TRAFFIC ASSESSMENT

Development of Northwest Corner

Kapolei Village

Kapolei, Oahu, Hawaii

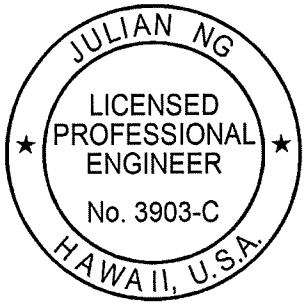
April 2008

Prepared for:

Bills Engineering, Inc.

and

State of Hawaii
Hawaii Housing Finance & Development Corporation



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Executive Summary

The Hawaii Housing Finance and Development Corporation is considering development alternatives for a 26.6-acre parcel in the Kapolei Village area, south of Farrington Highway and between Fort Barrette Road and Kealanani Avenue. Three alternatives were considered for access to the project site. In each alternative, four driveways would be provided for vehicular access; common to all alternatives are two driveways to Kealanani Avenue, one for all movements near the makai edge of the site and a second for right turns only closer to Farrington Highway. The alternatives considered variations in the turn restrictions on the other driveways, one to Fort Barrette Road and the other to Farrington Highway. The effects of the restrictions on turning movements at the driveways on the conditions at several nearby intersections were evaluated for the 2011 weekday PM Peak Hour.

At the existing signalized intersection of Farrington Highway, Fort Barrette Road, and Makakilo Drive, the addition of project traffic would result over-capacity conditions. The conversion of the existing right-turn only lane to a shared lane for right turns and through traffic would allow the intersection to operate near capacity if all movements are allowed at the driveways to Fort Barrette Road and to Farrington Highway; if left turns are not permitted into the Fort Barrette Road driveway, the signalized intersection of Farrington Highway, Fort Barrette Road, and Makakilo Drive would still be over its capacity with the change. An additional northbound lane on Fort Barrette Road would improve conditions at the intersection, allowing it to operate at near-capacity in any of the alternatives for driveway movements.

At the existing signalized intersection of Farrington Highway and Kealanani Avenue, the proposed commercial development by others will convert the existing T-intersection to a cross-intersection; restriping and split-phasing of the minor street approaches has been recommended in a draft traffic report for that project. The addition of the project traffic (from the proposed development of the Northwest Corner of Kapolei Villages) will increase traffic volumes,

resulting in near-capacity conditions if there are any restrictions on turning movements at the Farrington Highway or Fort Barrette Road driveways. If left turns are permitted at both of these driveways, the traffic volumes at the intersection of Farrington Highway and Kealanani Avenue would be lower and the intersection would operate at under capacity condition.

The addition of project traffic will change conditions at the existing signalized intersection of Fort Barrette Road and Kama'aha Avenue from under capacity to near capacity conditions in each of the driveway alternatives. The addition of a second westbound left turn lane from Kama'aha Avenue to southbound Fort Barrette Road will allow the intersection to operate at under capacity conditions in each of the alternatives.

At the driveway to Fort Barrette Road, the high volume of right turn traffic expected in the peak hour will exceed the capacity available from a stop-controlled driveway approach. The addition of an acceleration lane to allow right turn traffic to accelerate and merge will be necessary. If left turns are allowed at this intersection, traffic signals will be needed and a signal is expected to be warranted. If signalized, the intersection would operate at under capacity conditions.

At the driveway to Farrington Highway, the volume of right turn traffic expected in the peak hour will be less than 50 vehicles per hour, and a stop-controlled driveway approach would be adequate. If left turns are allowed at this intersection, traffic signals will be needed and a signal is expected to be warranted. If signalized, the intersection would operate at under capacity conditions if left turns are also allowed at the Fort Barrette Road driveway. If left turns are not allowed at the Fort Barrette Road driveway, higher volumes on Farrington Highway are expected and the new signalized intersection at Farrington Highway and driveway intersection would operate at near-capacity condition, which could be improved to under-capacity condition with the addition of a separate right turn lane for eastbound right turns from Farrington Highway into the project site.

Right turns leaving the site from the mauka driveway to Kealanani Avenue will be served at acceptable levels of service. Assuming a separate lane is provided for right turns from the makai driveway, this movement would have acceptable levels of service only if all turning

movements are permitted at the Fort Barrette Road driveway. With no left turns from the site to Fort Barrette Road, additional right turn traffic onto Kealanani Avenue is expected, and very long delays could result. A possible mitigation measure to decrease delays to acceptable level is the addition of a separate right turn lane for traffic from Kealanani Avenue into the makai site driveway.

Left turns from the makai driveway to Kealanani Avenue would have sufficient capacity from a stop-controlled approach. However, the higher left turn volume that is expected if left turns from the site onto Farrington Highway are not allowed will be served at unacceptable level of service but traffic signals at this intersection are not expected to be warranted.

Based on the traffic analyses, the alternative of allowing all movements at the proposed driveways to Fort Barrette Road and to Farrington Highway (Alternative C) would result in the best conditions at the various locations. However, this alternative may present some engineering challenges, including:

* providing for coordinated traffic signal timing between the existing traffic signal at Farrington Highway and the new traffic signal at the driveway
* providing for adequate left turn lanes for the existing intersection at Farrington Highway and at the new intersection.
* coordinating the location of the driveway, if all movements are allowed, as there is an existing access road located across Fort Barrette Road.

Allowing left turns and providing a traffic signal at the Farrington Highway driveway (Alternative A), however, are not expected to have similar challenges and would result in better conditions at all locations, as compared to the alternative of right turns only at this driveway (Alternative B). A complete traffic impact analysis report should be done and vehicular access as described for Alternative A should be pursued.

The evaluations reported herein suggest that development of the site should include the following roadway improvements:

a. an additional lane on northbound Fort Barrette Road between the proposed site driveway and Farrington Highway.

b. a separate right turn lane for eastbound traffic on Farrington Highway wishing to enter the site at the proposed driveway.

c. the addition of a right turn only lane from eastbound Farrington Highway to Kealanani Avenue.

d. a separate right turn lane for southbound traffic on Kealanani Avenue wishing to enter the site at the proposed makai driveway.

Introduction

The Hawaii Housing Finance and Development Corporation is considering development alternatives for a 26.6-acre parcel in the Kapolei Village area, south of Farrington Highway and between Fort Barrette Road and Kealanani Avenue (see Figure 1). This traffic assessment identifies the probable impact of one development scenario and provides preliminary planning-level analyses of alternatives for providing site access to the development.

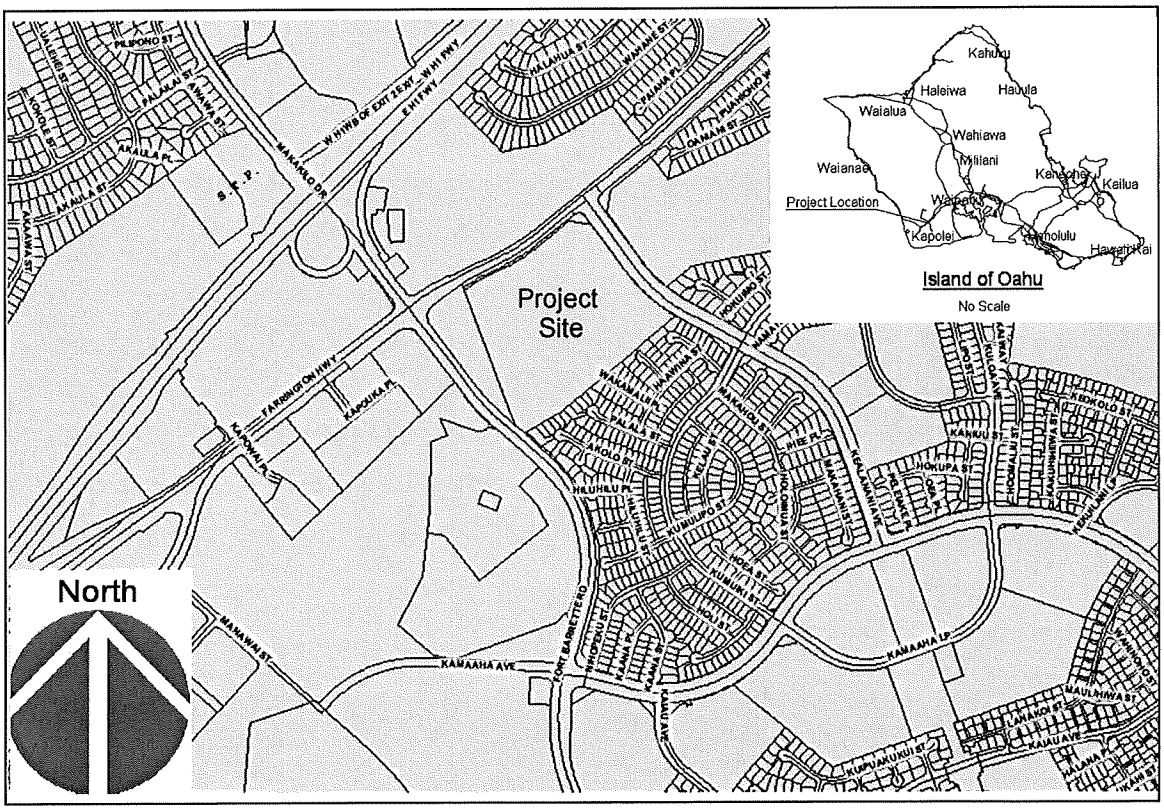


Figure 1 – Project Location

The analyses described herein are for the Weekday PM Peak Hour in the year 2011 assuming full development of the subject property. Other development in the area is also assumed, with baseline traffic (without the project) from an unpublished traffic report for the commercial development of the property across Farrington Highway (Wal-Mart). From the baseline traffic assignments, several roadway improvements have been assumed:

a. Completion of the planned widening of Fort Barrette Road to a four-lane divided highway, while maintaining the existing approach laneage at the intersection of Farrington Highway, Makakilo Drive, and Fort Barrette Road, except as noted below.

b. The addition of a second right turn lane on the westbound approach on Farrington Highway to Makakilo Drive (since baseline right turn volume = 410 vehicles in the PM Peak Hour).

c. Completion of the commercial development north of Farrington Highway, including an access road that becomes the fourth leg of the existing three-way intersection of Farrington Highway and Kealanani Avenue, and a right turn only driveway located approximately midway between Makakilo Drive and Kealanani Avenue.

Some of the improvements described above may be physically difficult to achieve; however, these assumptions are necessary for the purpose of evaluating intersection conditions and identifying the impact of the proposed development of the Northwest Corner site.

The analyses use the Planning Application from the 1985 *Highway Capacity Manual* (Critical Movement Analysis). While subsequent editions of the *Highway Capacity Manual* has more detailed analyses procedures, the Critical Movement Analysis is used because it is simple and results are not subject to assumptions about signal timing, traffic composition, or other operational details. In this analysis, the critical traffic volumes at a signalized intersection are determined by selecting a phasing scheme and determining which traffic movements conflict and will need to be served in different signal phases. The volumes are expressed in vehicles per lane and a sum of the critical (conflicting) movements is determined. A sum of 1,200 vehicles per lane per hour is the maximum for which desirable "under capacity" conditions can be expected. A sum higher than 1,200 but not more than 1,400 vehicles per lane per hour describes "near capacity" conditions, in which noticeable delay and some congestion may occur. A sum greater than 1,400 vehicles per hour indicates "over capacity" conditions,

and improvements to lower the sum would be needed. Typically, these improvements would include the addition of lanes for the movements that contribute to the critical movement sum.

The various projects in the area will have a major impact to regional traffic conditions. Highway improvements such as the North-South Road and Kapolei Parkway have been programmed in anticipation of the growth in the area. In addition, other transportation projects, most notably a fixed-guideway rapid transit system, are being considered to provide alternatives for travel into and out of the area and to improve access to various properties, both existing and proposed. The information about the proposed project presented herein can be used by others as input parameters for studies of future regional traffic conditions.

This assessment also provides preliminary evaluation of unsignalized intersections formed by the site access roadways, including evaluation of the four-hour warrants for the installation of traffic signals. Descriptions of levels of service for controlled movements at the unsignalized intersections are shown in the attached Appendix.

Baseline PM Peak Hour

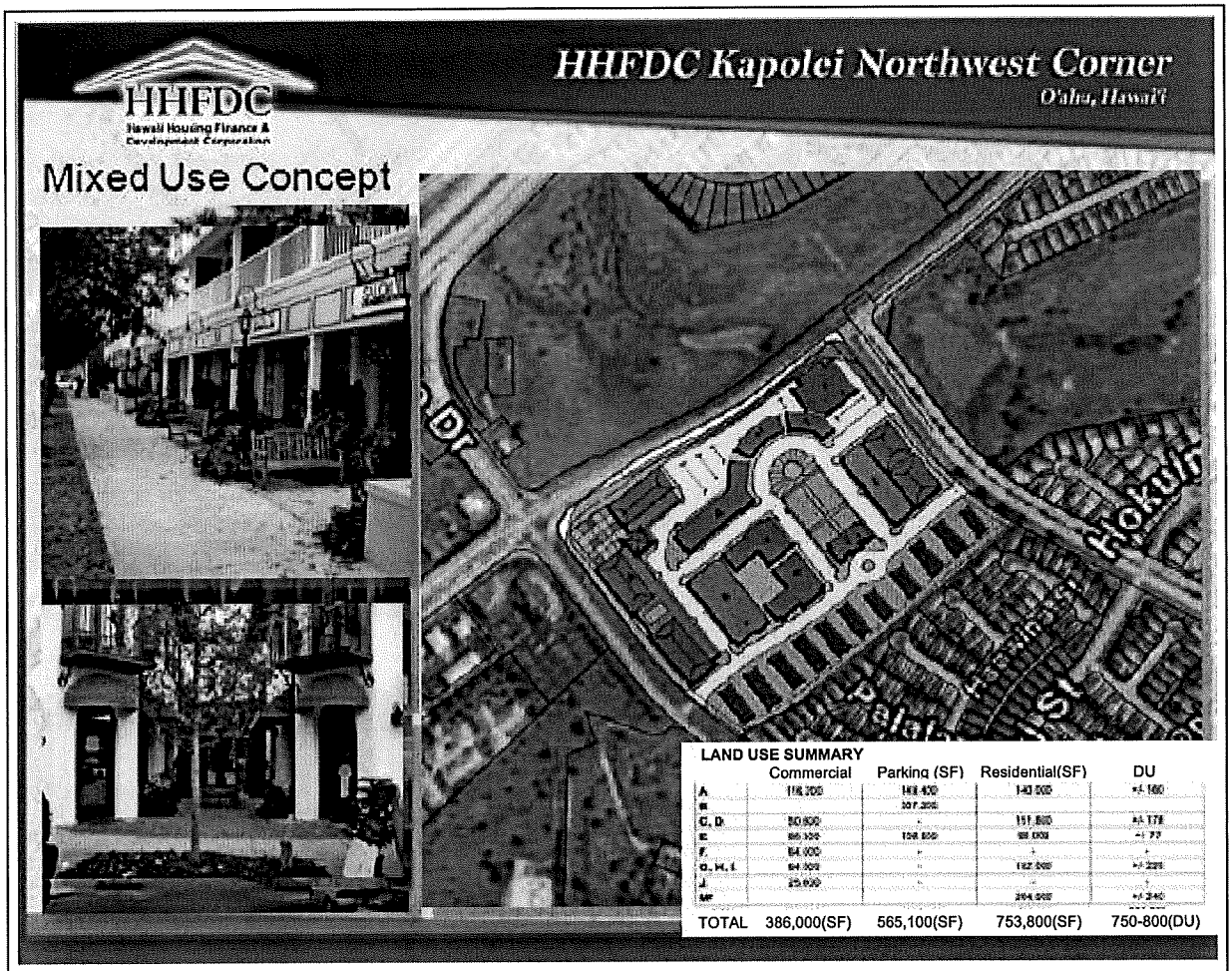
The baseline (without development of the Northwest Corner parcel) Weekday PM Peak Hour traffic volumes were taken from Figure 5-1 of the "Draft Final" traffic study for the Kapolei Commercial Development (Wilbur Smith Associates, June 23, 2006). Table 1 shows the results of the critical movement analyses and the conditions at the three signalized intersections nearest the Northwest Corner.

Table 1 – Baseline Conditions

	Sum of Critical Movements	Condition
Farrington Highway, Makakilo Drive, Fort Barrette Road (existing approach laneage)	1,205	Near capacity
Farrington Highway and Kealanani Avenue	837	Under capacity
Fort Barrette Road and Kama`aha Avenue	1,081	Under capacity

Project Description

The property is zoned BMX-3 (Community Business and Mixed use). Figure 2 shows a conceptual plan of the proposed development of the site.



from Hawaii Housing Finance and Development Corporation

Figure 2 – Proposed Development Plan

For this development, highest hourly volumes are expected in the weekday afternoon (PM) peak hour. The traffic generated by the development is estimated by applying trip rates from the *Trip Generation, 7th Edition* reference published by the Institute of Transportation Engineers. Trip rates for apartments based on the number of dwelling units were applied to the

number of residential units and trip rates for a shopping center were applied to the commercial floor area. Table 2 shows the rates and resulting vehicular trip estimates.

Table 2 – Project Traffic Generation (Weekday PM Peak Hour)

	Trip rates		Traffic Generated	
	Rate	% enter	Entering	Exiting
386.1 KSF Commercial	3.75	48%	695	753
800 Dwelling Units	0.62	65%	322	174
(KSF = 1,000 square feet gross building area)	Total Traffic Generated		1,017	927

Three access alternatives were considered. In each alternative, there will be a single driveway to Fort Barrette Road near the south boundary of the site, a single driveway to Farrington Highway opposite the commercial driveway, and two driveways to Kealanani Avenue. The differences in the alternatives are the movements allowed at each of the driveways; these differences are shown in Table 3.

Table 3 – Access Alternatives

Alternative	A	B	C
Site Driveway to Fort Barrette Road	Right turns (in and out) only		All turns permitted *
Site Driveway to Farrington Highway	All turns permitted *	Right turns (in/out) only	All turns permitted *
Mauka Driveway to Kealanani Avenue	Right turns (in and out) only		
Makai Driveway to Kealanani Avenue	All turns permitted		
* Traffic signal control assumed to be warranted			

Table 4 shows the impact of the proposed project, if all of the traffic generated by the proposed development is new traffic added to the area.

Table 4 – Project Impacts – Pass-By Traffic Not Considered

	Sum of Critical Movements, Condition			
	Baseline	Alt. A	Alt. B	Alt. C
Farrington Highway, Makakilo Drive, Fort Barrette Road	1,205 near capacity	1,510 over capacity	1,510 over capacity	1,447 over capacity
Farrington Highway and Kealanani Avenue	909 under capacity	1,306 near capacity	1,465 over capacity	1,250 near capacity
Fort Barrette Road and Kama`aha Avenue	1,081 under capacity	1,373 near capacity	1,373 near capacity	1,266 near capacity

A comparison of the alternatives indicates that Alternative C would result in the best conditions at the existing signalized intersections with the addition of project traffic. The turn restrictions imposed in Alternatives A and B result in higher volumes of turning traffic at each of these intersections, creating higher critical movement sums.

Traffic generated by shopping centers, however, include pass-by traffic, or traffic that is already on the adjacent streets. During the weekday PM peak period, various studies have shown pass-by trips to be between 8 percent and 90 percent of the total trips generated by a shopping center, with the higher percentage generally occurring with smaller shopping centers. Accounting for pass-by traffic would not reduce driveway turning movements, but will reduce the traffic volumes at the three signalized intersections. With the shopping center generating about 74% of the total traffic from the site, an assumption of 27% pass-by traffic would reduce the net traffic generated by 20%. Figures 3, 4, and 5 show the traffic assignments with consideration of the pass-by traffic. Table 5 shows the results of the analyses with the proposed project and an assumption of 27% pass-by traffic.

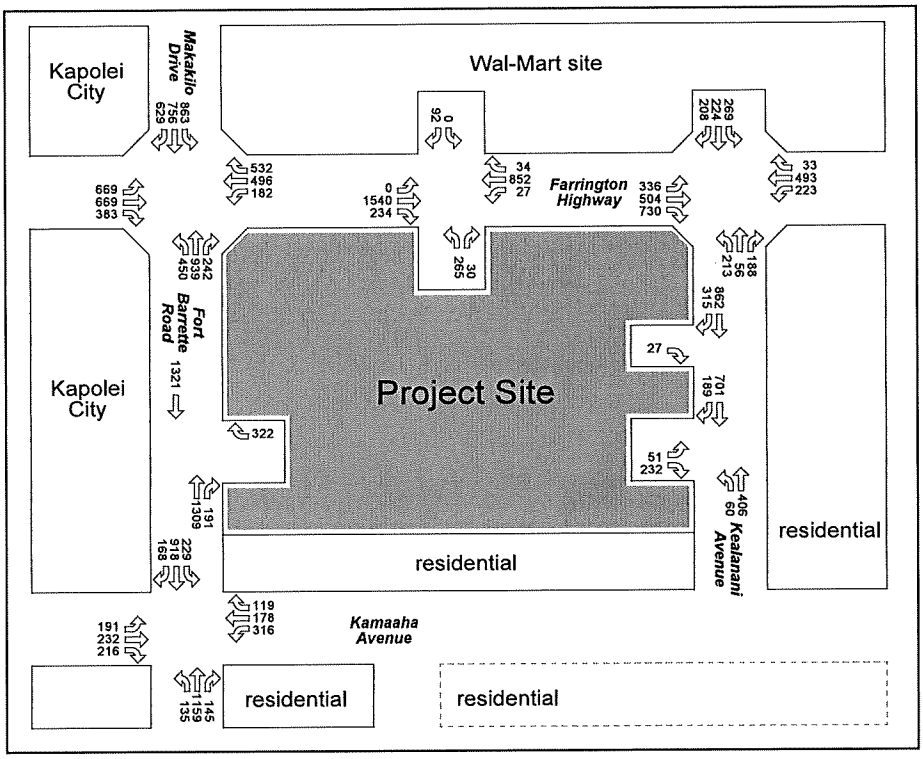


Figure 3 – Traffic Assignments, Alternative A

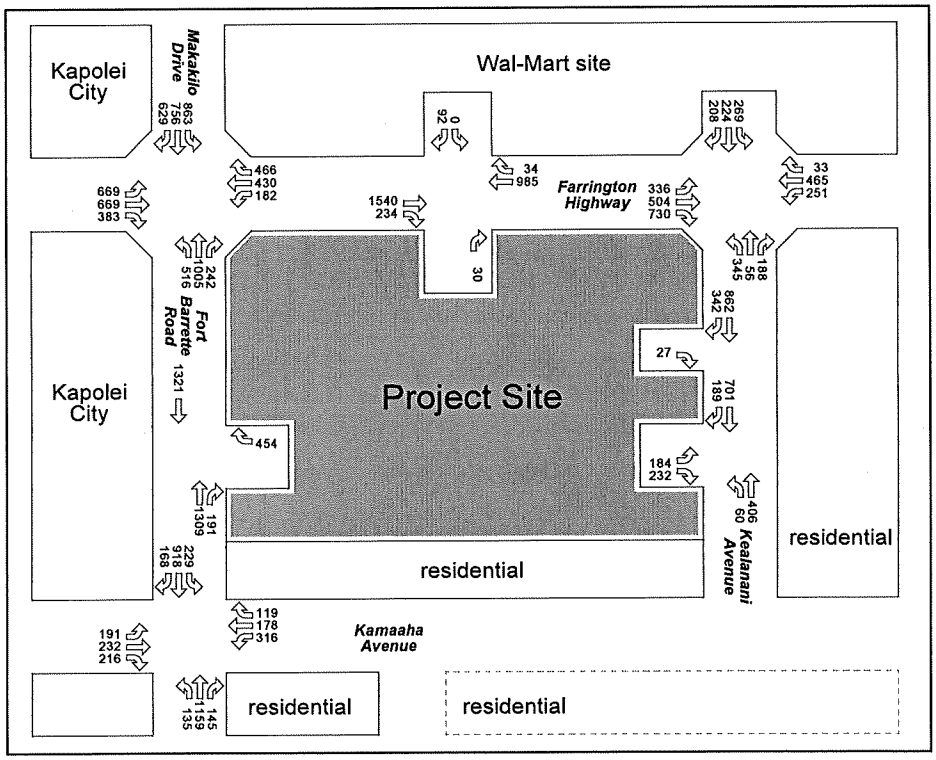


Figure 4 – Traffic Assignments, Alternative B

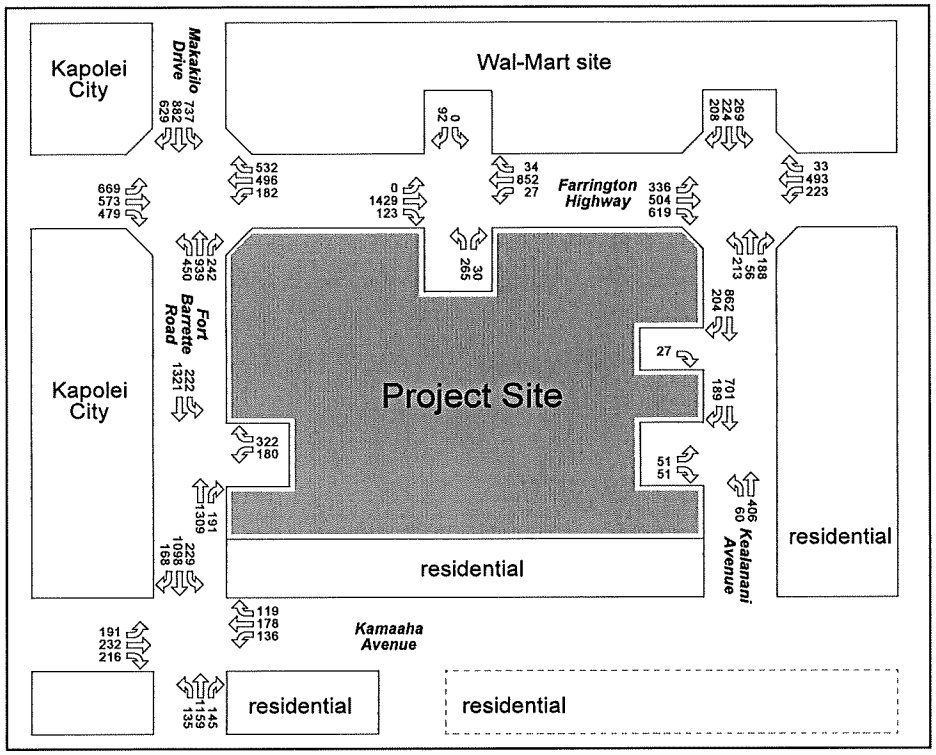


Figure 5 – Traffic Assignments, Alternative C

Table 5 – Project Impacts (27% Pass-By Trips)

Sum of Critical Movements, Condition	Baseline	Alt. A	Alt. B	Alt. C
Farrington Highway, Makakilo Drive, Fort Barrette Road (existing approach laneage)	1,205 near capacity	1,484 over capacity	1,484 over capacity	1,421 over capacity
Farrington Highway and Kealanani Avenue	909 under capacity	1,277 near capacity	1,436 over capacity	1,221 near capacity
Fort Barrette Road and Kama`aha Avenue	1,081 under capacity	1,357 near capacity	1,357 near capacity	1,249 near capacity

Consideration of pass-by trips results in slight improvements in the critical sums, and the differences among the alternatives are similar to those indicated in Table 4. The addition of project traffic will result in increased conflicts at the intersections with over-capacity or near-capacity conditions and mitigation measures will be needed.

Mitigation Measures to be Considered

Several mitigation measures were evaluated for the traffic assignments with the 27% pass-by traffic.

Intersection of Farrington Highway, Makakilo Drive, and Fort Barrette Road: One alternative would be changing the existing northbound curb lane from a right turn only lane to an option lane for right turn and through movements. While this change would result in lower critical movement sums, the intersection would still be over-capacity in Alternatives A or B and near-capacity in Alternative C. The addition of a third northbound through lane at the intersection and retaining a separate northbound right turn lane would further reduce the critical movement sum, but near-capacity conditions would remain. Providing four northbound lanes at the intersection for through traffic, with right turns sharing the far right lane would not make a significant difference but would require an additional lane on Makakilo Drive departing the intersection. Table 6 shows the results of the analyses with the mitigation measures.

Table 6 – Mitigation Measures, Intersection of Farrington Highway, Makakilo Drive, and Fort Barrette Road

Sum of Critical Movements, Condition	Baseline	Alt. A	Alt. B	Alt. C
Existing approach laneage	1,205 near capacity	1,484 over capacity	1,484 over capacity	1,421 over capacity
Converting northbound curb lane (right turns only) to option lane for right turns and through movements	1,186 under capacity	1,408 over capacity	1,397 near capacity	1,345 near capacity
Adding a third northbound through lane	1,186 under capacity	1,327 near capacity	1,316 near capacity	1,311 near capacity
Removing northbound right turn lane, replacing with two additional northbound through lanes	1,186 under capacity	1,309 near capacity	1,293 near capacity	1,311 near capacity

Additional improvements at this intersection do not appear to be feasible, as other corners are already developed. While restriping the westbound approach to add a second left turn lane

could be easily done, this change did not affect the sum of critical movements, as the westbound left turn is not a critical movement. Additional widening will also create longer pedestrian crossings, which will affect signal timing and increase delays to all users.

The results shown in Table 6 indicate that the intersection will operate at near capacity conditions with the addition of project traffic and an added northbound lane on Fort Barrette Road. However, there will be little difference in the condition at the intersection among the three alternative access schemes and between the alternatives of using the curb lane as an option lane or as a right-turn only lane.

Intersection of Farrington Highway and Kealanani Avenue: The final draft traffic study for the Kapolei Commercial area project suggested restriping of the northbound and southbound approaches at this intersection to convert the through-only lanes to option lanes for left turns and through traffic, along with a change in the signal phasing to split phases for the north-south movements. The effect of this change at that intersection is shown in Table 7.

Table 7 – Mitigation Measures, Intersection of Farrington Highway and Kealanani Avenue

Sum of Critical Movements, Condition	Baseline	Alt. A	Alt. B	Alt. C
Separate lanes for each movement on northbound and southbound approaches	909 under capacity	1,277 near capacity	1,436 over capacity	1,221 near capacity
Restripe northbound and southbound middle lanes as option lanes for left turns and through movements, split phasing	735 under capacity	1,245 near capacity	1,338 near capacity	1,190 under capacity

With the additional traffic from the proposed project, desirable under capacity conditions would occur only with either Alternative A or Alternative C. Conditions at this intersection would be worse with Alternative B (near-capacity condition). The addition of a separate right turn lane for eastbound traffic could improve conditions at this intersection to under capacity.

Intersection of Fort Barrette Road and Kama`aha Avenue: The expected increase in traffic volumes on Fort Barrette Road will change conditions at this intersection to near-capacity conditions in the PM Peak Hour. The addition of a second westbound left turn lane on

Kama'aha Avenue will add capacity to allow the intersection to operate at desirable under capacity condition with any of the three alternatives (Table 8).

Table 8 – Mitigation Measures, Intersection of Fort Barrette Road and Kama`aha Avenue

Sum of Critical Movements, Condition	Baseline	Alt. A	Alt. B	Alt. C
Baseline approach striping	1,081 under capacity	1,357 near capacity	1,357 near capacity	1,249 near capacity
Add a second westbound left turn lane	1,081 under capacity	1,199 under capacity	1,199 under capacity	1,181 under capacity

Site Driveway Connections

There are four proposed site driveways that connect to existing public roadways, with differing restrictions on vehicular movements depending on the alternative. Movements at the driveways were evaluated assuming that these connections operated as isolated unsignalized intersections; due to the proximity of signalized intersections, platoons of traffic will replace random arrivals and conditions should be better than indicated by the analyses.

Fort Barrette Road: The driveway to Fort Barrette Road will be located near the makai edge of the site, approximately 600 feet southeast of the existing signalized intersection with Farrington Highway. In Alternatives A and B, only right turns will be permitted at this driveway. The volume of right turns in from Fort Barrette Road is estimated to be 191 vehicles per hour in the PM Peak Hour, or 12½% of the total advancing volume of 1,533 vehicles per hour in each of the alternatives. A deceleration right turn lane should be provided for this movement. The volumes of right turns out of the site onto Fort Barrette Road are estimated to be 322 vehicles per hour in Alternatives A and C and 454 vehicles per hour in Alternative B. Table 9 shows the expected delays if the right turn movement out of the site is controlled by a stop sign.

Table 9 – Right Turns from Stop at Driveway to Fort Barrette Road

Alternative	A	B	C
Northbound volume on Fort Barrette Road	1,309	1,309	1,309
Driveway right turn volume from site	322	454	322
Stop control, volume/capacity ratio	1.84	2.59	1.84
Average delay (seconds) and Level of Service	(>300) F	(>600) F	(>300) F

The high volume of right turns and the poor conditions with stop sign control indicate that an acceleration lane should be provided to allow right turn traffic to accelerate and merge with the northbound traffic.

In Alternative C, left turns are allowed and the PM Peak Hour volume is estimated to be 180 vehicles per hour exiting the site and 222 vehicles per hour entering the site. Total two-way volume on Fort Barrette Road would be 2,852 vehicles per hour, and total northbound volume that southbound left turns would cross would be 1,309 vehicles per hour (vph). An unsignalized intersection would not be able to serve these volumes of left turns (Table 10).

The *Manual on Uniform Traffic Control Devices for Streets and Highways* ("MUTCD") provides guidance for the installation of traffic signals. It states that a traffic signal would be warranted if "for each of any 4 hours of an average day, the plotted points representing the vehicles per hour on the major street ... and the corresponding vehicles per hour on the minor-street approach ... all fall above the applicable curve in Figure 4C-1"; Figure 4C-1 notes that "80 vph applies as the lower threshold volume for a minor-street approach with one lane" when major street volume exceeds 1,400 vph.

Table 10 also shows estimated volumes in the fourth highest hour. The minor street volume is estimated to be 135 vph and the major street volume would exceed 1,400 vph; therefore, a signal is expected to be warranted at this driveway with Alternative C. If signalized, the intersection would operate at under capacity conditions in the PM Peak Hour, with a critical movement sum of 1,057 vehicles per lane.

Table 10 – Signal Warrant at Driveway to Fort Barrette Road

Alternative C	Southbound left turns (entering)		Westbound left turns (exiting)	
	Major	Minor	Major	Minor
PM Peak Hour volume	1,309	222	2,852	180
Stop control, volume/capacity ratio	0.77		5.47	
Average delay (seconds), Level of Service	(46.7) E		(>900) F	
Estimated 4th highest hour (% PM Peak Hour)	75%	65%	70%	75%
Fourth highest hour volumes	980	145	1,995	135

Farrington Highway: The driveway to Fort Barrette Road will be located near the center of the mauka frontage of the site, approximately 600 feet northeast of the existing signalized intersection with Fort Barrette Road and Makakilo Drive. The volumes of right turns in from Farrington Highway are estimated to be 234 vehicles per hour (vph) in the PM Peak Hour, or 13% of the total advancing volume of 1,774 vph in Alternatives A and B, and 123 vph or 8% of the total advancing volume of 1,552 vph in Alternative C. At this location, the curb lane has been assumed to be shared by right turns and through movements. The estimated volume of exiting right turns is 30 vph. Table 11 shows that conditions for the right turns from the driveway onto Farrington Highway will be acceptable.

Table 11 – Right Turns from Stop at Driveway to Farrington Highway

Alternative	A	B	C
Eastbound volume on Farrington Highway	1,774	1,774	1,543
Driveway right turn volume from site	30	30	30
Stop control, volume/capacity ratio	0.21	0.21	0.17
Average delay (seconds) and Level of Service	(34.4) D	(34.4) D	(28.3) C

In Alternatives A and C, all movements would be permitted at this driveway. The traffic assignments show 265 left turns from the site in either alternative. Table 12 shows the signal warrant evaluation.

Table 12 – Signal Warrant at Driveway to Farrington Highway

Northbound left turns (exiting) for:	Alternative A		Alternative C	
	Major	Minor	Major	Minor
PM Peak Hour	2,691	265	2,475	265
Stop control, volume/capacity ratio	3.84		3.10	
Average delay (seconds), Level of Service	(>1,200) F		(>900) F	
Estimated 4th highest hour (% PM Peak Hour)	75%	65%	75%	65%
Fourth highest hour volumes	2,030	155	1,625	155

The *Manual on Uniform Traffic Control Devices for Streets and Highways* states that a traffic signal would be warranted if "for each of any 4 hours of an average day, the plotted points representing the vehicles per hour on the major street ... and the corresponding vehicles per hour on the minor-street approach ... all fall above the applicable curve in Figure 4C-1"; Figure 4C-1 notes that "80 vph applies as the lower threshold volume for a minor-street approach with one lane" when major street volume exceeds 1,400 vph. Table 12 shows a minor street volume estimated to be 155 vph for the fourth highest hour, with major street volume exceeding 1,400 vph; therefore, a signal is expected to be warranted at this driveway with either Alternative A or Alternative C. If signalized, the intersection would operate at near-capacity conditions in the PM Peak Hour with Alternative A, with a critical movement sum of 1,271 vehicles (under-capacity conditions with a sum of 1,154 could be achieved with an added right turn lane into the site), and at under-capacity conditions (1,068) with Alternative C.

Kealanani Avenue: Two driveways are shown to Kealanani Avenue on the proposed plan. The driveway closer to Farrington Highway will be restricted to right turns in and out as no opening in the existing landscaped median is being proposed. A median opening, however, is

proposed at the second driveway, located approximately 500 feet from Farrington Highway, and all movements would be permitted at that driveway.

Table 13 shows the results of the analyses of the right turns out of the site at the first (mauka) driveway, assuming that the entering right turns share the curb lane with southbound through traffic on Kealanani Avenue.

Table 13 – Right Turns from Stop at Mauka Driveway to Kealanani Avenue

Alternative	A	B	C
Southbound volume on Kealanani Avenue	1,177	1,204	1,066
Driveway right turn volume from site	27	27	27
Stop control, volume/capacity ratio	0.11	0.12	0.10
Average delay (seconds) and Level of Service	(20.9) C	(21.4) C	(19.3) C

Table 14 shows the results of the analyses of the right turns out of the site at the second (makai) driveway, assuming that the entering right turns share the curb lane with southbound through traffic on Kealanani Avenue. Acceptable conditions (average delay of 31.6 seconds, Level of Service D) are possible with a separate right turn lane into the project site.

Table 14 – Right Turns from Stop at Makai Driveway to Kealanani Avenue

Alternative	A	B	C
Southbound volume on Kealanani Avenue	890	890	890
Driveway right turn volume from site	232	232	51
Stop control, volume/capacity ratio	0.78	0.78	0.17
Average delay (seconds) and Level of Service	(46.0) E	(46.0) E	(18.4) C

Table 15 shows the peak hour conditions for left turns at the intersection formed by the makai driveway and Kealanani Avenue, and estimates of traffic volumes in the fourth highest hour for Alternatives A or C, and for Alternative B.

Table 15 – Signal Warrant at Makai Driveway to Kealanani Avenue

Eastbound left turns (exiting) for:	Alternative A or C		Alternative B	
	Major	Minor	Major	Minor
PM Peak Hour	1,356	51	1,356	184
Stop control, volume/capacity ratio	0.24		0.88	
Average delay (seconds), Level of Service	(25.9) D		(76.9) F	
Estimated 4th highest hour (% PM Peak Hour)	75%	65%	75%	65%
Fourth highest hour volumes	1,015	35	1,015	120

In Alternative B, the left turns out of the driveway would have unacceptable delays. However, the estimates of traffic volumes in the fourth-highest hour are below the appropriate curve in the MUTCD's Figure 4C-1 (Figure 6). The volumes in the fourth-highest hour would need to be higher than the estimates shown in Table 15 if traffic signals were to be used to control movements at this driveway.

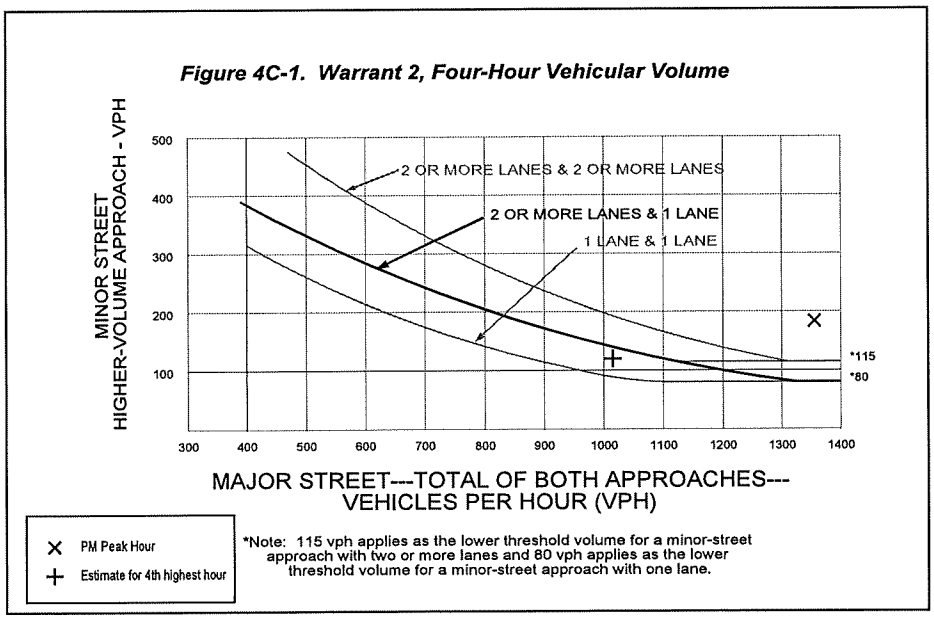


Figure 6 – Signal Not Warranted, Kealanani Avenue Driveway (Alternative B)

APPENDIX

The *Highway Capacity Manual 2000 (HCM)* provides analyses to determine "Levels of Service" (LOS) that are related to average delays. The methodology for unsignalized intersections uses traffic volumes, traffic characteristics, and intersection layout to estimate capacities and delays. At unsignalized intersections, levels of service are identified for stopped or yielding movements.

Levels of Service (LOS) are related to average delays as follows (Level of Service D or better is considered acceptable):

LOS	General Description of Delay	Average Delay (seconds per vehicle)
		Unsignalized intersection
A	Little or no delay	≤ 10
B	Short traffic delays	> 10 and ≤ 15
C	Average traffic delays	> 15 and ≤ 25
D	Long traffic delays	> 25 and ≤ 35
E	Very long traffic delays	> 35 and ≤ 50
F	Very long traffic delays	>50