Multi-Modal Transportation System Existing Conditions Performance Report
Oahu Regional Transportation Plan 2035 Project

Deliverable 5.1.2

Mobilizing Oahu | Fulfilling Our Legacy

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Acronyms Used in this Document

DTS	Department of Transportation Services
HDOT	Hawaii Department of Transportation
HOV	High-Occupancy Vehicle
ITS	Intelligent Transportation Systems
LOS	Level of Service
OahuMPO	Oahu Metropolitan Planning Organization
OD	Origin-Destination
ORTP	Oahu Regional Transportation Plan
OTS	Oahu Transit Services
SOV	Single-Occupancy Vehicle
T6/EJ	Title VI/Environmental Justice
TAZ	Transportation Analysis Zone
TDM	Transportation Demand Management
TSM	Transportation System Management
VMT	Vehicle Miles of Travel

Executive Summary

This report provides information regarding the performance of the existing multi-modal transportation system on the island of Oahu.[1] This information is provided in terms of the identified project performance measures, which are associated with five overarching goals that address the topics of transportation facilities, transportation operations and services, natural environment, human environment and quality of life, and land use and transportation integration.

Information on existing travel patterns includes daily screenline person trips, mode share, average vehicle occupancy, vehicle miles of travel, vehicle hours of travel, and vehicle hours of delay.

Transit system performance measures include system characteristics, transit travel times to selected destinations, and system-wide transit ridership.

Information on roadways includes system characteristics, facility level of service, auto travel times, accident risks, freight connections, and freight travel times.

Bicycle and pedestrian facilities are described, with reference to the ORTP 2035 deliverable 3.1.2, *Existing Transportation System Inventory Report* (2009).

Finally, information related to the natural and human environment includes a discussion of transportation facilities that could be susceptible to the impacts of global climate change, vehicle miles of travel in terms of air quality, and results of environmental justice analyses for accessibility and mobility.

[1] The year 2007 is used to reflect existing conditions, unless otherwise noted.

1 Introduction

1.1 Report Purpose

This report will describe the performance of the existing multi-modal transportation system – as of year 2007 – in terms of the identified project performance measures.

1.2 Report Overview

This section includes an overview of the chapters and content of the report; Chapter 2 summarizes existing travel patterns from an islandwide perspective; Chapter 3 documents performance of the existing transit system; Chapter 4 outlines performance of the roadway network; Chapter 5 summarizes the existing bicycle and pedestrian transportation systems; and Chapter 6 discusses the existing transportation system in terms of how it affects the natural and human environment. Throughout the report, performance will be described in relation to the project performance measures, which are based on five overarching goals that address the following topics:

- Transportation facilities
- Transportation operations and services
- Natural environment
- Human environment and quality of life
- Land use and transportation integration

The specific performance measures are listed in Appendix A. Several of the 31 performance measures identified are not applicable for analysis of existing conditions as they are intended to measure future year candidate improvements in comparison with each other rather than to an existing condition. Measures not addressed in this existing conditions report, but that will be assessed later for candidate improvements addressed in future plan analyses include the following:

- Measure 3, Modal Conflicts
- Measure 5, Regional Transportation Linkages
- Measure 6, Improved Accessibility to the Transportation System for Persons with Disabilities
- Measure 7, Economic Vitality
- Measure 9, Condition and/or Life Span of Transportation Infrastructure

- Measure 12, Homeland Security, Personal Security, and All-Hazards Preparedness
- Measure 15, Total Annual System Costs
- Measure 17, Travel Demand
- Measure 22, Natural Resource/Environmental Effects
- Measure 23, Reliance on Renewable and Sustainable Energy Sources
- Measure 25, Disruption During Construction
- Measure 29, Land Use Plans
- Measure 30, Built Environment Effects
- Measure 31, Compact, Mixed-Use Growth

2 Existing Travel Patterns

This chapter discusses existing travel patterns and conditions on Oahu from which to measure growth and/or changes for future year alternative network analyses.

2.1 Screenline Person Trips

Figures 2-1 and 2-2 show the locations of the screenlines that were used to analyze person trips for the year 2007.

Figure 2-1: Screenline Locations (Islandwide)

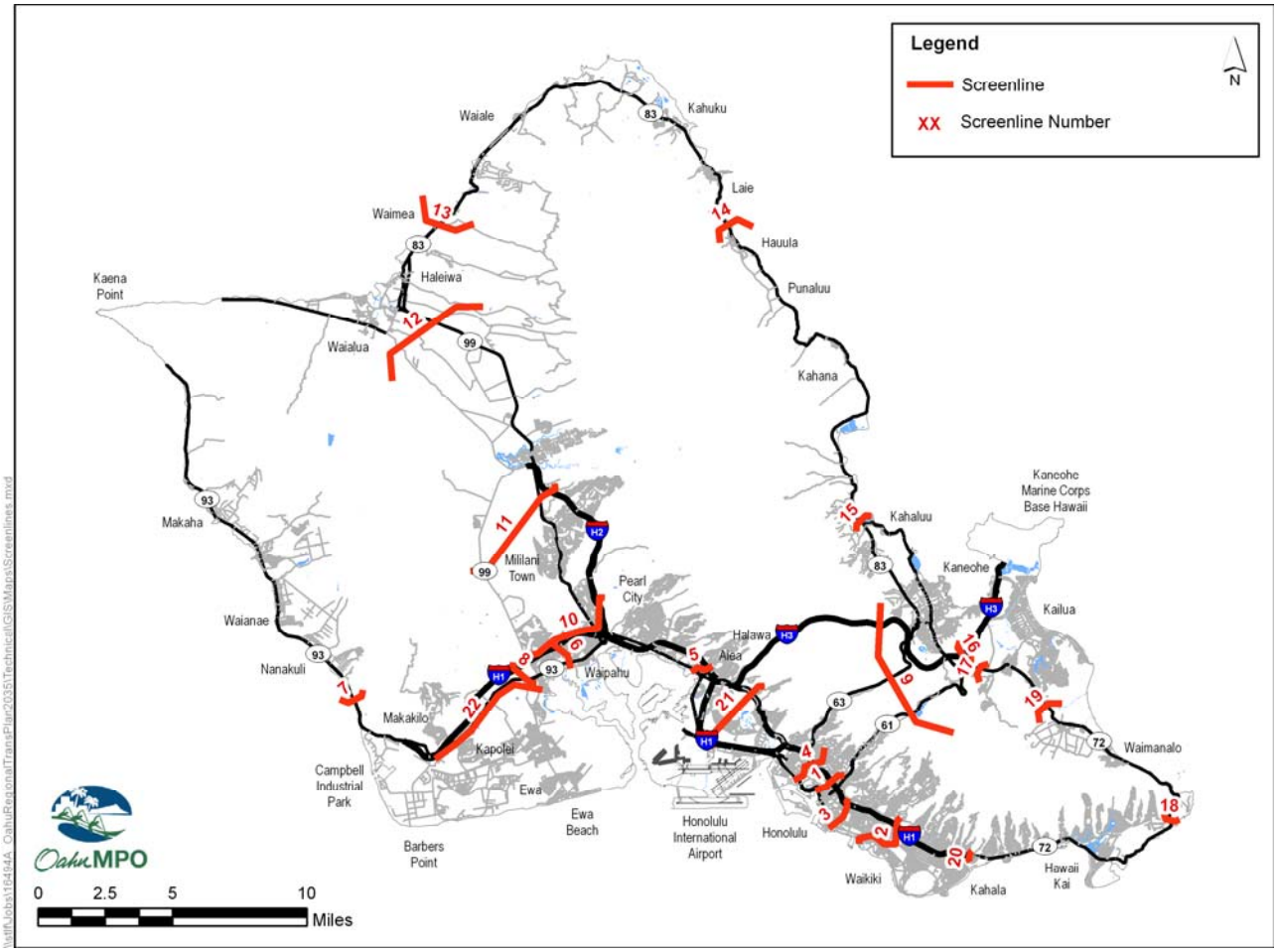


Figure 2-2: Screenline Locations (Honolulu and Surrounding Areas)

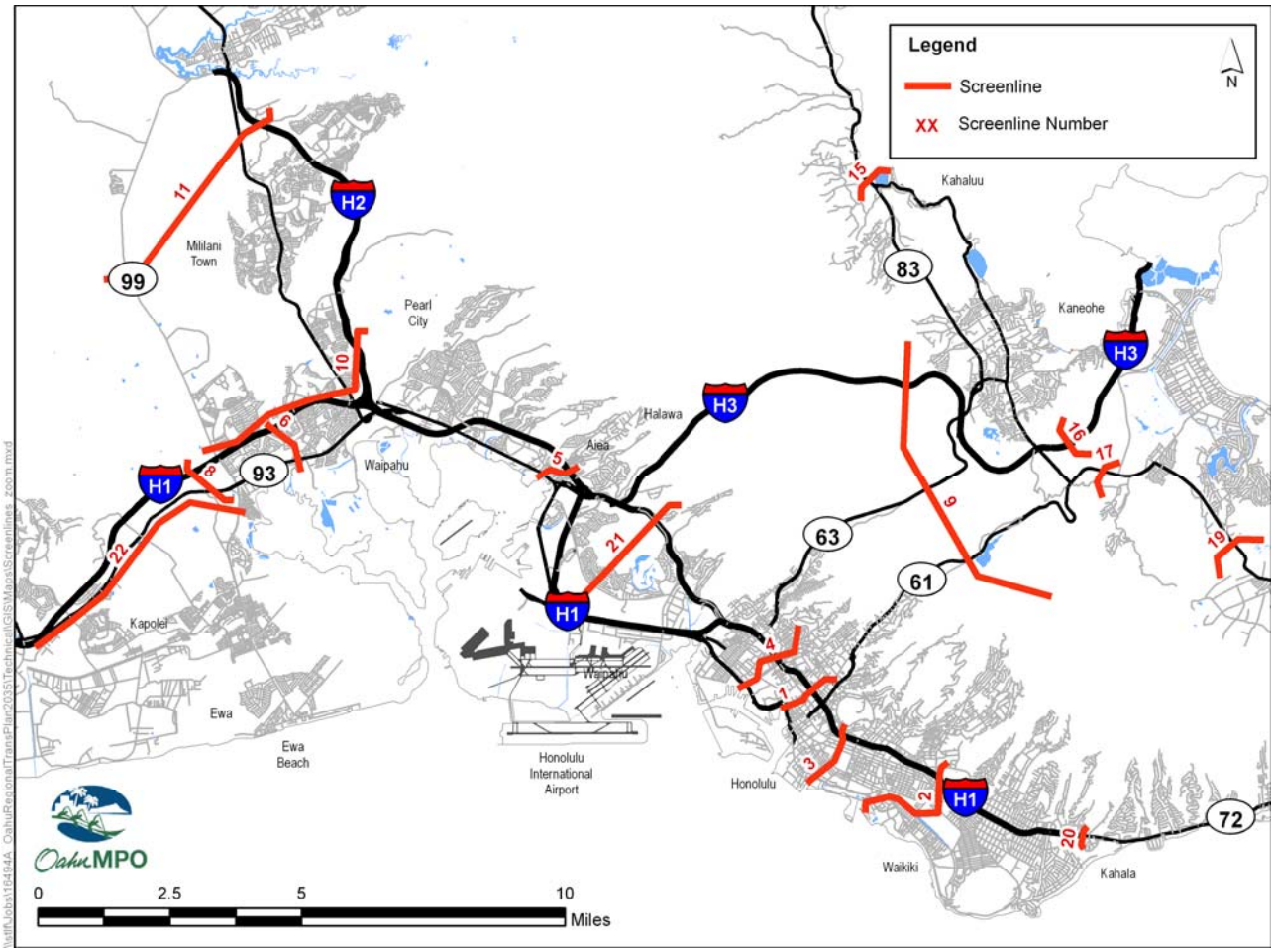


Table 2-1 shows daily person trips estimated by the travel demand forecasting model for the year 2007. Person trips are provided by screenline and broken out by the following modes of travel:

- Single occupancy vehicles,
- High occupancy vehicles with two or more persons, and
- Transit.

Screenline 5 (Kalauao), near Aiea, which captures person trips traveling between Downtown Honolulu and Waianae, Pearl City, Waipahu, Central Oahu and the rapidly growing areas of Ewa and Kapolei is estimated to have the maximum number of daily person trips, while Screenline 18 (Sandy Beach Park), near Hawaii Kai, has the minimum number of daily person trips out of the 22 screenlines chosen for this analysis.

The screenline estimates will be used to compare the growth at these locations for the future year forecasts.

Table 2-1 Daily Screenline Person Trips

Screenline	SOV	HOV 2+	Transit	Total
1. Nuuanu Stream Bridge	221,600	171,700	40,800	434,100
2. Manoa Palolo/Ala Wai Canal	251,600	171,800	39,800	463,200
3. East of Ward Ave	234,100	169,600	42,900	446,600
4. Kapalama Drainage Canal	220,000	175,700	42,500	438,200
5. Kalauao	305,000	243,500	34,800	583,300
6. Waikele	126,500	108,300	18,200	253,000
7. Kahe Point	28,000	35,300	8,700	72,000
8. Ewa	111,600	57,600	14,400	183,600
9. Trans Koolau	81,800	72,000	11,800	165,600
10. Waipahu	105,200	112,300	10,700	228,200
11. Wahiawa/Mililani	61,600	60,200	6,200	128,000
12. Haleiwa	14,900	16,100	1,700	32,700
13. Waimea	7,700	7,800	800	16,300
14. Hauula	9,300	8,400	1,700	19,400
15. Kahaluu	12,800	11,600	2,000	26,400
16. Kailua/Kaneohe	41,100	37,900	6,100	85,100
17. Maunawili	28,500	26,700	5,500	60,700
18. Sandy Beach Park	3,400	2,700	400	6,500
19. Waimanalo	10,200	10,600	1,100	21,900
20. Kahala	58,700	53,300	6,700	118,700
21. Salt Lake	202,000	173,800	33,100	408,900
22. Kalaeloa/Kapolei	71,900	79,700	12,600	164,200

2.2 Mode Share

Table 2-2 details the mode split for resident trips as estimated by the existing travel demand forecasting model for the year 2007. Of the 3,185,400 daily person trips, 84 percent are estimated to be made via the automobile, with nearly half of those coming in carpools with two or more occupants. A little over five percent of the trips are estimated to be made by transit and just over ten percent by walking or bicycling.

Table 2-2 Mode Share

Mode	Existing Person Trips	Percentage
SOV	1,209,400	38.0%
HOV	1,470,900	46.2%
Transit	164,800	5.2%
Bicycle	34,500	1.1%
Pedestrian	305,800	9.6%
Total	3,185,400	100.0%

2.3 Average Vehicle Occupancy

Average vehicle occupancy (AVO) is often used in travel demand forecasting as a measure of travel efficiency. To compute AVO, the total number of persons traveling in private vehicles is divided by the total number of private vehicle trips. Based on output from the year 2007 travel demand forecasting model, the AVO on Oahu (excluding buses and commercial vehicles) is estimated at 1.89 persons per vehicle. This AVO is averaged across all trip purposes. For home-based-work (HBW) trips, the AVO is calculated to be 1.34.

2.4 Vehicle Miles of Travel

Table 2-3 summarizes the total islandwide daily vehicle miles of travel (VMT) by motorized vehicles (including automobiles, buses, and commercial vehicles) as estimated by the travel demand forecasting model for the year 2007. Of the more than 13 million daily VMT estimated, approximately 40 percent are estimated to occur on the Interstate freeway system (e.g., Interstate H-1, H-2), while the estimated percentages of VMT on expressways (e.g., Likelike Highway), ramps, arterials and collector streets would be 12 percent, five percent, 31 percent, and 12 percent, respectively.

Table 2-3 Daily Vehicle Miles of Travel – 2007

Facility Type	Vehicle Miles of Travel	Percent
Freeways	5,272,900	40.1%
Expressways	1,555,000	11.8%
Ramps	704,800	5.4%
Arterials	4,102,300	31.2%
Collectors	1,507,600	11.5%
Total	**13,142,600**	**100.0%**

2.5 Vehicle Hours of Travel

Table 2-4 lists the total duration of islandwide daily trips by motorized vehicles as estimated by the travel demand forecasting model for the year 2007. Over 65 percent of the vehicle hours traveled is estimated to occur on Interstate freeways and arterials.

Table 2-4 Daily Vehicle Hours of Travel – 2007

Facility Type	Vehicle Hours of Travel	Percent
Freeways	109,700	28.6%
Expressways	33,000	8.6%
Ramps	33,900	8.8%
Arterials	144,100	37.6%
Collectors	62,500	16.3%
Total	**383,200**	**100.0%**

2.6 Vehicle Hours of Delay

Tables 2-5 and 2-6 show the estimated islandwide total hours of delay experienced in 2007 by all vehicles for the AM two-hour peak period, and daily, respectively. For these computations, a AM two-hour peak period – from 6:00 a.m. to 8:00 a.m. – is assumed.

Delay is calculated as the difference between predicted travel times and travel time under free-flow (uncongested) conditions. Vehicle hours of delay is often used as a measure of overall congestion levels. The existing year model results indicate that arterial streets currently experience the highest levels of delay of all the facility types throughout the day, even though more travel (i.e., VMT) is made on freeways. However during the AM two-hour peak period, the freeways experience the most delays.

Table 2-5 AM Two-Hour Peak Period Vehicle Hours of Delay – 2007

Facility Type	Vehicle Hours of Delay	Percent
Freeways	10,200	34.5%
Expressways	3,400	11.5%
Ramps	3,200	10.8%
Arterials	9,700	32.8%
Collectors	3,100	10.5%
Total	**29,600**	**100.0%**

Table 2-6 Daily Vehicle Hours of Delay – 2007

Facility Type	Vehicle Hours of Delay	Percent
Freeways	25,400	27.9%
Expressways	7,200	7.9%
Ramps	17,000	18.7%
Arterials	27,400	30.1%
Collectors	13,900	15.3%
Total	**90,900**	**100.0%**

3 Existing Conditions and Performance: Transit

The goal related to transportation facilities is *to provide an inclusive, multi-modal transport system whose connectedness provides efficient means for users desiring to move about the island by bicycle, freight carrier, pedestrian facility, road, transit service, and intermodal connectors*.

This chapter summarizes existing conditions for the transit-related performance measures developed to address this goal.

3.1 System Characteristics

The public transit system on Oahu consists of a variety of services. These include TheBus, which provides 100 numbered bus routes serving urban, suburban, and rural areas throughout the island; TheHandi-Van, a curb-to-curb, demand-based paratransit service; and the Leeward Oahu Transportation Management Association (LOTMA) commuter express, a private commuter bus service that provides non-stop freeway express lane service between Central Oahu and Honolulu.[2] Supplementing these services are transit centers, park-and-ride lots, and the State of Hawaii Department of Transportation (HDOT) vanpool program. More detailed information regarding the transit system on Oahu can be found in the ORTP 2035 deliverable 3.1.2, *Existing Transportation System Inventory Report* (2009).

3.2 System Performance

3.2.1 Transit Ridership

The total number of daily transit boardings, as estimated by the 2007 baseline travel demand forecasting model, is 230,200. This estimate will be used to compare the growth in transit boardings for the future year forecasts.

[2] The LOTMA commuter express was discontinued in December, 2008.

4 Existing Conditions and Performance: Roadways

This chapter summarizes existing conditions in relation to the performance measures for roadways developed to address the transportation facilities goal stated above.

4.1 System Characteristics

This section provides general descriptions of the roadway system on Oahu, as well as the operations management strategies that are utilized to make efficient use of the system. For more detailed information, please see the ORTP 2035 deliverable 3.1.2 *Existing Transportation System Inventory Report* (2009).

4.1.1 Roadway System

Freeways, expressways, arterials, and collectors are the basic transportation network elements allowing for the movements of people and goods on Oahu. The transportation network is used by all types of vehicles (including commercial vehicles), public and private transit services, bicycles, and pedestrians. The roadway system on Oahu is managed by HDOT and the City and County of Honolulu.

4.1.2 Operations Management Strategies

Various methods of Transportation Demand Management (TDM) and Transportation System Management (TSM) are utilized on Oahu to reduce travel demand and to make more efficient use of the existing transportation system. Examples of TDM and TSM measures specific to the island of Oahu include carpooling and vanpooling programs, commuter ride-matching services, contraflow operations, special shoulder lanes, high occupancy vehicle (HOV) lanes, and intelligent transportation systems (ITS). These measures are overseen either by HDOT or DTS, or by a private transportation management association.

4.2 System Performance

4.2.1 Highway and Arterial Level of Service

Level-of-service (LOS) is a measure that characterizes the operating conditions perceived by a driver or user of a roadway. Although LOS is a qualitative measure, it is based on quantitative indicators. LOS as presented in this report is based on volume-to-capacity ratios as reported from the 2007 baseline travel demand forecasting model. Six LOS designations (from A to F) are defined in the *Transportation Research Board's 2000 Highway Capacity Manual* (Transportation Research Board, 2000). LOS A represents ideal, congestion free operating

conditions and LOS F designates extremely congested breakdown conditions. LOS B through LOS D represent intermediate operating conditions and LOS E denotes congested conditions at the point of maximum service rate. Typically, LOS E is considered to be “at capacity,” while LOS F reflects overcapacity conditions.

Table 4-1 provides LOS summaries for all major roadways (in lane-miles) for the AM two-hour peak period, from 6:00 a.m. to 8:00 a.m. Over 76 percent of all roadway lane-miles islandwide are estimated to operate at LOS A during the AM two-hour peak period, while over ten percent are operating under congested conditions i.e., LOS E or F. Over 23 percent of freeways, expressways and ramps are operating under congested conditions, which is a significantly higher percentage than arterials and collectors, which show nearly five percent under congested conditions. This reflects the fact that freeways, expressways and ramps serve a proportionately higher level of commute trips.

Table 4-1 AM Two-Hour Peak Period Highway and Arterial LOS (lane-miles)

Facility Type	LOS A	LOS B	LOS C	LOS D	LOS E	LOS F	Total Lane Miles
Freeways	204	17	22	28	33	33	337
Expressways	65	6	9	9	18	22	129
Ramps	58	6	5	6	6	20	101
Arterials	616	42	27	27	19	30	761
Collectors	529	24	13	7	7	10	590
Total	**1,472**	**95**	**76**	**77**	**83**	**115**	**1,918**

Figure 4-1 through Figures 4-5 graphically map LOS for the modeled facilities throughout the island for the AM two-hour peak period. The majority of congested conditions can be seen in the Interstate H-1 corridor between Ewa and Downtown Honolulu. Other highly congested facilities of note include Fort Weaver Road in Ewa, Farrington Highway accessing Waianae, and the Pali Highway.

Figure 4-1: 2007 Existing Conditions AM Two-Hour Peak Period LOS – Islandwide

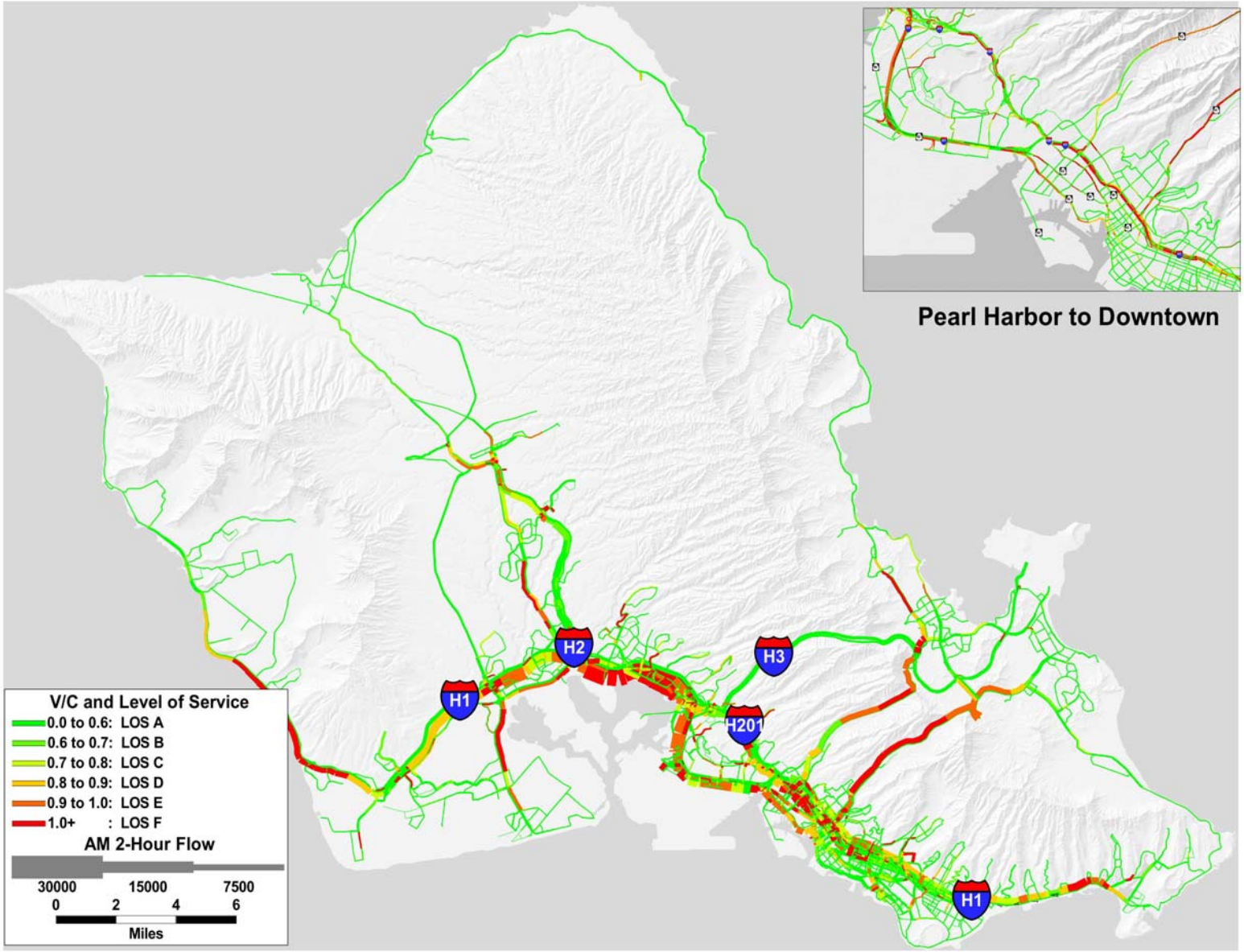


Figure 4-2: 2007 Existing Conditions AM Two-Hour Peak Period LOS – Kapolei and Ewa Area

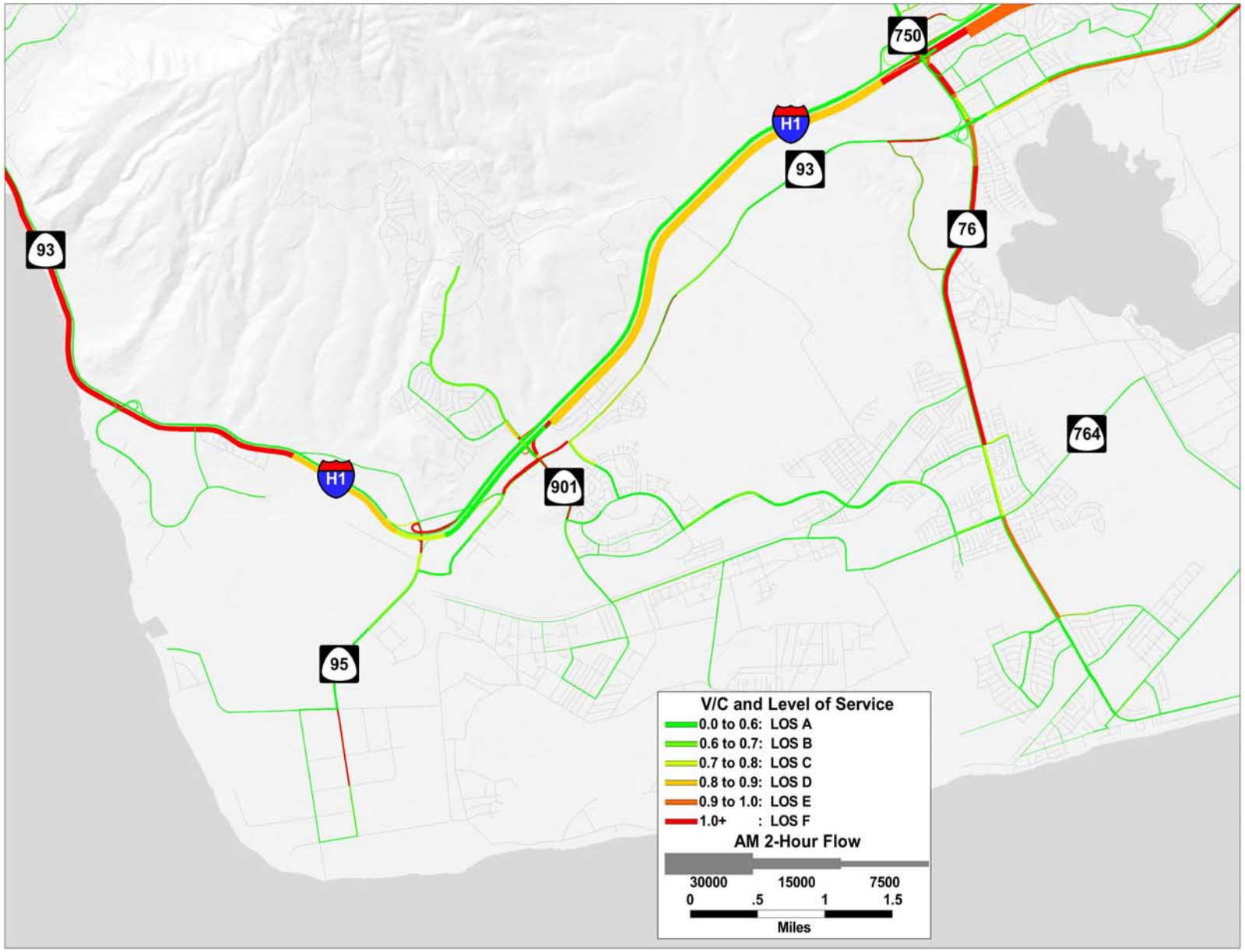


Figure 4-3: 2007 Existing Conditions AM Two-Hour Peak Period LOS – H-1 / H-2 Merge

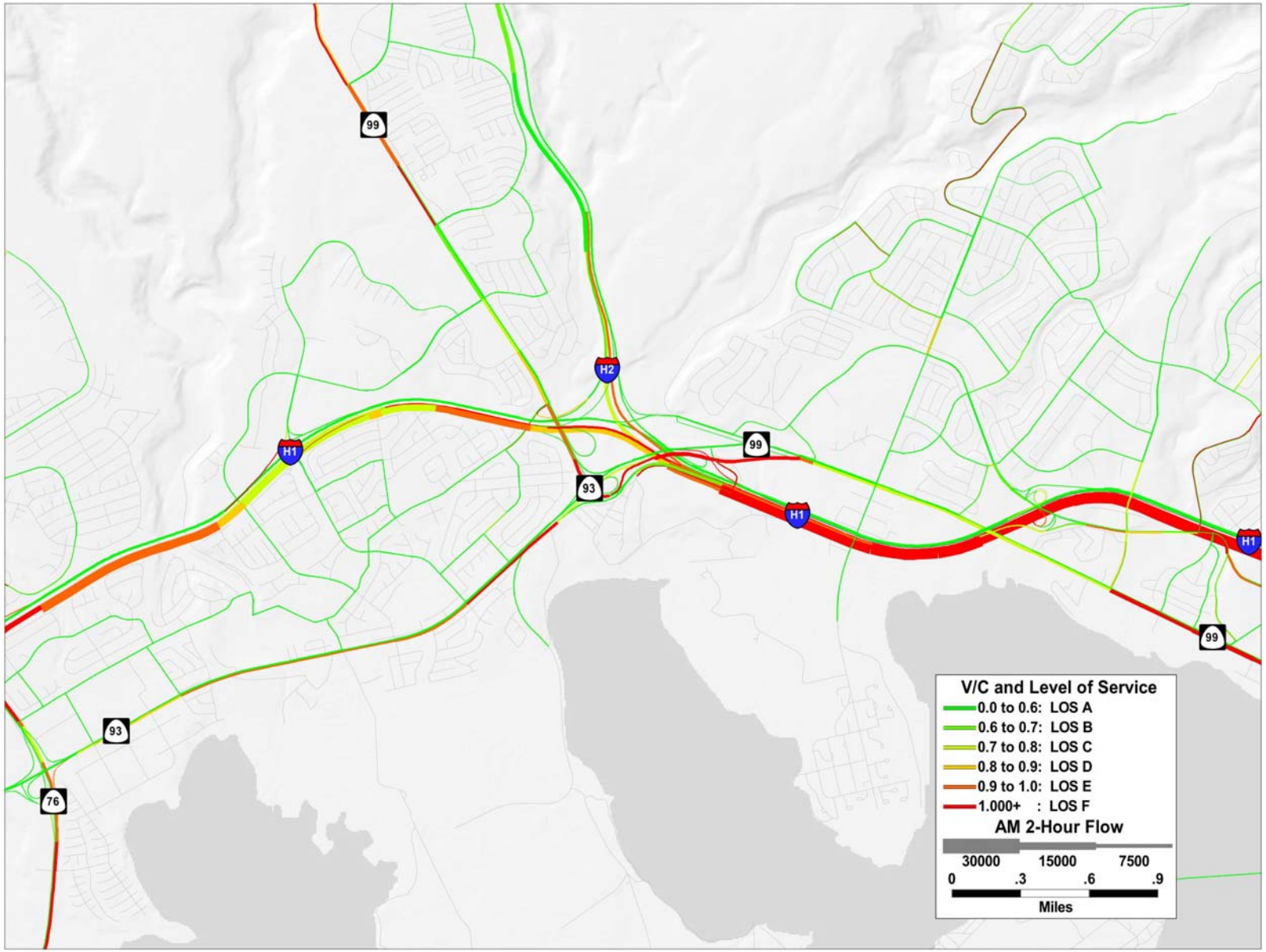


Figure 4-4: 2007 Existing Conditions AM Two-Hour Peak Period LOS – H-1 / H-201 / H-3

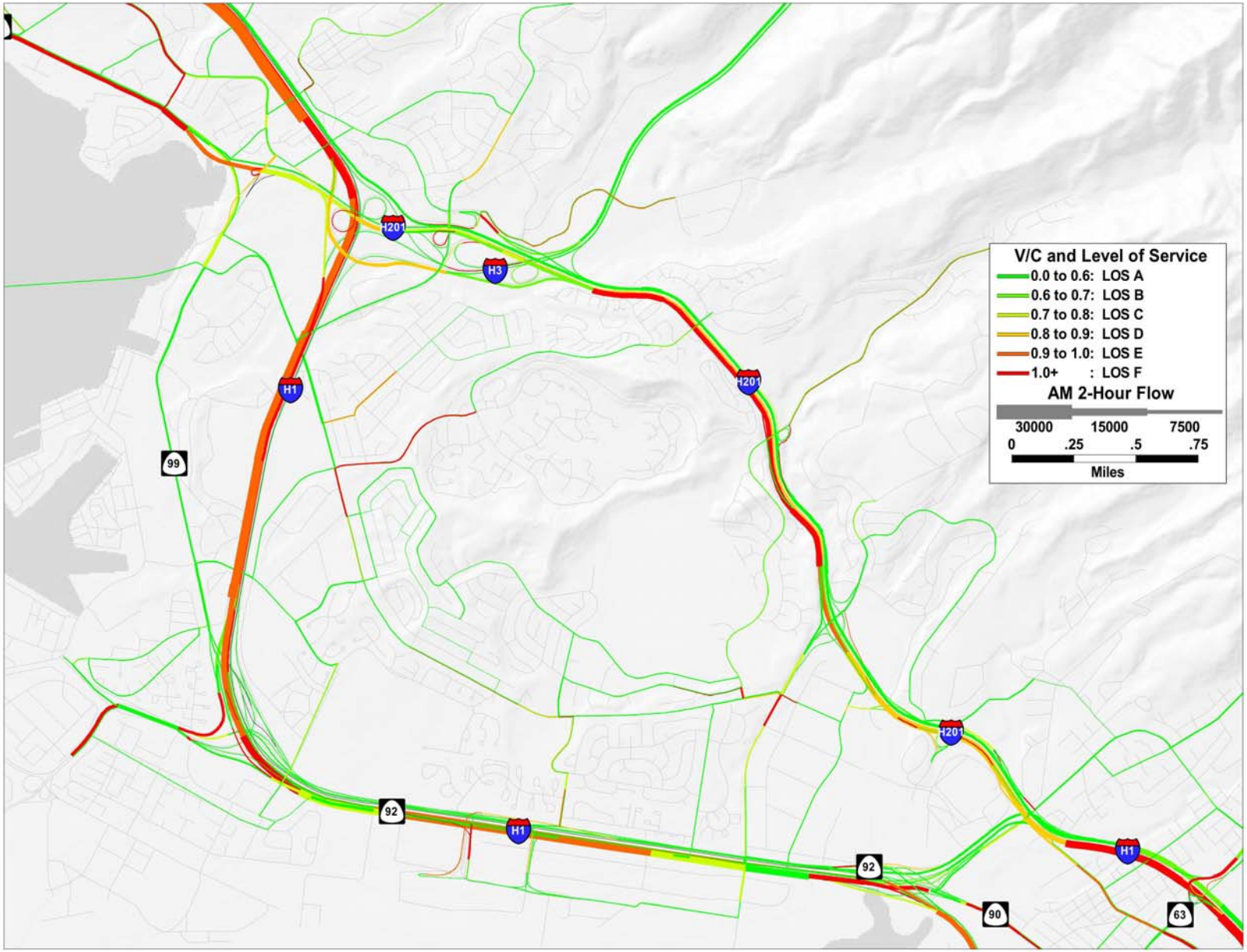
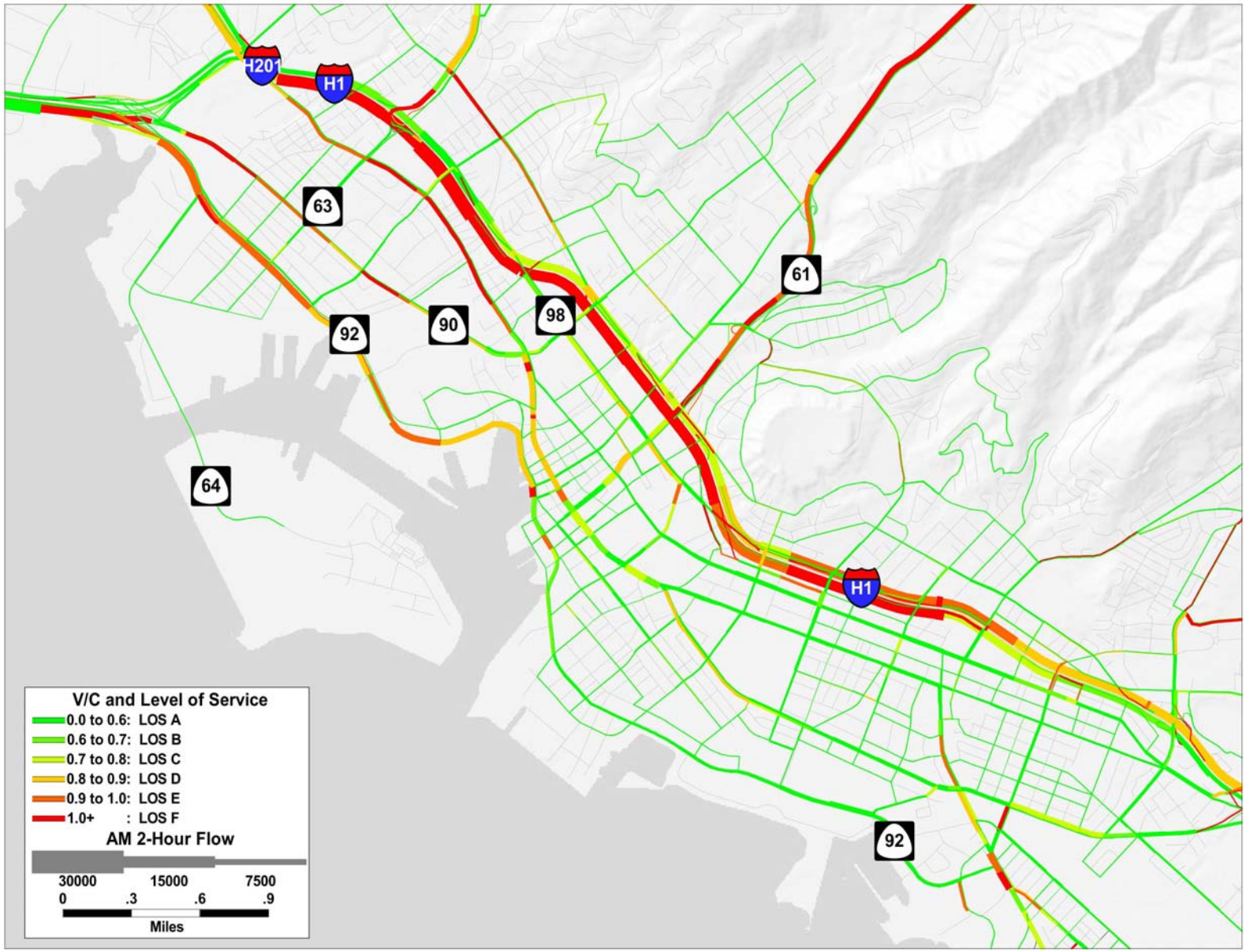


Figure 4-5: 2007 Existing Conditions AM Two-Hour Peak Period LOS – H-1 Downtown



4.2.2 Auto Travel Times to Selected Destinations

Travel times from each transportation analysis zone (TAZ) on Oahu to key destinations across the island were calculated for AM two-hour peak period, from 6:00 a.m. to 8:00 a.m., using the static assignment model, which is what is used in the traditional OahuMPO travel demand forecasting model. These have been summarized in the form of travel time contour maps (see Figure 4-6 through Figure 4-9). Key destinations chosen include Downtown Honolulu, Kapolei, Waikiki, Mililani, and the Honolulu International Airport. The travel times shown in these maps are the result of assigning two-hour (6:00 a.m. to 8:00 a.m.) peak period trip tables to a highway network using the TransCAD static multi-class assignment algorithm. A static assignment process uses equations (known as volume-delay functions) to represent delay on each link according to an average two-hour link capacity and the two-hour volume assigned to it. A key limitation of the algorithm is that it does not represent queuing, turning conflicts, or signal timing. The delay experienced on a link is only a function of the capacity of the link and the volume assigned to it, without any effects of downstream traffic queues. This means that the model may under-estimate travel times under congested conditions. However, the static equilibrium assignment model runs reasonably quickly and is multi-class, meaning HOV lanes are restricted to high-occupancy vehicles.

As part of the analyses performed for the ORTP, a “planning-level” Dynamic Traffic Assignment (DTA) model available in TransCAD has also been utilized for better understanding peak congestion. This model assigns traffic in 15-minute increments throughout the day, so that it can differentiate between shoulders of the peak and true peak conditions. Although it also relies on link-level volume-delay functions, the model considers queuing effects. Each link has a specific vehicle holding capacity (based on length) and when that holding capacity is exceeded, queues build up and reduce the capacity of upstream links. Analyses indicate that the model more accurately represents travel times under congested conditions, particularly on freeways. The limitations of this DTA model are that it is not multi-class (therefore, a simplification was made to reduce capacities of HOV lanes for the purposes analyses using the DTA model) and it does not represent signal timing or intersection geometry. Therefore it offers little advantage in modeling arterial delay over the standard static assignment algorithm.

Travel times estimated by the new DTA model are provided in Appendix B for comparison.

Figure 4-6 shows the estimated existing travel times to Downtown Honolulu. Travel times ranging from 60-to-120 minutes are estimated from the Waianae Coast and Ewa to Downtown Honolulu. Central Oahu and West Kapolei to Downtown have estimated travel times between 45 and 60 minutes.

Figure 4-6: 2007 Existing Conditions AM Two-Hour Peak Period Auto Travel Times to Downtown Honolulu

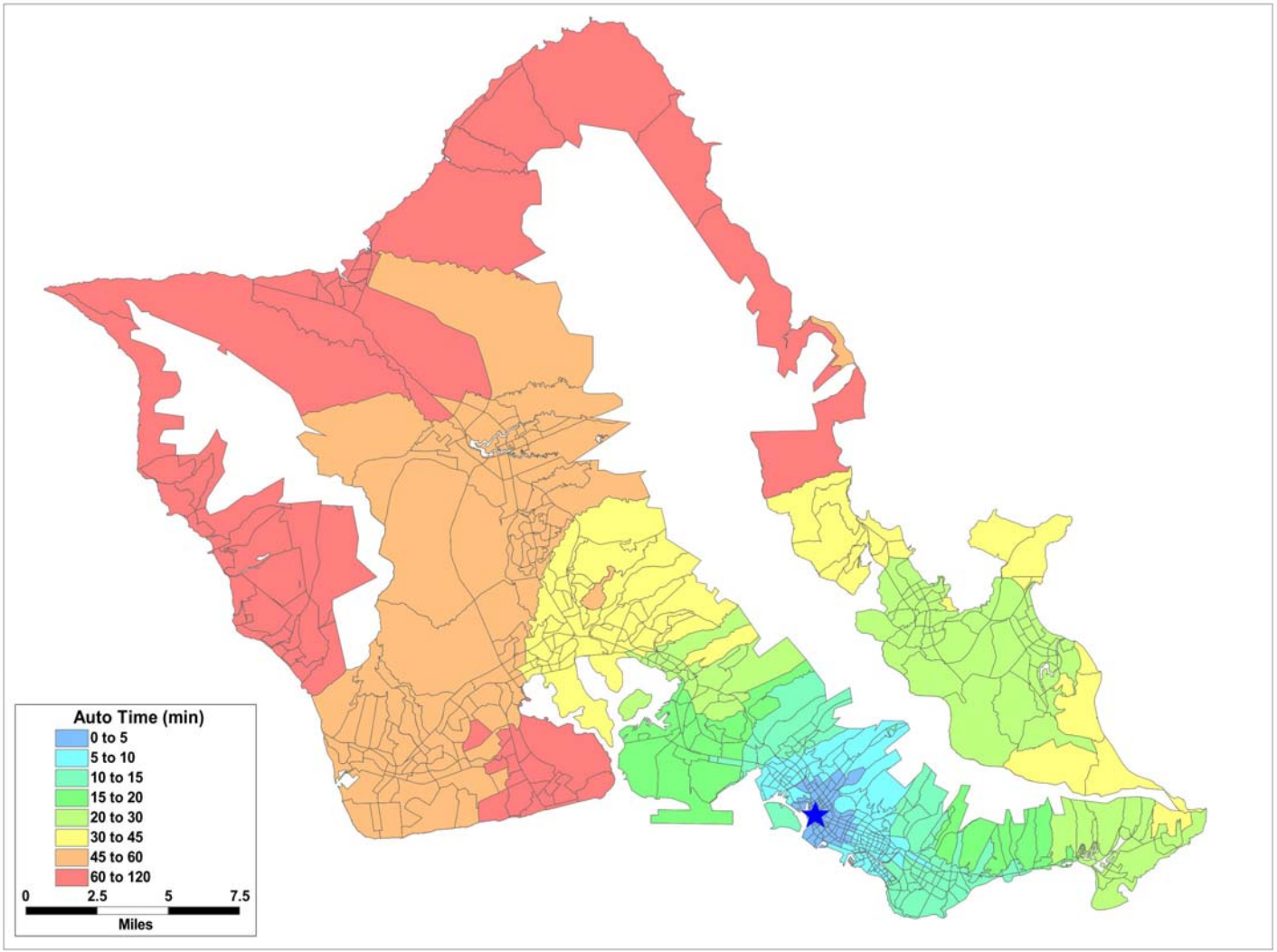


Figure 4-7 shows the estimated travel times to Kapolei. Travel times ranging from 20-to-45 minutes are projected from the Waianae Coast to Kapolei during the AM peak period. From Downtown Honolulu to Kapolei, travel times range from 20-to-30 minutes and increase progressively in the direction of Koko Head from Downtown Honolulu.

Figure 4-7: 2007 Existing Conditions AM Two-Hour Peak Period Auto Travel Times to Kapolei

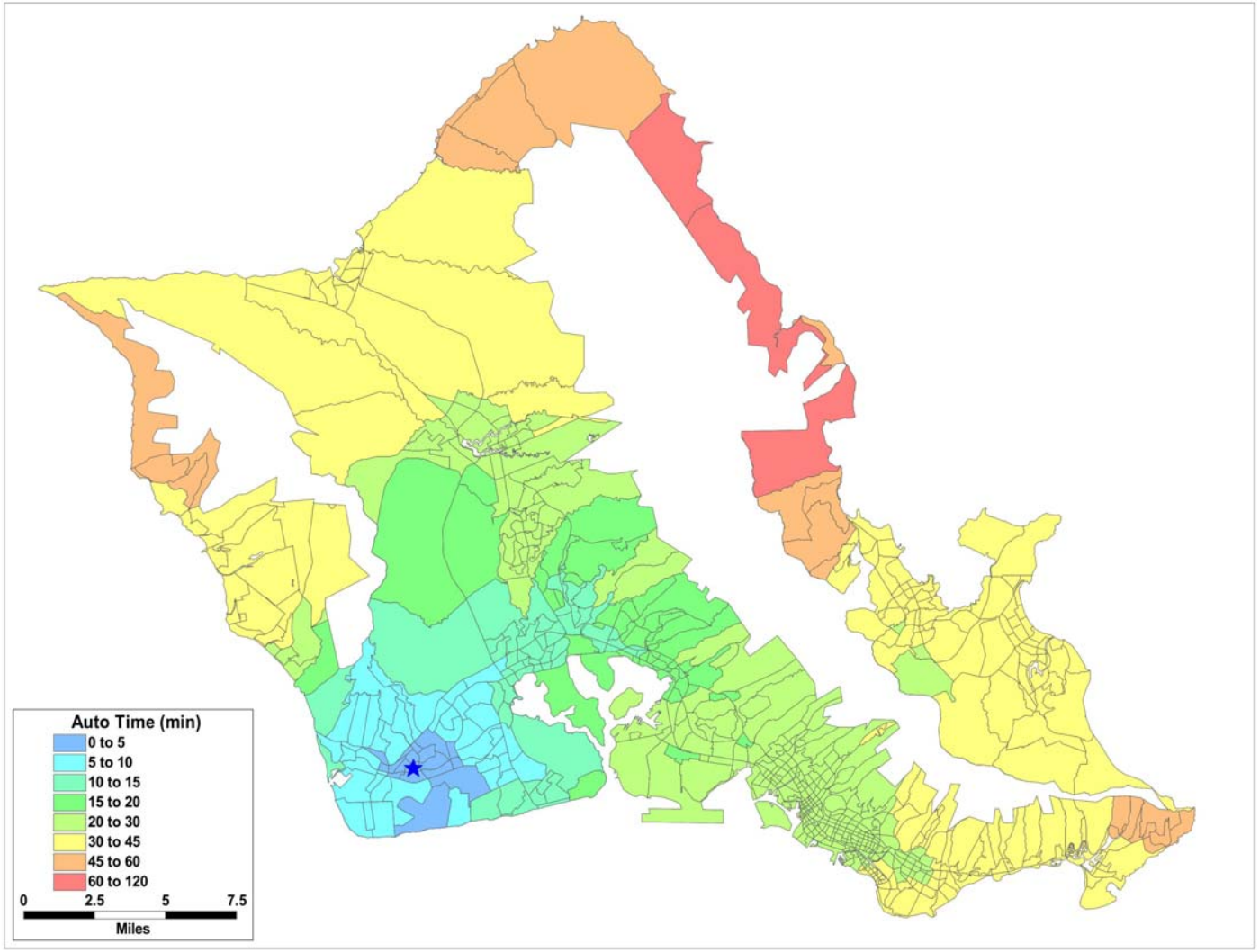


Figure 4-8 shows the estimated travel times to Waikiki. Travel time patterns for trips to Waikiki from the Leeward side of Oahu are somewhat similar to those with Downtown Honolulu as the destination. Travel times from the Koolauloa and North Shore areas range from 60-to-120 minutes and travel times from Downtown Honolulu peak at 20 minutes.

Figure 4-8: 2007 Existing Conditions AM Two-Hour Peak Period Auto Travel Times to Waikiki

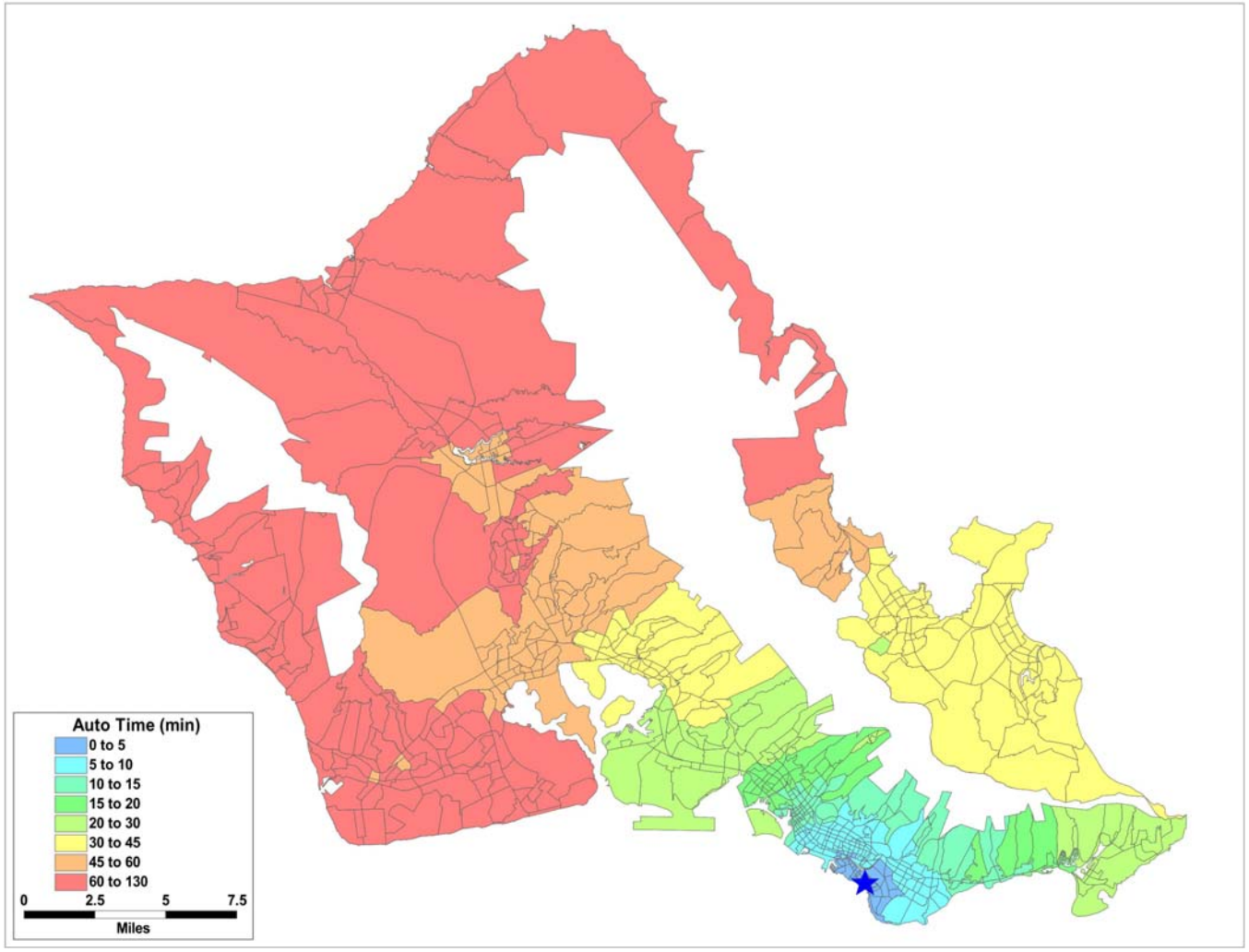


Figure 4-9 shows the estimated travel times to Mililani. Mililani, located centrally on Oahu, is accessible within 45 minute from most areas on the island. The Makaha and Hauula areas are still an exception with a travel time range between 60 and 120 minutes, along with the Waianae Coast, Koolauloa, and Hawaii Kai areas, from which travel times are estimated to be between 45 and 60 minutes.

Figure 4-9: 2007 Existing Conditions AM Two-Hour Peak Period Auto Travel Times to Mililani

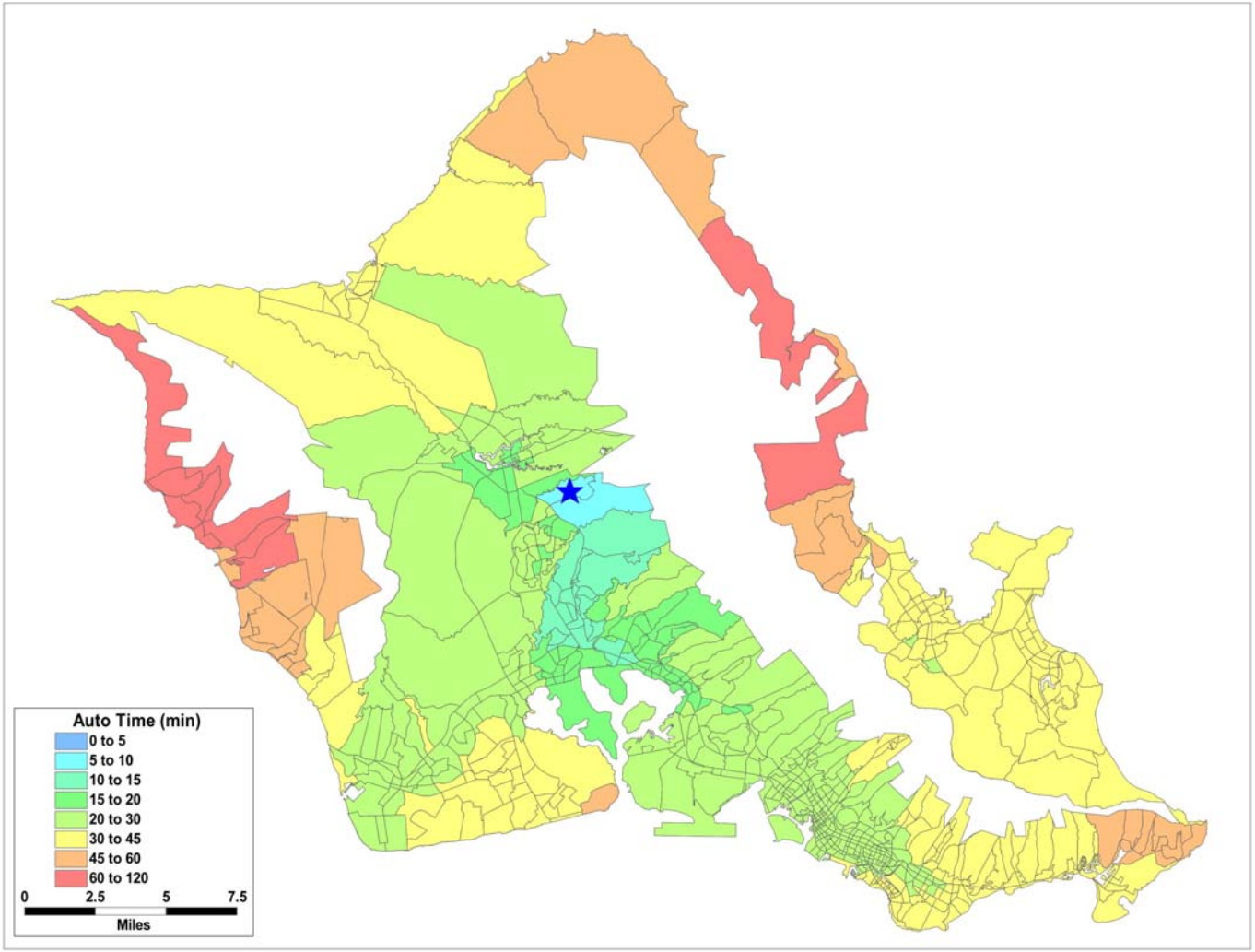
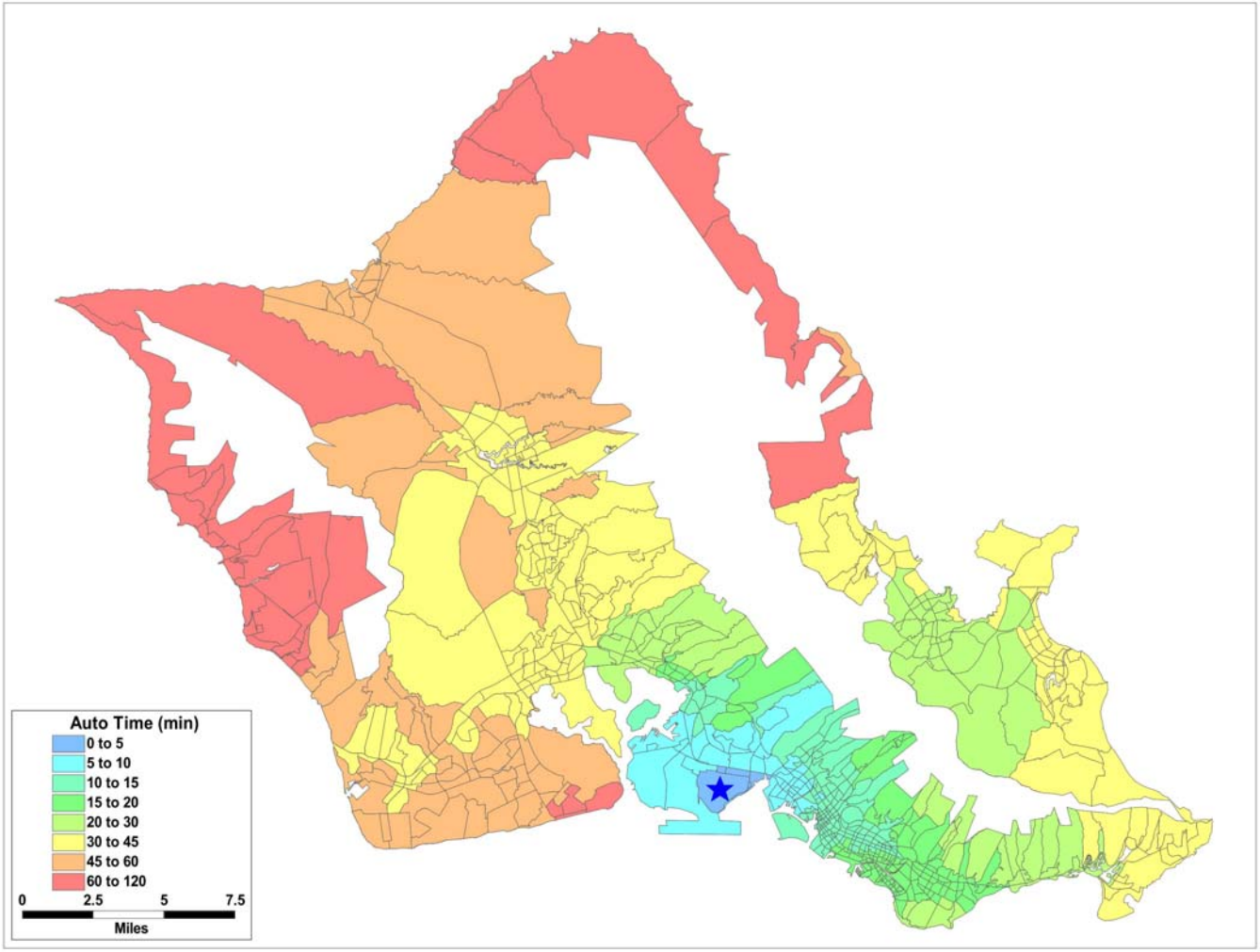


Figure 4-10 shows the estimated travel times to Honolulu International Airport. Travel times ranging from 60-to-120 minutes are estimated from the Waianae Coast and parts of Ewa and in excess of 45 minutes from parts of the North Shore area. From Downtown Honolulu, estimated travel times to the Airport range from 5–to-15 minutes.

Figure 4-10: 2007 Existing Conditions AM Two-Hour Peak Period Auto Travel Times to Honolulu International Airport



4.2.3 Accident Risks

Figure 4-11 and Figure 4-12 show existing high accident locations on Oahu. High accident locations for state routes are defined as intersections with three or more crashes per year for three consecutive years (2004-2006). The highest number of crashes (27 in three years) occurred at Likelike Highway (Route 63) and the junction with the northbound off-ramp to Kahekili highway (Route 83). Out of the 35 locations on the state routes shown on the map, 13 exist on Route 92, which includes sections of Nimitz Highway and Ala Moana Boulevard. Other state routes have five or fewer high accident locations.

For city streets, high accident locations are defined as intersections with nine or more crashes for three consecutive years (2004-2006). The highest number of crashes (50 in 3 years) occurred at the intersection of Beretania Street and Alakea / Queen Emma Street. Other locations had less than 25 crashes during this time period. The arterial corridor with most high accident locations is Kapiolani Boulevard followed by King Street and Beretania Street.

Figure 4-11: Existing High Accident Locations

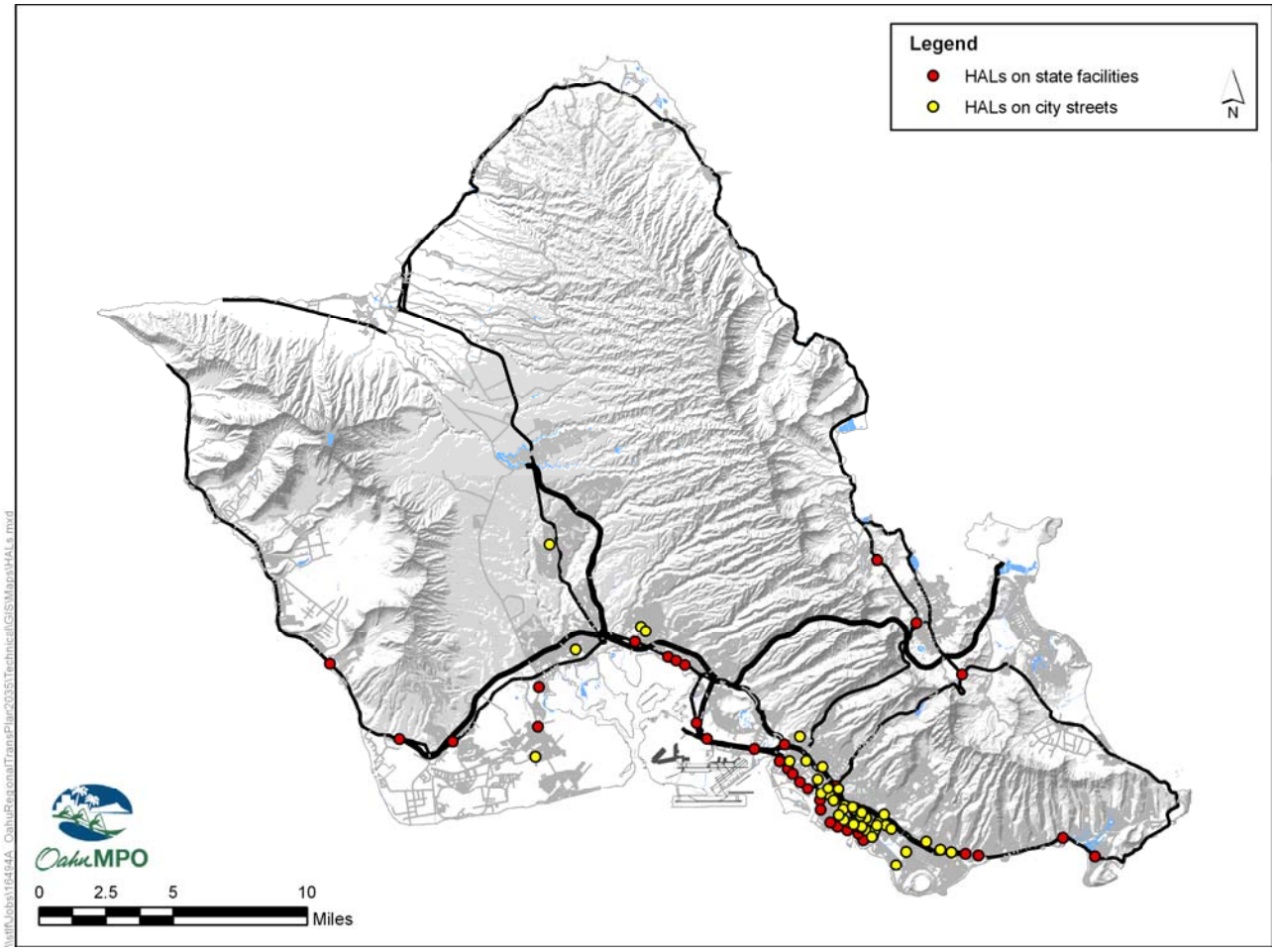
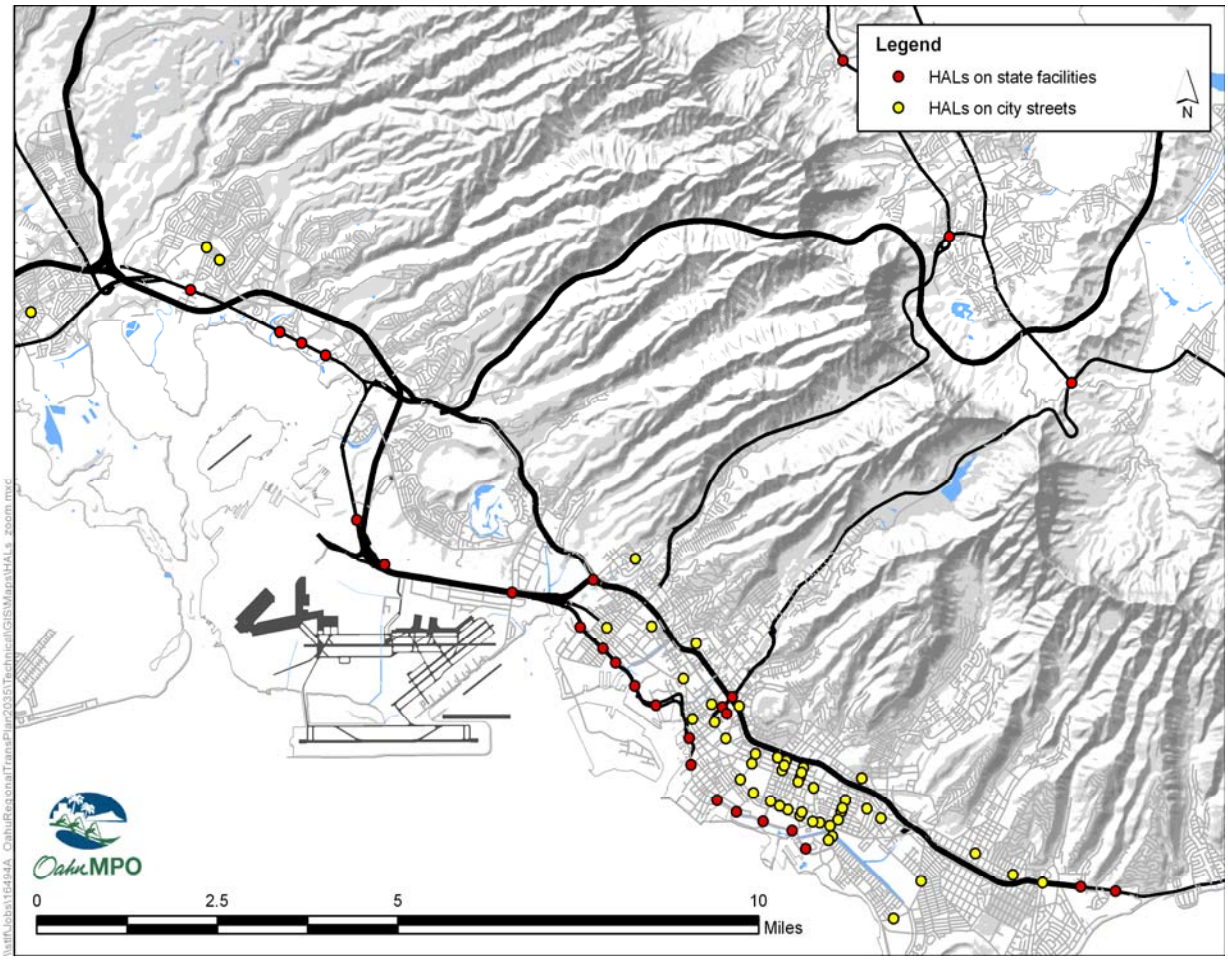


Figure 4-12: Existing High Accident Locations (Honolulu and Surrounding Areas)



4.2.4 Intermodal Freight Connections

As described in the ORTP 2035 deliverable 3.1.2, *Existing Transportation System Inventory Report* (2009), freight mobility is important to Oahu, with ocean transportation bringing in more than 98% of all imported food, building materials, manufactured goods, and energy products (HDOT, Harbors Division, 2009). Freight travel patterns on Oahu are focused around the two commercial harbors on the island (Honolulu Harbor and Kalaeloa Barbers Point Harbor) and Honolulu International Airport, with goods radiating out to outlying areas on the connecting highways.

4.2.5 Freight Travel Times for Selected Origin-Destination Pairs

Peak period travel times between key freight destinations are anticipated to be similar to those estimated for automobile travel, as shown in section 4.2.2. For example, freight travel times from various parts of Oahu to Honolulu Harbor are anticipated to be similar to those shown for automobile travel to Downtown Honolulu.

In addition, estimated automobile travel times to Waikiki and Honolulu International Airport are expected to be similar for freight.

5 Existing Conditions Performance: Bicycle and Pedestrian Facilities

A general assessment of the bicycle and pedestrian facility network will be provided, with reference to the ORTP 2035 3.1.2 deliverable, *Existing Transportation System Inventory Report* (2009). Key gaps in the networks will be identified, as well as the quality of access to existing primary pedestrian and bicycle facilities.

5.1 Bicycle Facilities

There are three primary facility types that provide the bikeway infrastructure on the island. The three facility types fall into the following categories as defined by the *Draft Oahu Bike Plan* (2009):

- Lanes (45 miles) - A bike lane refers to a section of the roadway that has been designated by striping, signing, and/or pavement markings for the preferential or exclusive use by bicyclists. Bike lanes are typically five to six feet in width (four foot minimum).
- Paths (42 miles) – Often referred to as shared-use paths, these are off-street facilities that are physically separated from motorized vehicular traffic by an open space or a barrier. These are typically 12 feet in width (10 foot minimum).
- Routes (32 miles) – Bike routes are shared facilities that are posted with street signage and sometimes marked with pavement markings.

A fourth facility type that does not currently exist on Oahu currently is the shoulder bikeway. Shoulder bikeways are proposed to be constructed along with various other bicycle infrastructure improvements in the *Draft Oahu Bike Plan* (2009).

5.2 Pedestrian System Overview

As described in the ORTP 2035 deliverable, 3.1.2, *Existing Transportation System Inventory Report* (2009), the pedestrian system provides residents and visitors with access to local shopping, business, residential, recreational, and educational opportunities. It also provides access to public transit services, which in turn expands opportunities for residents and visitors. More than one-third of residents do not have access to a car at any given time. These people are dependent on the pedestrian network to give them access to basic services and/or transportation options.

The quality and extent of Honolulu's pedestrian system varies depending on location. In certain areas, the City has invested heavily in creating a continuous and accessible pedestrian system while in other neighborhoods the condition of pedestrian facilities is poor or incomplete. As the City develops into new, previously

undeveloped areas, a complete and accessible network of sidewalks would most likely be constructed by private developers.

6 Natural and Human Environment

This chapter summarizes existing conditions in relation to the performance measures developed to address the natural and human environment. The goal related to natural environment is *to develop, operate, and maintain Oahu's transportation system in a manner that sustains environmental quality*. The goal related to human environment and quality of life is *to develop, operate, and maintain Oahu's transportation system in a manner that supports community-wide values related to health, safety, and civil rights*.

6.1 Susceptibility to Global Climate Change

Many future impacts from global climate change have been predicted by scientists. With its island setting, among the more significant of these impacts to Oahu are expected to be from sea-level rise and an increased severity of storms, including tidal surges, and their consequent impacts to transportation infrastructure. Therefore, it is anticipated that transportation facilities that are located within close proximity to coastal areas and other areas prone to flooding could be at risk. These facilities include the two commercial harbors on the island (Honolulu Harbor and Kalaeloa Barbers Point Harbor), Honolulu International Airport, and various roadways (particularly Kalanianaole Highway, Kamehameha Highway, and Nimitz Highway.

6.2 Air Quality

The State of Hawaii is currently in attainment for air quality. The 2007 existing year resulted in a daily total of 580,000 gallons of fuel consumed and 7,000 tons of CO2 emissions[3] from over 13,000,000 vehicle miles traveled from the roadways modeled[4] for Oahu.

6.3 Title VI/Environmental Justice (T6/EJ)

Four sub-measures are associated with T6/EJ: accessibility, equity, mobility, and public involvement and outreach. An existing conditions summary is not relevant to equity or public involvement and outreach and will not be included in this report. Accessibility and mobility are discussed below.

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[3] The methodology used to forecast green house gas emissions and energy consumption for the ORTP 2035 project is based in part on the GreenSTEP model (Oregon Department of Transportation, GreenSTEP Model Documentation, January 29, 2009). This model was developed by the Oregon Department of Transportation for analysis and comparison of greenhouse gas emissions resulting from land-use and transport strategies. The model estimates "wells-to-wheel" CO2 emissions based on motor vehicle use and fuel efficiency. The model takes into account vehicle miles of travel (VMT) by speed and facility type, and data regarding vehicle fleet fuel efficiency, to estimate daily and annual tons of CO2 resulting from motor vehicle fuel consumption. A more detailed description of how green house gas emissions were calculated is in Appendix C.

[4] The results include these facility types: freeways, expressways, arterials, ramps, and collectors.

6.3.1 Accessibility

Accessibility can be defined as the ease of reaching opportunities using surface (ground) transportation. Accessibility is evaluated from the standpoint of travel time. This evaluation assesses how accessible certain important destinations (e.g., shopping centers, employment centers, colleges, hospitals) are to T6/EJ TAZs compared with non-T6/EJ TAZs.

Travel time thresholds were used to measure accessibility. The thresholds were used to calculate the number of people within a predetermined travel time to those travel destination opportunities represented by specific trip generator zones. These include selected employment, college, regional shopping center, and hospital trip generators. A travel time threshold of 20 minutes was used for all trips.

Tables 6-1 through 6-4 show the accessibility to the selected trip generators for existing conditions for both T6/EJ and non-T6/EJ TAZs. The T6/EJ to non-T6/EJ ratio in the table describes the ratio of percent of T6/EJ TAZs to percent of non-EJ TAZs that are within 20 minutes travel time of the destinations. The magnitude of this ratio describes the degree of advantage that either the T6/EJ TAZs or the non-T6/EJ TAZs have over each other. If the ratio is less that one then the advantage lies with the non-T6/EJ TAZs, if the number is greater than one then the advantage lies with the T6/EJ TAZs. A value equal to one indicates parity between the TAZs.

This analysis demonstrates that, for peak-period auto trips, 20-minute accessibility to hospitals and regional shopping centers is very high and comparable for both the T6/EJ and non-T6/EJ populations. In contrast, non-T6/EJ populations have better accessibility to colleges and employment centers than T6/EJ populations. Similar patterns can be seen for off-peak auto trips and transit trips during both peak and off-peak periods.

Table 6-1 EJ TAZs within 20 minutes of Selected Destinations – Auto Trips (Peak)

	To Colleges			To Hospitals			To Regional Shopping Centers			To Employment Centers		
Measure	T6/EJ	Non-T6/EJ	T6/EJ to Non-T6/EJ Ratio	T6/EJ	Non-T6/EJ	T6/EJ to Non-T6/EJ Ratio	T6/EJ	Non-T6/EJ	T6/EJ to Non-T6/EJ Ratio	T6/EJ	Non-T6/EJ	T6/EJ to Non-T6/EJ Ratio
Number of TAZs	58	519	NA	108	640	NA	102	634	NA	78	594	NA
% of all TAZs	53.2%	79.2%	0.67	99.1%	97.7%	1.01	93.6%	96.8%	0.97	71.6%	90.7%	0.79
Number of People	74,383	583,327	NA	171,748	704,635	NA	156,144	704,115	NA	108,519	653,938	NA
% of all People	43.0%	79.6%	0.54	99.2%	96.2%	1.03	90.2%	96.1%	0.94	62.7%	89.3%	0.70

Table 6-2 EJ TAZs within 20 minutes of Selected Destinations – Auto Trips (Off-Peak)

	To Colleges			To Hospitals			To Regional Shopping Centers			To Employment Centers		
Measure	T6/EJ	Non-T6/EJ	T6/EJ to Non-T6/EJ Ratio	T6/EJ	Non-T6/EJ	T6/EJ to Non-T6/EJ Ratio	T6/EJ	Non-T6/EJ	T6/EJ to Non-T6/EJ Ratio	T6/EJ	Non-T6/EJ	T6/EJ to Non-T6/EJ Ratio
Number of TAZs	88	634	NA	108	654	NA	103	650	NA	94	645	NA
% of all TAZs	80.7%	96.8%	0.83	99.1%	99.8%	0.99	94.5%	99.2%	0.95	86.2%	98.5%	0.88
Number of People	135,462	718,216	NA	171,748	732,086	NA	157,565	727,933	NA	140,594	723,474	NA
% of all People	78.2%	98.1%	0.80	99.2%	100.0%	0.99	91.0%	99.4%	0.92	81.2%	98.8%	0.82

Table 6-3 EJ TAZs within 20 minutes of Selected Destinations – Transit Trips (AM)

	To Colleges			To Hospitals			To Regional Shopping Centers			To Employment Centers		
Measure	T6/EJ	Non-T6/EJ	T6/EJ to Non-T6/EJ Ratio	T6/EJ	Non-T6/EJ	T6/EJ to Non-T6/EJ Ratio	T6/EJ	Non-T6/EJ	T6/EJ to Non-T6/EJ Ratio	T6/EJ	Non-T6/EJ	T6/EJ to Non-T6/EJ Ratio
Number of TAZs	64	538	NA	97	581	NA	90	589	NA	68	497	NA
% of all TAZs	58.7%	82.1%	0.71	89.0%	88.7%	1.00	82.6%	89.9%	0.92	62.4%	75.9%	0.82
Number of People	88,984	599,243	NA	145,504	640,758	NA	126,709	620,673	NA	85,386	545,057	NA
% of all People	51.4%	81.8%	0.63	84.0%	87.5%	0.96	73.2%	84.7%	0.86	49.3%	74.4%	0.66

Table 6-4 EJ TAZs within 20 minutes of Selected Destinations – Transit Trips (Mid-day)

	To Colleges			To Hospitals			To Regional Shopping Centers			To Employment Centers		
Measure	T6/EJ	Non-T6/EJ	T6/EJ to Non-T6/EJ Ratio	T6/EJ	Non-T6/EJ	T6/EJ to Non-T6/EJ Ratio	T6/EJ	Non-T6/EJ	T6/EJ to Non-T6/EJ Ratio	T6/EJ	Non-T6/EJ	T6/EJ to Non-T6/EJ Ratio
Number of TAZs	69	574	NA	98	610	NA	102	617	NA	85	565	NA
% of all TAZs	63.3%	87.6%	0.72	89.9%	93.1%	0.97	93.6%	94.2%	0.99	78.0%	86.3%	0.90
Number of People	101,652	653,217	NA	153,706	684,306	NA	151,728	679,117	NA	109,938	616,664	NA
% of all People	58.7%	89.2%	0.66	88.8%	93.4%	0.95	87.6%	92.7%	0.94	63.5%	84.2%	0.75

6.3.2 Mobility

Mobility can be defined as the ease of movement of people, goods, and services. The mobility evaluation calculates the average travel time from both T6/EJ and non-T6/EJ designated areas to select employment centers during the AM peak period.

Table 6-5 presents the results of the mobility analysis showing the travel time to employment centers by automobile and transit for both T6/EJ and non-T6/EJ TAZs. The analysis demonstrates that the average travel time from the T6/EJ TAZs is approximately 15 minutes greater than the travel time from non-T6/EJ TAZs for autos and 21 minutes greater for transit.

Table 6-5 EJ Mobility – Average Travel Time to Employment Centers (AM Peak)

Mode	T6/EJ	Non-T6/EJ
Auto (minutes)	42	27
Transit (minutes)	62	41
Average by Auto or Transit (minutes)	**52**	**34**

7 Bibliography

Existing Transportation System Inventory Report, Oahu Regional Transportation Plan 2035 Project, July 2009.

Draft Oahu Bike Plan, City and County of Honolulu Department of Transportation Services, July 2009.

Highway Capacity Manual, Transportation Research Board, 2000.

Harbors Division, Department of Transportation website, http://www.state.hi.us/dot/harbors/oahu/economic.htm Accessed October 2009

Appendix A: ORTP 2035 Performance Measures

Performance Measure	Description
Transportation Facilities	
1. Bicycle and Pedestrian Facilities	Compares the level of investment in new or improved non-motorized transportation elements as well as potential impacts to existing bicycle and pedestrian facilities, and assesses how the scenario affects continuity of and accessibility to the bicycle/pedestrian network.
2. Intermodal Freight Connections	Assesses the quality of connections between freight modes (highway, air and seaports) based on quality (suitable routes, design standards, conflicts, etc) and redundancy of connections.
3. Modal Conflicts	Assesses the candidate improvements' affect(s) on the potential for modal conflicts by assessing the negative effect(s) on other travel modes.
4. Mode Share	Measures the share (as a percentage) of person-trips carried by travel modes (e.g., single-occupant vehicle, high-occupant vehicle, transit, bicycle, pedestrian) based on travel demand forecasting model output.
5. Regional Transportation Linkages	Assesses whether the candidate improvements provide connections between regional transportation facilities or services.
6. Improved Accessibility to the Transportation System for Persons with Disabilities	Assesses the level of investment in the proposed project or program that support Americans with Disabilities Act Accessibility Guidelines.
Transportation Operations and Services	
7. Economic Vitality	Assesses the contribution of candidate improvements to the economic development and vitality of the region in terms of both job creation and reducing the costs associated with congestion.
8. Average Vehicle Occupancy	Measures the average number of occupants per automobile based on travel demand forecasting model output, excluding buses and commercial vehicles.
9. Condition and/or Life Span of Transportation Infrastructure	Assesses whether the candidate improvements improve the condition and/or life span of transportation infrastructure and the degree to which strategies balance resources for construction, rehabilitation, and maintenance.
10. Highway and Arterial Level of Service (LOS)	Measures (in lane-miles) and maps LOS for all major highway and arterial segments based on demand model Volume/Capacity ratios.
11. Historical Accident Risks	Assesses whether candidate improvements address existing high-accident locations and maps those locations based on compiled accident data for available modes.
12. Homeland Security, Personal Security, and All-Hazards Preparedness	Assesses whether candidate strategies are consistent with and support Homeland Security initiatives, personal security concerns, and all-hazards preparedness.
13. Operations Management	Assesses whether the candidate improvements effectively

Performance Measure	Description
Strategies	employ Intelligent Transportation System, Transportation Systems Management and/or Transportation Demand Management (TDM) techniques.
14. Screenline Person-Trips	Measures the person-trips (all modes) crossing study area screenlines based on travel demand forecasting model output.
15. Total Annual System Costs	Estimates annualized transportation costs (capital, operating and maintenance) over a predetermined span of time based on available cost information.
16. Transit Ridership	Measures number of transit patrons based on travel demand forecasting model output.
17. Travel Demand	Assesses the degree to which candidate improvements employ or support TDM techniques to reduce travel demand based on the potential to reduce vehicle trips.
18. Travel Times [Selected Origin-Destination (OD) Pairs]:	
- Auto	Measures and maps as travel time contours the average peak period travel time between key destinations based on travel demand forecasting model output.
- Freight	Measures and maps as travel time contours the average peak period travel time between key freight destinations based on travel demand forecasting model output.
- Public Transit	Measures and maps as travel time contours the average peak period travel time between key destinations on transit based on travel demand forecasting model output.
19. Vehicle Hours of Delay	Measures the total hours of delay (daily and peak period) experienced by all vehicles on the network based on travel demand forecasting model output. Delay is the difference between predicted travel times and travel time under free-flow (uncongested) conditions.
20. Vehicle Hours of Travel	Measures the total duration of trips by motorized vehicles (automobiles, buses, trucks) based on travel demand forecasting model output.
21. Vehicle Miles of Travel (VMT)	Measures the total length of trips by motorized vehicles (automobiles, buses, trucks) based on travel demand forecasting model output.
Natural Environment	
22. Natural Resource/Environment Effects	Assesses potential disruption or other impacts to natural areas such as animal habitats, open spaces, beaches, archeological sites, and forested areas/vegetation based on the mapped location of sensitive areas and potential footprint changes associated with proposed projects.
23. Reliance on Renewable and Sustainable Energy	Assesses the degree to which candidate actions promote the use of renewable and sustainable energy sources for

Performance Measure	Description
Sources	transportation (over non-renewable sources).
24. Susceptibility to Global Climate Change	Evaluates the effects of global climate change, including rising sea level, on transportation infrastructure.
Human Environment and Quality of Life	
25. Disruption during Construction	Assesses potential disruption to neighborhoods (access, mobility, noise, dust, etc.) during construction of candidate improvements based on degree of travel disruption, availability of suitable alternate routes, and proximity to sensitive neighborhoods.
26. Energy Consumption	Assesses whether candidate actions reduce energy consumption based on VMT, presumed fuel efficiency assumptions, and mix of fuel/power sources.
27. Air Quality	The State of Hawaii is in attainment for air quality. Assesses the level of greenhouse gas emissions as the result of proposed projects based on VMT, presumed fuel efficiency assumptions, and mix of fuel/power sources.
28. Title VI/Environmental Justice (T6/EJ) :	
- Accessibility	Compares share of people within T6/EJ and non-T6/EJ TAZs who are within a 20-minute trip of selected work, shopping, education and healthcare destinations based on travel demand forecasting model output.
- Equity	Compares transportation funding allocations for T6/EJ and non-T6/EJ areas needs based on available cost information.
- Mobility	Compares travel times for work trips from T6/EJ and non-T6/EJ TAZs based on travel demand forecasting model output.
- Public Involvement and Outreach	Assesses concerns and issues of T6/EJ populations regarding transportation system performance and plan project selection based on feedback from focus groups, telephone surveys, and other public outreach initiatives. Assesses the degree to which outreach was done to T6/EJ populations.
Land Use and Transportation Integration	
29. Land Use Plans	Assesses whether the candidate improvements serve planned growth areas based on forecast population and employment growth.
30. Built Environment Effects	Assesses potential displacements of people and/or activities and structures to developed areas.
31. Compact, Mixed-Use Growth	Assesses the degree to which candidate actions would encourage land development that supports more efficient use of transportation services as a result of concentrated growth patterns, mix of uses, and/or development around public transportation facilities.

Appendix B: 2007 Existing DTA Model Travel Times

Travel times from all the TAZs in Oahu to key destinations across the island were calculated for the AM peak period – from 7:30 a.m. to 7:45 a.m. – using the DTA model. The DTA model is designed to reflect more accurately the affects of peak period congestion on travel times. Estimated travel times from the DTA model have been summarized in the form of travel time contour maps similar to those found in section 4.2.2. Key destinations selected include Downtown Honolulu, Kapolei, Waikiki, Mililani, and the Honolulu International Airport.

Figure B- 1 shows the estimated travel times to Downtown Honolulu. Similar to the static assignment model results shown in Figure 4-6, the DTA model estimates travel times ranging from 60-to-120 minutes for travel from the Waianae Coast and Ewa to Downtown Honolulu. However, the DTA model shows more highly congested conditions than the static assignment model for travel from many parts of Central Oahu to Downtown Honolulu, with estimated travel times between 60 and 120 minutes.

Figure B- 1: 2007 Existing Conditions DTA Auto Travel Times to Downtown Honolulu – 7:30 A.M.

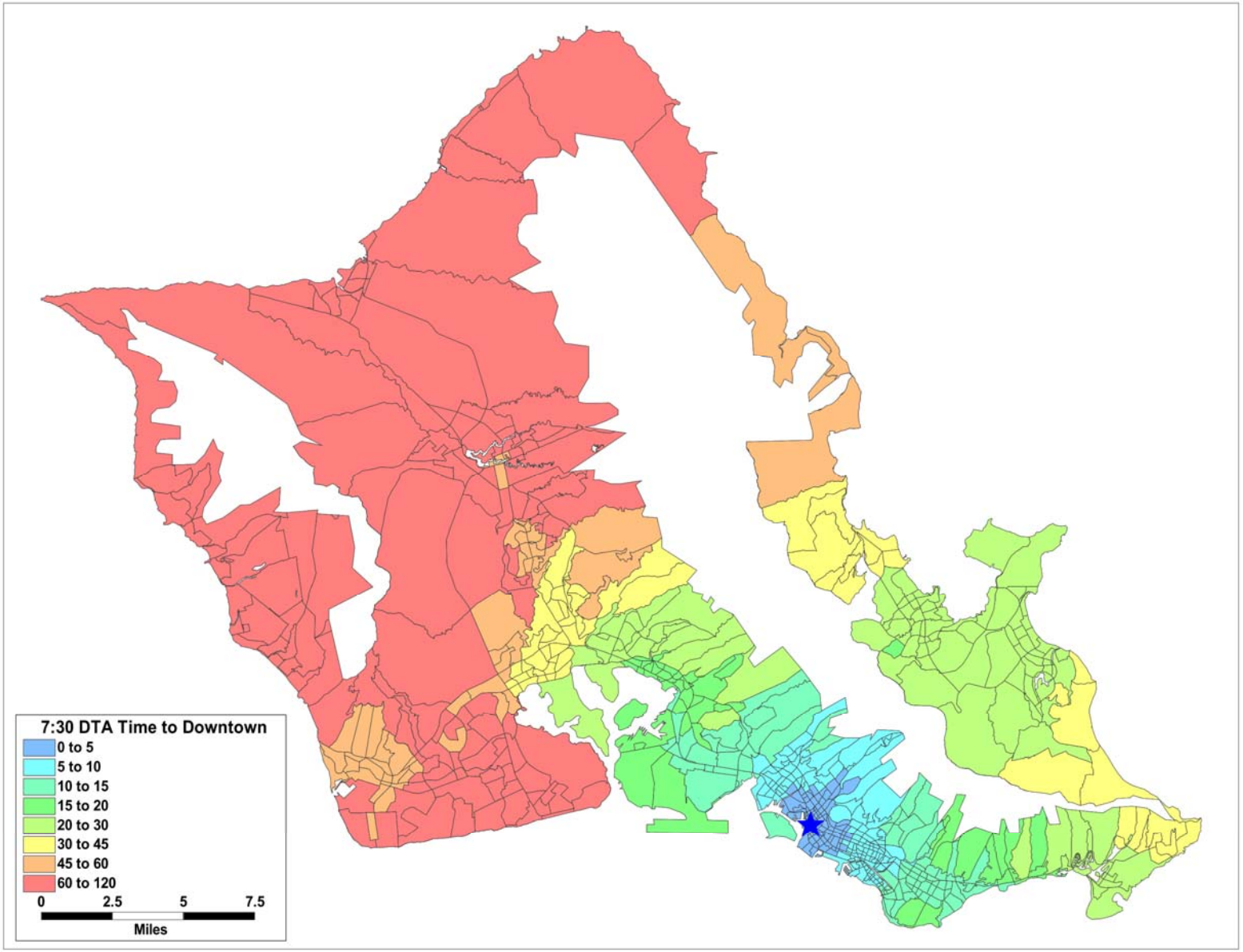


Figure B- 2 shows the estimated travel times to Kapolei. In contrast with the static assignment model results shown in Figure 4-7, the DTA model estimates travel times ranging from 30-to-60 minutes for travel from the Waianae Coast to Kapolei during the AM peak period. Travel times from other parts of the island are similar to those estimated by the static assignment model. For example, from Downtown Honolulu to Kapolei, travel times range from 20-to-30 minutes and increase progressively Koko Head of Downtown Honolulu.

Figure B- 2: 2007 Existing Conditions DTA Auto Travel Times to Kapolei – 7:30 A.M.

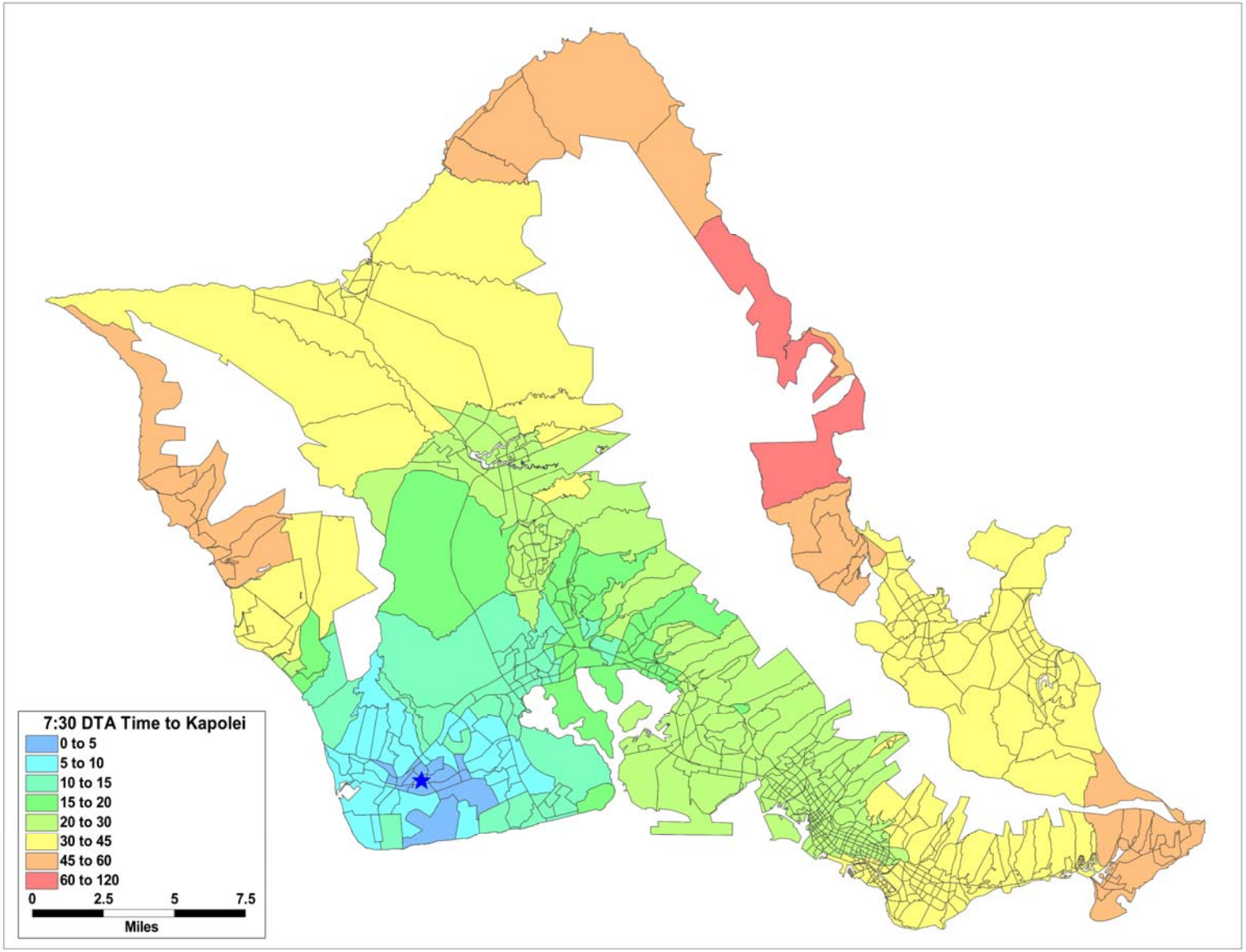


Figure B- 3 shows the estimated travel times to Waikiki. As with the static assignment model results shown in Figure 4-8, travel time patterns for trips to Waikiki from Leeward Oahu are similar to those with Downtown Honolulu as the destination, with the exception of Makaha, where travel to Waikiki is expected to be in the range of 120-to-130 minutes. Travel times from the Koolauloa and North Shore areas range from 60-to-120 minutes and travel times from Downtown Honolulu peak at 20 minutes. The DTA model estimates higher travel times than the static model for travel from some parts of Central Oahu.

Figure B- 3: 2007 Existing Conditions DTA Auto Travel Times to Waikiki – 7:30 A.M.

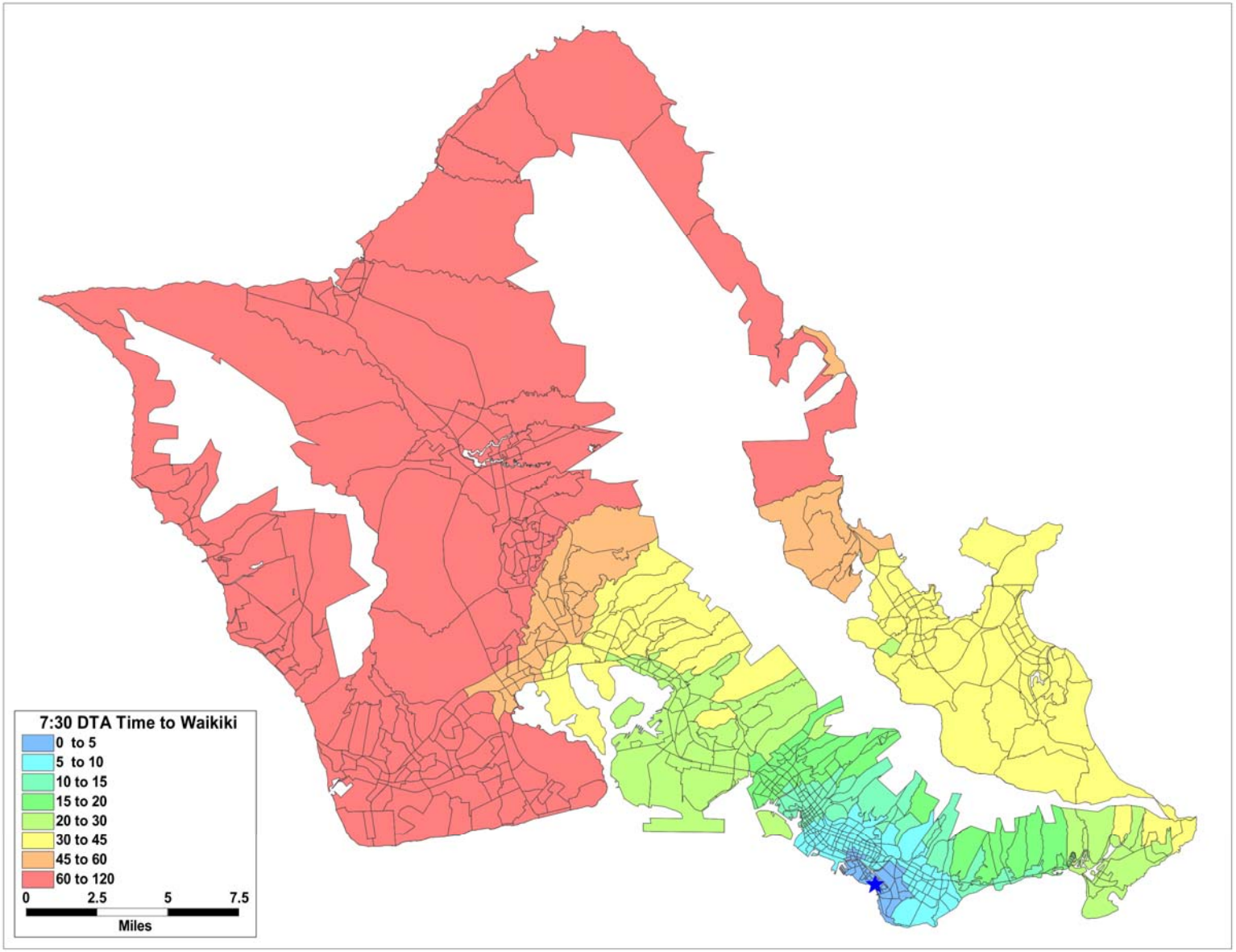


Figure B- 4 shows the estimated travel times to Mililani. Mililani, located centrally on Oahu, is accessible from most areas on the island in as much as 45 minutes. As with the static assignment model results shown in Figure 4-9, the Waianae Coast is still an exception with a travel time range between 60 and 120 minutes, along with the Koolauloa and Hawaii Kai areas, from which travel times are estimated to be between 45 and 60 minutes. In a departure from the general trend, the DTA model estimates travel times from the Hauula area to be shorter than those estimated by the static assignment model, with travel times between 45 and 60 minutes to Mililani (as opposed to 60-to-120 minutes in the static assignment model).

Figure B- 4: 2007 Existing Conditions DTA Auto Travel Times to Mililani – 7:30 A.M.

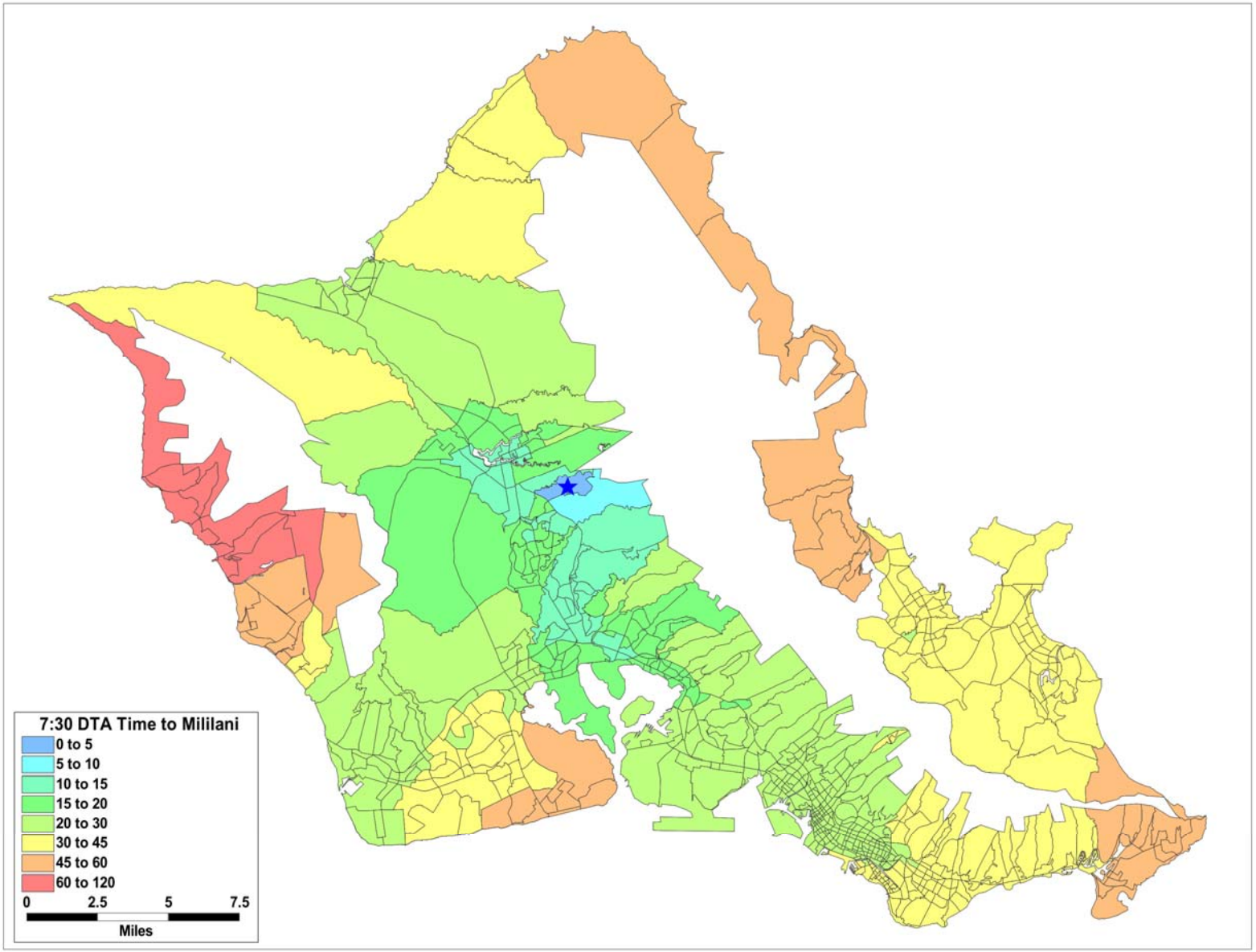
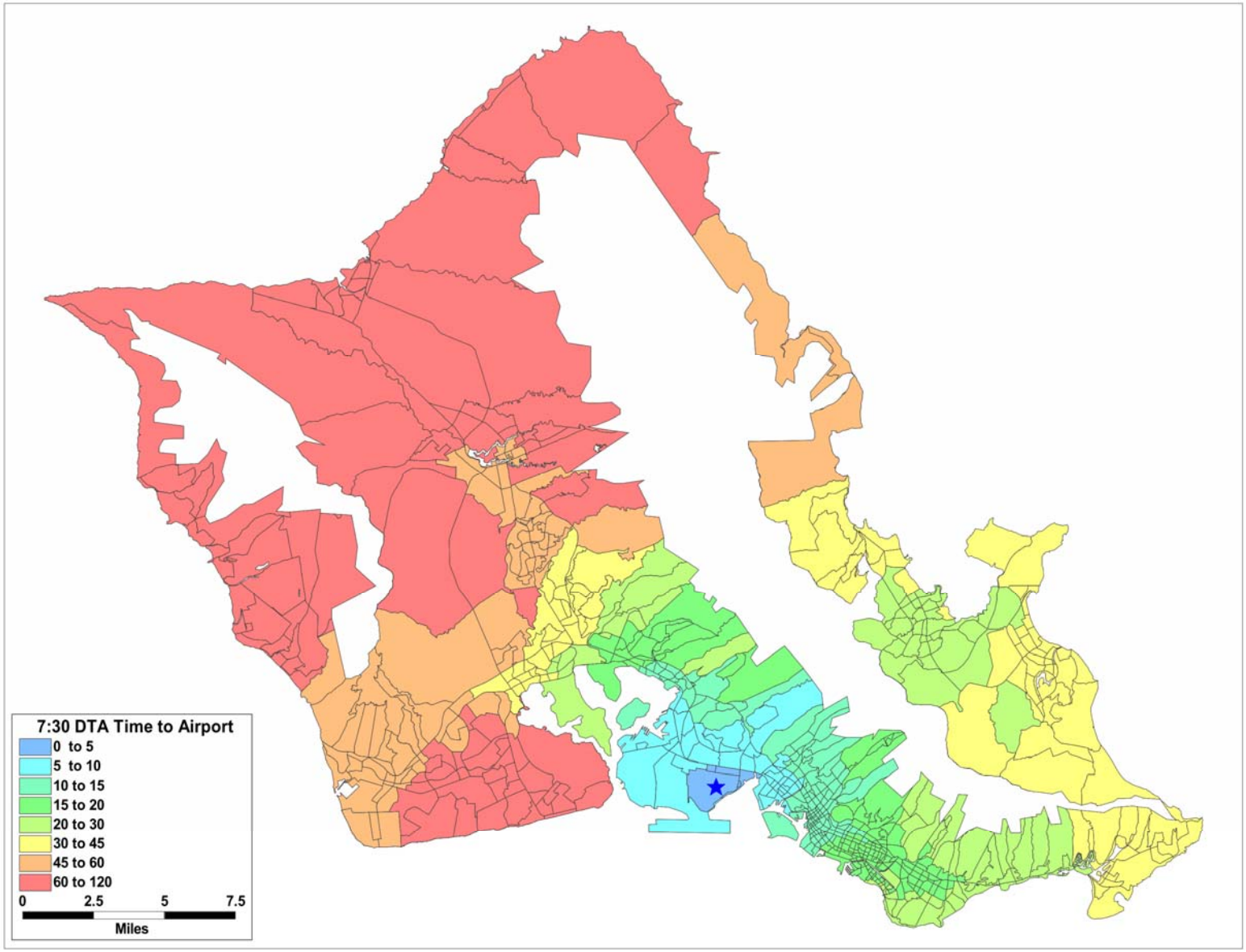


Figure B- 5 shows the estimated travel times to Honolulu International Airport. Similar to the static assignment model results shown in Figure 4-10, travel times estimated by the DTA model from Downtown Honolulu to the Airport range from 5-to-15 minutes, while travel times ranging from 60-to-120 minutes are estimated from Waianae Coast and Ewa (a greater portion of Ewa is estimated to be affected by congestion in the DTA model). However, estimated travel times from Central Oahu (45-to-120 minutes) are longer than those estimated by the static assignment model (30-to-60 minutes). Similarly, the DTA model shows travel from Haleiwa being more affected by congestion than the static assignment model, with travel times between 60 and 120 minutes, as opposed to 45-to-60 minutes in the static assignment model. However, similar to the estimated travel times to Mililani, travel times from the Hauula area to the Airport are estimated to be shorter in the DTA model than those estimated by the static assignment model, with travel times between 45 and 60 minutes to Airport (as opposed to 60-to-120 minutes in the static assignment model).

Figure B- 5: 2007 Existing Conditions DTA Auto Travel Times to Honolulu International Airport – 7:30 A.M.



Appendix C: Green House Gas Emissions Methodology

Introduction

The methodology used to forecast green house gas emissions and energy consumption for the ORTP 2035 project is based in part on the GreenSTEP[5] model. This model was developed by the Oregon Department of Transportation for analysis and comparison of greenhouse gas emissions resulting from land-use and transport strategies. The model estimates "wells-to-wheel" CO2 emissions based on motor vehicle use and fuel efficiency. The model takes into account vehicle miles of travel (VMT) by speed and facility type, and data regarding vehicle fleet fuel efficiency, to estimate daily and annual tons of CO2 resulting from motor vehicle fuel consumption.

Formula

The formula below shows how the daily CO2 emissions were calculated.

$$\text{Daily CO2 Emissions}_{ft,spd,vt} = VMT_{ft,spd,vt} / MPG_{ft,spd,vt} * CO2/MJ_{vt} * MJ$$

Where:

FT =	Facility Type
VT =	Vehicle Type
MJ =	Megajoule
CO2/MJ=	Fuel Efficiency
VMT =	Vehicle Miles of Travel
MPG =	Miles Per Gallon

The travel demand model produces VMT by facility type, area type, and speed bins in 5 mph increments. From the ORNL[6] study, the miles per gallon by speed bin was estimated for automobiles and trucks for freeways and arterials. VMT from the model is divided by the estimated miles per gallon for the vehicle type and facility type to obtain the amount of fuel in gallons. This is then multiplied by the estimated fuel efficiency for each vehicle type (automobiles versus trucks). Carbon content by the different fuel types are used to calculate the weighted average CO2 in grams per megajoule. The amount of gallons by vehicle type is then multiplied by the weighted average CO2 in grams per megajoule. This is then multiplied by the assumed number of megajoules per gallon of gas (121) to calculate total grams of CO2.

Assumptions

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[5] Oregon Department of Transportation, GreenSTEP Model Documentation, January 29, 2009.
[6] Oak Ridge National Laboratory did a study of 9 vehicles in the late 1990s to estimate MPG by vehicle operating speed.

The ORNL study is based on the fuel efficiency of a limited set of vehicles manufactured in the late 1990's. However, there was no significant change in fuel assumption between 1998 and 2007 for Hawaii according to the Hawaii Department of Energy[7] . Therefore the ORNL assumptions regarding fleet efficiency were held constant to 2007.

Results

The 2007 existing year resulted in a daily total of 580,000 gallons of fuel consumed and 7,000 tons of CO2 emissions from 13,140,000 vehicle miles traveled from the roadways modeled[8] for Oahu.

Results Existing Year 2007

	Daily
Total VMT[9]	13,140,000
Total Gallons Fuel	580,000
Total Grams CO2	6,519,500,000
Total Tons CO2	7,000
Tons per vehicle-mile	2,000

[7] http://hawaii.gov/dbedt/info/economic/databook/db2008
[8] The results include these facility types: freeways, expressways, arterials, ramps, and collectors.
[9] The VMT shown here differs slightly from the VMT reported in the "Multi-Modal Existing Conditions Performance Report" due to rounding.