2010 Levels-of-Service - Unsignalized Intersections(1)

Intersection and Movement	AM Peak Hour				PM Peak Hour				Sunday Peak Hour			
	Without Project		With Project		Without Project		With Project		Without Project		With Project	
	Delay [1]	LOS [2]	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Honoapiilani Highway at Waiolu Road												
Southbound Left	9.9	A	10.2	B	10.5	B	10.5	B	8.6	A	8.6	A
Westbound Left & Right	20.0	C	21.1	C	22.0	C	22.1	C	17.7	C	17.8	C
Waiale Road at East Waiko Rd												
Eastbound Left & Thru	7.9	A	8.0	A	8.4	A	8.5	A	7.9	A	8.0	A
Southbound Left & Right	17.3	C	19.9	C	17.0	C	18.9	C	13.4	B	13.6	B
Waiale Road at Kuikahi Drive												
Northbound Left	9.3	A	10.5	B	10.9	B	12.2	B	8.7	A	8.8	A
Eastbound Left	332.7	F		F	251.2	F	731.3	F	31.3	D	39.8	E
Eastbound Right	9.3	A	11.1	B	10.0	B	11.2	B	9.5	A	9.7	A
Waiale Road at Road A												
Northbound Left & Thru	7.6	A	8.0	A	8.0	A	8.0	A	7.8	A	7.8	A
Eastbound Left & Right	12.3	B	14.3	B	12.7	B	13.3	B	11.9	B	12.0	B
Waiale Road at Road C												
Northbound Left & Thru	7.7	A	7.7	A	7.7	A	7.8	A	7.6	A	7.7	A
Eastbound Left & Right	10.5	B	10.8	B	10.5	B	10.7	B	10.1	B	10.1	B

NOTES:
(1) Delay 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.

Mitigation

As noted in the previous section, mitigation is required at the intersection of Waiale Road at Kuikahi Drive to mitigate an expected Level-of-Service F. It should be noted that this intersection will operate at Level-of-Service F without and with the project. This implies that background growth and traffic from the related projects increases the traffic volumes and delays such that Level-of-Service F is the result. The proposed project contributes additional traffic that further aggravates the long delays.

There are three potential mitigation measures, each of which is discussed in the following paragraphs.

Intersection Widening

Widening of the intersection to provide a second lane for the eastbound to northbound left turn would require widening of Waiale Road northbound in order to accommodate the second left turn lane. This does not appear to be a viable option because of right-of-way constraints. It is also understood that the community has expressed its desire that Waiale Road be only two lanes wide.

Signalization

The peak hour warrants for a traffic signal are satisfied for both morning and afternoon peak hour conditions without the project. The warrants will also be satisfied for peak hour conditions with the project. As a signalized intersection, all movements will operate at Level-of-Service C, or better, during morning and afternoon peak hours.

Roundabout

An analysis of the intersection as a roundabout was performed. This analysis concluded that the intersection would have a volume-to-capacity ratio of 1.08 during the morning weekday peak hour. This implies that the intersection would operate a Level-of-Service F if converted to a roundabout. .The conclusion is that a roundabout at the intersection is not a viable mitigation measure.

Driveway Analysis

An analysis of anticipated traffic conditions at the project's driveway along Waiale Road was performed to determine the required lane configuration. The assumptions used in the analysis were that the driveway would have two exit lane, one left turn lane and one right turn lane, and the intersection would be unsignalized. The results of this analysis is summarized in Table15. As shown, all movements will operate at Level-of-Service D, or better. Level-of-Service D is the minimum acceptable level-of-service.

Table 15 2010 Levels-of-Service at Project Driveway along Waiale Road

Intersection and Movement	AM Peak Hour		PM Peak Hour		Sunday Peak Hour	
	Delay	LOS	Delay	LOS	Delay	LOS
Waiale Road at Project Driveway						
Northbound Left & Thru	8.3	A	8.3	A	7.8	A
Eastbound Left	25.2	D	19.9	C	12.4	B
Eastbound Right	10.3	B	10.7	B	9.7	A

NOTES:
(1) Delay 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.

An assessment of the need for a separate left turn lane for traffic turning into the project was performed using guidelines published by the Transportation Resource Board[6]. The assessment determined that a separate left turn lane is warranted at the driveway during the morning peak period. Accordingly, based on the findings of an accepted standard, a separate left turn lane along northbound Waiale Road at the project driveway is recommended.

The widening required for the left turn lane will also provide widening for a left turn refuge lane. This will improve the level-of-service and safety of traffic exiting the project onto Waiale Road.

[6] Transportation Resource Board, NCHRP Report 457, *Evaluating Intersection Improvements: An Engineering Study Guide*, 2001, Washington, D.C. p21-22

Other Traffic Issues

Secondary Access Along Honoapiilani Highway

The preceding traffic analysis is based on the assumption that there will be only one access and egress point to the project and that this would be the driveway along Waiale Road. This assumption is based on preliminary discusses with SDOT. SDOT indicated that it would not allow a secondary access along Honoapiilani Highway.

It is recommended that a secondary access along Honoapiilani Highway be pursued. A secondary access and egress should be provided for emergency services, construction activities and for use during special events. A traffic control offices should also be provided during construction and special events. The County has tentatively indicated it would support this second entrance for emergency services.

A secondary entrance along Honoapiilani Highway would divert traffic from Kuikahi Drive and therefore improve the levels-of-service at the intersections with Honoapiilani Highway and Waiale Road. The entrance should be restricted to right turns in and right turns out only.

APPENDIX A

SITE PLAN

APPENDIX B

TRAFFIC PROJECTION WORKSHEETS

APPENDIX C

LEVEL-OF-SERVICE CALCULATIONS