

Makakilo Drive Traffic Operations Study

Kapolei, Oahu, Hawaii

Prepared for:

**City and County of Honolulu
Department of Transportation Services**

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Traffic Operations Study Makakilo Drive, H-1 Freeway to Kikaha Street

Summary

The purpose of the study is to determine what changes could be made to address existing traffic problems, as well as those that are anticipated with changes in traffic volumes due the future extension of Makakilo Drive to the east. The extension will connect to the Kualakai Interchange and provide a second access to Makakilo; reduction in traffic volumes on portions of the existing Makakilo Drive is expected.

A traffic operations study was conducted to address existing and future conditions on Makakilo Drive, a minor arterial street that currently provides the only access into the Makakilo community in Ewa, Oahu. Traffic count data and speeds were recorded at three locations and crash (collision) data for 24 months were reviewed. An inventory of existing signs and pavement markings was conducted and field verified.

The existing problems identified include excessive vehicular speeds, the provision for the movement of non-vehicular traffic, and maintaining adequate traffic capacity.

The average speeds recorded generally exceeded the posted speed limit. The exception is in the mauka-bound direction between the traffic signals at the Palailai Street/Kulihi Street intersection and the Anipeahi Street intersection, and this could be due to the uphill acceleration from a stop at the signal located makai of the count station.

Several alternatives were considered for encouraging compliance with appropriate vehicular speed and the other stated purposes. These alternatives were determined to be undesirable or not feasible (for the reasons shown):

- **reduction in the number of traffic lanes** (the reduced number of lanes available for traffic will not be adequate for the existing peak hour traffic demands)
- **adding bicycle lanes** (bicycle lanes will reduce the number of lanes available for traffic, which will not adequately serve existing peak hour traffic demands)
- **roundabouts** (single-lane roundabouts would not adequately serve existing traffic demands, and while multi-lane roundabouts are used in other localities, these are not recommended at this time but could be an alternative in the future, after correct use of such devices has been generally accepted by the driving public)
- **placement of bulbouts or chicanes, or otherwise creating a meandering path for vehicles, to slow traffic** (introducing additional obstructions or a meandering path could be expected to increase the already high incidence of fixed-object collisions)

The narrowing of traffic lanes to a typical width of ten feet is recommended. On portions of Makakilo Drive where there are wide curb lanes with parking allowed, an edgeline to narrow and better define the traffic lane and to delineate a shoulder for curbside parking is recommended. The use of sharrows, in which the number of traffic lanes could be maintained while minimizing conflicts with parked vehicles, is recommended instead of bicycle lanes.

In the short-term, existing lane lines should be maintained to avoid confusion, as the successful removal (obliteration) of old markings is difficult; there will be some areas where lane widths will be as much as 12 feet. When those areas of pavement are reconstructed or overlaid, new pavement markings to create 10-foot wide lanes should be used with striped medians to reduce the travelway and provide a lateral separation of opposing traffic flows.

The construction of the extension to Makakilo Drive (to the east to meet Kualakai Parkway) will provide an alternative access to Makakilo, which should reduce traffic demands on portions of the existing Makakilo Drive.

Current expectation is that the extension will serve 17,600 vehicles per day (vpd). These daily totals compare with the 25,500 vpd counted in 2011 on Makakilo Drive between Palailai and Anipeahi Streets, 20,600 vpd counted between Kinohi Place and Panana Place, and 7,100 vpd counted near Makamae Loop. With the extension in place, the daily volumes on existing segments of Makakilo Drive are expected to be between 10,000 and 17,500 vpd.

However, depending on when the extension is completed and the resulting travel demand distribution, a reevaluation should be done at that time to determine if there are sufficient reductions in peak hour traffic demands within the study area to reconsider alternatives that are now not feasible.

Introduction

The City and County of Honolulu's Department of Transportation Services (City) is considering alternatives to address existing and future conditions on Makakilo Drive, a minor arterial street that currently provides the only access into the Makakilo community in Kapolei, Oahu.

The project location and project limits are shown in Figure 1. The study is based on the existing roadway network, prior to completion of the proposed future extension of Makakilo Drive to the east. With the completion and use of the extension, weekday peak hour traffic volumes on Makakilo Drive are expected to be reduced; however, the reduction is not expected to affect the recommendations.

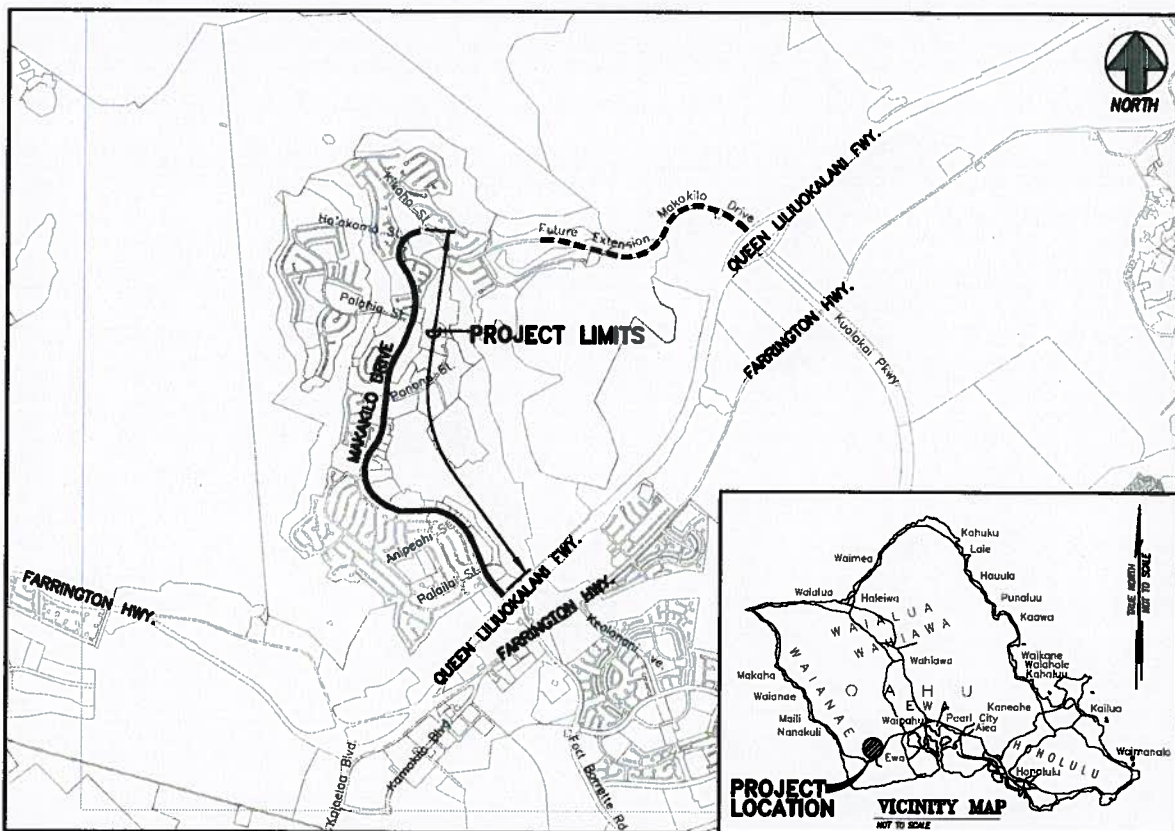


Figure 1 – Project Location

The purpose of the study is to determine what changes could be made to address existing traffic problems, as well as those that are anticipated with changes in traffic volumes that may occur with the extension of Makakilo Drive. These problems include excessive vehicular speeds, the provision for the movement of non-vehicular traffic, and maintaining adequate traffic capacity.

The study considers the possible alternatives that would not require acquisition of additional rights-of-way or major roadway reconstruction.

Applicable Standards

The guidelines generally accepted for roadway design are contained in *A Policy on Geometric Design of Highways and Streets*, a publication of the American Association of State Highway and Transportation Officials. The publication has undergone several revisions as additional research and experience becomes available. The latest (6th) edition, published in 2011, was used in evaluations contained herein.

Street signs and traffic markings are based on the latest edition (2009) and updates to the *Manual on Uniform Traffic Control Devices for Streets and Highways* ("MUTCD"), published by the Federal Highway Administration.

Makakilo Drive was constructed to City and County of Honolulu standards that were in effect at the time of construction (1970s to 1990s). Curbs and gutters define the roadway traffic surface, and sidewalks have been provided within the right-of-way.

The City and County of Honolulu's Traffic Code, which is Chapter 15 of the Revised Ordinances of Honolulu, provides specific regulations related to the use of streets and highways. Speed limits, the locations of no parking zones, and the locations of official public bus stops are listed in schedules attached to the Traffic Code; specific provisions are adopted and updated by City Council resolutions.

Schedules V and VII include descriptions of the locations of speed limits on City streets. Schedule V provides that Makakilo Drive, from a point 240 feet makai of Panana Street to its mauka dead end, has a speed limit of 25 miles per hour. Schedule VII provides that Makakilo Drive, from the H-1 Freeway Off-ramp (beginning of City jurisdiction) to a point 240 feet makai of Panana Street, has a speed limit of 35 miles per hour.

Schedule XXII describes no parking zones and Schedule XXV defines official bus stop locations. A summary of the portions of these current schedules that apply within the project limits is attached as Appendix A.

Existing Conditions

Makakilo Drive is a minor arterial street providing access to the Makakilo community, which is primarily residential in nature. Makakilo Drive begins at its intersection with Farrington Highway and Fort Barrette Road, and continues *mauka* into Makakilo. Makakilo Drive crosses over the Interstate Route H-1, where ramps provide connections to the freeway. City and County of Honolulu jurisdiction of Makakilo Drive, and the *makai* project limit, begins approximately 200 feet northwest (*mauka*) of the traffic signal at the H-1 westbound off-ramp terminal.

Makakilo Drive is a six-lane divided roadway from the *makai* project limit to its intersection with Palailai Street. Left turn lanes are located within the median at the approaches to the signalized intersections. From Palailai Street to a point approximately 600 feet *mauka* of Panana Street, Makakilo continues as a four-lane divided roadway (except that a third *makaibound* lane is provided for a distance of approximately 600 feet on the approach to Palailai Street intersection).

Mauka of Panana Street to Kikaha Street, Makakilo Drive is an undivided four-lane roadway with parallel parking generally allowed along the curbs. Near the intersection with Palahia Street, a left turn lane is provided at the expense of curbside parking. Beyond Kikaha Street, Makakilo Drive narrows to a two-lane street with curbside parking.

Typical sections are shown in Figure 2.

Traffic volume and speed surveys were taken on Makakilo Drive at three locations in September 2011 (Figure 3). The counts were taken using machine counters (mechanical and electronic devices that record pneumatic pulses from multiple tubes laid across traffic lanes) set up at each location. The counters include on-board computers that provide not only traffic volumes, but also speeds, recorded in 15-minute intervals. Traffic volumes and speeds on Makakilo Drive are summarized in Table 1; Appendix B provides the detailed count data.

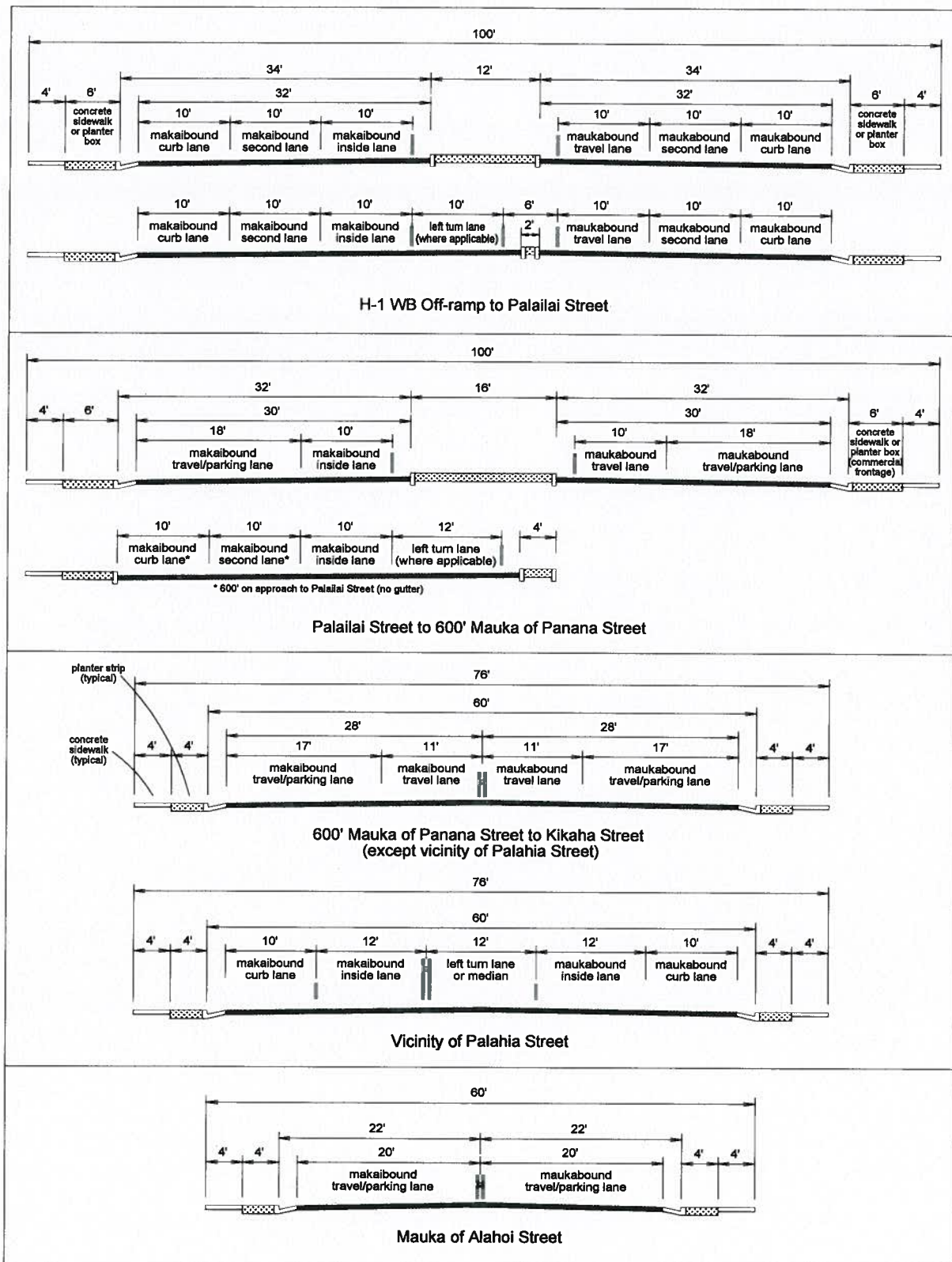


Figure 2 – Existing Typical Sections

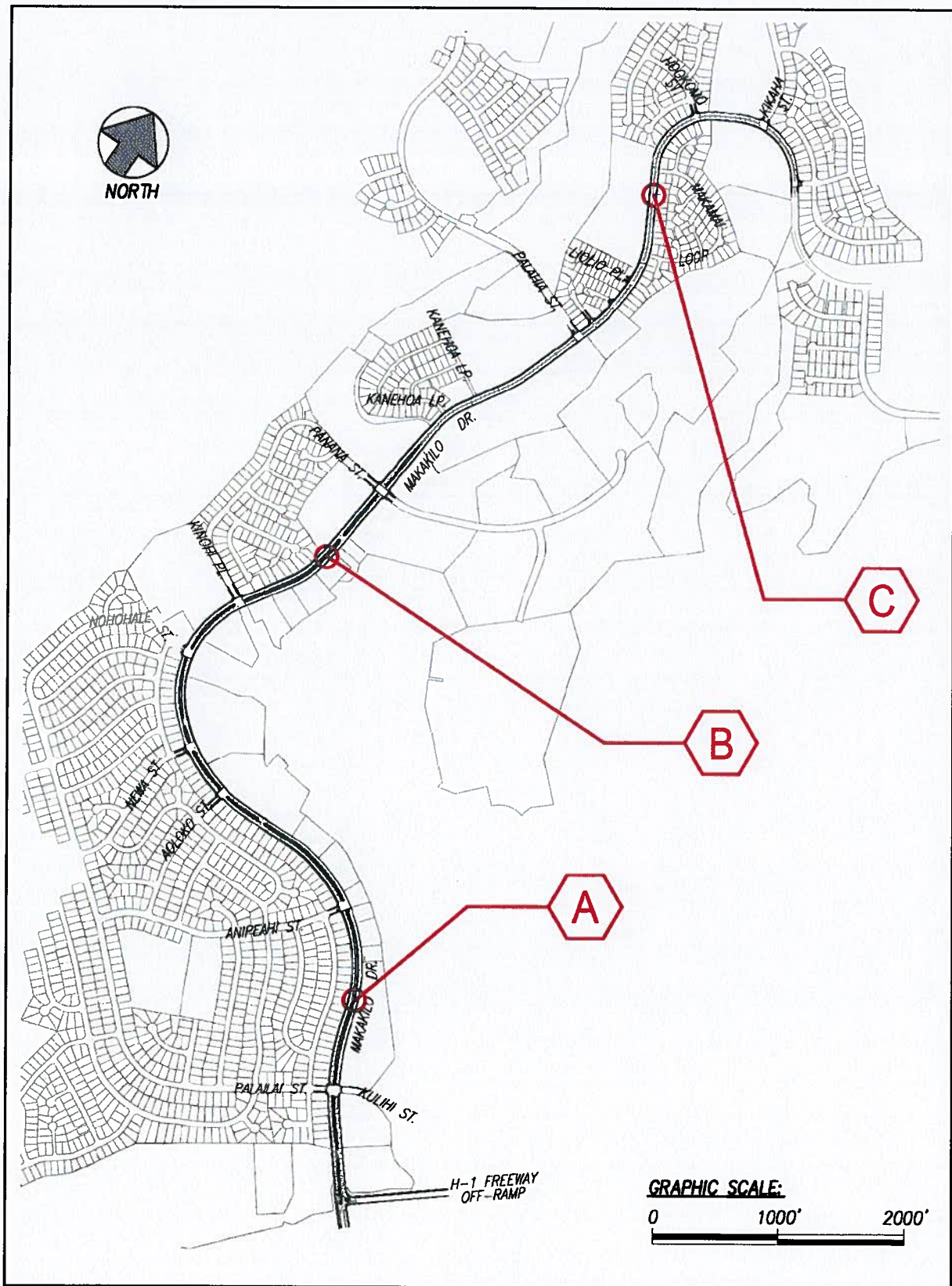


Figure 3 – Traffic Count Locations

Table 1 – Traffic Speeds and Volumes, September 2011

Traffic Speeds (average of two days' data)						
	Average speed (mph)		85 th percentile speed			
	makaibound	maukabound	makaibound	maukabound		
Location A (35 mph SL)	41.6	30.2	48.7	34.7		
Location B (35 mph SL)	32.0	34.5	37.8	40.3		
Location C (25 mph SL)	30.3	32.0	34.8	34.9		
Traffic Counts						
	24-Hour		AM Peak Hour		PM Peak Hour	
traffic direction	makai	mauka	makai	mauka	makai	mauka
Wednesday, September 7, 2011						
Location A	13,536	11,834	1,593	479	802	1,083
Location B	11,782	8,820	1,182	342	673	849
Location C	3,701	3,372	476	168	200	294
Thursday, September 8, 2011						
Location A	13,638	11,966	1,577	494	724	1,104
Location B	11,959	8,650	1,197	344	731	880
Location C	3,747	3,435	442	158	211	338
mph = miles per hour SL = posted speed limit						
Source: Julian Ng Incorporated						

The field crew noticed that the Honolulu Police Department had deployed a portable feedback sign (reminding drivers of the speed limit and advising them of their speed) approximately 200 feet makai of Location C for makaibound traffic a few days prior to the counts; the sign was in place through the two days of the counts.

The average speed shown in the table is the mean (arithmetic average) speed of all vehicles. An 85th percentile speed is also shown; this speed represents the speed below which 85 percent of the vehicles were recorded traveling across the count location. The 85th percentile speed* is often used as the basis of design.

* While traditionally, the 85th percentile speeds was at times used to determine speed limits, this practice is not recommended because the roadway design and roadside conditions, rather than driver preference, controls the speed at which the roadway can safely be used.

Traffic count Location A is approximately midway between the intersections with Palailai Street/Kulihi Street and with Anipeahi Street. At this location, Makakilo Drive is a divided roadway, with two traffic lanes in each direction (except that lane markings for a third makai bound lane begin approximately 120 feet makai of the count location) and the posted speed limit is 35 miles per hour. The daily totals for the two days of counts at Location A varied by about 1%, but the makai bound counts exceeded the mauka bound counts by 14%. The two-way daily count averaged about 25,500 vehicles per day, slightly lower than the average volumes shown in counts taken in 2009, possibly due to an undercounting of the mauka bound traffic. An earlier 48-hour count taken at this location and reported by the State of Hawaii Department of Transportation showed an average of 26,800 vehicles per day (daily volumes of 26,479 vehicles per day on Tuesday, January 27, 2009 and 27,213 vehicles per day on Wednesday, January 28, 2009).

Traffic count Location B is approximately midway between the intersections with Kinohi Place and with Panana Street. At this location, Makakilo Drive is a divided roadway, with two traffic lanes in each direction. This location is about 250 feet mauka of the first 35 mile per hour speed limit sign for makai bound traffic and halfway (about 300 feet) between a "reduced speed ahead" sign and a "school" sign for mauka bound traffic. The daily totals for the two days of counts at Location B varied by less than 2%, with the makai bound counts exceeding the mauka bound counts by 30-40%. The two-way daily count averaged about 20,600 vehicles per day, which is very close to the totals from earlier 48-hour counts taken at this location and reported by the State of Hawaii Department of Transportation, which showed daily volumes of 20,602 vehicles per day on Wednesday, May 13, 2009 and 20,609 vehicles per day on Thursday, May 14, 2009.

Traffic count Location C is just *makai* of the *mauka* intersection with Makamai Loop, fronting Makakilo Community Park. Posted speed limit is 25 miles per hour. The daily totals for the two days of counts at Location C varied by less than 2%, with the makai bound counts exceeding the mauka bound counts by about 10%. The two-way daily count averaged about 7,100 vehicles per day. While there are no recent counts at this location, an earlier 48-hour count taken farther mauka (beyond Kikaha Street) showed daily volumes of 2,897 vehicles per day on Tuesday, February 3, 2009 and 2,900 vehicles per day on Wednesday, February 4, 2009.

The count data indicated that 65% to 70% of the traffic volumes on Makakilo Drive were recorded between 6:30 AM and 6:30 PM (the average duration of daylight hours). Average traffic volumes during daylight hours, therefore, are about twice that of nighttime traffic.

Traffic engineers use the level of service concept to describe traffic conditions. Levels of Service (LOS) ranging from “A” to “F” are used, with LOS A describing very good conditions and LOS F describing congested, over-capacity conditions. Levels of service for roadway segments* were determined to be LOS D in the peak direction (makaibound) and LOS C in the opposite direction in the AM Peak Hour. In the PM Peak Hour, LOS C describes conditions in both directions.**

Data on traffic crashes were obtained from the City and County of Honolulu Department of Transportation Services. There were 56 major collisions on record for the two-year period from June 2009 to May 2011. Table 2 and Figure 4 show the types of collisions and the locations are shown in Table 3 and Figure 5.***

Table 2 – Collision Types and Times of Day, June 2009 to May 2011

Collision Type	June 2009 – May 2010			June 2010 – May 2011			Total
	day	twilight	night	day	twilight	night	
Fixed object	6	1	9	8	0	11	35
Rear-end	3	1	1	3	0	1	9
Sideswipe	0	1	2	1	0	2	6
Angle	1	0	0	2	0	1	4
Roll-back	0	0	0	1	0	0	1
Pedestrian	0	0	1	0	0	0	1
Total	10	3	13	15	0	15	56
note: “twilight” defined as the time of day 20 minutes before and 20 minutes after sunrise (or sunset)							
Source: Julian Ng Incorporated, using summary data from City and County of Honolulu, Department of Transportation Services							

In Table 2, the collision types were determined from brief descriptions that were provided in the summaries of the collision records. Several collisions with descriptions such as “vehicle sideswiped parked vehicle” were placed in the “fixed object” category; where the description did not specifically identify the struck vehicle as being parked, the collision was placed in the “sideswipe” category. A majority of the collisions (<60%) were fixed object crashes.

* Levels of service can also be determined from average delays at intersections; however, for the evaluation of the roadway, a generalized level of service is used. For a roadway like Makakilo Drive, a capacity of 700 vehicles per hour per lane is used; this volume is also the maximum volume at Level of Service E. Maximum service volumes for LOS D and LOS C (86% of capacity and 71% of capacity, or 600 and 500 are used, respectively).

** If the number of lanes available for motorized vehicles were reduced by one in each direction, per-lane volumes would increase, resulting in over-capacity conditions for makai bound traffic at Locations A & B in the AM Peak Hour and for both directions at Location B in the PM Peak Hour.

*** However, the numbers of collisions recorded over two years’ time are not sufficiently large to suggest that there are any other patterns or trends other than those discussed.

Collisions occurring at night totaled almost the same as during daylight hours, although total traffic during night hours is about half the traffic on the roadway during daylight hours.*

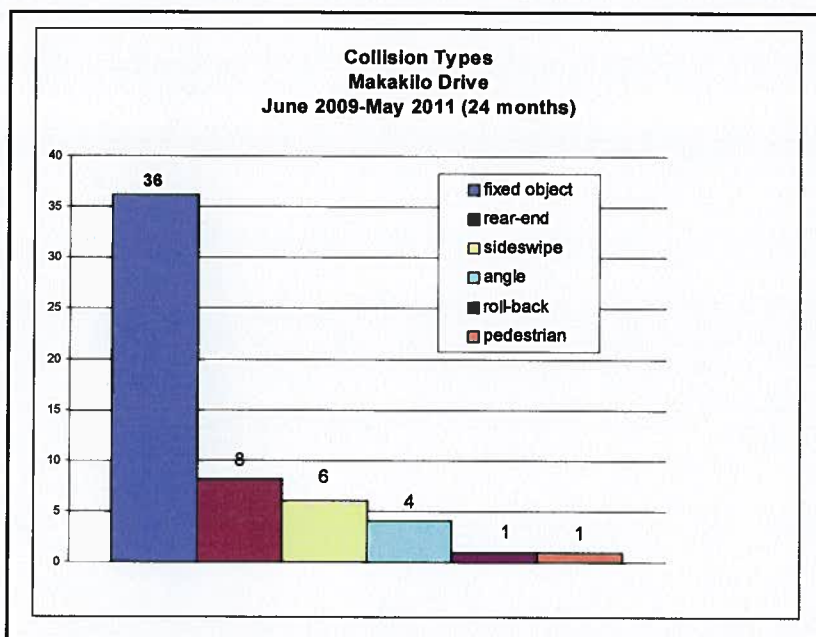
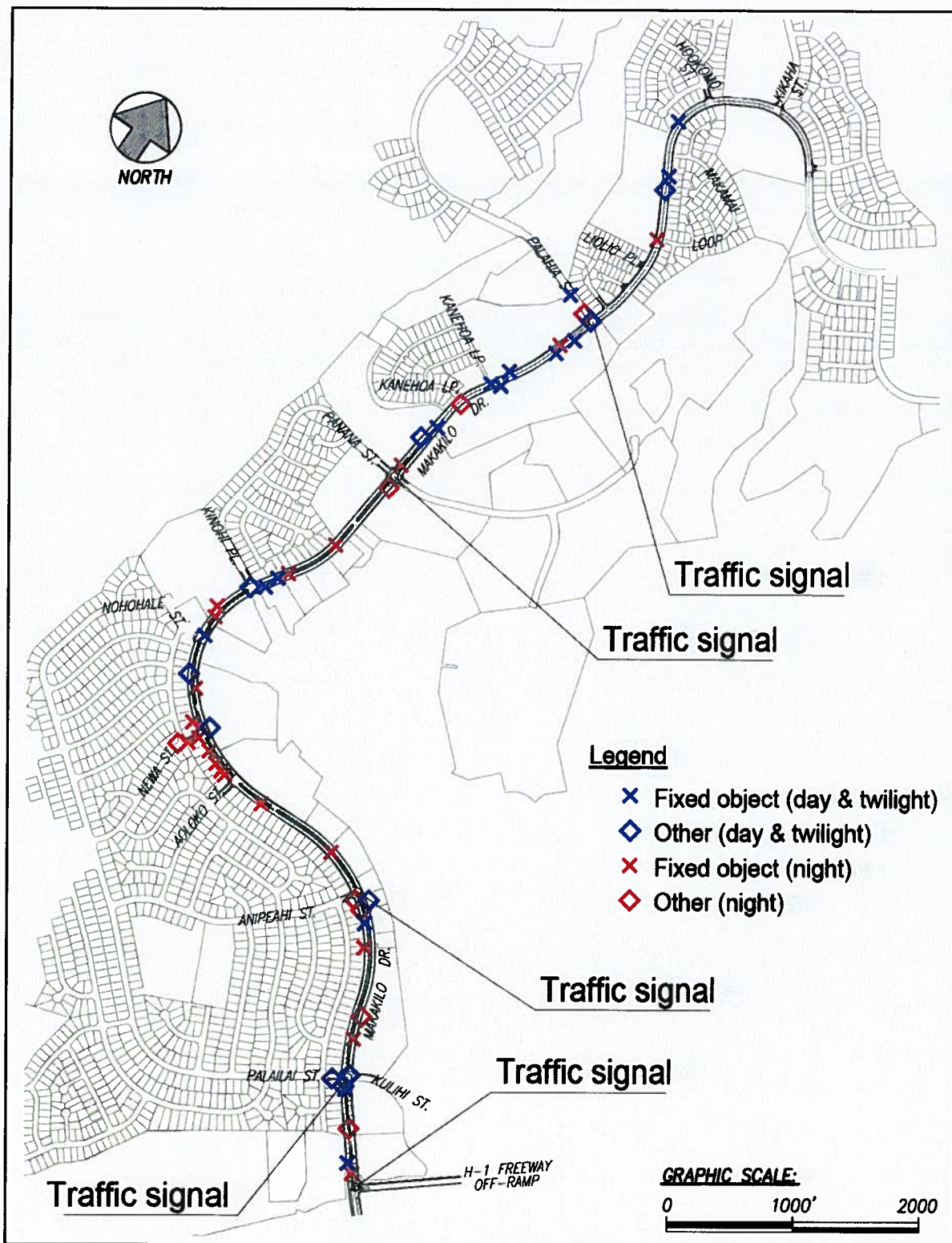


Figure 4 – Collision Types

Table 3 – Collision Locations, June 2009 to May 2011

Collision Location (Makakilo Drive, at or near)	Number
Ho'okomo Street	1
Makamai Loop	3
Palahia Street	7
Kanehoa Loop	3
Panana Street	4
Kinohi Place	4
Nohohale Street	4
Newa Street	11
Aoloko Street	2
Anipeahi Street	6
Palailai Street / Kulihi Street	6
(Non-intersection)	5
Source: City and County of Honolulu, Department of Transportation Services	

* The number of collisions reported during twilight hours is proportionate to the time that is considered "twilight" (80 minutes or 5.6% of 24 hours).



Existing signing and striping (pavement marking) plans for the project are attached as Sheets C-1 through C-12 (Appendix C). These plans are based on record drawings and field observations, and represent field conditions as of February 2012.

Sight Distance Evaluation

The sight distance along Makakilo Drive was analyzed to determine if there are any locations where there is inadequate time for a driver travelling on Makakilo Drive to see a potential situation ahead and bring his or her vehicle to a stop. The analysis specifically addressed the minimum required stopping sight distance along Makakilo Drive between the H-1 Freeway off-ramp and Kikaha Street. The stopping sight distance requirements were based on current AASHTO standards and calculations are included in Appendix D of this report.

The minimum stopping sight distance required was calculated for four driving conditions, as shown in Table 4, based on the design speed and the direction of travel. The roadway grade used in the calculations assumed a worst case scenario of 12% for vehicles travelling downhill and 5% for vehicles travelling uphill. The following table summarizes the minimum stopping sight distance calculated for each condition.

Table 4 – Stopping Sight Distance

Condition		Posted Speed Limit	Design Speed	Stopping Sight Distance (feet)
(Location)	Direction			
Below Palahia Street	Downhill	35 MPH	45 MPH	465
Below Palahia Street	Uphill	35 MPH	45 MPH	335
Above Palahia Street	Downhill	25 MPH	35 MPH	310
Above Palahia Street	Uphill	25 MPH	35 MPH	235

The calculated stopping sight distances were applied to the roadway at all driveways, intersections and horizontal curve locations to determine if any conditions exist where a driver's line of sight is impeded by physical objects within or alongside the roadway. The obstructions that are the most detrimental include trees with large diameter trunks or low-hanging canopies, perimeter walls or fences of properties along the roadway, and parked cars.

The sight distance analysis determined many locations where ideal driving conditions do not exist because obstructions are within the minimum stopping sight distance clear zone. The two locations listed below are of the most concern but the historical data do not show crashes occurring because of limited sight distance.

- In the downhill direction between Aoloko Street and Anipeahi Street, the horizontal curvature of the roadway combined with many residential driveways and on-street parking create a situation where driver visibility may be impeded. The posted speed limit is 35 mph, but this stretch of road is relatively steep and

cars are likely travelling at speeds greater than 35 mph. This area is approximately halfway between two count locations, where the 85th percentile speeds of downhill traffic were measured to be 38 and 49 miles per hour.

- The portion of roadway in the uphill direction between Aoloko Street and Kinohi Place is on a long horizontal curve approximately 1,800 feet in length. Street parking is allowed and there are street trees in the shoulder, both of which affect sight lines and within the minimum stopping sight distance clear zone. There are four driveways leading to multi-family housing developments located in this area.

At both locations, however, there have not been many collisions recorded, and those that were recorded were mostly collisions with fixed objects.

Adjustments to Existing Signing

Changes to existing signing were evaluated and recommendations for adjustments are contained in Appendix E.

Alternatives Considered

Several alternatives were considered, including traffic calming techniques. Traffic calming devices are used to encourage slower vehicular speeds, designate no parking areas, and enhance the pedestrian environment.

Speed humps and speed tables are raised portions of roadway near or at critical locations, intended to slow approaching traffic. However, the use of these devices on the segment of Makakilo Drive with a speed limit of 35 miles per hour is not appropriate. Even in the segments posted for a speed limit of 25 miles per hour, vertical changes in the travelway surface should not be introduced, especially since there is already a high incidence of collisions due to loss of control of a vehicle by the driver.

Bulbouts are used on approaches to intersections or driveways or near crosswalks to narrow the roadway, define no parking zones, and reduce the distance between opposite sides of the street. With bulbouts, care should be taken to avoid placing landscaping or street appurtenances in the bulbout areas that will compromise any needed clear line-of-sight. Chicanes are used to slow traffic by reducing the roadway width and slightly divert vehicle paths. Short segments of raised medians used to narrow roadways can also provide refuge areas if they are placed before and after crosswalks. However, each of these devices will add new obstructions in or near the roadway; considering the number of fixed-object collisions (35 in 24 months, of which 20 occurred at night) that have occurred on Makakilo Drive, these techniques involving the placement of additional obstructions is not recommended.

Future Traffic Conditions

In the short term, in addition to the traffic control devices described, the City plans to extend the shoulder striping between Anipeahi Street and Palahia Street, install new pedestrian crossing (“PED XING”) pavement markings on the approaches to unsignalized marked crosswalks between Aoloko Street and Kinohi Place, install two driver feedback signs, and install two school flashing beacons to supplement the school crossing warning signs.

Peak hour traffic volumes are not expected to increase. The Makakilo community is near completion and no significant increase in the number of dwelling units served by Makakilo Drive is anticipated. The long-range land transportation plan for Oahu includes an extension of Makakilo Drive from its current mauka terminus in the easterly direction to connect with the Interstate Route H-1 at the existing interchange with Kualakai Drive. Therefore, future traffic volumes are not expected to be greater than existing volumes in the segments makai of Panana Street. Makakilo residents will have the option to use the proposed extension, rather than continue to use the existing congested (during the AM Peak Hour) roadway, and traffic increases in the segments between Panana Street and the existing end of Makakilo Drive can be expected.

The August 2012 *O‘ahu Bike Plan* shows proposed bike lanes on “Makakilo Loop, Farrington Highway to Mekila Street” with bike lanes on Makakilo Drive, as a “Priority 2” project (Code 2-61). The plan states that Priority 2 “projects should be implemented following the completion of all Priority One projects. These projects will help expand the overall network, providing multiple routes to important services.” Priority One projects, which “are considered the most important facilities for the network and should be completed within the next 5-10 years” and include 84 projects, has an estimated cost totaling \$11.3 million (Tables 5 and 6 of the Bike Plan report).

Figure 1 of the plan shows use of Makakilo Drive and Pueonani Street, as well as a loop at the top using Ho‘okomo Street (28 feet curb-to-curb) and portions of Hookeha Street (28 feet curb-to-curb), Mekila Street (28 feet curb-to-curb), and Kikaha Street (varies 28 feet to 40 feet curb-to-curb). The bikeway improvements will eventually connect back to Farrington Highway using the extension of Makakilo Drive to the east and Kualakai Parkway.

Recommended Changes

Several minor modifications in signing were discussed under Existing Conditions above. Many traffic calming measures would not be appropriate due to the function of Makakilo Drive, its traffic volume, and the crash history. The addition of bicycle lanes would also present problems, as the roadway width is used for on-street parking and the existing number of lanes is needed for carrying peak hour traffic.

Bicycle use can be encouraged with the use of “sharrow” pavement markings, which are described in Section 9C.07 of the *Manual on Uniform Traffic Control Devices for Streets and Highways*. Figure 6 illustrates this pavement marking.

The use of sharrows should be supplemented by defining shoulder areas on Makakilo Drive, as illustrated in Figures 7 and 8.

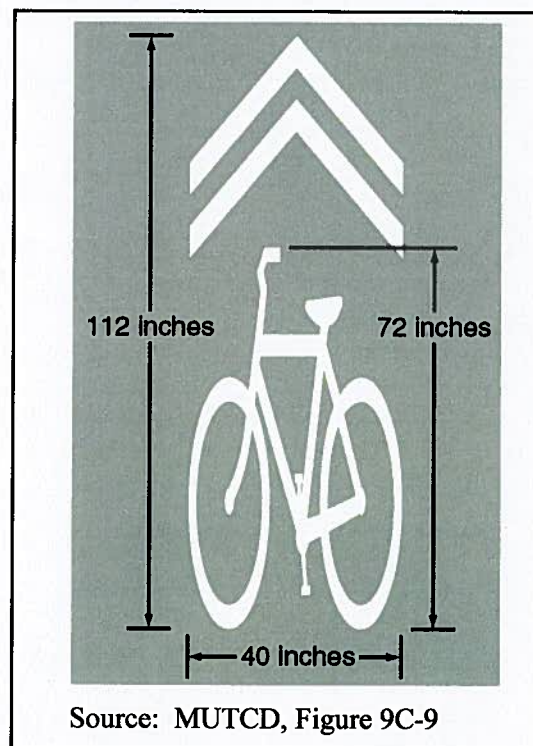


Figure 6 – Sharrow Detail

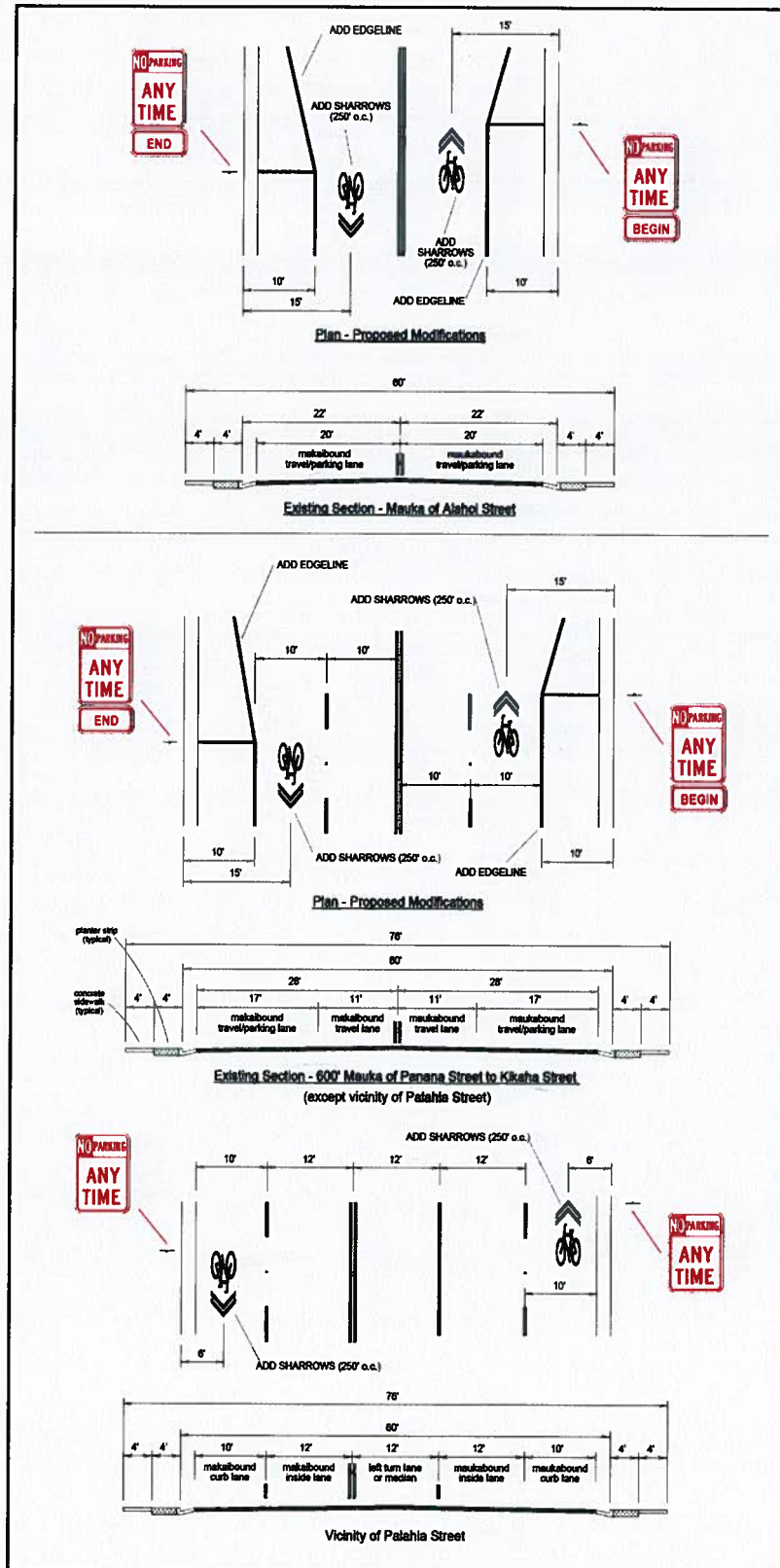
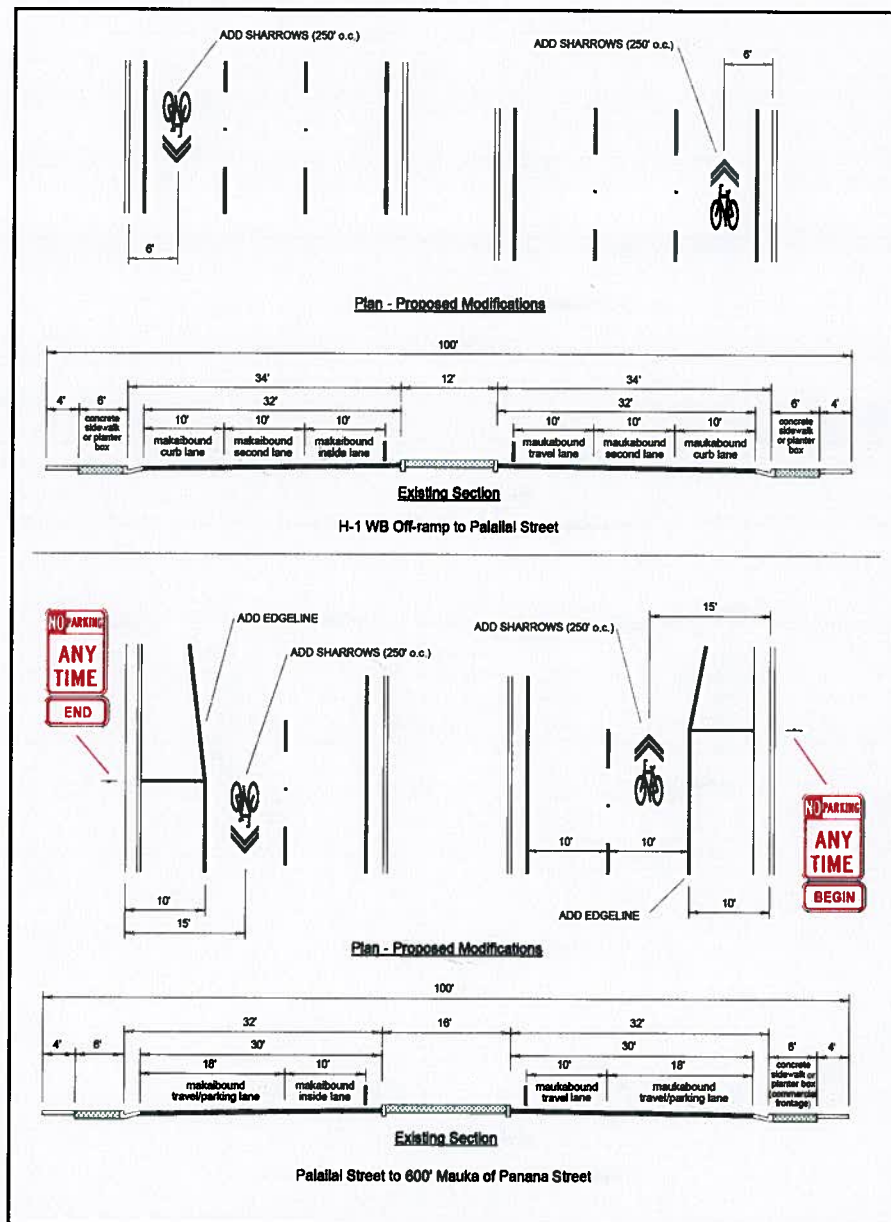


Figure 7 – Proposed Shoulder Striping and Sharrows Undivided Roadway



**Figure 8 – Typical Sharrow Layout
Divided Roadway**

In addition to sharrows, an edgeline is recommended in areas where there is now a wide lane intended for use as a travel lane with curbside parking. The layout would be similar to what is currently used along short segments of Makakilo Drive. Near driveways where parking would be prohibited to maintain sight lines, the edgeline should be tapered to the top of the gutter to reinforce the no parking signs. Approach and departure tapers at bus stops should also be delineated and the edgeline should be dashed to create two 10-foot wide lanes and a 10-foot wide bus stop bay. A solid line perpendicular to the curb can also be used to clearly show where permitted parking ends/begins.

Conclusions

A review of existing conditions along Makakilo Drive indicates that speeding occurs and that there are areas where sight distances do not support speeds higher than the posted speed limits. However, collision data do not show speeding as a major cause of crashes; drivers colliding with fixed objects were the primary type of crashes, and in many cases, the collision reports indicate that the driver fell asleep.

Many traffic calming techniques rely on narrowing the roadway using physical constraints to change the intended vehicle path or to add obstructions to restrict the width of roadway, which would cause drivers to slow down. Due to the type of collisions already occurring, the techniques that could affect a driver's control of a vehicle can not be recommended. A proposed bicycle lane on Makakilo Drive will adversely affect the roadway capacity for motor vehicles.

The addition of edgelines to define the current wide lane/parking zone into a narrower lane and define a roadway shoulder is recommended. With this clear definition of the parking area, sharrows should be placed on the outside travel lane to designate these lanes for shared use by bicycles and motor vehicles.

Appendix A – Applicable Provisions from Traffic Code

Schedule XXII – No Parking	Honolulu side, dist. 270' mauka direction from a pt. 32' makai of the makai c.p. of Makamai Lp.
	Honolulu side, dist. 270' mauka direction from a pt. appx. 45' makai of the makai c.p. of Makamai Lp.
	Waianae side, dist. 235' mauka direction from the mauka c.p. of Liolio Pl.
	Honolulu side, dist. 160' makai of property line ext. of Makakilo Community Park
	eastern side, dist. 383' southerly direction from a pt. 5' north of the northern c.p. of Painiu St.
	western side, dist. 355' southerly direction from pt. 30' north of the northern c.p. of Painiu Pl.
	eastern side, dist. 170' direction from the makai c.p. of Palahia St.
	Waianae (western) side, dist. 87' makai (southerly) direction from a pt. 293' makai of the makai c.p. of Palahia St.
	eastern side, dist. 68' makai direction from a pt. 425' makai of the makai c.p. of Palahia St.
	Waianae (western) side, dist. 95' mauka (northerly) direction from a pt. 165' mauka of the mauka c.p. of Kanehoa Lp. (mauka leg)
	eastern side, dist. 91' mauka direction from a pt. 36' makai of the makai c.p. of mauka intx. of Kanehoa Lp. and Makakilo Dr.
	Waianae (western) side, dist. 78' makai (northerly) direction from a pt. 16' mauka of the mauka c.p. of Kanehoa Lp. (mauka leg)
	eastern side, dist. 74' mauka direction from a pt. 14' makai of the makai c.p. of the makai intx. of Kanehoa Lp. and Makakilo Dr.
	eastern side, dist. appx. 230' southerly direction from the northern c.p. of Kinohi Pl.
	west side, dist. 70' northerly direction from northern c.p. of Nohohale St.
	kkhd side, dist. appx. 90' mauka direction from a pt. 47' makai of the makai c.p. of Nohohale St.
	mauka side, dist. appx. 65' mauka direction beginning from a pt. 150' mauka of mauka c.p. of Newa St.
	northern side, dist. appx. 240' westerly direction from a pt. appx. 130' east of the eastern c.p. of Aoloko St.
	northern side, dist. appx. 215' easterly direction from a pt. appx. 290' east of the eastern c.p. of Aoloko St.
	Waianae side, from a pt. 140' mauka of the mauka c. p. of Palailai St. to the H-1 Makakilo Dr. westbound off-ramp (end of C&C right-of-way)
	kkhd side, from the H-1 Makakilo Dr. westbound off-ramp (beginning of C&C right-of-way) to a pt. 60' mauka of the mauka c.p. of Palailai St.

Appendix A – Applicable Provisions from Traffic Code (continued)

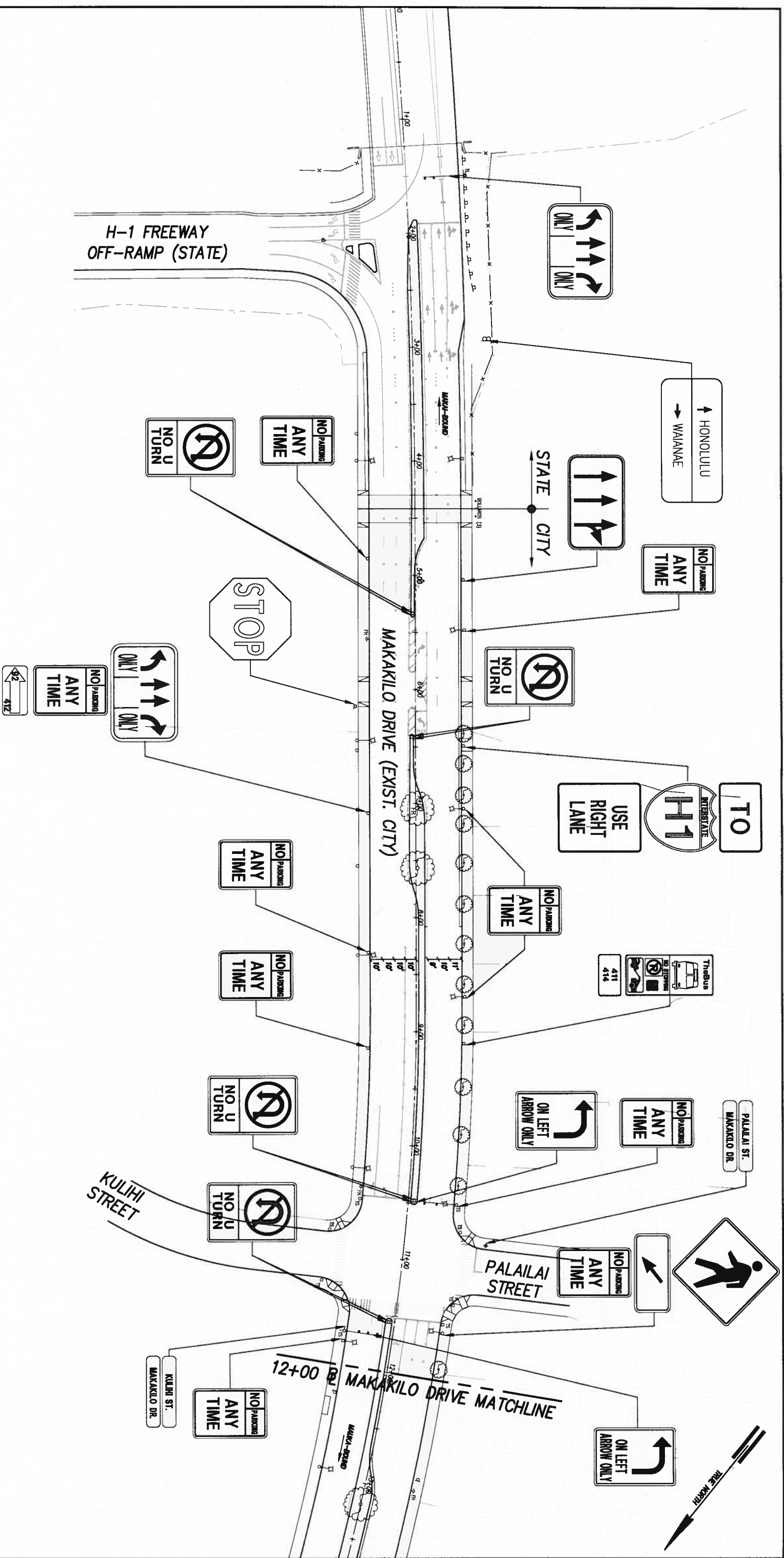
Schedule XXV – Bus Stops	Waianae side, dist. 150' makai direction from a pt. 52' makai of the makai c.p. of Palailai St.
	kkhd side, dist. 150' mauka direction from a pt. 44' mauka of the mauka c.p. of Palailai St.
	Honolulu side, dist. 150' makai direction from a pt. 90' makai of the makai c.p. of Anipeahi St.
	Waianae side, dist. 150' makai direction from a pt. 51' makai of the mauka property line of 92-650 Makakilo Dr.
	kkhd side, dist. 150' mauka direction from a pt. 23' mauka of the mauka c.p. of Newa St.
	Waianae side, dist. 130' makai direction from the makai c.p. of Newa St.
	kkhd side, dist. 137' mauka direction from the mauka c.p. of Kinohi Pl.
	Waianae side, dist. 150' makai direction from a pt. 93' makai of the makai c.p. of Kinohi Pl.
	kkhd side, dist. 150' makai direction from a pt. 30' makai of the makai c.p. of Panana St.
	Waianae side, dist. 150' mauka direction from a pt. 36' mauka of the mauka c.p. of Panana St.
	kkhd side, dist. 150' makai direction from a pt. 170' makai of the makai c.p. of Palahia St.
	Waianae side, dist. 150' makai direction from a pt. 142' makai of the makai c.p. of Palahia St.
	kkhd side, dist. 150' makai direction from a pt. 131' makai of the makai c.p. of Makamai Lp. (makai leg)
	Waianae side, dist. 150' mauka direction from a pt. 14' mauka of the makai c.p. of Makamai Lp. (makai leg)
	makai side, dist. 150' Waianae direction from a pt. 55' Waianae of the Waianae c.p. of Kikaha St.
	Waianae side, dist. 150' makai direction from a pt. 5' makai of the makai c.p. of Hookomo St.
Source: City and County of Honolulu, Department of Transportation Services c.p. = curb prolongation dist. = distance pt. appx. = point approximately	

Appendix B – Field Traffic Count Data

(pages B-1 through B-20 follow)

Appendix C – Existing Signing and Striping Plans

(sheets C-1 through C-12 follow)



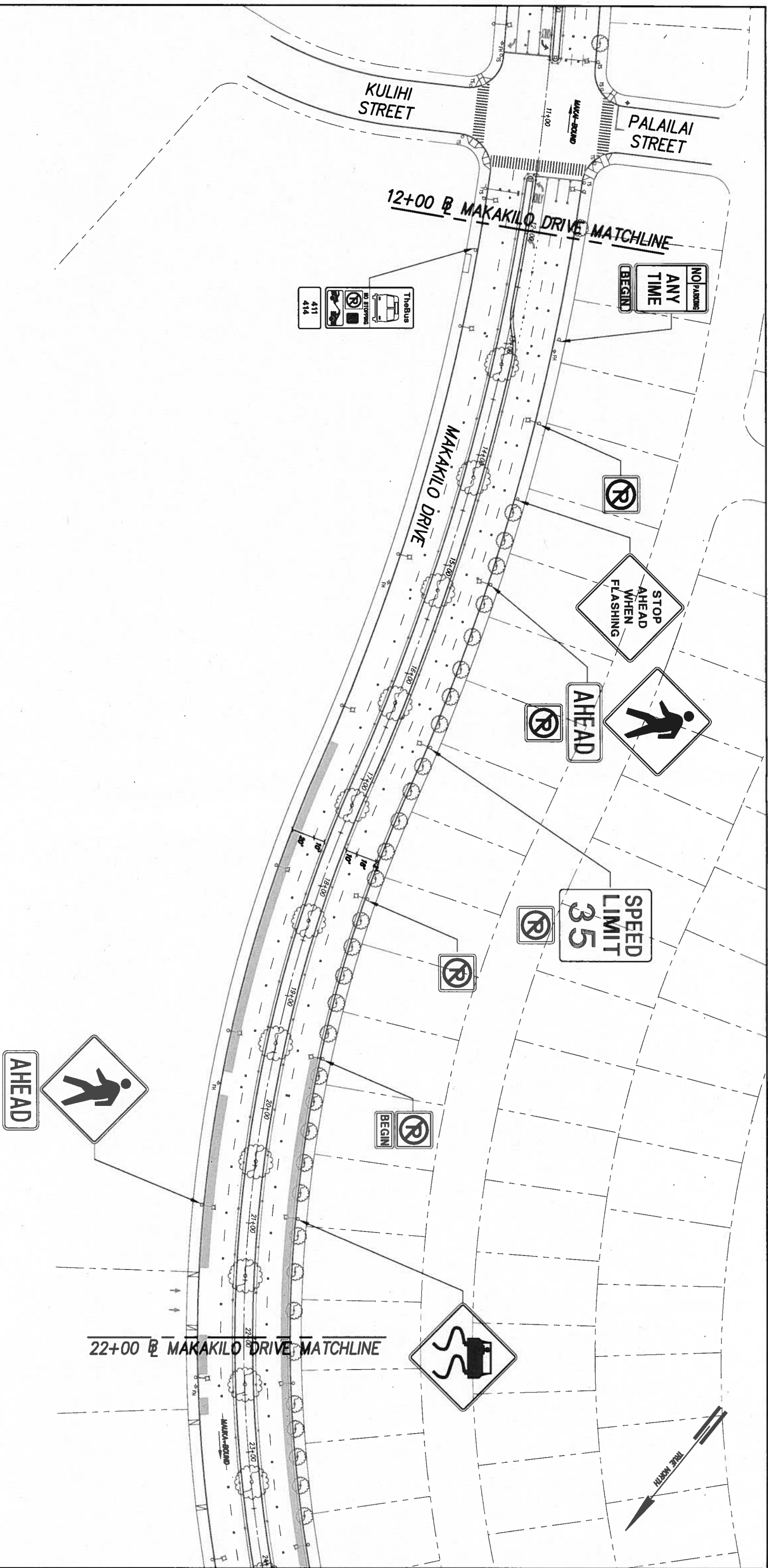
EXISTING SIGNING AND STRIPING PLAN - 1
SCALE: 1" = 40'



DEPARTMENT OF TRANSPORTATION SERVICES
CITY AND COUNTY OF HONOLULU
MAKAKILO DRIVE
(H-1 FREEWAY TO KIKAHA STREET)
MAKAKILO, OAHU, HAWAII

EXISTING SIGNING AND STRIPING PLAN - 1

ENGINEER: RK DATE: 04/30/14
DRAFTSMAN: RK CHECKED BY: GML
SCALE: AS SHOWN TRACER:



EXISTING SIGNING AND STRIPING PLAN - 2
SCALE: 1" = 40'

LEGEND:

PARKING ALLOWED

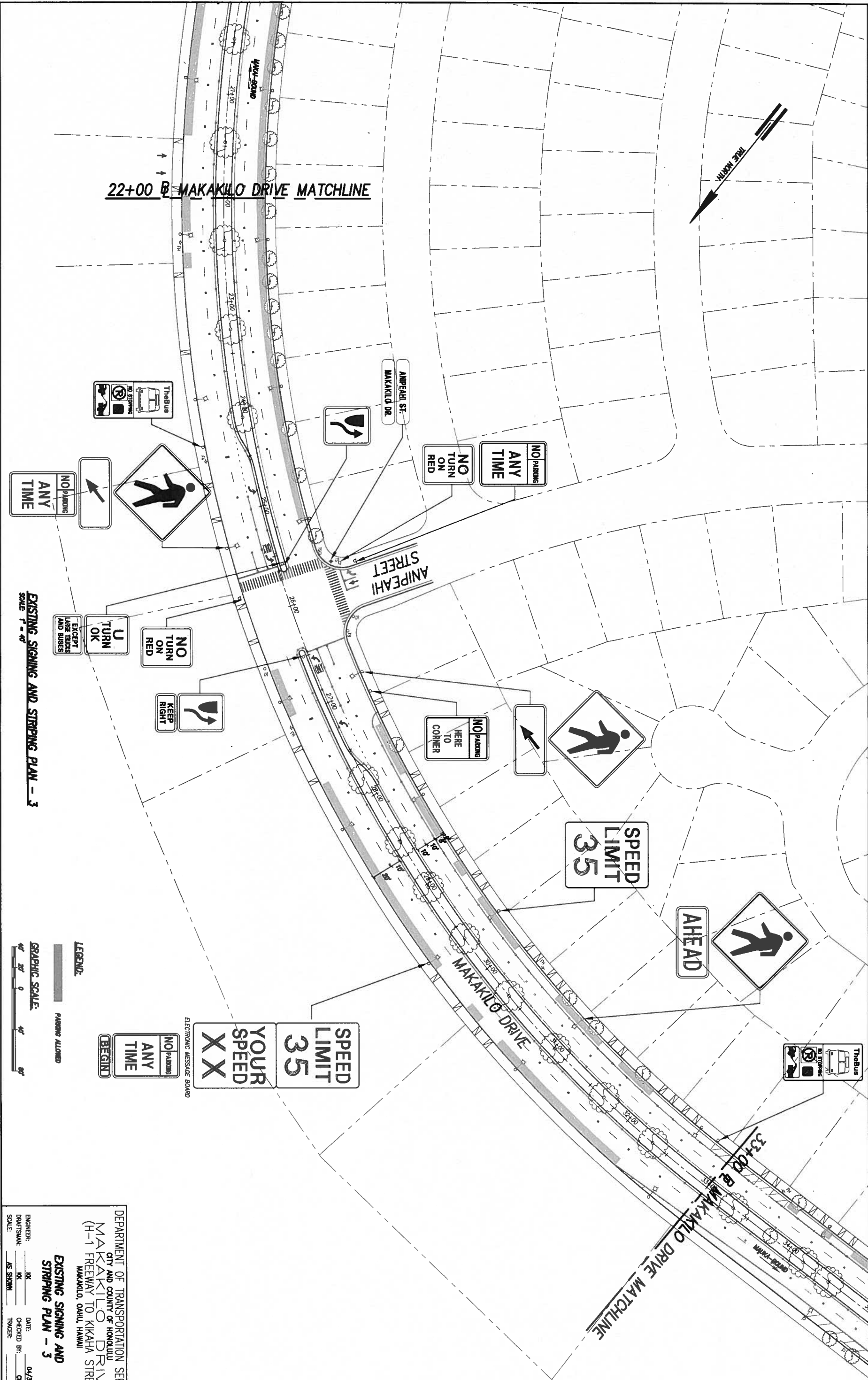
GRAPHIC SCALE:



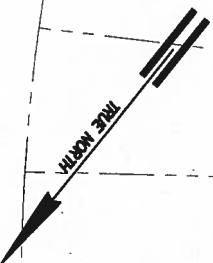
DEPARTMENT OF TRANSPORTATION SERVICES
CITY AND COUNTY OF HONOLULU
MAKAKILO DRIVE
(H-1 FREEWAY TO KIKAHUA STREET)
MAKAKILO, OAHU, HAWAII

EXISTING SIGNING AND STRIPING PLAN - 2

ENGINEER: RK DATE: 04/20/14
DRAFTSMAN: RK CHECKED BY: CML
SCALE: AS SHOWN TRACER:

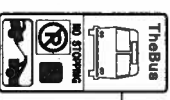


22+00 B MAKAKILO DRIVE MATCHLINE



ANPEAHI ST.
MAKAKILO DR.

NO PARKING
ANY TIME
NO TURN ON RED



NO PARKING
ANY TIME

ANPEAHI STREET

NO TURN ON RED
U TURN OK
EXCEPT LARGE TRUCKS AND BUSES



NO PARKING
HERE TO CORNER

SPEED LIMIT
35

AHEAD



MAKAKILO DRIVE

SPEED LIMIT
35
YOUR SPEED
XX

NO PARKING
ANY TIME
BEGIN

ELECTRONIC MESSAGE BOARD



33+00 B MAKAKILO DRIVE MATCHLINE

DEPARTMENT OF TRANSPORTATION SERVICES
CITY AND COUNTY OF HONOLULU
MAKAKILO DRIVE
(H-1 FREEWAY TO KIKAHUA STREET)
MAKAKILO, OAHU, HAWAII

EXISTING SIGNING AND STRIPING PLAN - 3

ENGINEER: NK DATE: 04/20/14
DRAFTSMAN: NK CHECKED BY: CM
SCALE: AS SHOWN TRACER:

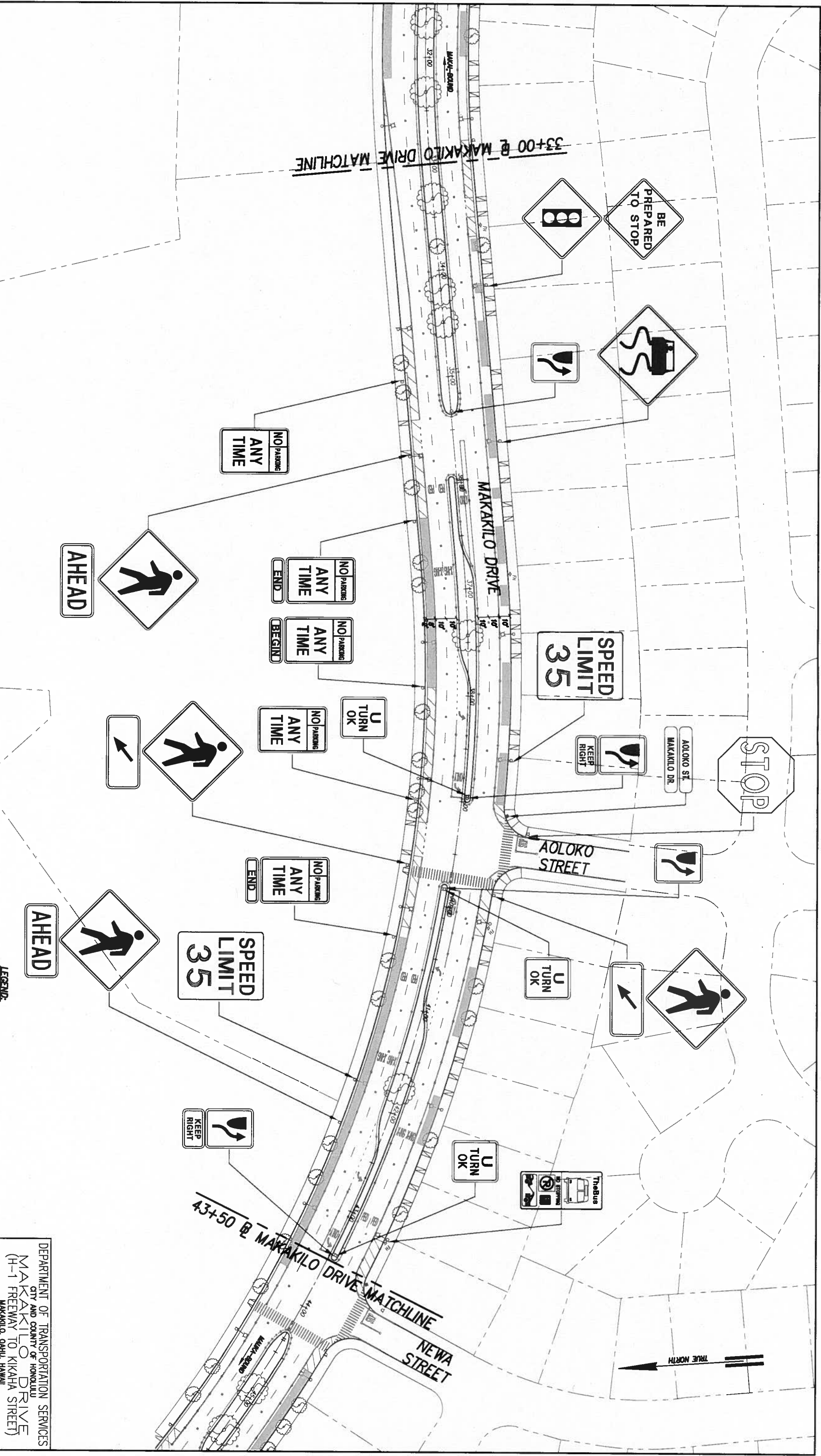
LEGEND:

PARKING ALLOWED

GRAPHIC SCALE:

40' 20' 0 40' 80'

EXISTING SIGNING AND STRIPING PLAN - 3
SCALE 1" = 40'



33+00 @ MAKAKILO DRIVE MATCHLINE

MAKAKILO DRIVE

SPEED LIMIT 35

STOP

AOLOKO ST.
MAKAKILO DR.

AOLOKO STREET

SPEED LIMIT 35

AHEAD

AHEAD

43+50 @ MAKAKILO DRIVE MATCHLINE

NEWA STREET

TRUE NORTH

DEPARTMENT OF TRANSPORTATION SERVICES
CITY AND COUNTY OF HONOLULU
MAKAKILO DRIVE
(H-1 FREEWAY TO KIKAHA STREET)
MAKAKILO, OAHU, HAWAII

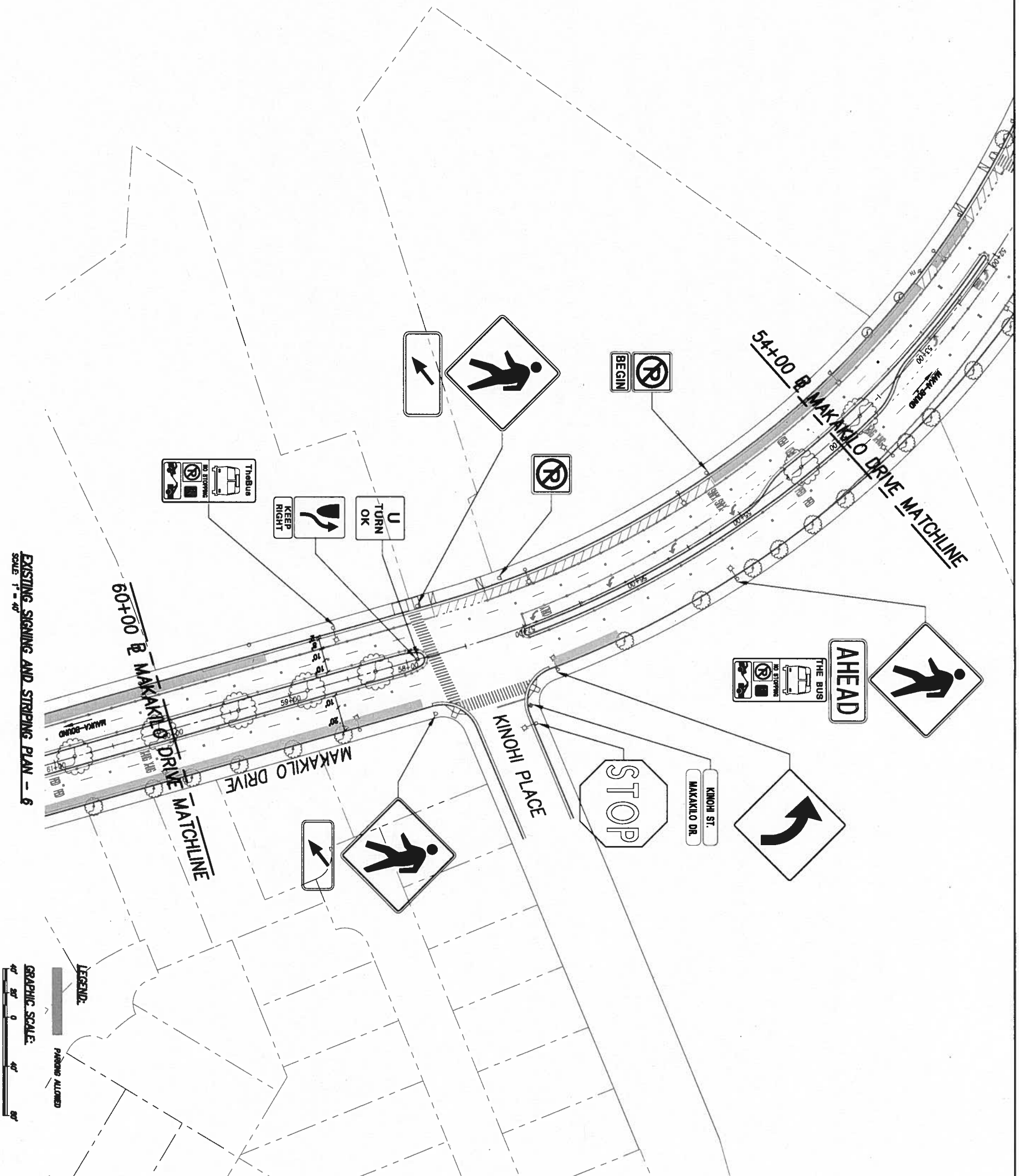
EXISTING SIGNING AND STRIPING PLAN - 4

ENGINEER: _____ DATE: 04/20/14
DRAFTSMAN: _____ CHECKED BY: _____
SCALE: AS SHOWN TRACER: _____

EXISTING SIGNING AND STRIPING PLAN - 4
SCALE: 1" = 40'

LEGEND:
PARKING ALLOWED

GRAPHIC SCALE:
40' 20' 0' 40' 80'



EXISTING SIGNING AND STRIPING PLAN - 6
SCALE 1" = 40'

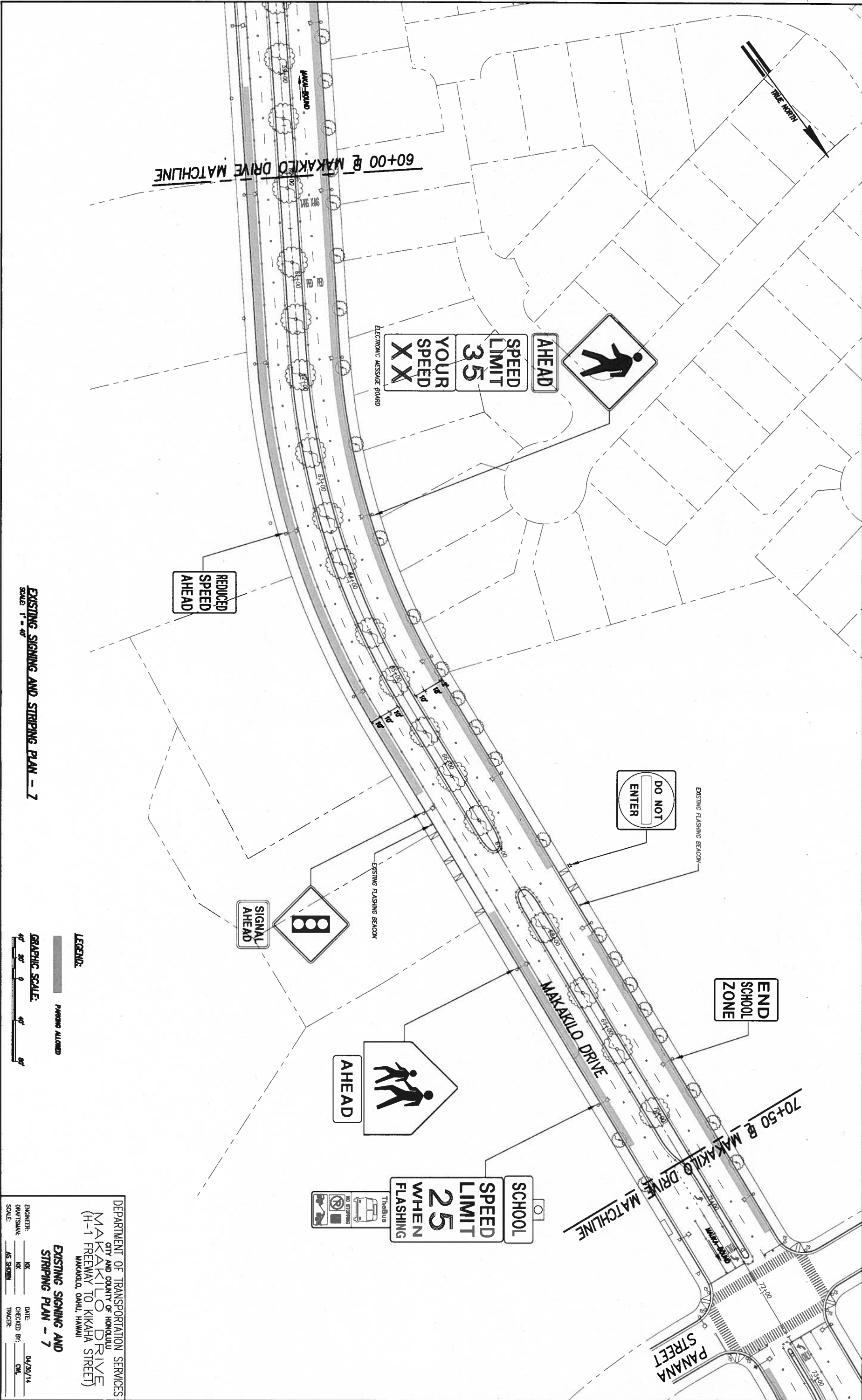
GRAPHIC SCALE:
40' 30' 0' 40' 80'
PARKING ALLOWED

LEGEND:
PARKING ALLOWED

DEPARTMENT OF TRANSPORTATION SERVICES
CITY AND COUNTY OF HONOLULU
MAKAKILO DRIVE
(H-1 FREEWAY TO KIKAHA STREET)
MAKAKILO, OAHU, HAWAII

EXISTING SIGNING AND STRIPING PLAN - 6

ENGINEER: KK DATE: 04/29/14
DRAFTSMAN: KK CHECKED BY: CML
SCALE: AS SHOWN TRACKER:



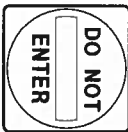
60+00 @ MAKAKILO DRIVE MATCHLINE



AHEAD
SPEED
LIMIT
35
YOUR
SPEED
XX

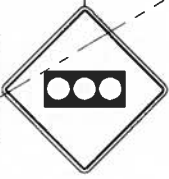
ELECTRONIC MESSAGE BOARD

REDUCED
SPEED
AHEAD

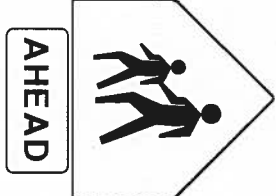


EXISTING FLASHING BEACON

SIGNAL
AHEAD

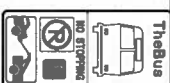


EXISTING FLASHING BEACON



AHEAD

SCHOOL
SPEED
LIMIT
25
WHEN
FLASHING



END
SCHOOL
ZONE

70+50 @ MAKAKILO DRIVE MATCHLINE

PANANA
STREET

DEPARTMENT OF TRANSPORTATION SERVICES
CITY AND COUNTY OF HONOLULU
MAKAKILO DRIVE
(H-1 FREEWAY TO KIKAHUA STREET)
MAKAKILO, OAHU, HAWAII

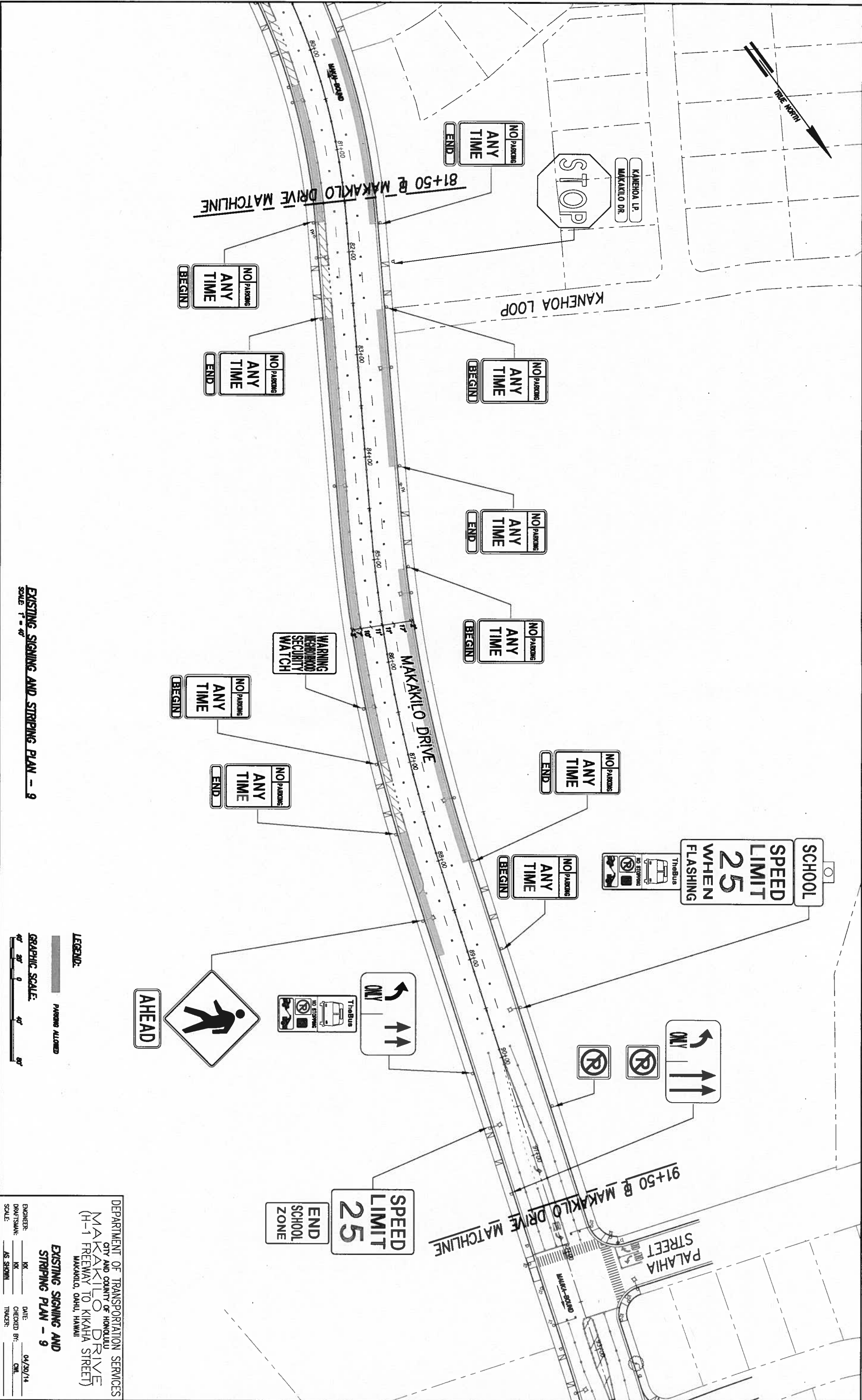
EXISTING SIGNING AND
STRIPING PLAN - 7

ENGINEER: _____ DATE: 04/20/14
DRAFTSMAN: KK CHECKED BY: CM
SCALE: AS SHOWN TRACKER: _____

EXISTING SIGNING AND STRIPING PLAN - 7
SCALE: 1" = 40'

LEGEND:
PARKING ALLOWED

GRAPHIC SCALE:
40' 20' 0' 40' 80'



EXISTING SIGNING AND STRIPING PLAN - 9

SCALE 1" = 40'

LEGEND:

PARKING ALLOWED

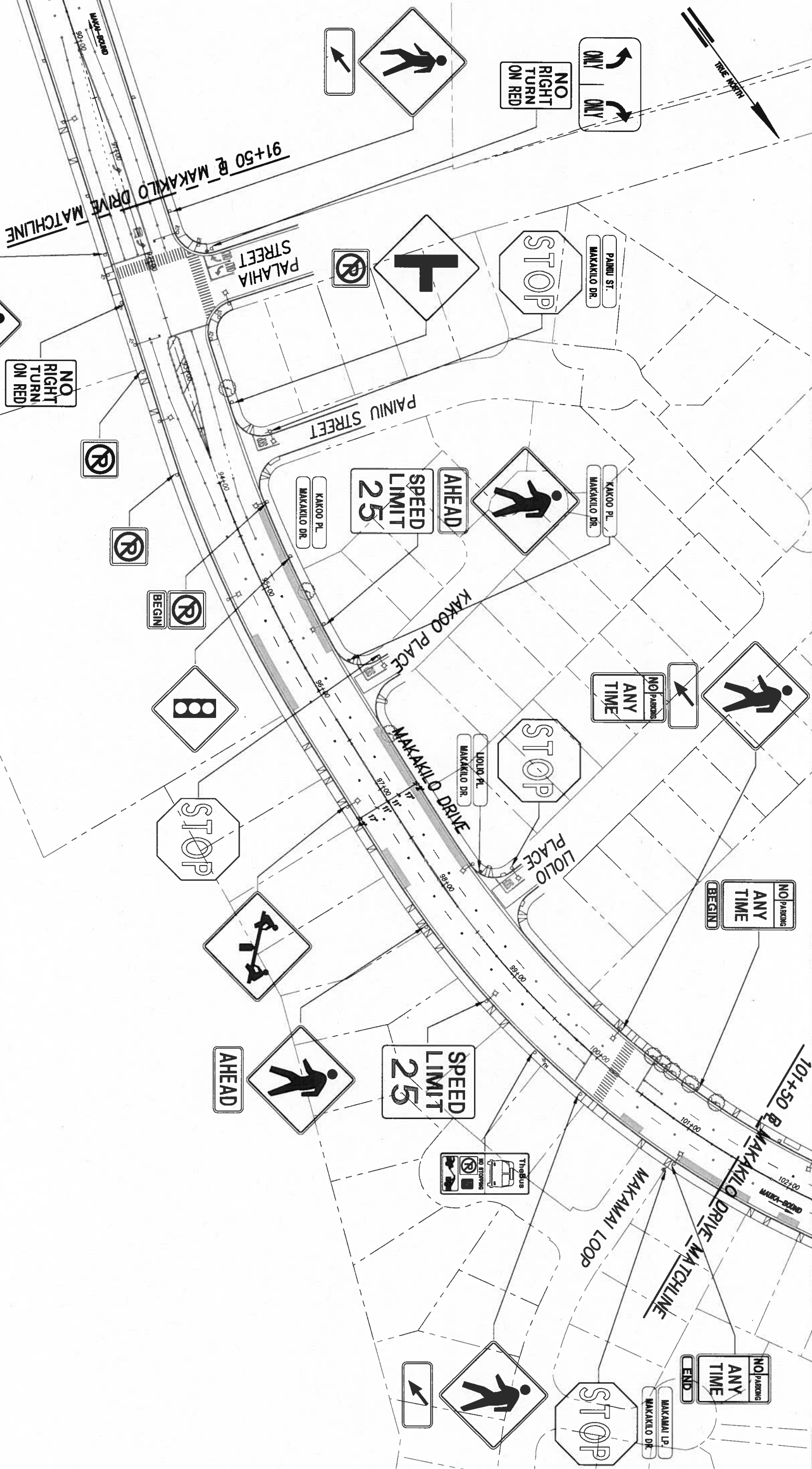
GRAPHIC SCALE:



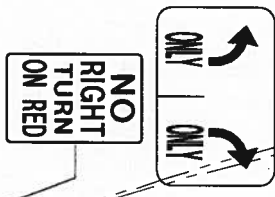
DEPARTMENT OF TRANSPORTATION SERVICES
CITY AND COUNTY OF HONOLULU
MAKAKILO DRIVE
(H-1 FREEWAY TO KIKAHUA STREET)
MAKAKILO, OAHU, HAWAII

EXISTING SIGNING AND STRIPING PLAN - 9

ENGINEER: _____ DATE: 04/20/14
DRAFTSMAN: _____ CHECKED BY: _____
SCALE: AS SHOWN TRACKER: _____



NO
RIGHT
TURN
ON RED



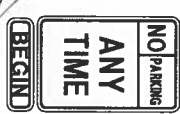
NO
RIGHT
TURN
ON RED



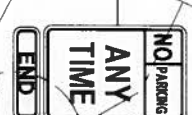
BEGIN



NO
PARKING
ANY
TIME



NO
PARKING
ANY
TIME
BEGIN



NO
PARKING
ANY
TIME
END



TheBus
NO STOPPING

LEGEND:

PARKING ALLOWED

GRAPHIC SCALE:



EXISTING SIGNING AND STRIPING PLAN - 10
SCALE: 1" = 40'

DEPARTMENT OF TRANSPORTATION SERVICES
CITY AND COUNTY OF HONOLULU
MAKAKILO DRIVE
(H-1 FREEWAY TO KIKAHA STREET)
MAKAKILO, OAHU, HAWAII

EXISTING SIGNING AND STRIPING PLAN - 10

ENGINEER: _____ DATE: 04/20/14
DRAFTSMAN: KR _____ CHECKED BY: CM
SCALE: AS SHOWN TRACER: _____



AHEAD

SPEED
LIMIT
25

NO PARKING
ANY
TIME
BEGIN

SPEED
LIMIT
25



101+50 & MAKAKILO DRIVE MATCHLINE

107+50 & MAKAKILO DRIVE MATCHLINE

MAKAMAI LOOP

DEPARTMENT OF TRANSPORTATION SERVICES
CITY AND COUNTY OF HONOLULU
MAKAKILO DRIVE
(H-1 FREEWAY TO KIKAHUA STREET)
MAKAKILO, OAHU, HAWAII

EXISTING SIGNING AND
STRIPING PLAN - 11

ENGINEER: _____ DATE: 04/29/14
DRAFTSMAN: IK CHECKED BY: CM
SCALE: AS SHOWN TRACER: _____

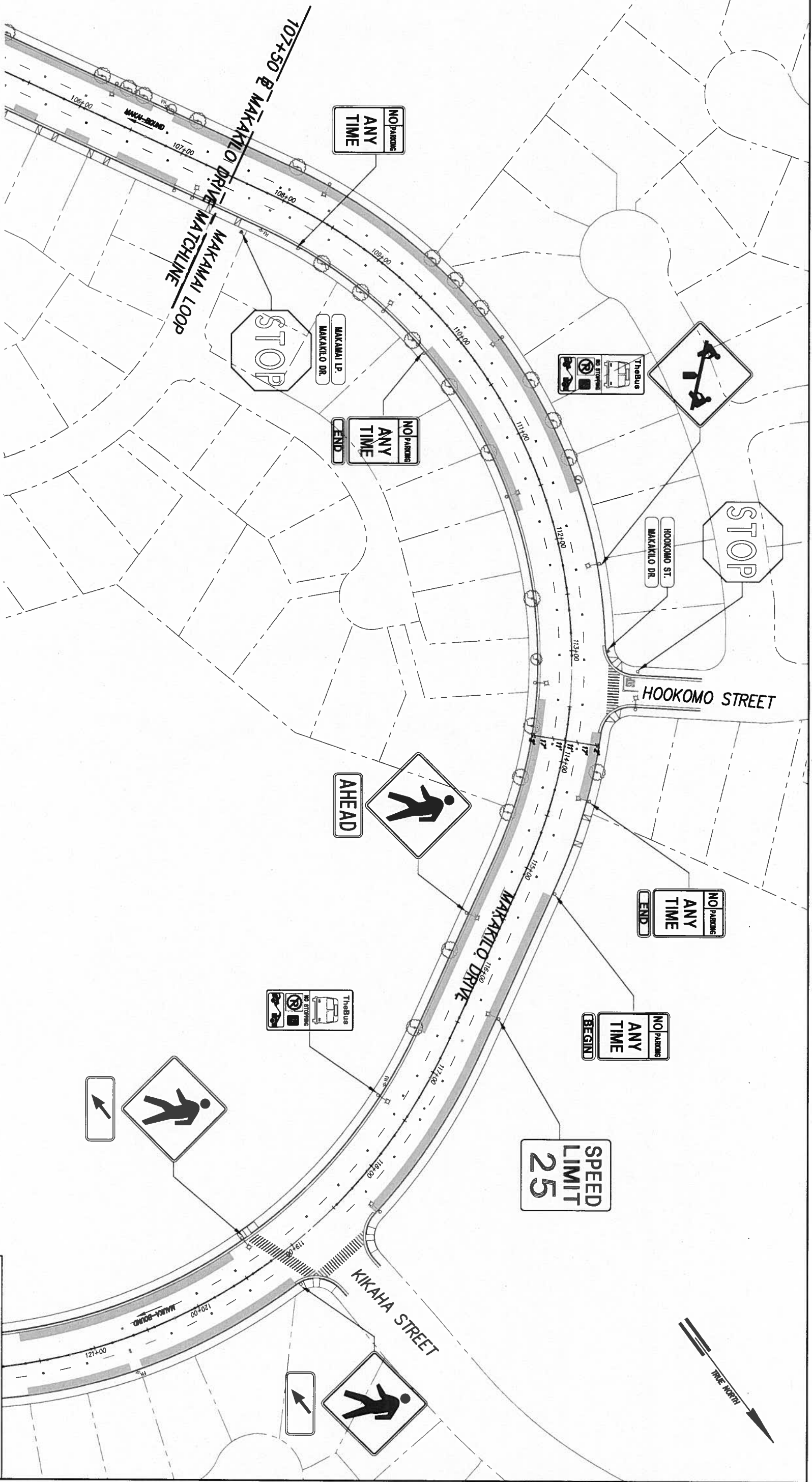
GRAPHIC SCALE:



LEGEND:

PARKING ALLOWED

EXISTING SIGNING AND STRIPING PLAN - 11
SCALE: 1" = 40'



EXISTING SIGNING AND STRIPING PLAN - 12

SCALE: 1" = 40'

LEGEND:

PARKING ALLOWED

GRAPHIC SCALE:



DEPARTMENT OF TRANSPORTATION SERVICES
CITY AND COUNTY OF HONOLULU
MAKAKILO DRIVE
(H-1 FREEWAY TO KIKAHA STREET)
MAKAKILO, OAHU, HAWAII

EXISTING SIGNING AND STRIPING PLAN - 12

ENGINEER: _____ DATE: 04/30/14
DRAFTSMAN: IKR CHECKED BY: CMH
SCALE: AS SHOWN TRACER: _____

Appendix D – Basis of Sight Distance Evaluation

PURPOSE & DESIGN CRITERIA

Purpose: A sight distance evaluation was performed to analyze the minimum required stopping sight distance for the existing Makakilo Drive between the H-1 Freeway off-ramp and Kikaha Street based on current AASHTO standards.

Design Criteria:

- 1) Design speed:
 - a) Below Panana Street intersection: Legal and posted speed limit of 35 miles per hour (mph), design speed is 45 mph.
 - b) Above Panana Street intersection: Legal and posted speed limit of 25 miles per hour (mph), design speed is 35 mph.
- 2) Maximum grade along Makakilo Drive is 12%. For downhill conditions, a grade of (-)12% shall be used; for uphill conditions a grade of 5% shall be used.
- 3) A brake reaction time of 2.5 seconds is used.
- 4) Height of the driver's eye at 3.50 ft.
- 5) Deceleration rate on wet pavement is 11.2 ft/sec².
- 6) The locations of the intersections and driveways along the roadway are based on as-built drawings on file with the City and County of Honolulu and data gathered from field visits.

CONCLUSIONS

Based on the calculations shown on page D-2, the minimum required stopping sight distance below the intersection of Makakilo Drive and Palahia Street is 465 feet for cars travelling downhill and 335 for cars travelling uphill. Above the intersection of Makakilo Drive and Palahia Street, the minimum required stopping sight distance is 310 feet in the downhill direction and 235 in the uphill direction. These stopping sight distances shall be used for the analysis of horizontal and vertical curves and minimum clear zone requirements at all driveway and intersections along Makakilo Drive.

REFERENCES

- 1) American Association of State Highway and Transportation Officials, *A Policy on Geometric Design of Highways and Streets 2011 6th Edition*, 2011.

CALCULATIONS

Stopping sight distance is the sum of the distance traversed during the brake reaction time and the distance to brake the vehicle to a stop. From pp. 3-3 to 3-6 in Reference 1:

$$SSD = d_1 + d_B$$

$$d_1 = 1.47 * V * t$$

$$d_B = V^2 / (30 * ((a / 32.2) \pm G)))$$

where: SSD = stopping sight distance (feet)

d_1 = brake reaction distance (feet)

d_B = braking distance on grade

V = design speed (mph)

t = brake reaction time (sec)

a = deceleration rate (ft/s²)

G = grade, rise/run, (ft/ft or 100 * percent grade)

- a) Determine stopping sight distance for a design speed of 45 mph and a downhill roadway grade of 12%.

$$d_1 = 1.47 * 45 * 2.5 = \underline{165.38 \text{ ft}}$$

$$d_B = 45^2 / (30 * ((11.2 / 32.2) - 0.12))) = \underline{296.28 \text{ feet}}$$

$$SSD = 165.38 + 296.28 = 461.66 \text{ or } \underline{465 \text{ ft (rounded)}}$$

- b) Determine stopping sight distance for a design speed of 45 mph and a uphill roadway grade of 5%.

$$d_1 = 1.47 * 45 * 2.5 = \underline{165.38 \text{ ft}}$$

$$d_B = 45^2 / (30 * ((11.2 / 32.2) + 0.05))) = \underline{169.67 \text{ feet}}$$

$$SSD = 165.38 + 169.67 = 335.05 \text{ or } \underline{335 \text{ ft (rounded)}}$$

- c) Determine stopping sight distance for a design speed of 35 mph and a downhill roadway grade of 12%.

$$d_1 = 1.47 * 35 * 2.5 = \underline{128.63 \text{ ft}}$$

$$d_B = 35^2 / (30 * ((11.2 / 32.2) - 0.12))) = \underline{179.23 \text{ feet}}$$

$$SSD = 128.63 + 179.23 = 307.86 \text{ or } \underline{310 \text{ ft (rounded)}}$$

- d) Determine stopping sight distance for a design speed of 35 mph and a uphill roadway grade of 5%.

$$d_1 = 1.47 * 35 * 2.5 = \underline{128.63 \text{ ft}}$$

$$d_B = 35^2 / (30 * ((11.2 / 32.2) + 0.05))) = \underline{102.64 \text{ feet}}$$

$$SSD = 128.63 + 102.64 = 231.27 \text{ or } \underline{235 \text{ ft (rounded)}}$$

Makakilo Drive Traffic Operations Study

Table 1: Existing Sight Distance Evaluation and Proposed Mitigation

DESCRIPTION	STATION	POSTED SPEED LIMIT	UP or DOWN HILL	REQUIRED SSD (FT.)	AVAILABLE SSD (FT.) (30' back)	MEETS MINIMUM REQUIRED SSD?	PROPOSED MITIGATION	PARKING IMPACT (CURB LF)	SHEET NO.	REQUIRED SSD (FT.)	MEETS MINIMUM REQUIRED SSD?
Intersection Queen Liliuokalani Fwy. Off-ramp and Makakilo Drive (uphill)	2+00	35	UP	335	190	NO	(NONE) - SIGNAL			335	YES
Driveway (uphill)											
Driveway (downhill)	4+00	35	UP	335	400	YES			13	335	YES
Driveway (downhill)	4+00	35	DOWN	465	700	YES				465	YES
Intersection Kulihi St. & Makakilo Dr. (uphill)	11+00	35	UP	335	160	NO	(NONE) - SIGNAL			335	YES
Intersection Kulihi St. & Makakilo Dr. (downhill)	11+00	35	DOWN	465	170	NO	(NONE) - SIGNAL			465	YES
Driveway (uphill)	21+70	35	UP	335	70	NO	2a - ADD NO PARKING	(55)		335	YES
Driveway (uphill)	23+20	35	UP	335	70	NO	2b - ADD NO PARKING	(50)		335	YES
Driveway (uphill)	24+00	35	UP	335	400	YES				335	YES
Driveway (uphill)	26+00	35	UP	335	400	YES				335	YES
Driveway (uphill)	28+00	35	UP	335	400	YES				335	YES
Intersection Anipeahi St. & Makakilo Dr. (downhill)	28+00	35	DOWN	465	180	NO	(NONE) - SIGNAL, NO RIGHT TURN ON RED POSTED			465	NO
Driveway (uphill)	29+80	35	UP	335	80	NO	3a - ADD NO PARKING	(50)			
Driveway (uphill)	30+40	35	UP	335	80	NO	3b - ADD NO PARKING	(55)		335	YES
Driveway (downhill)	27+40	35	DOWN	465	25	NO	(NONE) - SINGLE FAMILY DW				
Driveway (downhill)	28+20	35	DOWN	465	25	NO	(NONE) - SINGLE FAMILY DW				
Driveway (downhill)	29+00	35	DOWN	465	25	NO	(NONE) - SINGLE FAMILY DW				
Driveway (downhill)	29+50	35	DOWN	465	25	NO	(NONE) - SINGLE FAMILY DW				
Driveway (downhill)	30+25	35	DOWN	465	25	NO	(NONE) - SINGLE FAMILY DW				
Driveway (downhill)	30+60	35	DOWN	465	25	NO	(NONE) - SINGLE FAMILY DW				
Driveway (downhill)	31+50	35	DOWN	465	25	NO	(NONE) - SINGLE FAMILY DW				
Driveway (downhill)	32+15	35	DOWN	465	25	NO	(NONE) - SINGLE FAMILY DW				
Driveway (downhill)	32+45	35	DOWN	465	25	NO	(NONE) - SINGLE FAMILY DW				
Driveway (uphill)	32+50	35	UP	335	25	NO	3c - ADD NO PARKING	(18)		465	NO
Driveway (uphill)	35+50	35	UP	335	425	YES	4a - REINSTATE ALLOWABLE PARKING	150		335	YES
Driveway (downhill)	33+40	35	DOWN	465	40	NO	(NONE) - SINGLE FAMILY DW			465	YES
Driveway (downhill)	34+00	35	DOWN	465	25	NO	(NONE) - SINGLE FAMILY DW			465	YES
Driveway (downhill)	34+35	35	DOWN	465	25	NO	(NONE) - SINGLE FAMILY DW			465	YES
Driveway (downhill)	35+05	35	DOWN	465	25	NO	(NONE) - SINGLE FAMILY DW			465	YES
Driveway (downhill)	35+90	35	DOWN	465	25	NO	(NONE) - SINGLE FAMILY DW				
Driveway (downhill)	36+30	35	DOWN	465	25	NO	(NONE) - SINGLE FAMILY DW				
Driveway (downhill)	37+30	35	DOWN	465	50	NO	(NONE) - SINGLE FAMILY DW				
Driveway (downhill)	37+60	35	DOWN	465	25	NO	(NONE) - SINGLE FAMILY DW				
Driveway (downhill)	38+45	35	DOWN	465	25	NO	(NONE) - SINGLE FAMILY DW				
Intersection Aioloko St. & Makakilo Dr. (downhill)	39+40	35	DOWN	465	560	YES				465	YES
Driveway (uphill)	39+40	35	UP	335	190	NO	4b - ADD NO PARKING	(155)		335	YES
Driveway (downhill)	40+30	35	DOWN	465	25	NO	(NONE) - SINGLE FAMILY DW			465	YES
Driveway (downhill)	41+25	35	DOWN	465	60	NO	(NONE) - SINGLE FAMILY DW			465	YES
Driveway (downhill)	41+55	35	DOWN	465	25	NO	(NONE) - SINGLE FAMILY DW			465	YES
Driveway (downhill)	42+35	35	DOWN	465	550	YES				465	YES
Driveway (downhill)	42+65	35	DOWN	465	530	YES				465	YES
Driveway (uphill)	43+90	35	UP	335	250	NO	5a - ADD NO PARKING	(80)		335	YES
Intersection Newa St. & Makakilo Dr. (downhill)	43+90	35	DOWN	465	90	NO	5b - ADD NO PARKING	(5)		465	YES
Driveway (uphill)	51+80	35	UP	335	110	NO	5c - ADD NO PARKING	(240)		335	YES
Intersection Nohohale St. & Makakilo Dr. (downhill)	51+80	35	DOWN	465	480	YES				465	YES
Driveway (uphill)	57+40	35	UP	335	280	NO	6a - ADD NO PARKING	(65)		335	YES
Intersection Kinohi Pl. & Makakilo Dr. (downhill)	57+40	35	DOWN	465	120	NO	6b - ADD NO PARKING	(240)		465	YES

DESCRIPTION	STATION	POSTED SPEED LIMIT	UP or DOWN HILL	REQUIRED SSD (FT.)	AVAILABLE SSD (FT.) (10' back)	MEETS MINIMUM REQUIRED SSD?	PROPOSED MITIGATION	PARKING IMPACT (CURB LF)	SHEET NO.	REQUIRED SSD (FT.)	MEETS MINIMUM REQUIRED SSD?
Driveway (uphill)	66+75	35	UP	335	130	NO	7a - ADD NO PARKING	(60)	C-7	335	YES
Driveway (uphill)	67+25	35	UP	335	210	NO	7a - ADD NO PARKING			335	YES
Driveway (downhill)	67+50	35	DOWN	465	80	NO	7b - ADD NO PARKING	(230)		465	YES
Intersection Panana St. & Makakilo Dr. (uphill)	72+10	25	UP	235	300	YES				335	YES
Intersection Panana St. & Makakilo Dr. (downhill)	72+10	25	DOWN	310	300	NO	8a - CHANGE EDGESTRIPING FOR BUS BAY APPROACH	(10)		465	YES
Driveway (downhill)	78+60	25	DOWN	310	35	NO	8b - ADD NO PARKING	(80)	C-8		
Driveway (uphill)	79+80	25	UP	235	60	NO	8c - ADD NO PARKING	(155)		335	YES
Driveway (uphill)	82+30	25	UP	235	70	NO	9a - ADD NO PARKING	(135)			
Driveway (downhill)	79+75	25	DOWN	310	40	NO	8d - ADD NO PARKING	(60)		465	YES
Driveway (downhill)	82+30	25	DOWN	310	50	NO	9b - ADD NO PARKING	(150)		465	YES
Driveway (downhill)	84+75	25	DOWN	310	55	NO	9d - ADD NO PARKING	(250)		465	YES
Driveway (uphill)	82+30	25	DOWN	310	70	NO	9c - ADD NO PARKING	(50)		335	YES
Driveway (downhill)	88+50	25	DOWN	310	400	YES	9g - ADD NO PARKING	(50)		465	YES
Driveway (uphill)	87+35	25	UP	235	40	NO	9e - ADD NO PARKING	(50)		335	YES
		25	DOWN	310	80	NO	9f - ADD NO PARKING	(40)			
Driveway (uphill)	90+80	25	UP	235	240	YES				335	YES
Intersection Palahia St. & Makakilo Dr. (downhill)	92+30	25	DOWN	310	245	NO	NOTE: UPHILL SD PROVIDED AS PART OF 10a			310	YES
Driveway (uphill)	93+10	25	UP	235	300	YES	10b - ADD ALLOWABLE PARKING	100		235	YES
Intersection Painiu Pl. & Makakilo Dr. (downhill)	93+85	25	DOWN	310	60	NO	10a - ADD NO PARKING	(140)		310	YES
Driveway (uphill)	96+60	25	UP	235	80	NO	(NONE) - SINGLE FAMILY DW			235	YES
Driveway (uphill)	96+90	25	UP	235	110	NO	(NONE) - SINGLE FAMILY DW			235	YES
Intersection Kakoo Pl. & Makakilo Dr. (downhill)	96+15	25	DOWN	310	65	NO	10c - ADD NO PARKING	(145)		310	YES
Driveway (uphill)	97+40	25	UP	235	300	YES				235	YES
Driveway (uphill)	98+00	25	UP	235	35	NO	(NONE) - SINGLE FAMILY DW			235	YES
Intersection Lioilo Pl. & Makakilo Dr. (downhill)	98+40	25	DOWN	310	265	NO	10e - ADD NO PARKING			310	YES
Driveway (uphill)	98+20	25	UP	235	75	NO	(NONE) - SINGLE FAMILY DW			235	YES
Driveway (uphill)	99+10	25	UP	235	450	YES				235	YES
Driveway (downhill)	99+85	25	DOWN	310		NO	NOTE: UPHILL SD PROVIDED AS PART OF 11a				
Driveway (uphill)	100+90	25	UP	235	35	NO	10d - ADD NO PARKING	(20)		235	YES
Driveway (downhill)	101+40	25	DOWN	310	50	NO	11a - ADD NO PARKING	(25)			
Driveway (uphill)	101+90	25	UP	235	25	NO	11b - ADD NO PARKING	(135)		310	YES
Driveway (uphill)	102+40	25	UP	235	25	NO	(NONE) - SINGLE FAMILY DW			235	YES
Driveway (uphill)	102+90	25	UP	235	25	NO	(NONE) - SINGLE FAMILY DW			235	YES
Driveway (uphill)	103+35	25	UP	235	25	NO	(NONE) - SINGLE FAMILY DW			235	YES
Driveway (uphill)	103+80	25	UP	235	25	NO	(NONE) - SINGLE FAMILY DW			235	YES
Driveway (uphill)	104+35	25	UP	235	80	NO	(NONE) - SINGLE FAMILY DW			235	YES
Driveway (uphill)	104+85	25	UP	235	25	NO	(NONE) - SINGLE FAMILY DW			235	YES
Driveway (uphill)	105+40	25	UP	235	25	NO	(NONE) - SINGLE FAMILY DW			235	YES
Driveway (uphill)	105+85	25	UP	235	25	NO	(NONE) - SINGLE FAMILY DW				
Driveway (uphill)	106+40	25	UP	235	25	NO	(NONE) - SINGLE FAMILY DW				
Driveway (uphill)	107+60	25	UP	235	70	NO	11c - ADD NO PARKING	(80)		235	YES
Intersection Ho'okomo St. & Makakilo Dr. (downhill)	113+30	25	DOWN	310	60	NO	12a - ADD NO PARKING	(20)		310	YES
Driveway (downhill)	114+55	25	DOWN	310	130	NO	12b - ADD NO PARKING	(75)			
Intersection Kikaha St. & Makakilo Dr. (downhill)	118+75	25	DOWN	310	400	YES				310	YES

Appendix E – Existing Signage Evaluation

Purpose

Existing warning signing placements within the project limits were evaluated* to determine if any changes are needed to convey the signs' intent and to conform to the current MUTCD provisions.

Advance Warning Signs

Advance warning signs for crosswalks, such as pedestrian crossing {W11-2}** or "SIGNAL AHEAD" {W3-3} signs, should be located far enough away from crosswalks that drivers will be able to stop if necessary, but should be located close enough that the object of the warning is apparent to the driver. The MUTCD provides guidance on the placement of warning signs. They "should be placed so that they provide an adequate perception-response time" but "should not be placed too far in advance of the condition, such that drivers might tend to forget the warning because of other driving distractions."

The MUTCD guideline for placement of advance warning signs assume that a driver will recognize the warning sign 180 feet before passing the sign, and allow 2½ seconds for the driver to evaluate the situation, decide to stop if necessary, and apply the brakes. A desirable distance is computed from these parameters. For a driver traveling downhill at a design speed of 45 miles per hour, an advance warning sign would be placed 450 feet from the crosswalk (for uphill traffic, 320 feet at a design speed of 45 miles per hour, 260 feet and 185 feet for downhill and uphill traffic, respectively, at 35 miles per hour).

Of the twenty advance warning signs for crosswalks or traffic signals within the project limits, the distances listed above were used with a 100-foot leeway in either direction to determine that nine signs should be relocated. These are listed in Table E-1 below. One pedestrian crossing advance warning sign, for maukabound traffic approaching the crosswalk at Newa Street (Station 42+30), should be relocated farther from the intersection; its placement could be switched with an existing speed limit sign to improve its location. Eight pedestrian crossing advance warning signs are located too far from the crosswalks and relocation closer to the crossing should be considered.

Table E-1 – Advance Warning Sign Locations

	Distance to crosswalk	
	Existing	Ideal †
Pedestrian crossing ahead, maukabound before Anipeahi Street	500 feet	320 feet
Pedestrian crossing ahead, maukabound before Newa Street	185 feet	320 feet
Pedestrian crossing ahead, makaibound before Kinohi Street	560 feet	450 feet
Pedestrian crossing ahead, maukabound before Panana Street	540 feet	185 feet
School crossing ahead, maukabound before Panana Street	370 feet	185 feet
School crossing ahead, makaibound before Panana Street	470 feet	260 feet
Signal ahead, makaibound before Panana Street	510 feet	260 feet
Pedestrian crossing ahead, maukabound before Palahia Street	350 feet	185 feet
Pedestrian crossing ahead, maukabound before Kikaha Street	350 feet	185 feet

† nearest 5 feet, based on guidelines from *MUTCD* Table 2C4

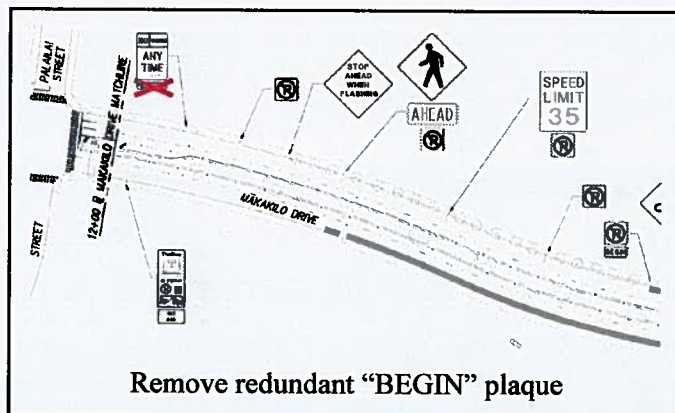
* this evaluation is based on conditions observed in the field as of August 2, 2012.

** text inside {} refers to sign identification nomenclature used in the *Manual on Uniform Traffic Control Devices for Streets and Highways*

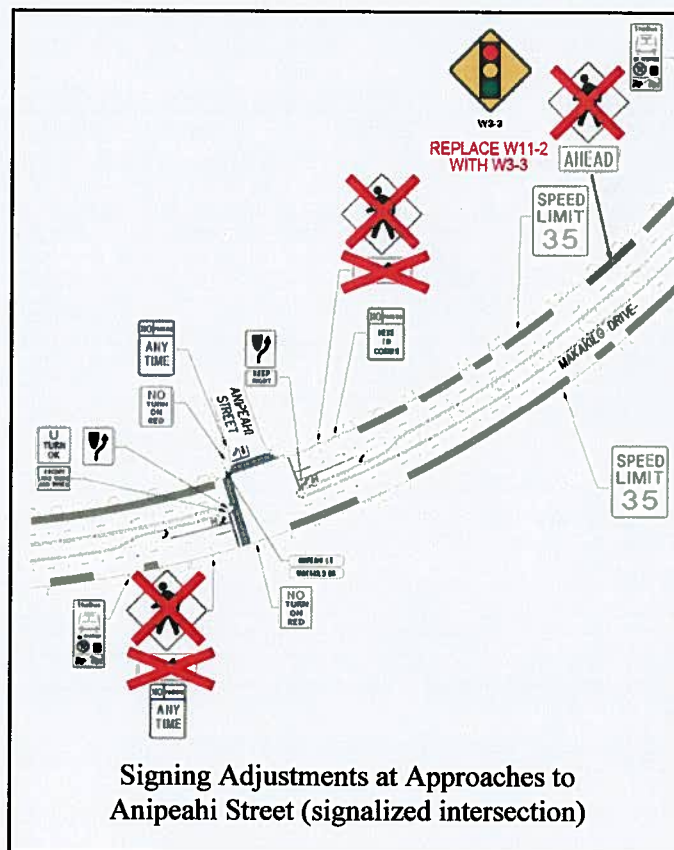
Other Mislocated or Missing Signs

In addition, several signs may be placed incorrectly or missing.

On Sheet C-2 (Station 12+90, makaibound), in the middle of what appears to be an extended no parking zone, a supplemental "BEGIN" plaque {R3-9cP} is used below a no parking sign; since parking is not permitted before the sign, the supplemental plates should be removed.



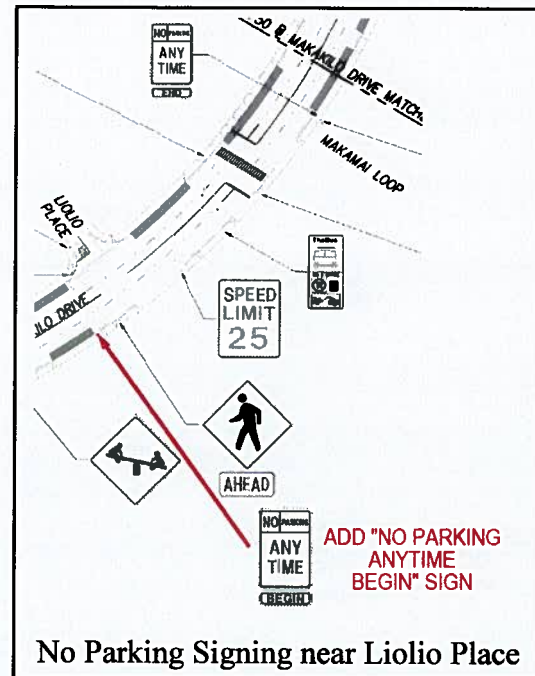
On Sheet C-3 at the approaches to the signalized intersection with Anipeahi Street, diagonal down arrow plaques {W16-7P} are used to supplement pedestrian warning signs {W11-2} in both directions; these signs, however, are located 35 feet (maukabound) and 105 feet (makaibound) from the crosswalk. Further, there is an advance warning sign located 500 feet mauka of the intersection for makaibound traffic. However, pedestrian warning signs are used "where unexpected entries into the roadway might occur" (MUTCD Section 2C-50); since the crosswalk is at a signalized intersection, removal of the warning signs should be considered. Replacement of the existing advance warning sign for pedestrian crossing (makaibound traffic at Station 31+00) with a Signal Ahead sign {W3-3} should be considered.



On Sheet C-5, a curve ahead sign {W1-2} is used in the middle of a curve (Station 49+50) and it should be removed; correct placement of this warning sign, if it is needed, would be in advance of the curve (near Station 34+00; however, there are already many signs near that location).

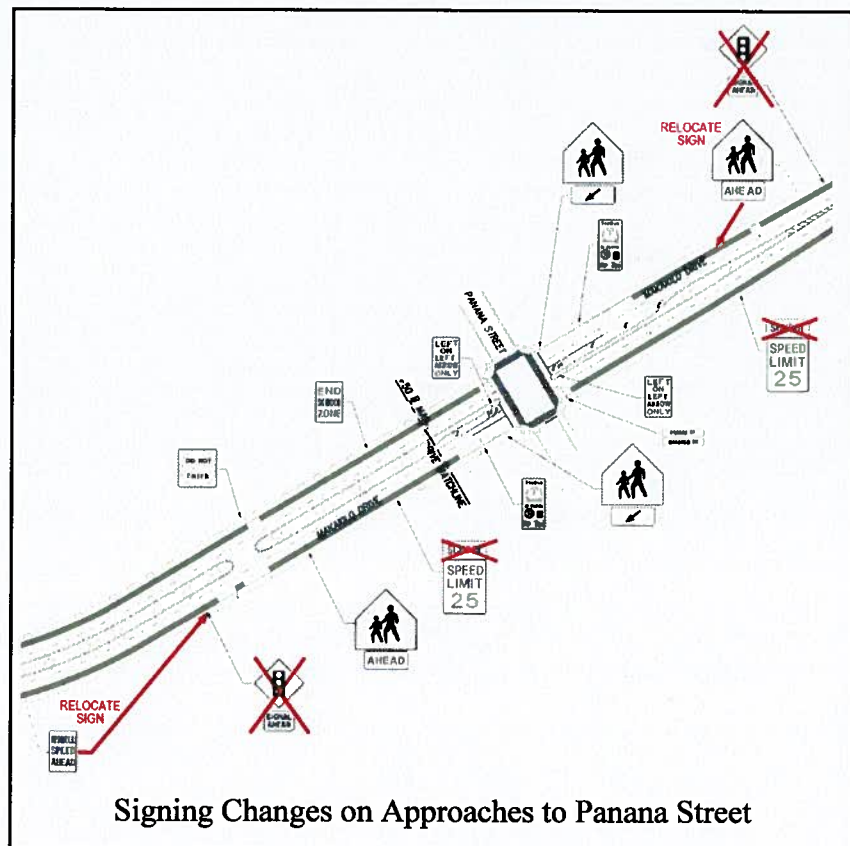
On Sheet C-6, in the median mauka of Kinohi Place (Station 57+90), a "U TURN OK" sign faces maukabound traffic and a keep right sign {R4-7} (with supplemental "KEEP RIGHT" plaque) faces makaibound traffic; they are on the wrong sides of the post and should be remounted.

On Sheet C-10, mauka of the makai intersection with Makamai Loop (Station 101+10, maukabound), there is a "NO PARKING ANY TIME END" sign mauka of a marked crosswalk near the Makakilo Community Park, but there is no corresponding "NO PARKING ANY TIME BEGIN" sign posted prior to that sign. The parking schedule includes a provision for no parking on the "Honolulu side, dist(ance) 160 feet makai of property line ext(ension) of Makakilo Community Park." This defines a parking prohibition on the Honolulu side of Makakilo Drive extending from 98+00 to 99+60. A "NO PARKING ANY TIME BEGIN" sign is needed near Station 98+00 (opposite Liolio Place).



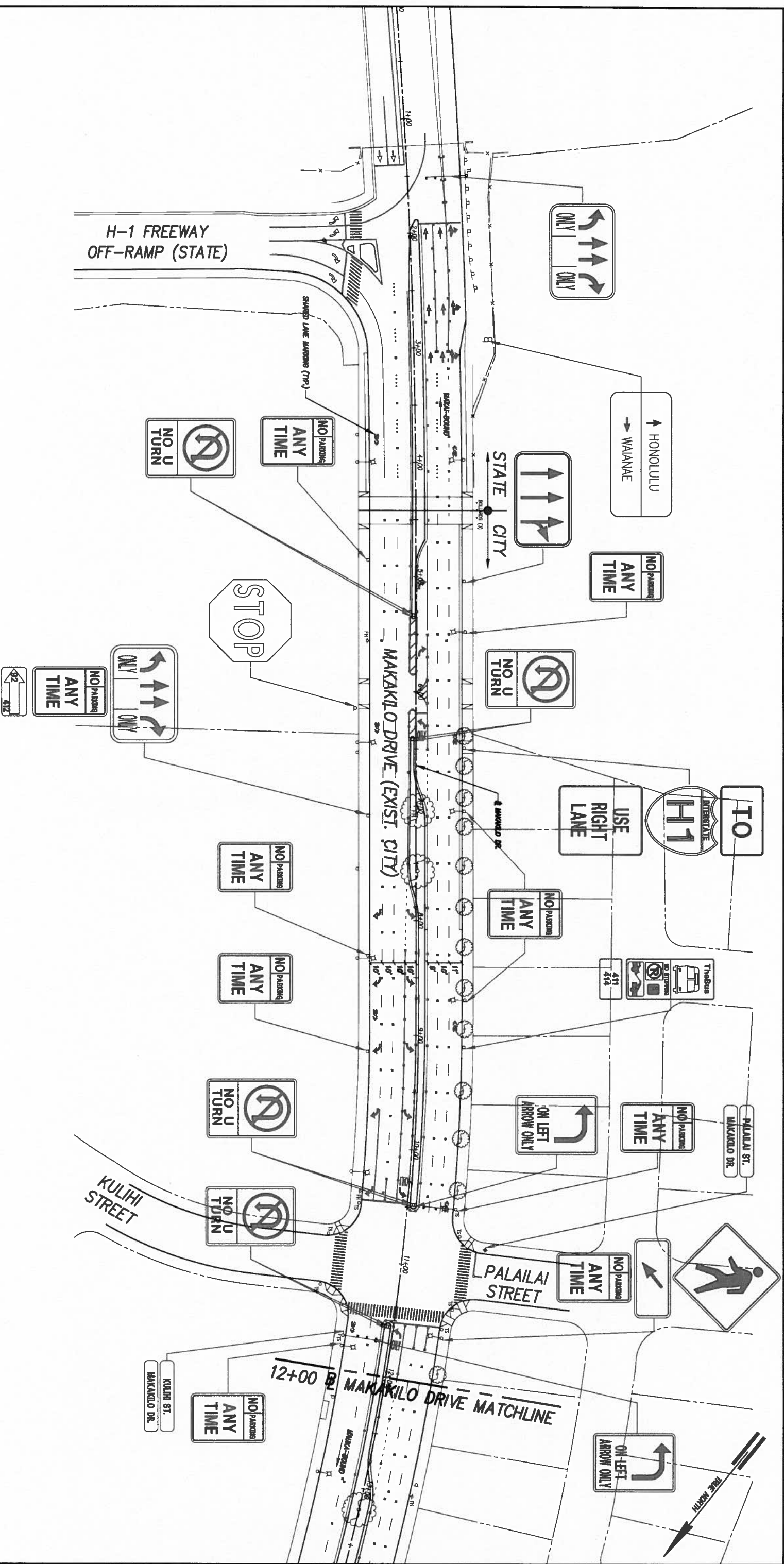
In addition, the placement of two advance warning signs for the same condition should be reconsidered, as this situation provides no additional information to the driver (and could be confusing), adds clutter (thereby reducing the effectiveness of all traffic signs), and increases maintenance requirements.

At the maukabound approach to Panana Street (Sheet C-7), there are advance warning signs for both signal ahead {W3-3 & W16-9P} (Station 66+30) and school crossing ahead {WS1-1 & W16-9P} (Station 68+10). There are both school crossing ahead and signal ahead signs on the makaibound approach (Sheet C-8). Further, the ideal locations of these signs (Table E-1) would result in the signs being located virtually next to each other. Also, in the area near Panana Street, there are "school" plaques used to supplement speed limit signs, which could mislead drivers into mistakenly thinking the speed limit applies only when school children are present.

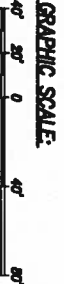


Appendix F – Proposed Signing and Striping Plans

(sheets C-1 through C-12 follow)



PROPOSED SIGNING AND STRIPING PLAN - 1
SCALE: 1" = 40'

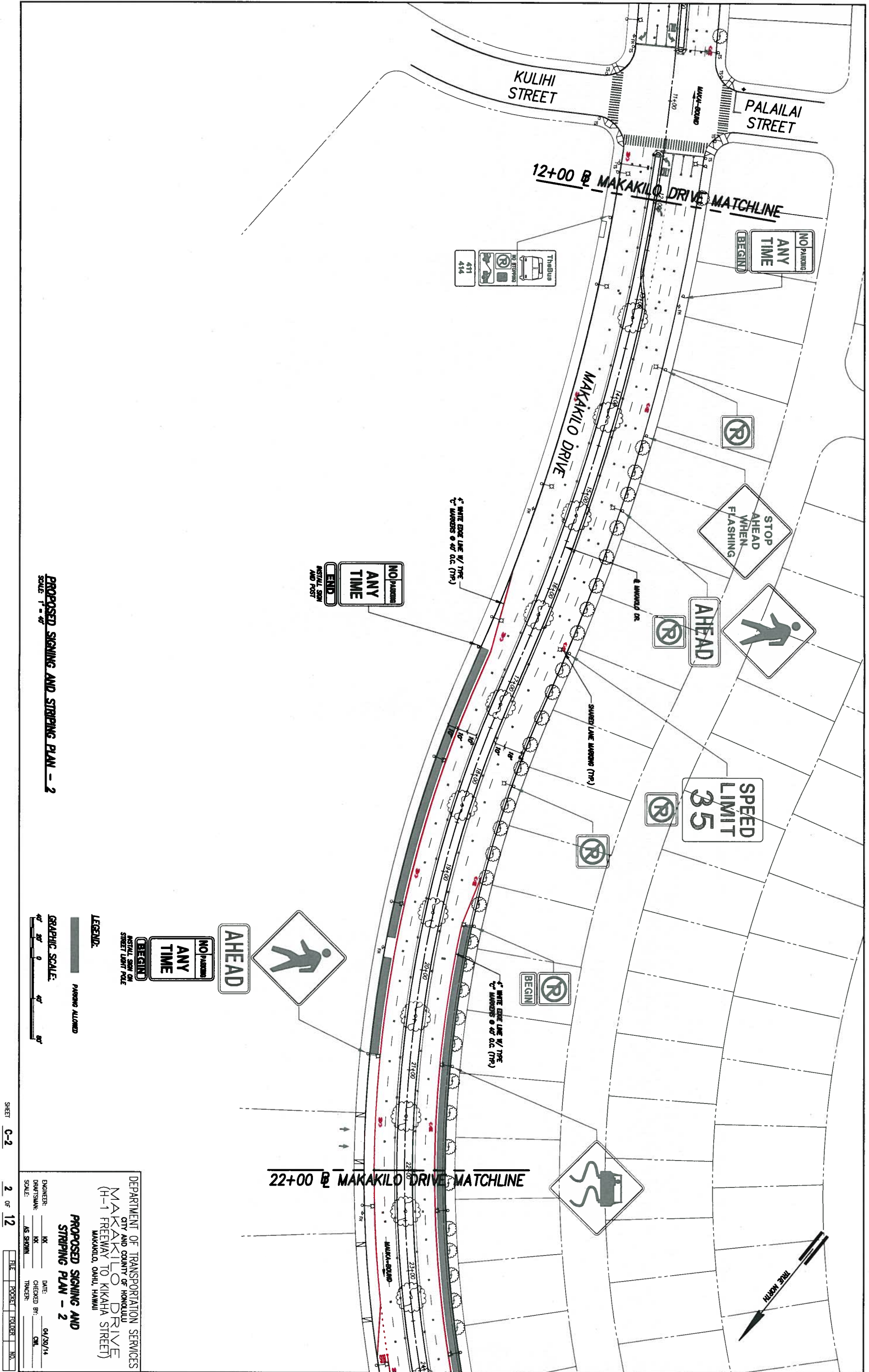


DEPARTMENT OF TRANSPORTATION SERVICES
CITY AND COUNTY OF HONOLULU
MAKAKILO DRIVE
(H-1 FREEWAY TO KIKAHUA STREET)
MAKAKILO, OAHU, HAWAII

PROPOSED SIGNING AND STRIPING PLAN - 1

ENGINEER: _____ DATE: 04/20/14
DRAFTSMAN: JR. CHECKED BY: CM
SCALE: AS SHOWN

FILE: _____ PROJECT NUMBER: _____ NO. _____



PROPOSED SIGNING AND STRIPING PLAN - 2
SCALE 1" = 40'

GRAPHIC SCALE:
40' 20' 0' 40' 80'

LEGEND:
PARKING ALLOWED

NO PARKING ANY TIME
BEGIN
INSTALL SIGN AND POST

AHEAD

Pedestrian crossing sign

NO PARKING ANY TIME
END
INSTALL SIGN AND POST

WHITE EDGE LINE W/ TYPE
C MARKERS @ 40' O.C. (TYP.)

WHITE EDGE LINE W/ TYPE
C MARKERS @ 40' O.C. (TYP.)

22+00 @ MAKAKILO DRIVE MATCHLINE

12+00 @ MAKAKILO DRIVE MATCHLINE

SPEED LIMIT 35

AHEAD

STOP AHEAD WHEN FLASHING

Pedestrian crossing sign

NO PARKING ANY TIME
BEGIN

No parking sign

No parking sign

No parking sign

No parking sign

NO PARKING ANY TIME
BEGIN

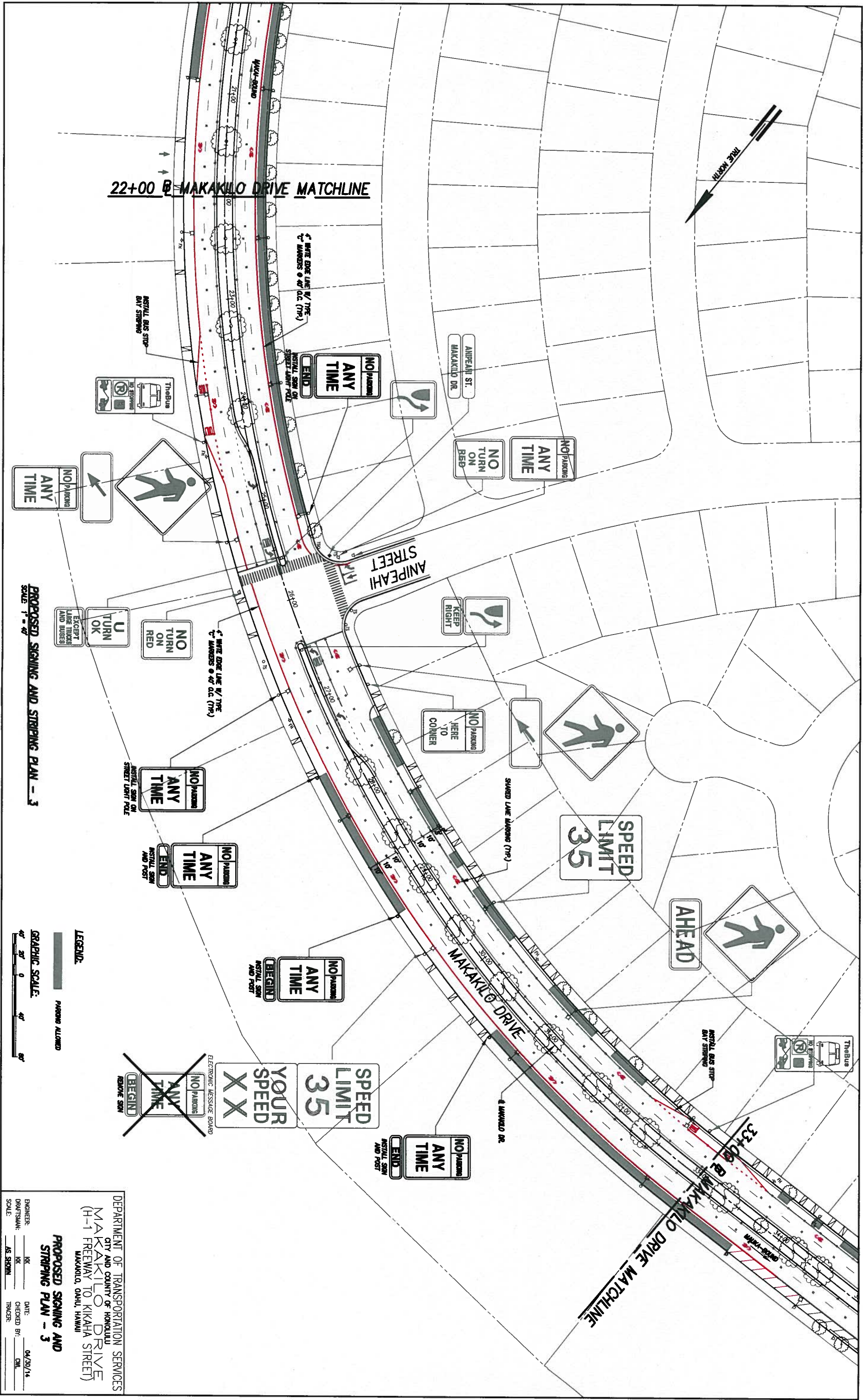
Wavy line warning sign



DEPARTMENT OF TRANSPORTATION SERVICES
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MAKAKILO DRIVE
(H-1 FREEWAY TO KIKAHA STREET)
MAKAKILO, OAHU, HAWAII

PROPOSED SIGNING AND STRIPING PLAN - 2

ENGINEER: _____ DATE: 04/29/14
DRAFTSMAN: _____ CHECKED BY: _____
SCALE: AS SHOWN TRACER: _____



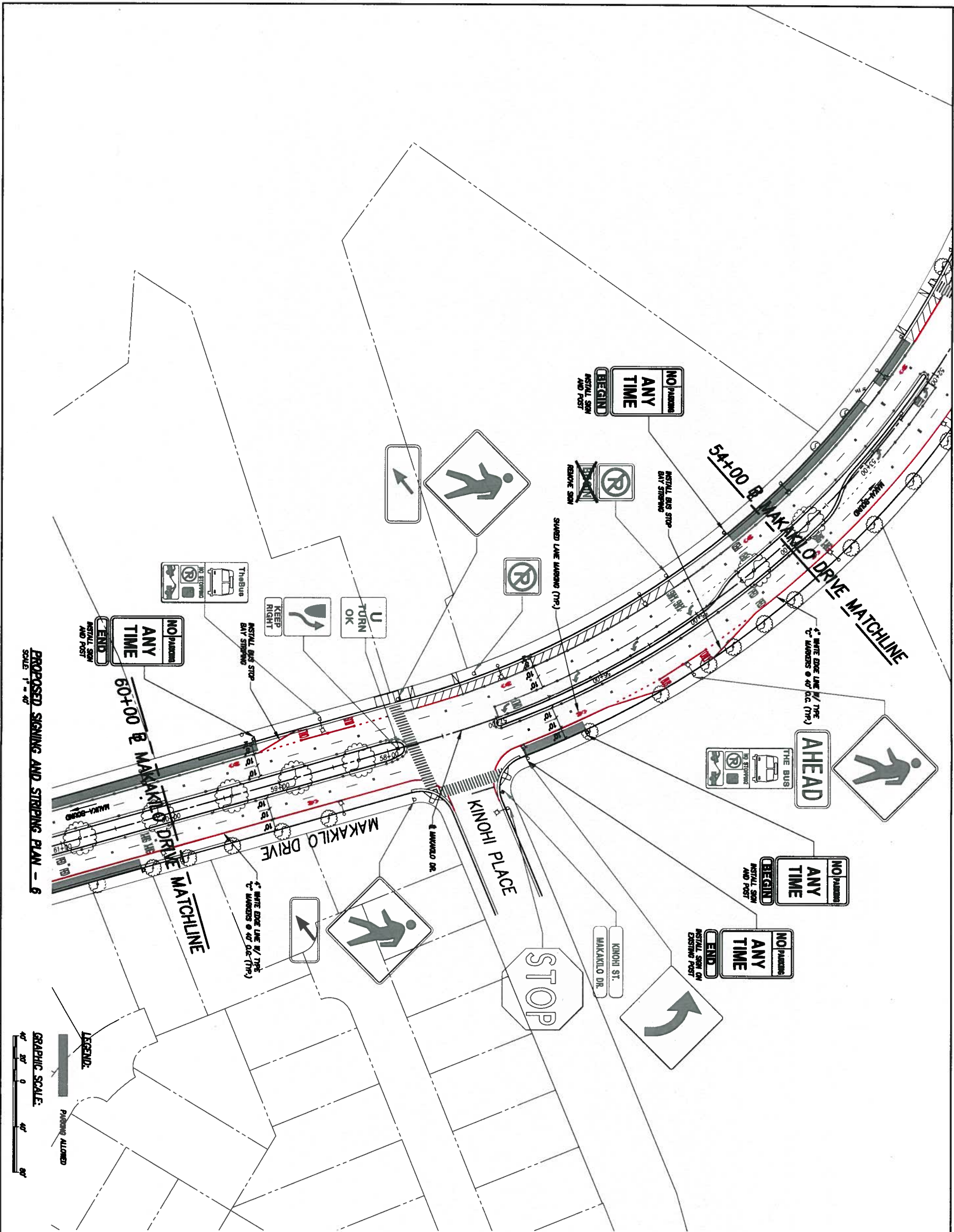
PROPOSED SIGNING AND STRIPING PLAN - 3
SCALE: 1" = 40'

LEGEND:

PARKING ALLOWED

GRAPHIC SCALE:

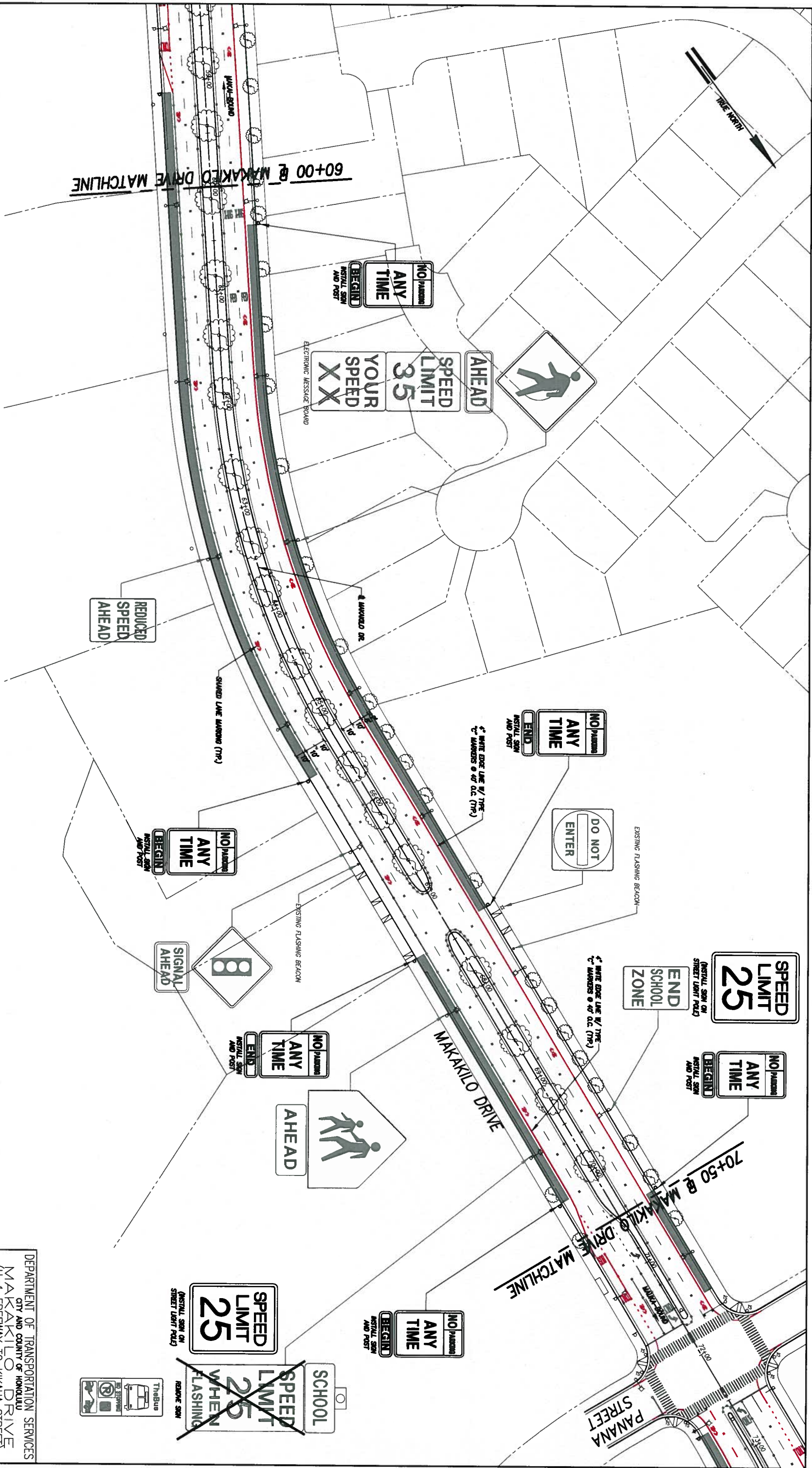
40' 20' 0' 40' 80'



DEPARTMENT OF TRANSPORTATION SERVICES
CITY AND COUNTY OF HONOLULU
MAKAKILO DRIVE
(H-1 FREEWAY TO KIKAHUA STREET)
MAKAKILO, OAHU, HAWAII

PROPOSED SIGNING AND STRIPING PLAN - 6

ENGINEER: _____ DATE: 04/29/14
DRAFTSMAN: IKR CHECKED BY: CML
SCALE: AS SHOWN TRACKER: _____



PROPOSED SIGNING AND STRIPING PLAN - 2

SCALE: 1" = 40'

LEGEND:

PARKING ALLOWED

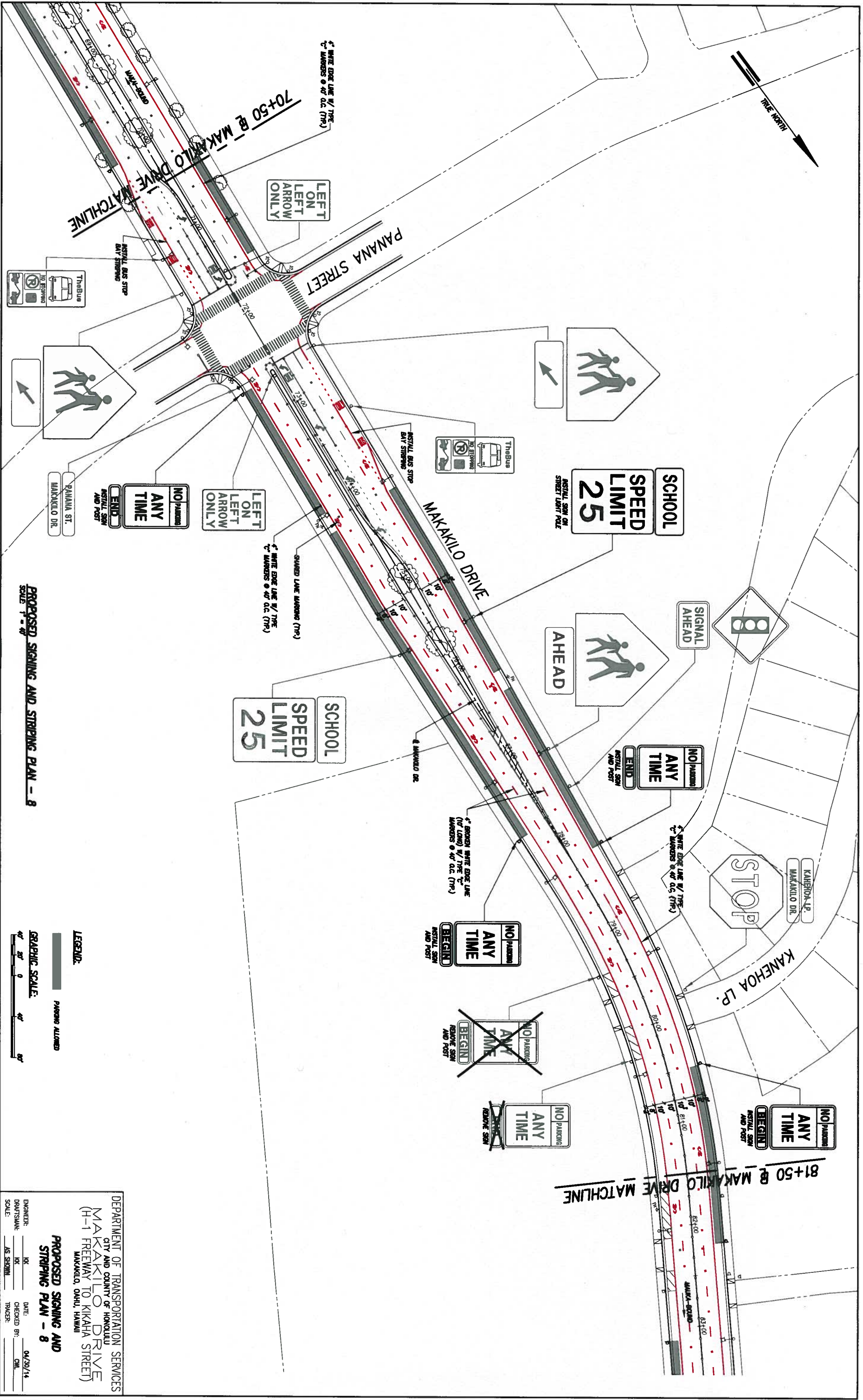
GRAPHIC SCALE:



DEPARTMENT OF TRANSPORTATION SERVICES
CITY AND COUNTY OF HONOLULU
MAKAKILO DRIVE
(H-1 FREEWAY TO KIKAHUA STREET)
MAKAKILO, OAHU, HAWAII

PROPOSED SIGNING AND STRIPING PLAN - 7

ENGINEER: _____ DATE: 04/20/14
DRAFTSMAN: _____ CHECKED BY: _____
SCALE: _____ AS SHOWN TRACER: _____



PROPOSED SIGNING AND STRIPING PLAN - 8

GRAPHIC SCALE:
40' 20' 0' 40' 80'

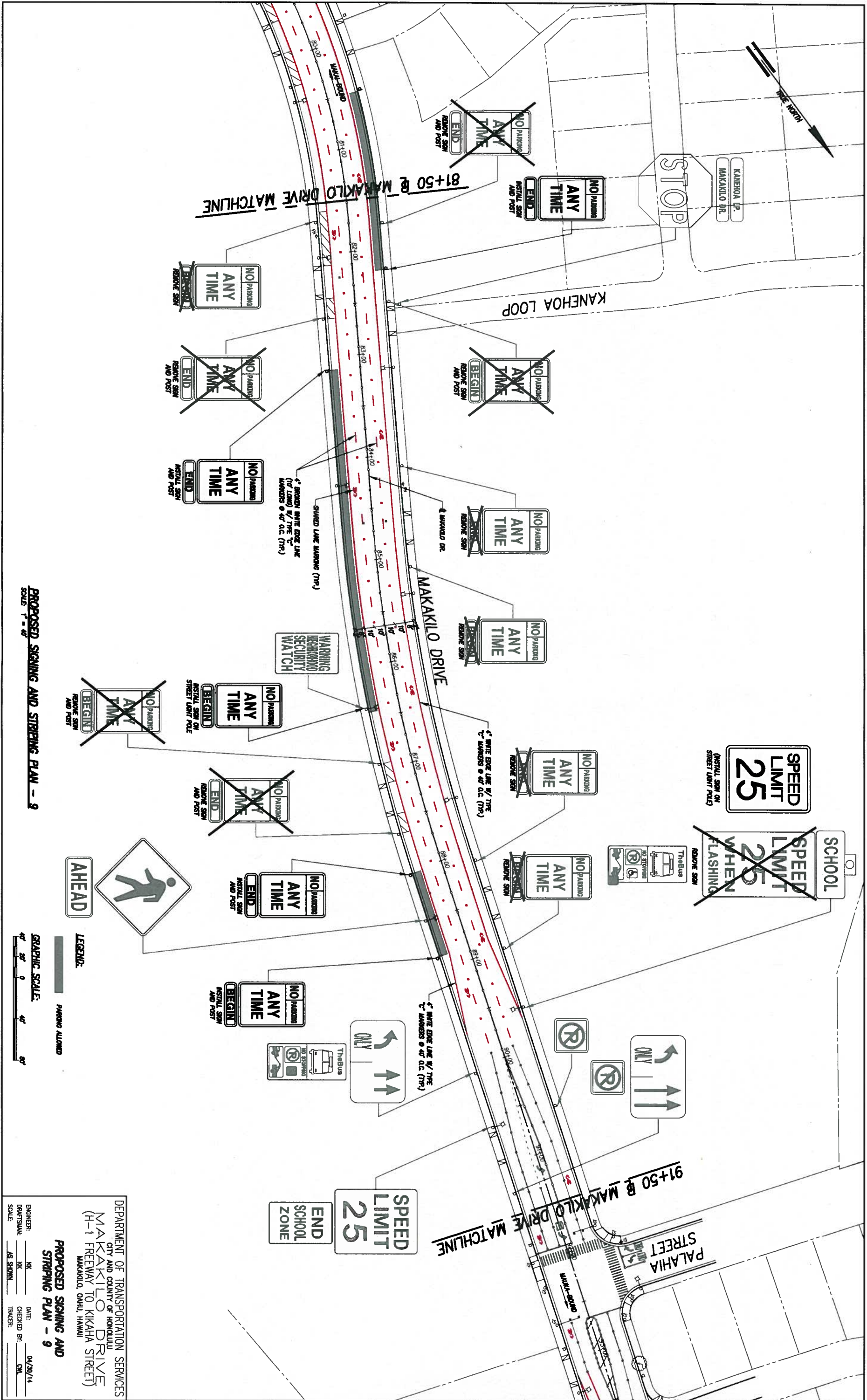
LEGEND:

PARKING ALLOWED

DEPARTMENT OF TRANSPORTATION SERVICES
CITY AND COUNTY OF HONOLULU
MAKAKILO DRIVE
(H-1 FREEWAY TO KIKAHUA STREET)
MAKAKILO, OAHU, HAWAII

PROPOSED SIGNING AND STRIPING PLAN - 8

ENGINEER: _____ DATE: 04/29/14
DRAFTSMAN: _____ CHECKED BY: CML
SCALE: AS SHOWN TRACER: _____



PROPOSED SIGNING AND STRIPING PLAN - 9

GRAPHIC SCALE:
40' 20' 0' 40'

AHEAD

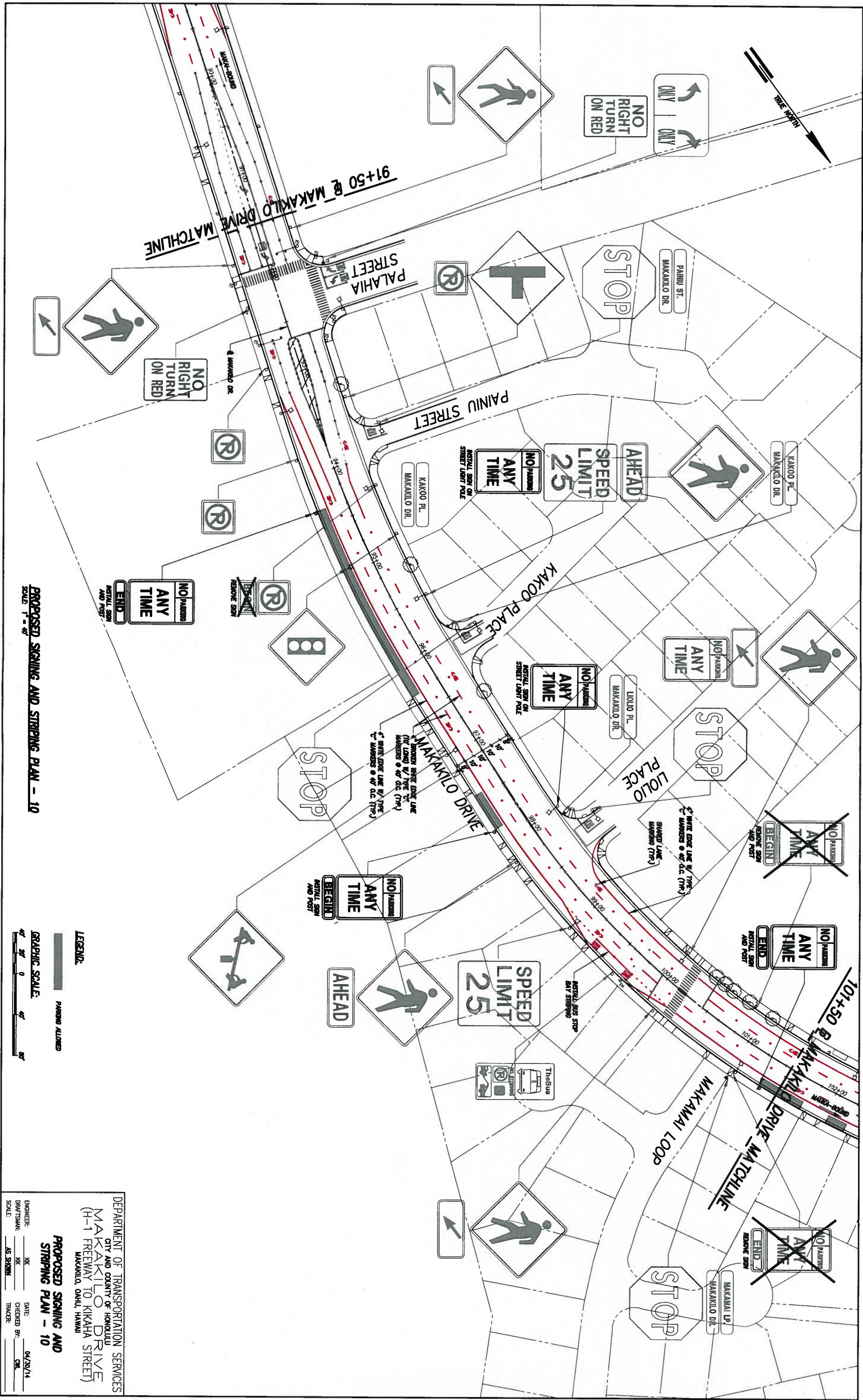
LEGEND:
PAVING ALLOWED

DEPARTMENT OF TRANSPORTATION SERVICES
CITY AND COUNTY OF HONOLULU
MAKAKILO DRIVE
(H-1 FREEWAY TO KIKAHUA STREET)
MAKAKILO, OAHU, HAWAII

PROPOSED SIGNING AND STRIPING PLAN - 9

ENGINEER: KK
DRAFTSMAN: KK
SCALE: AS SHOWN

DATE: 04/20/14
CHECKED BY: CML
TRACER:



PROPOSED SIGNING AND STRIPING PLAN - 10

SCALE: 1" = 40'

LEGEND:

PARKING ALLOWED

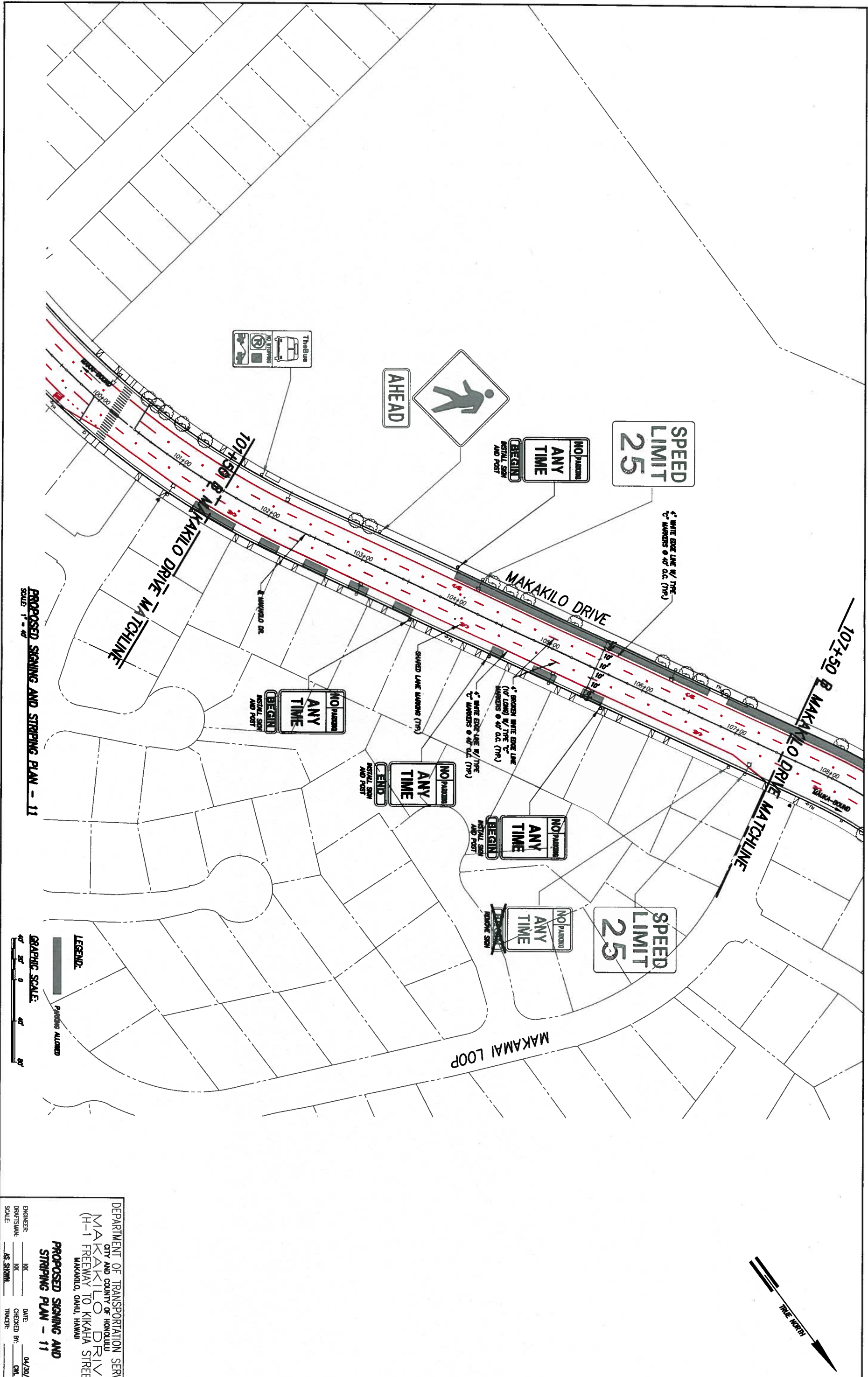
GRAPHIC SCALE:



DEPARTMENT OF TRANSPORTATION SERVICES
CITY AND COUNTY OF HONOLULU
MAKAKILO DRIVE
(H-1 FREEWAY TO KIKAHA STREET)
MAKAKILO, OAHU, HAWAII

PROPOSED SIGNING AND STRIPING PLAN - 10

ENGINEER: _____ DATE: 04/29/14
DRAFTSMAN: _____ CHECKED BY: _____
SCALE: AS SHOWN TRACKER: _____



PROPOSED SIGNING AND STRIPING PLAN - 11

SCALE: 1" = 40'

LEGEND:

PARKING ALLOWED

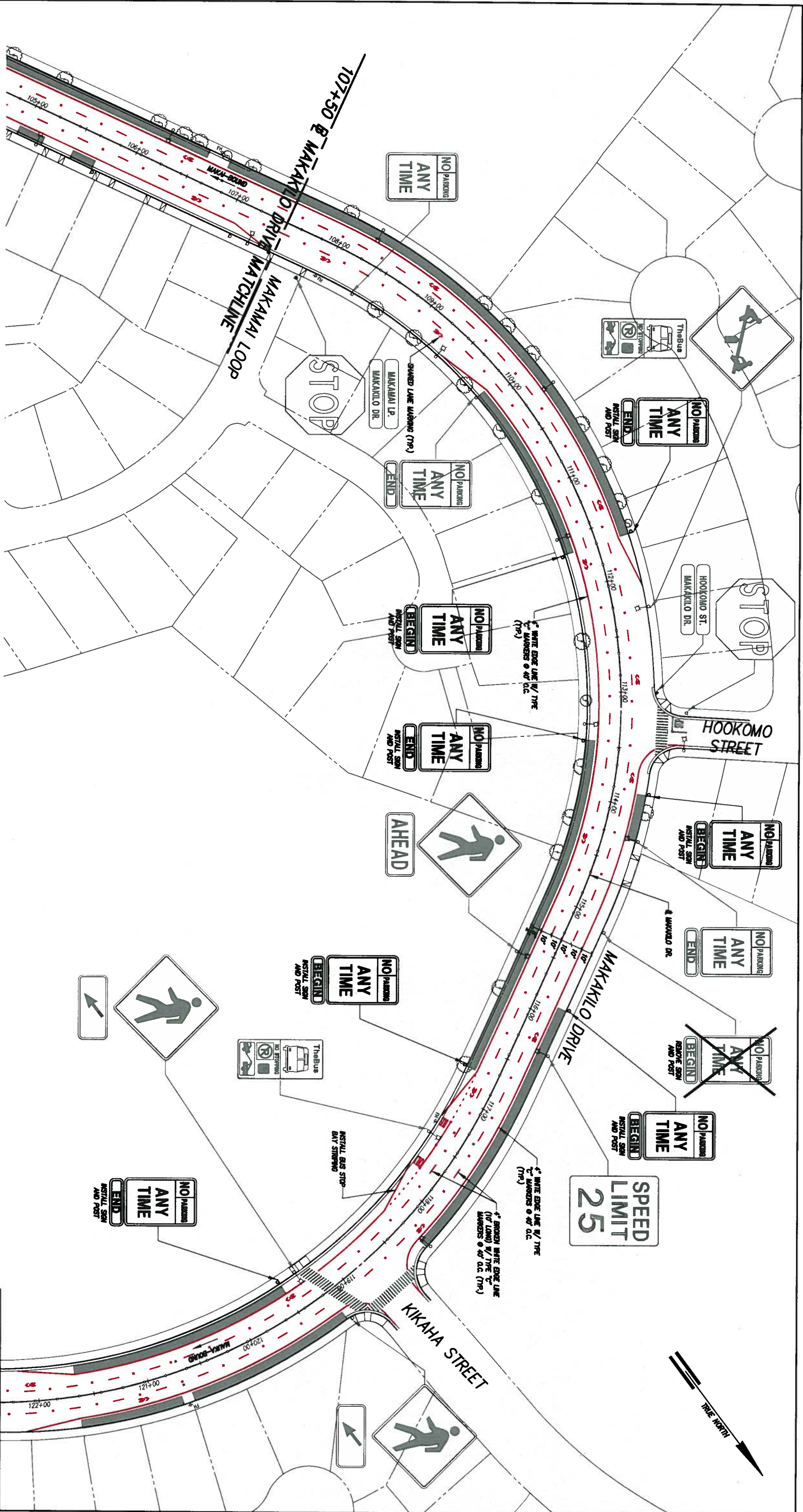
GRAPHIC SCALE:



DEPARTMENT OF TRANSPORTATION SERVICES
CITY AND COUNTY OF HONOLULU
MAKAKILO DRIVE
(H-1 FREEWAY TO KIKAHUA STREET)
MAKAKILO, OAHU, HAWAII

PROPOSED SIGNING AND STRIPING PLAN - 11

ENGINEER: _____ DATE: 04/20/14
DRAFTSMAN: IKL CHECKED BY: CML
SCALE: AS SHOWN TRACER: _____



PROPOSED SIGNING AND STRIPING PLAN - 12

SCALE: 1" = 40'

LEGEND:

PARKING ALLOWED

GRAPHIC SCALE:



DEPARTMENT OF TRANSPORTATION SERVICES
CITY AND COUNTY OF HONOLULU
MAKAKILO DRIVE
(H-1 FREEWAY TO KIKAHA STREET)
MAKAKILO, OAHU, HAWAII

PROPOSED SIGNING AND STRIPING PLAN - 12

ENGINEER: _____ DATE: 04/29/14
DRAFTSMAN: _____ CHECKED BY: _____
SCALE: AS SHOWN TRACER: _____