# PRELIMINARY ACOUSTIC STUDY FOR THE HONOAPIILANI HIGHWAY REALIGNMENT AT OLOWALU TOWN LAHAINA, MAUI

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# CHAPTER I. SUMMARY

The existing and future traffic noise levels in the environs of the proposed Honoapiilani Highway realignment mauka of Olowalu Town on the island of Maui were studied to evaluate potential noise impacts associated with the Build Alternative. Noise measurements were obtained, traffic noise predictions developed, and noise abatement alternatives evaluated.

Existing traffic noise levels in the project area probably exceed the U.S. Federal Highway Administration (FHWA) and Hawaii State Department of Transportation, Highways Division (HDOT) noise abatement criteria at two existing residences. Future (CY 2020) traffic noise levels are expected to continue to exceed the "66 Leq" HDOT noise abatement criteria at one of the two existing residences under the No-Build Alternative. The noise abatement criteria will not be exceeded at existing noise sensitive dwelling units under the Build Alternative. Traffic noise mitigation measures in the form of noise barrier construction, increased setback distances, or closure and air conditioning may be applied at future residences of the Olowalu Town development. Because of the potential visual impacts of the noise barriers and the potential for graffiti, landscaping should be used on the roadway side of the barriers.

The following general conclusions can be made in respect to the number of impacted structures and lands which can be expected by CY 2020 under the Build Alternative. These conclusions are valid as long as the future vehicle mixes and average speeds do not differ from the assumed values.

- The HDOT's ">15 dB increase" criteria for substantial change in traffic noise levels will not be exceeded at any existing noise sensitive structure. Maximum increases in traffic noise levels in the project area should not exceed 7.3 dB as a result of growth in traffic volumes and the construction of the new highway.

- Under the No Build Alternative, future traffic noise levels at 1 existing residence which is located within the limits of project construction are expected to exceed the HDOT "66 Leq" criteria.

- Under the Build Alternative, future traffic noise levels at existing residences which are located within the limits of project construction are not expected to exceed the HDOT "66 Leq" criteria.

- Future traffic noise levels at the commercial structure (Olowalu Grocery Store) on Honoapiilani Highway should not exceed current HDOT and FHWA noise abatement criteria under the Build or No Build Alternatives.

- The construction of sound attenuation barriers along the new highway Rights-of-Way and Top of Fill is a possible noise mitigation measure which could be applied to meet FHWA and HDOT policy criteria at future residences or other noise sensitive uses. For ground level receptors, sound attenuating walls which are required to meet the minimum HDOT's 7 dBA attenuation criteria at the affected residences may be constructed. Other noise mitigation measures (increased buffer distances and closure and air conditioning) may also be applied at the developer's option to meet HDOT and well as FHA/HUD sound attenuation criteria.

Potential short term construction noise impacts are possible during the project construction period along the entire project corridor. However, minimizing these types of noise impacts is possible using standard curfew periods, properly muffled equipment, administrative controls, and construction barriers as required. The possible use of blasting or chemicals to break or dislodge rock will be considered to reduce the total construction period, and to reduce the amount of time required to remove the rock if only mechanical (such as hoe ram) equipment were used. Controlled blasting operations using relatively small charges may be feasible without causing adverse noise and vibration impacts at nearby residences. In addition, the use of chemical expansion to break or dislodge rock during construction will also be considered where blasting or mechanical means are less desirable.

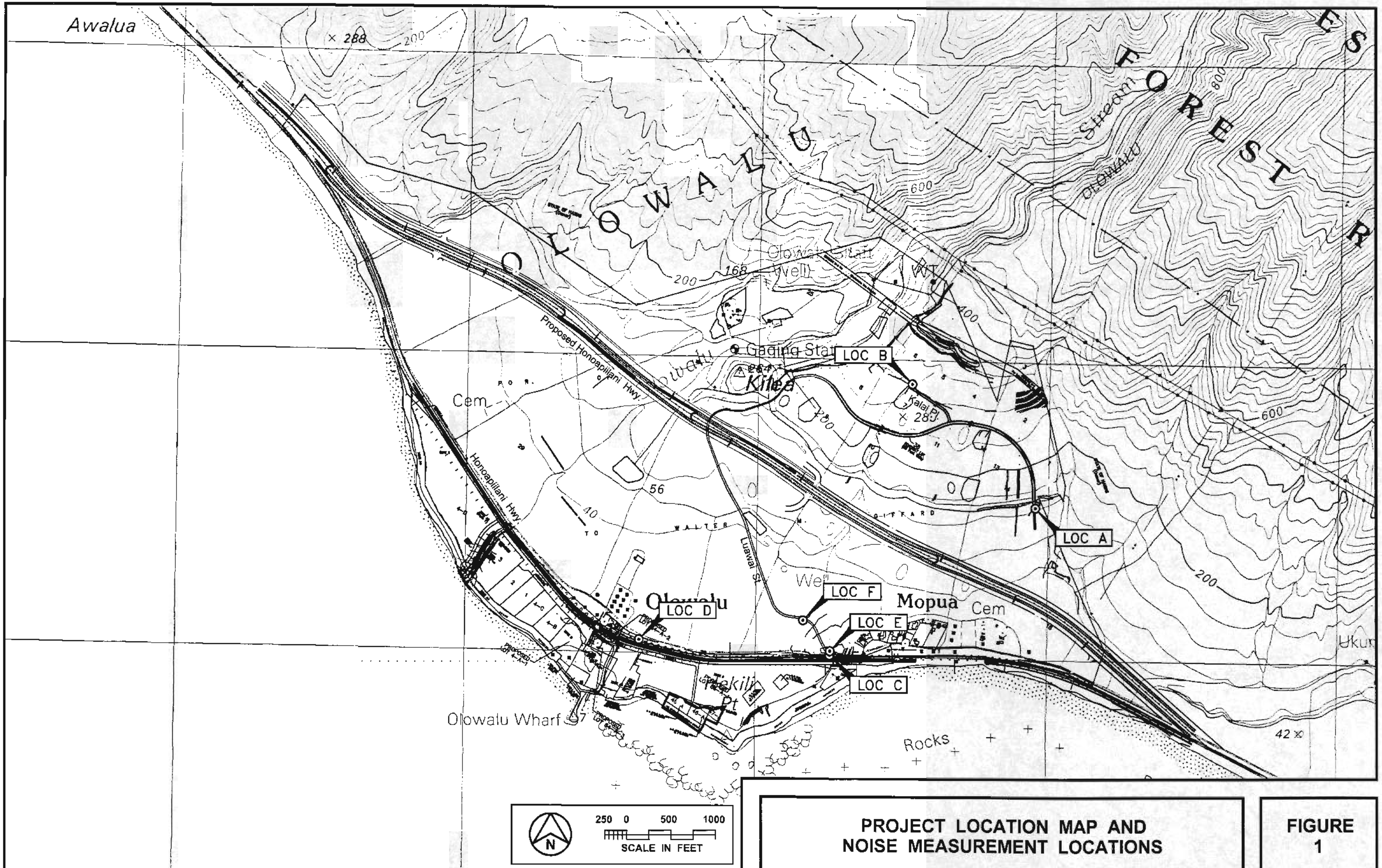
# CHAPTER II. GENERAL STUDY METHODOLOGY

Noise Measurements. Existing traffic and background ambient noise levels at six locations in the project area were measured in July 2011. The traffic noise measurements were used to calibrate the traffic noise model which was used to calculate the Base Year (CY 2011) and future (CY 2020) traffic noise levels under the No Build and Build Alternatives. The background ambient noise measurements were used to define existing noise levels at noise sensitive receptors which may be affected by the project. Also, the measurements were used in conjunction with forecast traffic noise levels to determine if future traffic noise levels are predicted to "substantially exceed" existing background ambient noise levels at these noise sensitive receptors, and therefore exceed FHWA and HDOT noise standards and noise abatement criteria.

The noise measurement locations ("A," "B," "C," "D," "E," and "F") are shown in Figure 1. The results of the traffic and background noise measurements are summarized in Table 1. In the table, Leq represents the average (or equivalent), A-Weighted, Sound Level. A list and description of the acoustical terminology used are contained in Appendix B.

Traffic Noise Predictions. The Federal Highway Administration (FHWA) Traffic Noise Model, Version 2.5 (or TNM, see Reference 1) was used as the primary method of calculating Base Year and future traffic noise levels, with model parameters adjusted to reflect terrain, ground cover, and local shielding conditions. At all traffic noise measurement locations, the measured noise levels were compared with TNM model predictions to insure that measured and calculated noise levels for the existing conditions were consistent and in general agreement. As indicated in Table 1, spot counts of traffic volumes were also obtained during the measurement periods and were used to generate the Equivalent Sound Level (Leq) predictions shown in the table. The average vehicle speeds entered into the TNM were typically higher than posted speeds during the am and off-peak periods so as to achieve better agreement between measured noise levels and those calculated by the TNM. During the pm peak period, when traffic congestion was greater, the average vehicle speeds were closer to the posted speed limits. With these input speed adjustments, the agreement between measured and predicted traffic noise levels was considered to be good and sufficiently accurate to formulate the Base Year and future year traffic noise levels.

Base Year traffic noise levels were then calculated at receptor locations shown in Figure 2 along the existing and proposed highway corridors using Base Year (2011) traffic volume and average vehicle speed data for the PM peak hour from Reference 2. The traffic volumes are summarized in Appendix C. Traffic mix by vehicle types for the various sections of the existing and future roadway were derived from observations during the noise monitoring periods. Determinations of the periods of highest hourly traffic volumes along the project corridor were made after reviewing the AM and PM peak hour traffic volumes from Reference 2, the noise measurement results, and Reference 3. Total two-way traffic volumes were generally highest during the PM peak




PROJECT LOCATION MAP AND NOISE MEASUREMENT LOCATIONS

FIGURE 1

## TABLE 1
## TRAFFIC AND BACKGROUND NOISE MEASUREMENT RESULTS

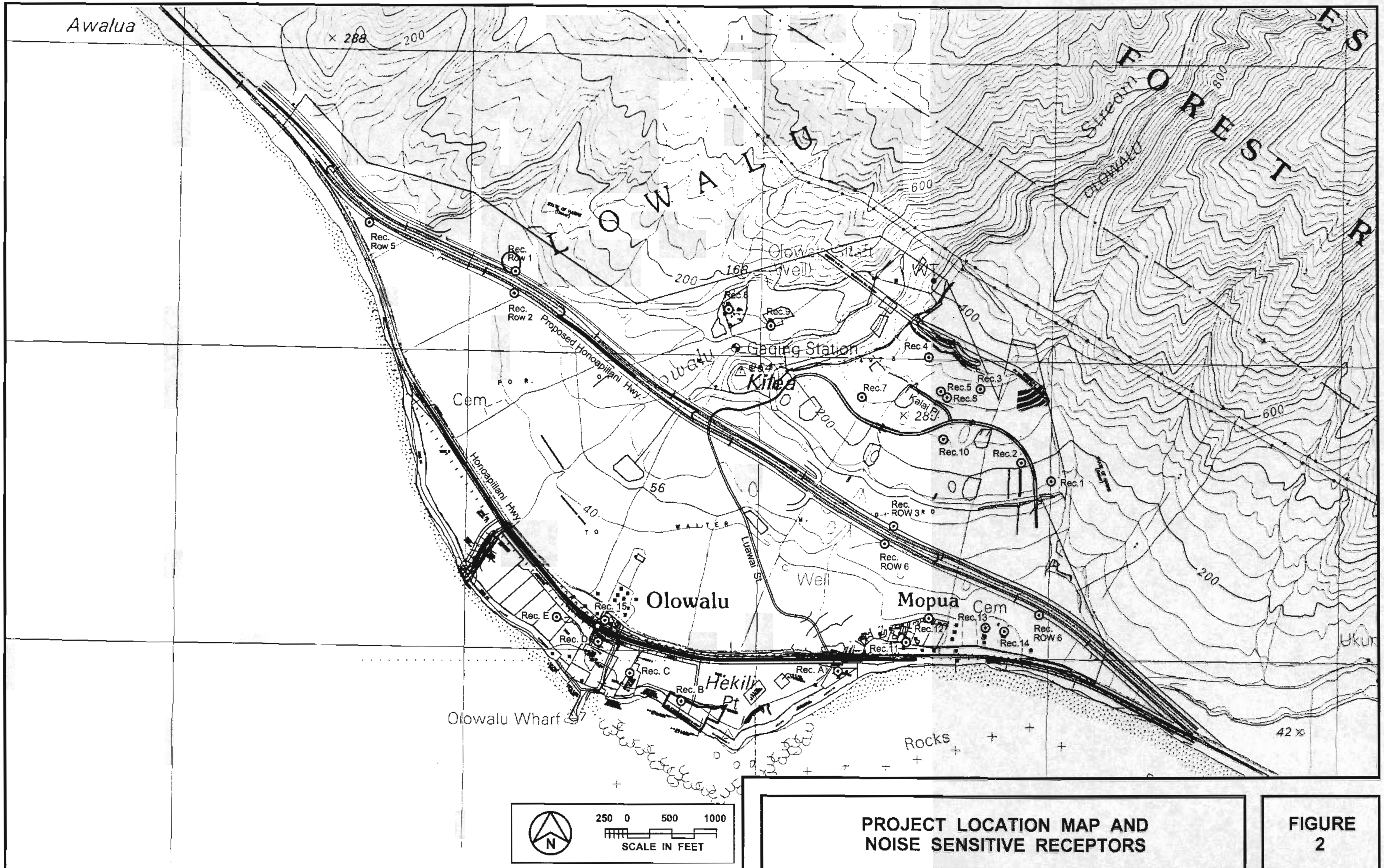
| | LOCATION | Time of Day (HRS) | Ave. Speed (MPH) | ------ Hourly Traffic Volume ------ AUTO | M.TRUCK | H.TRUCK | Measured Leq (dB) | Predicted Leq (dB) |
|---|---|---|---|---|---|---|---|---|
| A | At east end of Luawai Street (7/10/11) | 0944 TO 1014 | N/A | N/A | N/A | N/A | 42.2 | N/A |
| B | At west end of Kalai Place (7/10/11) | 1032 TO 1102 | N/A | N/A | N/A | N/A | 38.0 | N/A |
| C | 60 FT from the center-line of Honoapiilani Highway (7/11/11) | 0645 TO 0745 | 55 | 1,330 | 40 | 19 | 71.7 | 70.2 |
| D | 50 FT from the center-line of Honoapiilani Highway (7/11/11) | 0755 TO 0855 | 47 | 1,261 | 34 | 38 | 70.4 | 70.4 |
| C | 60 FT from the center-line of Honoapiilani Highway (7/11/11) | 1132 TO 1232 | 55 | 1,472 | 45 | 20 | 70.8 | 70.7 |
| E | 110 FT from the center-line of Honoapiilani Highway (7/11/11) | 1132 TO 1232 | 55 | 1,472 | 45 | 20 | 60.0 | 60.4 |

## TABLE 1 (CONTINUED)
## TRAFFIC AND BACKGROUND NOISE MEASUREMENT RESULTS

| | LOCATION | Time of Day (HRS) | Ave. Speed (MPH) | ------ Hourly Traffic Volume ------ AUTO | M.TRUCK | H.TRUCK | Measured Leq (dB) | Predicted Leq (dB) |
|---|---|---|---|---|---|---|---|---|
| F | 400 FT from the center-line of Honoapiilani Highway (7/11/11) | 1241 TO 1311 | N/A | N/A | N/A | N/A | 49.1 | N/A |
| E | 110 FT from the center-line of Honoapiilani Highway (7/11/11) | 1241 TO 1311 | N/A | N/A | N/A | N/A | 60.7 | N/A |
| A | At east end of Luawai Street (7/11/11) | 1321 TO 1351 | N/A | N/A | N/A | N/A | 44.6 | N/A |
| E | 110 FT from the center-line of Honoapiilani Highway (7/11/11) | 1321 TO 1351 | N/A | N/A | N/A | N/A | 60.7 | N/A |
| B | At west end of Kalai Place (7/11/11) | 1355 TO 1425 | N/A | N/A | N/A | N/A | 38.4 | N/A |
| E | 110 FT from the center-line of Honoapiilani Highway (7/11/11) | 1355 TO 1425 | N/A | N/A | N/A | N/A | 60.1 | N/A |

## TABLE 1 (CONTINUED)
## TRAFFIC NOISE MEASUREMENT RESULTS

| | LOCATION | Time of Day (HRS) | Ave. Speed (MPH) | ------ Hourly Traffic Volume ------ AUTO | M.TRUCK | H.TRUCK | Measured Leq (dB) | Predicted Leq (dB) |
|---|---|---|---|---|---|---|---|---|
| D | 50 FT from the center-line of Honoapiilani Highway (7/11/11) | 1435 TO 1535 | 42 | 1,463 | 25 | 22 | 69.0 | 69.0 |
| C | 60 FT from the center-line of Honoapiilani Highway (7/11/11) | 1616 TO 1716 | 47 | 1,900 | 28 | 8 | 69.1 | 69.1 |
| E | 110 FT from the center-line of Honoapiilani Highway (7/11/11) | 1616 TO 1716 | 47 | 1,900 | 28 | 8 | 58.6 | 58.9 |




**PROJECT LOCATION MAP AND NOISE SENSITIVE RECEPTORS**

**FIGURE 2**

hour. However, measured traffic noise levels were actually higher by 1 to 3 dBA during the AM and midday peak hours than during the PM peak hour. This was due to the lower average vehicle speeds observed during the PM peak hour when traffic congestion was greatest. For the purposes of this study, the PM peak hour was used to model the period with the highest traffic noise levels using the average vehicle speeds provided in Reference 2. But in all evaluations of the existing and future traffic noise levels in respect to FHWA or HDOT noise mitigation thresholds, a 3 dBA margin of safety was applied to the calculated PM peak hour noise levels which were calculated using the traffic volumes and average vehicle speeds of Reference 2.

The Equivalent (or Average) Hourly Sound Level [Leq(h)] noise descriptor was used to calculate the Base Year and CY 2020 traffic noise levels as required by Reference 4. Aerial photo maps, tax maps, and project plans (where available) of the area were used to determine terrain, ground cover, and local shielding effects and distances from building structures, which were entered into the noise prediction model. Topographic maps of the areas far beyond the highway Rights-of-Way were not available, so receptor elevations were assumed to be equal to the ground elevations shown on the USGS topographic maps at locations closest to the study receptors. Using the measured traffic noise levels shown in Table 1 along Honoapiilani Highway, the average vehicle speeds were adjusted so as to achieve the best agreement between measured and predicted traffic noise levels using the traffic noise model. These derived average speeds shown in Table 1 were compared to those provided in Reference 2 for the Base Year, and the differences were noted.

For noise modeling of the existing and the future traffic noise levels, the average vehicle speeds contained in Reference 2 were used in conjunction with the PM peak hour traffic volumes in Reference 2 (and reproduced in Appendix C). Because the highest hourly noise level may occur during free-flow traffic conditions at hours other than during the PM peak hour, it is possible that the predictions of traffic noise levels during the PM peak hour may be underestimating the worst case hourly traffic noise level by at least 3 dBA. For this reason, a 3 dBA margin of safety was applied to the PM peak hour noise levels which were calculated using the average vehicle speeds of Reference 2.

Future year (2020) traffic noise levels were calculated at receptor locations shown in Figure 2 for the No Build and Build (roadway realignment) Alternatives using the future traffic assignments and average vehicle speeds of Reference 2. Forecast mixes of vehicle types were assumed to be identical for both existing and future traffic, with 96.0% automobiles, 2.0% medium trucks, 2.0% heavy trucks and buses. Assumed average vehicle speeds for Year 2020 were assumed to be lower than their Base Year values for the No Build Alternative (from Reference 2), and in accordance with estimates provided in Reference 2 for the Build Alternative along the new highway. Future traffic conditions along the existing highway under the No Build Alternative are expected to worsen, with average vehicle speeds declining as a result of increased congestion.

Impact Assessments and Mitigation. Following the calculation of the future traffic noise levels, evaluations of the future traffic noise levels and impacts at noise sensitive receptor locations along Honoapiilani Highway and in the land areas at higher elevations east of the existing highway within the limits of construction were made. Comparisons of predicted future traffic noise levels with FHWA and HDOT noise abatement criteria (see Table 2) were made to determine specific locations where the noise abatement criteria are expected to be exceeded.

The HDOT 66 Leq(h) noise abatement threshold criteria and the HDOT "greater than 15 dB increase" criteria were applied to all noise sensitive buildings along the project corridor. By Reference 5, the HDOT has replaced the FHWA 67 Leq(h) criteria with their 66 Leq(h) criteria. The HDOT 71 Leq(h) noise abatement threshold criteria and the HDOT "greater than 15 dB increase" criteria were applied to all commercial buildings along the project corridor. Along the project corridor, the locations of the 66 and 71 Leq(h) traffic noise contours, without the benefit of shielding from natural terrain or man-made sound barriers, were also used to identify noise sensitive and commercial receptor locations, respectively, where the HDOT's noise abatement criteria would not be exceeded, and which would not require more detailed evaluations. In addition, the HDOT's criteria of "greater than 15 dB increase above existing background noise levels" was also used as a noise abatement criteria for this project (from Reference 5).

Where noise mitigation measures were indicated for this project, the effectiveness of sound attenuating barriers and other possible noise mitigation measures were evaluated. The ability to meet the HDOT criteria of 7 dBA noise reduction was also examined for various noise barrier heights. Because the new highway plans and profiles obtained from Reference 6 were preliminary and subject to future refinement, the results of the noise mitigation analysis and conclusions were also subject to future modifications. However, the initial results indicated that noise mitigation measures may only be required for future noise sensitive receptors under the Action Alternative.

The noise barriers which would be required to meet the HDOT's 7 dBA noise reduction criteria were then examined in respect to potential cost per benefited residence. By HDOT policy (Reference 5), the sound attenuation walls were considered "reasonable and feasible" if their costs did not exceed $60,000 per benefited residence. For CMU walls, a cost of $39.00 per square foot was used to develop the cost estimates for the sound attenuation walls. For rock walls, a cost of $35.00 per square foot was used to develop the cost estimates for sound attenuating walls which are located on top of existing rock walls. Walls whose estimated cost exceeded $60,000 per benefited residence were identified for possible exclusion from the highway realignment project. This task was not completed because noise barriers should not be required for existing noise sensitive receptors, but may be examined in respect to future noise sensitive receptors.

Because the Olowalu Town Development plan includes proposed development

# TABLE 2

## FHWA & HDOT NOISE ABATEMENT CRITERIA
## [Hourly A–Weighted Sound Level––Decibels (dBA)]

| ACTIVITY CATEGORY | LEQ (h) (Note 2) | DESCRIPTION OF ACTIVITY CATEGORY |
|---|---|---|
| A | 57 (Exterior) | Lands on which serenity and quiet are of extra–ordinary significance and serve an important public need and where the preservation of those qualities is essential if the areas are to continue to serve their intended purpose. |
| B (Note 1) | 67 (Exterior) | Residential. |
| C (Note 1) | 67 (Exterior) | Active sport areas, amphitheaters, auditoriums, campgrounds, cemeteries, day care centers, hospitals, libraries, medical facilities, parks, picnic areas, places of worship, playgrounds, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, recreation areas, Section 4(f) sites, schools, television studios, trails, and trail crossings. |
| D | 52 (Interior) | Auditoriums, day care centers, hospitals, libraries, medical facilities, places of worship, public meeting rooms, public or non profit institutional structures, radio studios, recording studios, schools, and television studios. |
| E (Note 1) | 72 (Exterior) | Hotels, motels, offices, restaurants/bars, and other develped lands, properties or activities not included in A–D or F. |
| F | –––––– | Agriculture, airports, bus yards, emergency services, industrial, logging, maintenance facilities, manufacturing, mining, rail yards, retail facilities, shipyards, utilities (water resources, water treatment, electrical), and warehousing. |
| G | –––––– | Undeveloped lands that are not permitted. |

Notes:

1. Includes undeveloped lands permitted for this activity category.
2. The Hawaii State Department of Transportation, Highways Division, utilizes Leq criteria levels which are 1 Leq unit less than the FHWA values shown.

of noise sensitive properties along the new highway alignment, the potential for future traffic noise levels exceeding the Federal Housing Administration, Housing and Urban Development (FHA/HUD) noise standard was also examined. For the purposes of determining noise acceptability for funding assistance from federal agencies, an exterior noise level of 65 DNL (Day-Night Average Sound Level) or lower is considered acceptable. The DNL noise metric incorporates a 24-hour average of instantaneous A-Weighted sound levels as read on a standard Sound Level Meter. Additionally, sound levels which occur during the nighttime hours of 10:00 PM to 7:00 AM are increased by 10 decibels (dB) prior to computing the 24-hour average by the DNL. In Appendix B, the Ldn symbol is used in place of the DNL descriptor symbol.

The relationship between the peak hour Leq and DNL were derived from the hourly traffic volumes along Honoapiilani Highway of Reference 3. The hourly noise levels and DNL at 100 FT setback distance from the highway were calculated as shown in Figure 3. From Figure 3, it was concluded that the DNL was approximately 3 dB greater than the PM peak hour Leq when traffic congestion is present during the PM peak hour.

Evaluations of potential airborne noise and ground vibrations from blasting operations to break and/or dislodge rock during construction were also performed. Predictions of expected airborne and ground vibration levels were performed at the closest residential areas in the project environs. Comparisons between predicted levels with current blast noise and vibration criteria and standards were also performed. Potential airborne noise and vibration impacts from blasting operations during construction were then evaluated, and mitigation measures recommended as necessary.

## FIGURE 3

## HOURLY VARIATIONS OF TRAFFIC NOISE AT 100 FT SETBACK DISTANCE FROM THE CENTERLINE OF HONOAPIILANI HIGHWAY NEAR UKUMEHAME BEACH PARK (STA. B74003001089; MAY 20, 2009)

## CHAPTER III. EXISTING ACOUSTICAL ENVIRONMENT

For the purposes of this study, 2011 was used as the Base Year for calculating changes in traffic noise levels associated with the future No Build and Build Alternatives. The Base Year noise environment along the project corridor was described by calculating the Hourly Equivalent Sound Level [Leq(h)] along the existing roadway during the PM peak traffic hour for the 2011 time period. The hourly sound level, expressed in decibels, represents the average level of traffic noise along the project roadway during the PM peak hour of the study's Base Year.

Table 3 presents the traffic volume, speed, and mix assumptions used to calculate the Base Year noise levels during the PM peak hour along the existing Honoapiilani Highway. Shown in Table 3 are the calculated peak hour Leq(h)'s at reference distances of 50, 100, and 200 FT from the geometrical center of the inbound and outbound lanes of the highway. The calculated distances to the 66 and 71 Leq noise contour lines under unobstructed, line-of-sight conditions to the roadway are shown in Table 4A for the PM peak hour. The actual distances to the contour lines will generally be less than indicated in Table 4A when intervening structures or terrain obstructions exist between the roadway and a receptor. This reduction (or shrinkage) of the traffic noise contour distances from the roadway's centerline is the result of noise shielding (or attenuation) effects caused by the intervening structures or terrain features (such as highway cuts).

By using the traffic noise data shown in Tables 3, 4A, and 4B and aerial photo maps of the existing improvements on the west (makai) and east (mauka) sides of the project corridor, the relationship of the existing free-field traffic noise contours to existing noise sensitive dwellings and commercial buildings in the project area were obtained. Table 4B was also included to depict the existing setback distances to the 65 DNL and 75 DNL contours.

Table 5 presents the Base Year traffic noise levels at the various noise sensitive structures on both sides of the existing Rights-of-Way. The relationships of these receptor locations to the existing highway are shown in Figure 2. The existing traffic noise levels could possibly exceed the 66 Leq criteria at 2 single family structures (Receivers 15 and A) within the limits of project construction during the off-peak or AM peak hour, when traffic noise levels may be as much as 3 dBA higher than the 64.3 dBA values shown at Receivers 15 and A for the PM peak hour. From Table 4A, existing traffic noise levels could exceed the HDOT 66 Leq criteria at any residence located within 93 feet from the centerline of the highway. During the off-peak or AM peak hour, the HDOT 66 Leq criteria could be exceeded at 131 feet setback distance from the centerline of the existing highway. Existing traffic noise levels do not exceed the 71 Leq criteria for commercial properties at the Olowalu General Store.

Existing residences mauka of the existing highway at the east end of the project presently experience traffic noise levels between 53 and 61 dBA during the PM peak hour, and between 56 and 64 dBA during the off-peak and AM peak hour, and are

## TABLE 3

## EXISTING (CY 2011) TRAFFIC VOLUMES AND NOISE LEVELS ALONG VARIOUS SECTIONS OF HONOAPILLANI HIGHWAY ( PM PEAK HOUR )

| | SPEED | TOTAL | ********** VOLUMES (VPH) ************ | | | | | |
|---|---|---|---|---|---|---|---|---|
| LOCATION | (MPH) | VPH | AUTOS | M TRUCKS | H TRUCKS | 50' Leq | 100' Leq | 200' Leq |
| West End of Olowalu Town * | 44 | 1,776 | 1,704 | 36 | 36 | 69.8 | 64.3 | 58.4 |
| At Olowalu Grocery Store ** | 41 | 1,785 | 1,713 | 36 | 36 | 69.0 | 63.0 | 58.2 |
| East End of Olowalu Town *** | 48 | 1,787 | 1,715 | 36 | 36 | 70.9 | 65.4 | 59.3 |

Notes:

1. * 43 mph westbound; 45 mph eastbound
2. ** 45 mph westbound; 37mph eastbound
3. ** 50 mph westbound; 46 mph eastbound
4. All distances shown are from the center of Honoapiilani Highway.
5. Calculated Leq's are for unobstructed line-of-sight conditions.
6. The calculated Leq's for the AM and mid-day peak hours may be as much as 3 dBA higher than the values shown for the PM peak hour.

## TABLE 4A

## YEAR 2011 AND 2020 DISTANCES TO 66 AND 71 LEQ CONTOURS ( NO ACTION, PM PEAK HOUR )

| STREET SECTION | 66 Leq SETBACK (FT) EXISTING | 66 Leq SETBACK (FT) CY 2020 | 71 Leq SETBACK (FT) EXISTING | 71 Leq SETBACK (FT) CY 2020 |
|---|---|---|---|---|
| West End of Olowalu Town | 81 | 79 | 43 | 42 |
| At Olowalu Grocery Store | 71 | 71 | 40 | 40 |
| East End of Olowalu Town | 93 | 73 | 49 | 39 |

**Notes:**

(1) All setback distances are from the roadways' centerlines.
(2) See TABLES 3 and 6 for traffic volume, speed, and mix assumptions.
(3) Setback distances are for unobstructed line-of-sight conditions.
(4) Loose soil conditions assumed along all roadways.

## TABLE 4B

## YEAR 2011 AND 2020 DISTANCES TO 65 AND 75 DNL CONTOURS ( NO ACTION, DNL )

| STREET SECTION | 65 DNL SETBACK (FT) EXISTING | 65 DNL SETBACK (FT) CY 2020 | 75 DNL SETBACK (FT) EXISTING | 75 DNL SETBACK (FT) CY 2020 |
|---|---|---|---|---|
| West End of Olowalu Town | 131 | 129 | 38 | 37 |
| At Olowalu Grocery Store | 116 | 116 | 35 | 36 |
| East End of Olowalu Town | 147 | 121 | 44 | 34 |

**Notes:**

(1) All setback distances are from the roadways' centerlines.
(2) See TABLES 3 and 6 for traffic volume, speed, and mix assumptions.
(3) Setback distances are for unobstructed line-of-sight conditions.
(4) Loose soil conditions assumed along all roadways.

## TABLE 5

## EXISTING AND FUTURE TRAFFIC NOISE LEVELS WITHOUT AND WITH THE PROPOSED PROJECT ( 4.92 FT RECEPTOR, PM PEAK HOUR )

| RECEPTOR LOCATION | | EXISTING (CY 2011) Leq | | ----- FUTURE (CY 2020) Leq ------ NO BUILD / (CHANGE) | | BUILD / (CHANGE) |
|---|---|---|---|---|---|---|
| HONOAPIILANI HIGHWAY (MAUKA): | | | | | | |
| TMK 4-8-03:010 | (Rec. 1 ) | 39.3 | | 39.0 /-0.3 | | 43.5 / 4.2 |
| TMK 4-8-03:096 | (Rec. 2 ) | 39.0 | | 38.7 /-0.3 | | 43.4 / 4.4 |
| TMK 4-8-03:087 | (Rec. 3 ) | 37.3 | | 37.2 /-0.1 | | 41.1 / 3.8 |
| TMK 4-8-03:089 | (Rec. 4 ) | 37.0 | | 36.9 /-0.1 | | 41.1 / 4.1 |
| TMK 4-8-03:088a | (Rec. 5 ) | 37.6 | | 37.5 /-0.1 | | 42.1 / 4.5 |
| TMK 4-8-03:088b | (Rec. 6 ) | 37.7 | | 37.6 /-0.1 | | 42.3 / 4.6 |
| TMK 4-8-03:091 | (Rec. 7 ) | 38.2 | | 38.1 /-0.1 | | 45.1 / 6.9 |
| TMK 4-8-03:011 | (Rec. 8 ) | 37.7 | | 37.7 /0.0 | | 44.9 / 7.2 |
| TMK 4-8-03:012 | (Rec. 9 ) | 37.5 | | 37.6 /0.1 | | 44.0 / 6.5 |
| TMK 4-8-03:094 | (Rec. 10 ) | 38.8 | | 38.6 /-0.2 | | 44.7 / 5.9 |
| TMK 4-8-04:004 | (Rec. 11 ) | 60.7 | | 59.2 /-1.5 | | 44.6 / -16.1 |
| TMK 4-8-04:003 | (Rec. 12 ) | 52.5 | | 51.5 /-1.0 | | 46.8 / -5.7 |
| TMK 4-8-03:018a | (Rec. 13 ) | 54.4 | | 53.2 /-1.2 | | 49.9 / -4.5 |
| TMK 4-8-03:018b | (Rec. 14 ) | 54.9 | | 53.7 /-1.2 | | 51.0 / -3.9 |
| TMK 4-8-03:031 | (Rec. 15 ) | 64.3 | * | 64.4 /0.1 | * | 38.5 / -25.8 |
| HONOAPIILANI HIGHWAY (MAKAI): | | | | | | |
| TMK 4-8-03:002 | (Rec. A ) | 64.3 | * | 62.6 /-1.7 | | 41.1 / -23.2 |
| TMK 4-8-03:045 | (Rec. B ) | 50.7 | | 50.6 /-0.1 | | 37.5 / -13.2 |
| TMK 4-8-03:044 | (Rec. C ) | 54.1 | | 54.2 /0.1 | | 37.6 / -16.5 |
| TMK 4-8-03:084 | (Rec. D ) | 60.1 | | 60.2 /0.1 | | 37.9 / -22.2 |
| TMK 4-8-03:122 | (Rec. E ) | 58.0 | | 58.1 /0.1 | | 37.9 / -20.1 |
| NEW HONOAPIILANI HIGHWAY: | | | | | | |
| ROW 1 | (Rec. ROW 1) | 41.7 | | 41.9 0.2 | | 65.9 24.2 |
| ROW 2 | (Rec. ROW 2) | 42.4 | | 42.5 0.1 | | 64.6 22.2 |
| ROW 3 | (Rec. ROW 3) | 42.5 | | 42.1 -0.4 | | 65.6 23.1 |
| ROW 4 | (Rec. ROW 4) | 43.6 | | 43.2 -0.4 | | 51.8 8.2 |
| ROW 5 | (Rec. ROW 5) | 57.9 | | 57.8 -0.1 | | 65.2 7.3 |
| ROW 6 | (Rec. ROW 6) | 49.9 | | 49.0 -0.9 | | 62.5 12.6 |

**Note:**

* Traffic noise levels shown may exceed 66 Leq noise abatement criteria for Activity Category B during off-peak or AM peak hours when traffic noise levels may be 3 dBA higher than the PM peak hour values shown in the table.

within the HDOT 66 Leq noise abatement criteria. The existing residence west of the Olowalu General Store building (Receiver 15) currently experiences traffic noise levels of 64 dBA during the PM peak hour, and as high as 67 dBA during the off-peak or AM peak hour. These levels could exceed the HDOT 66 Leq noise abatement criteria for residences during the off-peak or AM peak hour.

The existing residence on the makai side of the highway at the Luawai Street intersection (Receiver A) currently experiences traffic noise levels of 64 dBA during the PM peak hour, and as high as 67 dBA during the off-peak or AM peak hour. These levels could exceed the HDOT 66 Leq noise abatement criteria for residences during the off-peak or AM peak hour.

At areas removed from Honoapiilani Highway (such as the residences mauka of the highway and near Luawai Street), existing traffic and background noise levels are typically greater than 35 dBA and less than 45 dBA. At these locations which are removed from the existing highway, other non-traffic noise sources (birds, local traffic, distant construction or yard maintenance equipment, and foliage moving with the wind) also were contributors to the total background noise levels.

## CHAPTER IV. DESCRIPTION OF FUTURE TRAFFIC NOISE LEVELS

Under the Build Alternative, realignment of Honoapiilani Highway is proposed as shown in Figure 1. Figure 2 presents the noise sensitive receptor (or receiver) locations where future traffic noise levels were calculated for the No Build and Build Alternatives using the FHWA Traffic Noise Model.

The future traffic noise levels in the project area during CY 2020 were evaluated for the No Build and Build Alternatives. The same methodology that was used to calculate the Base Year noise levels was also used to calculate the Year 2020 noise levels. Under the No Build Alternative, it was assumed that the existing Honoapiilani Highway would remain, and carry higher traffic volumes at reduced average speeds. Under the Build Alternative, the existing highway would be replaced by a new mauka alignment which would carry even higher traffic volumes at reduced average speeds. Under both the No Build and Build Alternatives, vehicle mixes were assumed to be identical to the Base Year values.

Tables 5, 6, and 7A summarize the traffic conditions, noise levels, and setback distances for the Build Alternative during the PM peak hour in CY 2020. The predicted CY 2020 traffic noise levels during the PM peak hour at the various receptor locations are shown in Table 5 for the No Build and Build Alternatives. Table 5 also indicates the increases in future traffic noise levels expected under the No Build and Build Alternatives prior to the inclusion of sound attenuation walls. Under the No Build Alternative, relatively small increases and decreases in traffic noise levels are expected to occur throughout the project area. As indicated in Table 5, the increases and decreases in future traffic noise levels under the Build Alternative vary in relationship to the receptors' proximity to the existing and proposed highway alignment. Future traffic noise levels at receptors in the immediate vicinity of the existing highway are predicted to decrease by approximately 4 to 26 dBA between CY 2011 and CY 2020 as a result of new highway alignment under the Build Alternative. Future traffic noise levels at existing receptors closer to the proposed highway realignment are predicted to increase by approximately 4 to 7 dBA between CY 2011 and CY 2020 as a result of new highway alignment under the Build Alternative. Under both the No Build or Build Alternatives, no existing residence is predicted to experience traffic noise levels above the HDOT 66 Leq noise abatement criteria by CY 2020.

Tables 4A and 4B depict the changes in setback distances from the existing highway centerline to the critical 66 Leq, 71 Leq, 65 DNL, and 75 DNL contours under the No Build Alternative. Tables 7A and 7B depict the predicted setback distances to the critical 66 Leq, 71 Leq, 65 DNL, and 75 DNL contours from the future highway centerline under the Build Alternative.

Table 6 contains the results of calculations of future traffic noise levels at 50, 100, and 200 feet from centerline of the proposed new highway alignment. It should be noted that the traffic noise levels shown in Table 6 may be as much as 3 dBA higher

# TABLE 6

## FUTURE (CY 2020) TRAFFIC VOLUMES AND NOISE LEVELS ALONG VARIOUS SECTIONS OF NEW HONOAPIILANI HIGHWAY ( PM PEAK HOUR; UNDER BUILD ALTERNATIVE )

| LOCATION | SPEED (MPH) | TOTAL VPH | ********* VOLUMES (VPH) *********** AUTOS | M TRUCKS | H TRUCKS | 50' Leq | 100' Leq | 200' Leq |
|---|---|---|---|---|---|---|---|---|
| West End of Olowalu Town * | 40 | 2,381 | 2,285 | 48 | 48 | 73.4 | 65.8 | 59.0 |
| At O-Turn Project Access 1 ** | 36 | 2,383 | 2,287 | 48 | 48 | 72.2 | 64.6 | 58.1 |
| At O-Turn Project Access 2 *** | 33 | 2,331 | 2,237 | 47 | 47 | 71.2 | 63.7 | 57.2 |
| East End of Olowalu Town **** | 37 | 2,282 | 2,190 | 46 | 46 | 72.4 | 64.8 | 58.1 |

Notes:

1. * 38 mph westbound; 41 mph eastbound
2. ** 37 mph westbound; 35 mph eastbound
3. *** 38 mph westbound; 28 mph eastbound
4. **** 38 mph westbound; 35 mph eastbound
5. All distances shown are from the center of Honoapiilani Highway.
6. Calculated Leq's are for unobstructed line-of-sight conditions.
7. The calculated Leq's for the AM and mid-day peak hours may be as much as 3 dBA higher than the values shown for the PM peak hour.

## TABLE 7A

## YEAR 2011 AND 2020 DISTANCES TO 66 AND 71 LEQ CONTOURS ( ACTION, PM PEAK HOUR )

| STREET SECTION | 66 Leq SETBACK (FT) | | 71 Leq SETBACK (FT) | |
|---|---|---|---|---|
| | EXISTING | CY 2020 | EXISTING | CY 2020 |
| West End of Olowalu Town * | N/A | 98 | N/A | 62 |
| At O-Turn Project Access 1 ** | N/A | 88 | N/A | 56 |
| At O-Turn Project Access 2 *** | N/A | 81 | N/A | 51 |
| East End of Olowalu Town **** | N/A | 90 | N/A | 57 |

**Notes:**

(1) All setback distances are from the roadways' centerlines.
(2) See TABLE 6 for traffic volume, speed, and mix assumptions.
(3) Setback distances are for unobstructed line-of-sight conditions.
(4) Loose soil conditions assumed along all roadways.

## TABLE 7B

## YEAR 2011 AND 2020 DISTANCES TO 65 AND 75 DNL CONTOURS ( ACTION, DNL )

| STREET SECTION | 65 DNL SETBACK (FT) | | 75 DNL SETBACK (FT) | |
|---|---|---|---|---|
| | EXISTING | CY 2020 | EXISTING | CY 2020 |
| West End of Olowalu Town * | N/A | 147 | N/A | 57 |
| At O-Turn Project Access 1 ** | N/A | 132 | N/A | 51 |
| At O-Turn Project Access 2 *** | N/A | 120 | N/A | 46 |
| East End of Olowalu Town **** | N/A | 134 | N/A | 52 |

**Notes:**

(1) All setback distances are from the roadways' centerlines.
(2) See TABLE 6 for traffic volume, speed, and mix assumptions.
(3) Setback distances are for unobstructed line-of-sight conditions.
(4) Loose soil conditions assumed along all roadways.

during the off peak or AM peak hours, when average traffic speeds may be higher than those shown in the table for the PM peak hour. Based on the results contained in Table 6, it was concluded that the HDOT 66 Leq noise abatement criteria would not be exceeded during the PM peak hour in CY 2020 beyond the 200 foot wide Right-of-Way, but that the HDOT 66 Leq noise abatement criteria could be exceeded beyond the 200 foot wide Right-of-Way during the off-peak or AM peak hour (after adding 3 dBA to the results in Table 6).

Table 7A contains the setback distances of the 66 and 71 Leq traffic noise contours from the centerline of the proposed new highway during the PM peak hour. Both the 66 and 71 Leq contours are not predicted to be outside the new highway's Rights-of-Way during the PM peak hour, but may be located outside the Rights-of-Way during the off-peak or AM peak hours. The locations of the 66 Leq contour under these worst case conditions range from 108 feet to 133 feet from the new highway's centerline. So noise buffer distances of 108 to 133 feet from the new highway's centerline will be required for any noise sensitive land use or park land if other noise mitigation measures are not included in the project. The 71 Leq traffic noise contour should not extend beyond the new highway's Rights-of-Way during the PM, off-peak, or AM peak hours, so other less sensitive land uses (such as commercial) located near the new highway alignment should not require traffic noise mitigation measures.

The existing residence west of the Olowalu General Store building is predicted to experience future traffic noise levels of 64 dBA during the PM peak hour, and as high as 67 dBA during the off-peak or AM peak hour under the No Build Alternative. These levels exceed the HDOT 66 Leq noise abatement criteria for residences during the off-peak or AM peak hour. This is the only existing residence where future traffic noise levels are predicted to exceed 66 Leq under the No Build Alternative. Under the Build Alternative, no existing residence is predicted to experience traffic noise levels which exceed 66 Leq during the PM, off-peak, or AM peak hours.

The 71 Leq criteria for commercial properties will not be exceeded at existing or future commercial properties under the No Build or Build Alternatives by CY 2020.

The following general conclusions can be made in respect to the impacted structures and lands which can be expected by CY 2020 under the Build Alternative. These conclusions are valid as long as the future vehicle mixes and average speeds do not differ from the assumed values.

- The HDOT's ">15 dB increase" criteria for substantial change in traffic noise levels will not be exceeded at any existing noise sensitive structure. Maximum increases in traffic noise levels in the project area should not exceed 7.0 dB as a result of growth in traffic volumes and realignment of the highway.

- Under the No Build Alternative, future traffic noise levels during the PM peak hour are expected to decrease or increase slightly at existing single family dwellings on both sides of the highway. Traffic noise levels at the existing dwelling next to Olowalu General Store may continue to exceed the 66 Leq criteria under the No Build Alternative.

- Future traffic noise levels should not exceed the 71 Leq criteria for commercial structures under the No Build or Build Alternatives along the existing or new highway.

- Under the Build Alternative, the 66 Leq noise mitigation criteria may be exceeded along the new highway if adequate setback distances are not provided for future residences, public use structures, or park lands. These setback distances may range from 108 to 147 feet from the new highway centerline, and may be reduced if sound attenuating walls are constructed along the future highway Rights-of-Way.

## CHAPTER V. POSSIBLE NOISE MITIGATION MEASURES

Possible noise mitigation measures considered included the following:

A. Restricting the Growth In the Number of Noisy Buses, Heavy Trucks, Motorcycles, and Automobiles with Defective Mufflers. The percentage contribution to the total traffic noise by heavy trucks, buses, and noisy vehicles is currently less than 30 percent, and elimination of these noise sources would reduce total traffic noise levels by less than 2.0 Leq(h) units. Restricting the growth rate of these vehicles (to growth rates below passenger automobile growth rates) could produce noise reductions in the order of 0.1 to 1.0 dB, which are not considered significant for the level of regulatory efforts required.

B. Alteration of the Horizontal Or Vertical Alignment of the Roadway. This project involves the realignment of the eastbound and westbound lanes of the highway and involves major alterations to the vertical and horizontal alignments of Honoapiilani Highway at Olowalu. Existing noise sensitive receptors which are located along the existing highway alignment will benefit from reductions in traffic noise levels of 4 to 26 dBA due to increased distances between their locations and the highway. Existing noise sensitive receptors located north of the existing highway will experience increased traffic noise levels ranging from 4 to 7 dBA due to the shortened distances between their locations and the highway. Increases in future traffic noise levels should not exceed the HDOT's ">15 dB increase" criteria for substantial change in traffic noise levels.

C. Acquisition of Property Rights for Construction of Noise Barriers, and/or Construction of Noise Barriers Along the Right-of-Way. For single story, noise sensitive buildings, construction of a sound attenuating wall is normally the preferred noise mitigation measure. The 5 to 7 dB of noise attenuation achievable with a 6 FT high wall is normally sufficient for single story structures. Because of the higher sloping terrain on the north side of the proposed highway, wall heights may need to be higher due to the elevated structures. In addition, the upper floors of those structures will not benefit from sound attenuation walls which are 6 to 8 feet high. Wall heights in excess of 8 feet above ground level along the Rights-of-Way will be required to attenuate traffic noise at the upper floor spaces. It should also be noted that the sound barrier will block the views to the roadway which some of the residents may enjoy. For this reason, concurrence from the affected homeowners should be obtained prior to construction of a sound barrier as a noise mitigation measure.

D. Acquisition of Real Property Interests To Serve As A Noise Buffer Zone. Because the highway realignment is part of a Master Plan for Olowalu Town, the allocation of lands for noise buffer zones along the new highway will be considered in the planning for the entire project. For this reason, acquisition of developed lands along the existing highway for noise buffers is not required.

E. Noise Insulation of Public Use or Nonprofit Institutional Structures. It is anticipated that no public use structures should require noise insulation as a result of the proposed highway realignment.

# CHAPTER VI. FUTURE TRAFFIC NOISE IMPACTS AND POSSIBLE NOISE MITIGATION MEASURES

Future traffic noise levels are not expected to exceed the HDOT 66 Leq(h) noise abatement criteria by CY 2020 under the Build Alternative at existing noise sensitive structures on both sides of the new highway. Adequate margins of 3 dBA or more exist between the HDOT 66 Leq noise abatement criteria and the predicted future noise levels at these existing noise sensitive structures. Therefore, additional sound attenuation measures should not be required to mitigate future traffic noise impacts at existing noise sensitive receptors.

At planned residences, parks, and other noise sensitive land uses along the proposed highway alignment, future traffic noise levels may exceed the HDOT 66 Leq criteria. Possible noise mitigation measures include: increasing the Rights-of-Way widths along the new highway from 200 feet to as much as 294 feet at noise sensitive receptor locations; including additional buffer distances of 20 to 47 feet between the Rights-of-Way and the noise sensitive structure or exterior area of frequent human use; or adding sound attenuating walls along the makai and mauka Rights-of-Way or Tops of Fill or tops of retaining walls fronting noise sensitive lots. Because the project's grading plans and detailed highway sections were not available, it was not possible to determine the top wall elevations which are required to comply with the minimum 7 dB attenuation criteria of HDOT for ground level receptors. So, if adequate setback distances (see following paragraph) of the noise sensitive structures are not possible, the project plans should include sound attenuating walls along the mauka (north) Right-of-Way, and along the top of fill along the makai (south Right-of-Way.

The adequate setback distances from future highway centerline to meet the HDOT 66 Leq criteria are as follows: a. 133 feet west of Project Access 1; b. 119 feet between Access 1 and Access 2; c. 108 feet between Access 2 and Access 3; and d. 120 feet east of Project Access 3. These setback distances should be adequate to allow for a 3 dBA increase in the peak hour noise levels.

The adequate setback distances from the future highway centerline to meet the FHA/HUD 65 DNL standard are as follows: a. 147 feet west of Project Access 1; b. 132 feet between Access 1 and Access 2; c. 120 feet between Access 2 and Access 3; and d. 134 feet east of Project Access 3.

Where required sound attenuating wall heights exceed 6 feet, a variance from local building codes may be required to construct the taller walls which may be required to achieve at least 7 dBA of noise reduction. By the existing HDOT policy (see Reference 5), an acceptable noise mitigation measure is one which provides at least 7 dBA of sound attenuation. In order to achieve this performance, the wall height must meet the minimum height requirement, the sound attenuating walls must be continuous without see-through openings, and must be constructed from solid materials which have a minimum surface weight of 5 pounds per square foot. Use of landscaping on the a minimum surface weight of 5 pounds per square foot. Use of landscaping on the roadway side of the wall is also recommended to soften the visual impacts of the walls and to minimize the potential for graffiti.

By the existing HDOT policy (see Reference 5), if the cost of the sound attenuating wall does not exceed $60,000 per benefited residence, construction of walls can be considered to be reasonable and feasible.

It is anticipated that potential noise impacts at any new noise sensitive or commercial establishments located in the project area may be mitigated through the inclusion of sound walls or other noise mitigation measures (such as closure and air conditioning) within the individual lot development plans. In addition, any new commercial establishments, public use facilities, or housing units which may be planned alongside the roadway represent areas of potential adverse noise impacts if adequate noise mitigation measures are not incorporated into the planning of these future projects. It is anticipated that the project's roadway improvements will be completed prior to any redevelopment of the presently open areas adjacent to the roadway, and that noise abatement measures such as adequate setbacks, sound attenuating walls or berms, or closure and air conditioning will be incorporated into these new developments along the roadway as required. In any event, new structures whose building permits were obtained after the date of this noise study will not qualify for noise abatement measures under existing HDOT procedures.

# CHAPTER VII. CONSTRUCTION NOISE IMPACTS

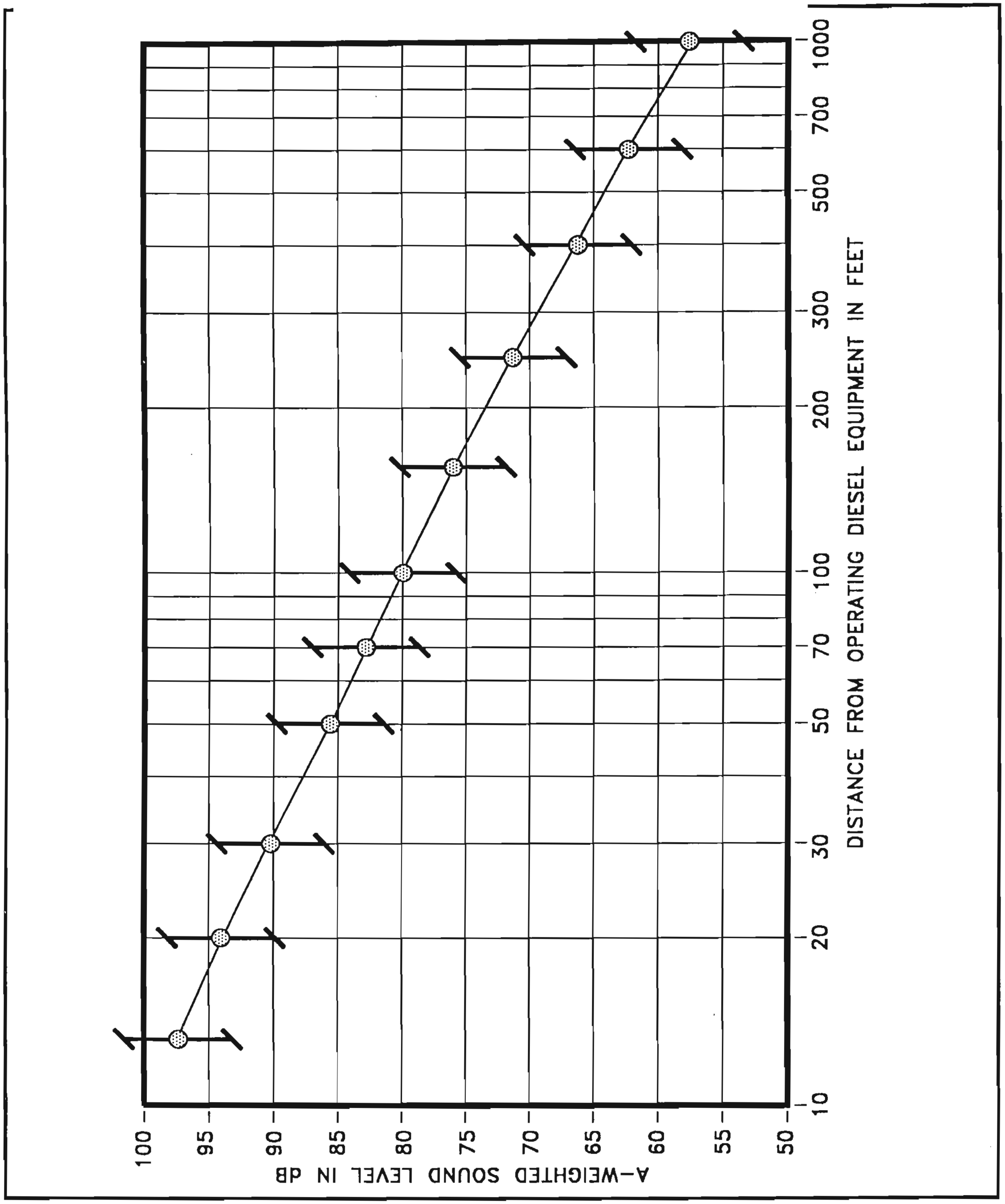
General Construction. Short-term noise impacts associated with construction activities along the existing highway may occur. These impacts can occur as a result of the relatively low background noise levels at existing dwelling units closest to the anticipated construction corridor. The total duration of the construction period for the proposed project is not known, but noise exposure from construction activities at any one receptor location is not expected to be continuous during the total construction period.

Noise levels of diesel powered construction equipment typically range from 80 to 90 dBA at 50 FT distance. Typical levels of noise from construction activity (excluding pile driving activity) are shown in Figure 4. The maximum impulsive noise levels of rock breaking equipment (such as hoe rams) can be 5 to 8 dBA greater than those shown in Figure 4. Adverse impacts from construction noise are not expected to be in the "public health and welfare" category due to the temporary nature of the work and due to the administrative controls available for its regulation. Instead, these impacts will probably be limited to the temporary degradation of the quality of the acoustic environment in the immediate vicinity of the project site.

Construction noise levels at existing structures can intermittently exceed 75 dBA when work is being performed within 300 feet of these structures. Along the new highway Rights-of-Way, distances between the construction sites and receptors are expected to be between 300 and 2000 FT, and construction noise levels may intermittently exceed 75 dBA. The State Department of Health currently regulates noise from construction activities under a permit system (Reference 7). Under current permit procedures (see Figure 5), noisy construction activities are restricted to hours between 7:00 AM and 6:00 PM, from Monday through Friday, and exclude certain holidays. Noisy construction activities are normally restricted to the hours of 9:00 AM to 6:00 PM on Saturdays, with construction not permitted on Sundays. These restrictions minimize construction noise impacts on noise sensitive receptors along the roadway project corridor, and have generally been successfully applied. In this way, construction noise impacts on noise sensitive receptors can be minimized.

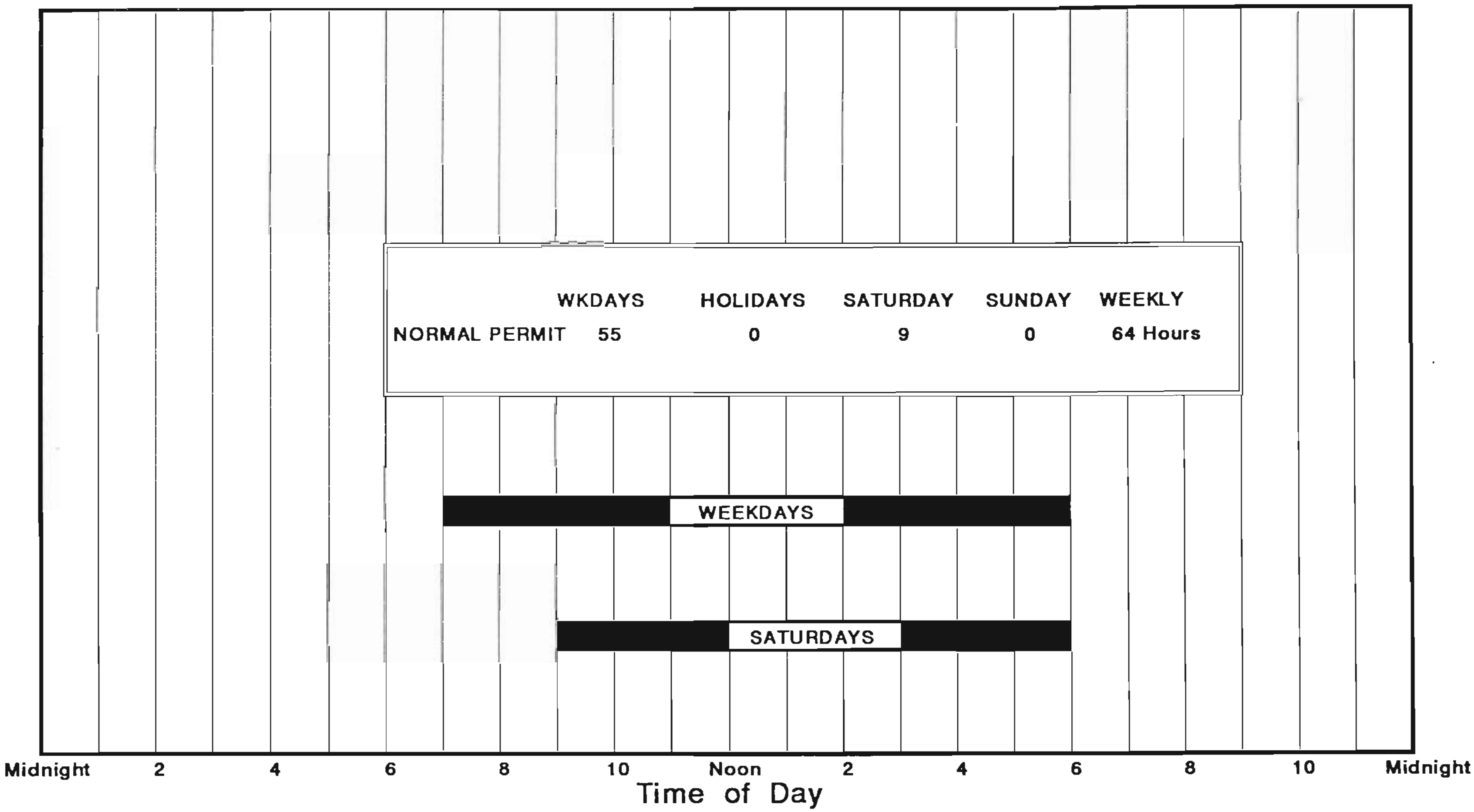
In addition, the use of quieted portable engine generators and diesel equipment should be specified for use within 500 FT of noise sensitive properties. Heavy truck and equipment staging areas should also be located at areas which are at least 500 FT from noise sensitive properties whenever possible. Truck routes which avoid residential communities should be identified wherever possible. The use of 8 to 12 FT high construction noise barriers may also be used where close-in construction work to noise sensitive structures is unavoidable.

Blasting. Blasting may be used to fragment and/or dislodge rock during the construction operations to reduce the time required to cut into the faces of the existing highway cuts. Nighttime or early morning blasting operations should not be required.




**ANTICIPATED RANGE OF CONSTRUCTION NOISE LEVELS VS. DISTANCE**

**FIGURE 4**




AVAILABLE WORK HOURS UNDER DOH PERMIT PROCEDURES FOR CONSTRUCTION NOISE

FIGURE 5

Blast induced ground and air vibrations have the potential to startle or annoy surrounding residents, and to also cause damage to structures. However, when properly controlled, blasting operations at the proposed construction site need not pose significant risks of damage or annoyance to neighboring buildings or residents.

Airborne Noise from Blasting. The air blasts associated with blasting are concussion type, low frequency vibrations, which are of relatively short duration (or impulsive) and generally described in terms of peak over pressure in psi, or in dBL. The dominant sources of the air blast are the Air Pressure Pulse, which is caused by the large displacement of the ground surface near the charge, and the Stemming Release Pulse, which is caused by gas pressure ejecting the stemming (fill) material from the hole bored for the explosive charge. The low frequency characteristic (usually referred to as bass sounds) of air blast noise tends to induce vibrations in structures (and subsequent complaint reactions) due to the low resonant frequency (10 to 25 Hz) of buildings. High frequency sounds of amplitudes equal to blast noise generally do not induce vibrations and cause physical damage to structures. Although the human ear has an opposite characteristic (i.e., the ear is less sensitive to low frequency sounds), structures which vibrate can produce secondary audible effects such as rattling sounds (of fixtures, doors, etc.), and effects which are sensitive to touch (or feelable). Sound levels at which these secondary effects occur vary with the weight (and probably stiffness) of the structure. In general, the inception point of sound induced vibration is difficult to establish, but may occur at levels as low as 80 dBL. These levels are significantly below the peak levels of 120 to 136 dBL which have been associated with low risk of damage to structures.

If blasting is used to break or dislodge rock, the charge weights per delay will be adjusted so as to eliminate any risk of damage to nearby structures. The levels of air blast are anticipated to be well below the structural damage criteria for buildings, so risks of window glass breakage from the blasting at the proposed project are considered to be very low. Since complaints resulting from air blast noise levels may occur at levels considerably below those necessary to cause damage to structures (120 to 136 dBL), additional analyses were conducted to estimate the percent of the neighboring population which may be highly annoyed by blasting operations. At air blast noise levels of 120 dBL, and with no more than five blasts per week, the average noise exposure levels from blasting operations are predicted to be 41 Lcdn, which is analogous to 41 Ldn except for the use of C-Weighting rather than A-Weighting filters. An exposure level of 41 Lcdn (or 41 Ldn) is very low, and less than 1.0 percent of the population exposed to this level are expected to be highly annoyed (see Reference 8). For these reasons, risks of adverse noise impacts from blasting operations of up to five blasts per week which are also controlled to avoid risks of damage to structures are considered to be very low.

Ground Vibration from Blasting. Ground vibrations, or seismic waves, are also generated during blasting operations, and are generally described in terms of peak particle velocity in inches/ second. Most of the seismic energy remains trapped in the ground, but some energy is released as an over pressure pulse into the air (or Rock

Pressure Pulse). In general, the ground vibrations as well as the airborne Rock Pressure Pulse are expected to be less intrusive than the Air Pressure and Stemming Release Pulses. As an example, tunneling work under Dole Street on Oahu for a sewer project generated some initial air blast complaints from nearby residents during blasting of the surface entrance to the tunnel. However, once the entrance to the tunnel was formed and blasting was confined to tunneling underground, complaints stopped.

Predictions of peak over pressure or ground vibration levels vs. scaled distance from the blast are not precise, with initial uncertainties for a given location in the order of 20 to 30 dBL. For this reason, it is standard practice to employ seismograph monitoring of air and ground vibrations during blasting operations with a 3-axis geophone (for ground vibrations) and a microphone (for air vibrations).

The separation distances between the potential blasting areas and surrounding noise sensitive neighbors range are relatively large and range from approximately 300 feet to 2,000 feet. At the shorter separation distances between the blast areas and surrounding noise sensitive neighbors, charge weights will probably be limited to less than three pounds of explosives per delay. At 2.75 pounds of explosives per delay, the predicted vibration levels at 300 feet separation distance are in the order of 0.04 to 0.20 inches per second. These predicted levels of ground vibration are encroaching into the thresholds for structural or architectural damage to buildings, and may be feelable (see TABLE 8). In addition, these levels are also encroaching into the 0.35 inches per second threshold recommended to minimize adverse human responses to vibrations resulting from sporadic impulsive shock excitations (see Reference 9). Based on these predictions of vibration levels from blasting operations, it was concluded that risks of adverse impacts from ground vibrations can be very low, but the sizes of the charge weights per delay will need to be controlled in order to minimize risks of damage to nearby structures.

<u>Mitigation of Noise and Vibration Impacts from Blasting</u>. Because blasts may be both feelable and audible at the surrounding residences, mitigation measures will probably be required to minimize risks of antagonizing nearby residents. These recommended mitigation measures are described as follows:

- Regularly monitor air blast and ground vibration levels simultaneously at the closest noise sensitive residence(s) or structure(s) during the blasting operations to develop the data base for the surrounding area.

- For initial blasts, prior to establishment of a data base of ground vibration and air blast levels vs. scaled distance, use the minimum practical charge weight (in equivalent pounds of TNT) per delay as well as the minimum practical number of delays (or bore holes).

- If practical, reduce maximum air blast levels to less than 110 dBL at the nearest noise sensitive residences in response to air blast complaints. Possible methods

## TABLE 8

## SUMMARY OF BUILDING DAMAGE CRITERIA

| PEAK GROUND VELOCITY (mm/sec) | PEAK GROUND VELOCITY (in/sec) | COMMENT |
|---|---|---|
| 193.04 | 7.6 | Major damage to buildings (mean of data). |
| 137.72 | 5.4 | Minor damage to buildings (mean of data). |
| 101.16 | 4.0 | 'Engineer structures' safe from damage. |
| 50.8 | 2.0 | Safe from damage limit (probability of damage <5%). |
| | | No structural damage. |
| 33.02 | 1.3 | Threshold of risk of 'architectural' damage for houses. |
| 25.4 | 1.0 | No data showing damage to structures for vibration <1 in./sec. |
| 15.24 | 0.6 | No risk of 'architectural' damage to normal buildings. |
| 10.16 | 0.4 | Threshold of damage in older homes. |
| 5.08 | 0.2 | Statistically significant percentage of structures may experience minor damage (including earthquake, nuclear event, and blast data for old and new structures). |
| | | No 'architectural' damage. |
| 3.81 | 0.5 to 0.15 | Upper limits for ruins and ancient monuments. |
| 1.0 | 0.04 | Vertical vibration clearly perceptible to humans. |
| 0.32 | 0.01 | Vertical vibration just perceptible to humans. |

Source: 'State-of-the-Art Review: Prediction and Control of Groundborne Noise and Vibration from Rail Transit Trains'; U.S. Department of Transportation; December 1983.

of accomplishing this are: reducing charge sizes; increasing delay intervals; increasing hole depth; orienting bore holes to direct the Stemming Release Pulse away from noise sensitive properties; trucking in high quality stemming material to minimize stemming blowouts; and filling (sandbagging) over the area to be blasted and the detonating chord.

- Schedule actual blasting during the warm periods of the day to minimize the possibility of thermal ducting and focusing of air blast noise at large distances from the blast. If possible, also schedule blasting during fixed time periods, so that the members of the community can also schedule their activities accordingly.

- The most conservative vibration criteria for damage to "Ruins and Ancient Monuments" (see TABLE 8) is 0.15 inches per second. Initial test shots should be structured so as to not exceed this limit at the closest structures, with subsequent shots adjusted to reflect the results of the blast monitoring data.

## APPENDIX A. REFERENCES

(1) "FHWA Highway Traffic Noise Model User's Guide;" FHWA-PD-96-009, Federal Highway Administration; Washington, D.C.; January 1998 and Version 2.5 Upgrade (April 14, 2004).

(2) Existing and Future Peak Hour Traffic Volumes along Honoapiilani Highway; July 5, 2011 email from Bill Frampton.

(3) Hourly Traffic Volumes On Honoapiilani Highway At Station B74003001089; Hawaii State Department of Transportation, Highways Division, Planning Branch; May 20, 2009.

(4) Federal Highway Administration; "Procedures for Abatement of Highway Traffic Noise and Construction Noise;" 23 CFR Chapter I, Subchapter H, Part 772;" April 1, 1995.

(5) "Highway Noise Policy and Abatement Guidelines;" Hawaii State Department of Transportation, Highways Division, and U.S. Department of Transportation, Federal Highway Administration; April 25, 2011.

(6) Preliminary Plans and Sections of Proposed Realignment of Honoapiilani Highway; May 11, 2011 email from Mark M. Matsuda, Otomo Engineering, Inc.

(7) "Title 11, Administrative Rules, Chapter 46, Community Noise Control;" Hawaii State Department of Health; September 23, 1996.

(8) "Method for Assessment of High-Energy Impulsive Sounds with Respect to Residential Communities;" American National Standard, ANSI S12.4; Acoustical Society of America.

(9) "Guide to the Evaluation of Human Exposure to Vibration in Buildings;" American National Standard, ANSI S2.71; Acoustical Society of America.

# APPENDIX B

# EXCERPTS FROM EPA'S ACOUSTIC TERMINOLOGY GUIDE

Descriptor Symbol Usage

The recommended symbols for the commonly used acoustic descriptors based on A-weighting are contained in Table I. As most acoustic criteria and standards used by EPA are derived from the A-weighted sound level, almost all descriptor symbol usage guidance is contained in Table I.

Since acoustic nomenclature includes weighting networks other than "A" and measurements other than pressure, an expansion of Table I was developed (Table II). The group adopted the ANSI descriptor-symbol scheme which is structured into three stages. The first stage indicates that the descriptor is a level (i.e., based upon the logarithm of a ratio), the second stage indicates the type of quantity (power, pressure, or sound exposure), and the third stage indicates the weighting network (A, B, C, D, E.....). If no weighting network is specified, "A" weighting is understood. Exceptions are the A-weighted sound level and the A-weighted peak sound level which require that the "A" be specified. For convenience in those situations in which an A-weighted descriptor is being compared to that of another weighting, the alternative column in Table II permits the inclusion of the "A". For example, a report on blast noise might wish to contrast the LCdn with the LAdn.

Although not included in the tables, it is also recommended that "Lpn" and "LepN" be used as symbols for perceived noise levels and effective perceived noise levels, respectively.

It is recommended that in their initial use within a report, such terms be written in full, rather than abbreviated. An example of preferred usage is as follows:

The A-weighted sound level (LA) was measured before and after the installation of acoustical treatment. The measured LA values were 85 and 75 dB respectively.

Descriptor Nomenclature

With regard to energy averaging over time, the term "average" should be discouraged in favor of the term "equivalent". Hence, Leq, is designated the "equivalent sound level". For Ld, Ln, and Ldn, "equivalent" need not be stated since the concept of day, night, or day-night averaging is by definition understood. Therefore, the designations are "day sound level", "night sound level", and "day-night sound level", respectively.

The peak sound level is the logarithmic ratio of peak sound pressure to a reference pressure and not the maximum root mean square pressure. While the latter is the maximum sound pressure level, it is often incorrectly labelled peak. In that sound level meters have "peak" settings, this distinction is most important.

"Background ambient" should be used in lieu of "background", "ambient", "residual", or "indigenous" to describe the level characteristics of the general background noise due to the contribution of many unidentifiable noise sources near and far.

With regard to units, it is recommended that the unit decibel (abbreviated dB) be used without modification. Hence, DBA, PNdB, and EPNdB are not to be used. Examples of this preferred usage are: the Perceived Noise Level (Lpn was found to be 75 dB. Lpn = 75 dB). This decision was based upon the recommendation of the National Bureau of Standards, and the policies of ANSI and the Acoustical Society of America, all of which disallow any modification of bel except for prefixes indicating its multiples or submultiples (e.g., deci).

Noise Impact

In discussing noise impact, it is recommended that "Level Weighted Population" (LWP) replace "Equivalent Noise Impact" (ENI). The term "Relative Change of Impact" (RCI) shall be used for comparing the relative differences in LWP between two alternatives.

Further, when appropriate, "Noise Impact Index" (NII) and "Population Weighed Loss of Hearing" (PHL) shall be used consistent with CHABA Working Group 69 Report Guidelines for Preparing Environmental Impact Statements (1977).

## TABLE I

## A-WEIGHTED RECOMMENDED DESCRIPTOR LIST

| | TERM | SYMBOL |
|---|---|---|
| 1. | A-Weighted Sound Level | $L_A$ |
| 2. | A-Weighted Sound Power Level | $L_{WA}$ |
| 3. | Maximum A-Weighted Sound Level | $L_{max}$ |
| 4. | Peak A-Weighted Sound Level | $L_{Apk}$ |
| 5. | Level Exceeded x% of the Time | $L_x$ |
| 6. | Equivalent Sound Level | $L_{eq}$ |
| 7. | Equivalent Sound Level over Time (T) (1) | $L_{eq(T)}$ |
| 8. | Day Sound Level | $L_d$ |
| 9. | Night Sound Level | $L_n$ |
| 10. | Day-Night Sound Level | $L_{dn}$ |
| 11. | Yearly Day-Night Sound Level | $L_{dn(Y)}$ |
| 12. | Sound Exposure Level | $L_{SE}$ |

(1) Unless otherwise specified, time is in hours (e.g. the hourly equivalent level is $L_{eq(1)}$). Time may be specified in non-quantitative terms (e.g., could be specified a $L_{eq(WASH)}$ to mean the washing cycle noise for a washing machine).

SOURCE: EPA ACOUSTIC TERMINOLOGY GUIDE, BNA 8-14-78,

## APPENDIX B (CONTINUED)

### TABLE II

### RECOMMENDED DESCRIPTOR LIST

| TERM | A-WEIGHTING | ALTERNATIVE(1) A-WEIGHTING | OTHER(2) WEIGHTING | UNWEIGHTED |
|---|---|---|---|---|
| 1. Sound (Pressure)(3) Level | $L_A$ | $L_{pA}$ | $L_B$, $L_{pB}$ | $L_p$ |
| 2. Sound Power Level | $L_{WA}$ | | $L_{WB}$ | $L_W$ |
| 3. Max. Sound Level | $L_{max}$ | $L_{Amax}$ | $L_{Bmax}$ | $L_{pmax}$ |
| 4. Peak Sound (Pressure) Level | $L_{Apk}$ | | $L_{Bpk}$ | $L_{pk}$ |
| 5. Level Exceeded x% of the Time | $L_x$ | $L_{Ax}$ | $L_{Bx}$ | $L_{px}$ |
| 6. Equivalent Sound Level | $L_{eq}$ | $L_{Aeq}$ | $L_{Beq}$ | $L_{peq}$ |
| 7. Equivalent Sound Level (4) Over Time(T) | $L_{eq(T)}$ | $L_{Aeq(T)}$ | $L_{Beq(T)}$ | $L_{peq(T)}$ |
| 8. Day Sound Level | $L_d$ | $L_{Ad}$ | $L_{Bd}$ | $L_{pd}$ |
| 9. Night Sound Level | $L_n$ | $L_{An}$ | $L_{Bn}$ | $L_{pn}$ |
| 10. Day-Night Sound Level | $L_{dn}$ | $L_{Adn}$ | $L_{Bdn}$ | $L_{pdn}$ |
| 11. Yearly Day-Night Sound Level | $L_{dn(Y)}$ | $L_{Adn(Y)}$ | $L_{Bdn(Y)}$ | $L_{pdn(Y)}$ |
| 12. Sound Exposure Level | $L_S$ | $L_{SA}$ | $L_{SB}$ | $L_{Sp}$ |
| 13. Energy Average Value Over (Non-Time Domain) Set of Observations | $L_{eq(e)}$ | $L_{Aeq(e)}$ | $L_{Beq(e)}$ | $L_{peq(e)}$ |
| 14. Level Exceeded x% of the Total Set of (Non-Time Domain) Observations | $L_{x(e)}$ | $L_{Ax(e)}$ | $L_{Bx(e)}$ | $L_{px(e)}$ |
| 15. Average $L_x$ Value | $L_x$ | $L_{Ax}$ | $L_{Bx}$ | $L_{px}$ |

(1) "Alternative" symbols may be used to assure clarity or consistency.

(2) Only B-weighting shown. Applies also to C,D,E,.....weighting.

(3) The term "pressure" is used only for the unweighted level.

(4) Unless otherwise specified, time is in hours (e.g., the hourly equivalent level is Leq(1). Time may be specified in non-quantitative terms (e.g., could be specified as Leq(WASH) to mean the washing cycle noise for a washing machine.

## APPENDIX C

## SUMMARY OF BASE YEAR AND FUTURE YEAR TRAFFIC VOLUMES ALONG HONOAPIILANI HIGHWAY

| ROADWAY LANES | **** CY 2011 ***** | | CY 2020 (NO BUILD) | | CY 2020 (BUILD) | |
|---|---|---|---|---|---|---|
| | AM VPH | PM VPH | AM VPH | PM VPH | AM VPH | PM VPH |
| Along Existing Honoapiilani Highway: | | | | | | |
| At Solid Waste Transfer Station (WB) | 865 | 935 | 995 | 1,075 | N/A | N/A |
| At Solid Waste Transfer Station (EB) | 606 | 841 | 697 | 967 | N/A | N/A |
| Two-Way | 1,471 | 1,776 | 1,692 | 2,042 | N/A | N/A |
| At Olowalu General Store (WB) | 865 | 933 | 995 | 1,073 | N/A | N/A |
| At Olowalu General Store (EB) | 622 | 852 | 715 | 980 | N/A | N/A |
| Two-Way | 1,487 | 1,785 | 1,710 | 2,053 | N/A | N/A |
| At Luawai Street (WB) | 863 | 944 | 991 | 1,086 | N/A | N/A |
| At Luawai Street (EB) | 608 | 843 | 698 | 969 | N/A | N/A |
| Two-Way | 1,471 | 1,787 | 1,689 | 2,055 | N/A | N/A |
| Along Proposed Honoapiilani Highway: | | | | | | |
| At Solid Waste Transfer Station (WB) | N/A | N/A | N/A | N/A | 1,170 | 1,220 |
| At Solid Waste Transfer Station (EB) | N/A | N/A | N/A | N/A | 771 | 1,161 |
| Two-Way | N/A | N/A | N/A | N/A | 1,941 | 2,381 |
| At Project Access 1 (WB) | N/A | N/A | N/A | N/A | 1,108 | 1,222 |
| At Project Access 1 (EB) | N/A | N/A | N/A | N/A | 781 | 1,161 |
| Two-Way | N/A | N/A | N/A | N/A | 1,889 | 2,383 |
| At Project Access 2 (WB) | N/A | N/A | N/A | N/A | 1,059 | 1,201 |
| At Project Access 2 (EB) | N/A | N/A | N/A | N/A | 814 | 1,130 |
| Two-Way | N/A | N/A | N/A | N/A | 1,873 | 2,331 |
| At Project RIRO Access 3 (WB) | N/A | N/A | N/A | N/A | 1,049 | 1,209 |
| At Project RIRO Access 3 (EB) | N/A | N/A | N/A | N/A | 817 | 1,073 |
| Two-Way | N/A | N/A | N/A | N/A | 1,866 | 2,282 |

NOTES:

1. "No Build" Represents Conditions without Olowalu Town Master Plan Project and without Honoapiilani Highway Realignment.
2. "Build" Represents Conditions with Olowalu Town Master Plan Project At Build-Out Plus Honoapiilani Highway Realignment.