Appendix E: Noise Study

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Environmental Noise Assessment
Keaau-Pahoa Road Improvements Project
Puna, Hawaii County, Hawaii

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DLAA Project No. 06-36

Prepared for:
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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 EXECUTIVE SUMMARY

1.1 The Hawaii Department of Transportation is proposing improvements to Keaau-Pahoa Road. The improvements will involve widening the roadway to accommodate up to two additional lanes in each direction. The proposed project is approximately 9.5 miles from the end of the existing Keaau Bypass to its intersection with Pahoa-Kapoho Road.

1.2 The project area currently experiences relatively high ambient noise levels that are dynamic and depend significantly on the vehicular traffic patterns of Keaau-Pahoa Road. Long term noise measurements conducted along Keaau-Pahoa Road show that noise levels range from 61 to 69 dBA during peak traffic hours and 55 to 64 dBA at night.

1.3 The various construction phases of the project may generate significant amounts of noise that could impact the residences and businesses located along the project corridor. The actual noise levels produced during construction will be a function of the methods employed during each stage of the construction process. The noise from construction activities should be relatively short term, occur only during daytime hours, and must comply with State Department of Health noise regulations.

1.4 A detour route is not planned to divert traffic away from the construction zone. However, the area surrounding Keaau-Pahoa Road may experience heavier traffic due to the reduced speed and possible reduction in travel lanes in the limited three-lane segment that will be in place north of Shower Drive. As a result, traffic noise (from vehicular traffic only, not including construction noise) is likely to decrease during the construction period. However, these changes will be short term and only during the construction period.

1.5 A significant sound level increase is predicted for the future year 2038 forecast for both the “no-build” and “worst-case-build” alternatives. The traffic noise increases correlate with the projected increase in peak hour traffic volumes along the roadway and therefore vary over the length of the roadway. However, the change in traffic noise due to the widening of Keaau-Pahoa Road is predicted to be less than 3 dB. A change in sound level less than 3 dB is not considered to be significant.

1.6 Many noise receptors located alongside Keaau-Pahoa Road currently experience (or will experience in the future) traffic noise levels that exceed the Federal Highway Administration (FHWA) and Hawaii Department of Transportation (HDOT) noise abatement criteria. Several additional receptors will exceed the criteria due to the road widening project. Noise mitigation should be considered for residences located along the project corridor.

2.0 PROJECT DESCRIPTION

The Keaau-Pahoa Road Improvements project is located in Puna on the east side of the Big Island of Hawaii. The proposed project is approximately 9.5 miles from the end of the existing 4-lane Keaau Bypass to its intersection with Pahoa-Kapoho Road. The area along the proposed project corridor is a rural area with mostly residential and commercial buildings situated on both sides of the roadway.

The project proposes to widen the roadway to accommodate up to two additional lanes in each direction. The project will also consider bike lanes, bus pull-outs, shoulders and median treatments. Currently there are 3 "Build Alternatives" under consideration. For the noise impact analysis, only a "worst-case" alignment was considered for the prediction of traffic noise levels in the future. This scenario is a combination of the widest cross sections under Build Alternatives 4 and 5 which varies between 4 and 6 vehicular traffic lanes.

During construction, continual traffic will be permitted along the highway throughout the project and a detour route is not planned. However, traffic speed will likely be reduced through the construction area.

3.0 NOISE GUIDELINES, STANDARDS, AND REGULATIONS

Various local and federal agencies have established guidelines and standards for assessing environmental noise impacts and set noise limits as a function of land use. A brief description of common acoustic terminology used in these guidelines and standards is presented in Appendix A.

3.1 State of Hawaii, Community Noise Control

The State of Hawaii Community Noise Control Rule [Reference 1] defines three classes of zoning districts and specifies corresponding maximum permissible sound levels due to *stationary* noise sources such as air-conditioning units, exhaust systems, generators, compressors, pumps, etc. The Community Noise Control Rule does not address most *moving* sources, such as vehicular traffic noise, air traffic noise, or rail traffic noise. However, the Community Noise Control Rule does regulate noise related to construction activities, which may not be stationary.

The maximum permissible noise levels are enforced by the State Department of Health (DOH) for any location at or beyond the property line and shall not be exceeded for more than 10% of the time during any 20-minute period. The specified noise limits which apply are a function of the zoning and time of day as shown in Figure 1. With respect to mixed zoning districts, the rule specifies that the primary land use designation shall be used to determine the applicable zoning district class and the maximum permissible sound level. In determining the maximum permissible sound level, the background noise level is taken into account by the DOH.

3.2 U.S. Federal Highway Administration (FHWA)

The FHWA defines four land use categories and assigns corresponding maximum hourly equivalent sound levels, $L_{eq(h)}$, for traffic noise exposure [Reference 2], which are listed in Figure 2. For example, Category B, defined as picnic and recreation areas, parks, residences, motels, hotels, schools, churches, libraries, and hospitals, has a corresponding maximum exterior L_{eq} of 67dBA and a maximum interior L_{eq} of 52 dBA. In this study, most land can be considered to fall into land use category B or C. These limits are viewed as design goals, and all projects meeting these limits are deemed in conformance with FHWA noise standards. Calculation of traffic noise levels should be conducted using a Federal Highway Administration traffic noise model [Reference 3].

3.3 Hawaii Department of Transportation (HDOT)

The HDOT has adopted FHWA's design goals for traffic noise exposure in its noise analysis and abatement policy [Reference 4]. According to the policy, a traffic noise impact occurs when the predicted traffic noise levels "approach" or exceed FHWA's design goals or when the predicted traffic noise levels "substantially exceed the existing noise levels." The policy also states that "approach" means at least 1 dB less than FHWA's design goals and "substantially exceed the existing noise levels" means an increase of at least 15 dB.

3.4 U.S. Environmental Protection Agency (EPA)

The U.S. EPA has identified a range of yearly day-night equivalent sound levels, L_{dn}, sufficient to protect public health and welfare from the effects of environmental noise [Reference 5]. The EPA has established a goal to reduce exterior environmental noise to an L_{dn} not exceeding 65 dBA and a future goal to further reduce exterior environmental noise to an L_{dn} not exceeding 55 dBA. Additionally, the EPA states that these goals are not intended as regulations as it has no authority to regulate noise levels, but rather they are intended to be viewed as levels below which the general population will not be at risk from any of the identified effects of noise.

4.0 EXISTING ACOUSTICAL ENVIRONMENT

Two types of noise measurements were conducted to assess the existing acoustical environment within the project corridor. The first noise measurement type consisted of continuous long-term ambient noise level measurements (Locations L1 and L2). The second type of noise measurement was short-term (Location S1). The methodology, location, and results for each of the measurements are described below and the measurement locations are illustrated in Figure 3.

4.1 Long Term Noise Measurements

4.1.1 Long-Term Noise Measurement Procedure

The ambient noise measurements took place on January 20th to January 21st, 2010. Continuous, hourly averaged sound levels were recorded for 24 hours at each location. The measurements were taken using a Larson-

Davis Laboratories, Model 820, Type 1 Sound Level Meter together with a Gras, Model 40AQ Type-1 Microphone. Calibration was checked before and after the measurements with a Larson-Davis Model CAL200 calibrator. Both the sound level meter and the calibrator have been certified by the manufacturer within the recommended calibration period. The microphones were mounted on tripods, approximately 6 feet above grade. Windscreens covered the microphones during the entire measurement period. The sound level meters were secured in a weather resistant case.

4.1.2 Long-Term Noise Measurement Locations

Makuu Farmers Market (L1): The meter was located on the north-eastern side of Keaau-Pahoa Road, approximately 105 feet east of the centerline of the road.

Private Residence (L2): The meter was located on the western side of Keaau-Pahoa Road, approximately 70 feet west of the centerline of the road.

4.1.3 Long-Term Noise Measurement Results

The results from these long-term sound measurements are graphically presented in Figures 4 and 5, which show the measured hourly equivalent sound level, L_{eq}, and the 90 percent exceedance level, L_{90}, in A-weighted decibels (dBA) as a function of the measurement date and time. The graph for Location L2 shows an "overload" condition which occurred on the evening of January 20^{h}. This error may have been caused by wet weather conditions.

The ambient sound levels at both locations are relatively dynamic and depend significantly on the vehicular traffic patterns of Keaau-Pahoa Road. The dominant noise source for both locations is vehicular traffic noise along Keaau-Pahoa Road. Secondary noise sources include birds, wind, rain, and occasional aircraft flyovers.

4.2 Short Term Noise Measurements

An approximate 1-hour equivalent sound level, L_{eq}, was measured in the vicinity of Location L1 where the sound level meter was positioned approximately 70 feet north-east of the centerline of Keaau-Pahoa Road,. Vehicular traffic counts and traffic mix were documented during the measurement period. The noise measurement was taken using a Larson-Davis Laboratories, Model 824, Type-1 Sound Level Meter together with a Larson-Davis, Model 2541 Type-1 Microphone. Calibration was checked before and after the measurements with a Larson-Davis Model CAL200 calibrator. Both the sound level meter and the calibrator have been certified by the manufacturer within the recommended calibration period. The microphone and sound level meter were mounted on a

tripod, approximately 5 feet above grade. A windscreen covered the microphone during the entire measurement period.

The measurements were conducted during the peak AM and PM traffic hour and were used to validate the traffic noise model prediction software (as discussed in Section 5.2.1 below).

5.0 POTENTIAL NOISE IMPACTS

5.1 Project Construction Noise

The area along Keaau-Pahoa Road is zoned for agricultural, residential and commercial uses. The Hawaii Community Noise Control Rules state that the primary land use designation shall be used to determine the applicable zoning district class. Maximum permissible noise levels are specified by the State rules for daytime and nighttime hours, but ambient noise levels are also taken into account. Construction noise levels are expected to exceed the daytime limits and a permit must be obtained from the State DOH to allow the operation of construction equipment.

Much of the project area can be considered noise sensitive as residences and businesses along Keaau-Pahoa Road may be impacted by the project construction noise due to their proximity to the project. The actual noise levels produced during construction will be a function of the methods employed during each stage of the construction process. Typical ranges of construction equipment noise are shown in Figure 6.

The Keaau-Pahoa Road improvements may include involve roadway excavation and embankment; drain line trenching and backfilling, concrete work, utility pole relocation, and roadway paving., etc. and will utilize equipment such as jackhammers, saw cutters, backhoes, front loaders, dump trucks, generators, and compressors. Pavement cutters, jackhammers, backhoes and earthmoving equipment, e.g., bulldozers and diesel-powered trucks will probably be the loudest equipment used during construction.

5.2 Compliance with FHWA/HDOT Noise Guidelines

5.2.1 Traffic Noise Model Overview

As required by the Federal Highway Administration, traffic noise levels were calculated using the FHWA's Traffic Noise Model [Reference 6]. The existing road conditions were modeled for peak hour AM and PM traffic and a vehicular traffic noise analysis was completed at 181 noise receiver locations (most of which are single family homes). Noise projections were also calculated for the same receiver locations during the peak hour AM and PM traffic for both the "no-build" and "build" alternatives for the year 2038, referred to as "future" year herein. For the "build" noise impact analysis, a worst-case alignment was the basis for the traffic noise model where the roadway lanes are positioned closest to the receivers. This alignment is a combination of Build Alternative 5 (a six-

lane cross-section from Keaau Bypass to Paradise Drive) and Build Alternative 4 (a four-lane cross-section from Paradise Drive to the southern terminus of the project at Pahoa-Kapoho Road).

The traffic noise analysis is also based on the peak hour AM and PM traffic volumes provided by the Traffic Consultant [Reference 7]. The short term noise level measurements and traffic counts were used to validate the traffic noise model prediction software. Vehicular traffic was modeled under free flow conditions at a speed of 55 miles per hour. The terrain surrounding the project corridor was assumed to be hard (i.e., acoustically reflective) and flat (i.e., no change in elevation). Sound levels predicted at the receiver locations have been calculated at approximately 13 feet above ground. This height represents a worst-case scenario of a listener on a second story lanai or in a second story bedroom with an open window. While most of the residences along Keaau-Pahoa Road are single story structures, they are often built on a raised foundation. In almost all cases, predicted sound levels at 5 feet would be equal to or slightly less than at 13 feet.

Traffic outside the project corridor may also impact residences, schools, or businesses on side streets connecting to Keaau-Pahoa Road. However, these streets were outside the scope of the study area which was confined to Keaau-Pahoa Road from Keaau Bypass to Pahoa-Kapoho Road.

5.2.2 Projection Vehicular Traffic Noise

A comparison of projected future peak hour traffic noise levels with and without the roadway improvements is presented in Table 1. A sound level increase of 0.2 dB to 3.7 dB over existing levels is predicted for the future "no-build" alternative. The increase in traffic noise at the beginning of the project (from Keaau Bypass to Shower Drive) is small compared to the remainder of the project because the shoulder lane planned for 2038 is currently in use by morning commuters in the east-bound direction. Furthermore, the traffic noise increases correlate with the projected increases in peak hour traffic volumes and vary over the length of the roadway. Sound level increases of 1.3 dB to 5.5 dB over existing levels are predicted for the future build alternative and also vary over the length of the roadway. The most pronounced increases occur between Pohaku Place and Makuu Drive.

The projected increase in vehicular traffic noise levels due to the Keaau-Pahoa Road improvements project is expected to vary from 0 to 2.5 dB, depending on the noise receiver location. An increase of less than 3 dB is usually considered to be below the threshold of perceptible level change for humans and is, therefore, not considered to be significant. The proposed new lanes will improve the traffic flow along the roadway. Noises that are likely to increase due to the new lanes are noises caused by more vehicles traveling at the posted speed limit of 55 mph. Vehicles will

not need to slow or stop to wait for turning vehicles. Another factor that should be considered is the fact that the highway will be widened on both sides throughout the project limits. Thus, the highway widening will move the noise source closer to a noise receptor (i.e., for each home along the highway). Essentially, the near traffic lane will become closer. Consequently, the occupants of these residences will experience a traffic noise increase. It is important to note that the Traffic Noise Model was based on a "worst-case" roadway alignment which is a combination of alternatives 4 and 5. The predicted traffic noise levels may be less for certain sections of the project corridor based on the chosen alternative.

The FHWA has a design goal of 67 dBA or less for Land Use Category B (residences, churches, schools, etc.) and 72 dBA for Land Use Category C (agricultural and commercial areas, etc.) According to HDOT's Noise Analysis and Abatement Policy, when traffic noise levels "approach" the FHWA design goal, i.e., within one decibel, traffic noise impact will occur and noise abatement measures must be considered. Table 2 shows that, of the 181 noise receiver locations, (a) 117 receivers are calculated to approach or exceed the FHWA/HDOT noise abatement criteria (NAC) under the existing roadway alignment and traffic volumes, (b) 33 additional receivers will approach or exceed the NAC in the future without the project, and (c) 16 receivers will approach or exceed the NAC with the roadway improvements project.

A detour route is not planned to divert traffic away from the construction zone. However, residences in the area surrounding Keaau-Pahoa Road may experience heavier traffic due to the reduced speed and possible reduction in travel lanes. As a result, vehicular traffic noise (which does not include construction noise) is likely to decrease during the construction period. However, these changes will be short term and only during the construction period.

5.3 Compliance with EPA Noise Guidelines

The EPA has an existing design goal of $L_{dn} \leq 65$ dBA and a future design goal $L_{dn} \leq 55$ dBA for exterior noise levels. In the future, increased traffic noise will contribute to the overall ambient noise level. Although some of the residences currently experience noise levels that exceed the EPA guidelines, the expected increase in L_{dn} due to the widening of Keaau-Pahoa Road is expected to be less than 3 dB. It is important to note that the EPA noise guidelines are design goals and not enforceable regulations. However, these guidelines and design goals are useful tools for assessing the noise environment.

6.0 NOISE IMPACT MITIGATION

6.1 Mitigation of Construction Noise

In cases where construction noise exceeds, or is expected to exceed the State's "maximum permissible" property line noise levels [Reference 1], a permit must be obtained from the State DOH to allow the operation of vehicles, cranes, construction equipment, power tools, etc., which emit noise levels in excess of the "maximum permissible" levels.

In order for the State DOH to issue a construction noise permit, the Contractor must submit a noise permit application to the DOH, which describes the construction activities for the project. Prior to issuing the noise permit, the State DOH may require action by the Contractor to incorporate noise mitigation into the construction plan. The DOH may also require the Contractor to conduct noise monitoring or community meetings inviting the neighboring residents and business owners to discuss construction noise. The Contractor should use reasonable and standard practices to mitigate noise, such as using mufflers on diesel and gasoline engines, using properly tuned and balanced machines, etc. However, the State DOH may require additional noise mitigation, such as temporary noise barriers, or time of day usage limits for certain kinds of construction activities.

Specific permit restrictions for construction activities [Reference 1] are:

> "No permit shall allow any construction activities which emit noise in excess of the maximum permissible sound levels ... before 7:00 a.m. and after 6:00 p.m. of the same day, Monday through Friday."
>
> "No permit shall allow any construction activities which emit noise in excess of the maximum permissible sound levels... before 9:00 a.m. and after 6:00 p.m. on Saturday."
>
> "No permit shall allow any construction activities which emit noise in excess of the maximum permissible sound levels on Sundays and on holidays."

The use of hoe rams and jack hammers 25 lbs. or larger, high pressure sprayers, chain saws, and pile drivers are restricted to 9:00 a.m. to 5:30 p.m., Monday through Friday. In addition, construction equipment and on-site vehicles or devices whose operations involve the exhausting of gas or air, excluding pile hammers and pneumatic hand tools weighing less than 15 pounds, must be equipped with mufflers [Reference 1].

The State DOH noise permit does not limit the noise level generated at the construction site, but rather the times at which noisy construction can take place. Therefore, noise mitigation for construction activities should be addressed using project management, such that the time restrictions within the State DOH permit are followed.

6.2 Mitigation of Vehicular Traffic Noise

As discussed above, traffic noise levels along Keaau-Pahoa Road currently approach or exceed FHWA/HDOT's noise abatement criteria at 65% of the properties listed in Table 1. Thus, the noise receptors adjacent to the highway are experiencing a traffic noise impact even before the new lanes are added. Although the added lanes do not substantially increase future traffic noise levels over the no-build alternative noise levels, a traffic noise impact still occurs since the traffic noise levels exceed the FHWA criteria [Reference 8]. Therefore, noise abatement measures must be considered.

Abatement consideration should weigh the abatement benefits, costs, and overall social, economic, and environmental effects. The FHWA considers a 5 dB reduction in noise level to be significant. Per FHWA/HDOT's standards, mitigation measures need to be economically reasonable and feasible (i.e., acceptable to the affected residents). Possible mitigation measures, listed in order of effectiveness, include:

a. Air-conditioning or forced ventilation for those impacted residences along Keaau-Pahoa Road. At the impacted homes, jalousie windows should be replaced with standard storm windows with acoustical gaskets. Typical exterior-to-interior noise reduction for naturally ventilated homes, i.e., with open windows, is only 9 dB. Noise reduction for air-conditioned homes with the windows closed is significantly higher.

b. Construction of noise barriers (that incorporate landscaping for aesthetic purposes) whether within or outside the highway right-of-way. Factors such as distances to roadways and setbacks, intervening ground conditions, barrier construction, barrier height, roadway elevations, receiver height, etc., will determine the noise reduction afforded by a traffic noise barrier. Typically, a sound level reduction of at least 5 dB can be expected where a noise barrier just breaks the line-of-sight from the receiver to the roadway. However, many of the residences have driveways off of Keaau-Pahoa Road which would necessitate a break or gap in the noise barrier wall. The reduction in traffic noise levels will be less significant for the areas of the project corridor where gaps in the noise barrier wall would be common, e.g., the residential lots located on the western side of the road. In the case of multiple story or elevated structures, it is not likely that the 5 dB reduction would be achieved without using excessively high walls.

c. Acquisition of real property or interests therein (predominantly unimproved property) to serve as a buffer zone to preempt development which would be adversely impacted by traffic noise.

d. Traffic management measures (e.g., traffic control devices and signing for prohibition of certain vehicle types, time-use restrictions for certain vehicle types, modified speed limits, and exclusive land designations).

REFERENCES

1. Chapter 46, *Community Noise Control*, Department of Health, State of Hawaii, Administrative Rules, Title 11, September 23, 1996.

2. *Department of Transportation, Federal Highway Administration Procedures for Abatement of Highway Traffic Noise*, Title 23, CFR, Chapter 1, Subchapter J, Part 772, 38 FR 15953, June 19, 1973; Revised at 47 FR 29654, July 8, 1982.

3. *Federal Highway Administration's Traffic Noise Model*, FHWA-RD-77-108; U.S. Department of Transportation, December 1978.

4. *Noise Analysis and Abatement Policy*, Department of Transportation, Highways Division, State of Hawaii, June 1997.

5. *Toward a National Strategy for Noise Control*, U.S. Environmental Protection Agency, April 1977.

6. *Federal Highway Administrations Traffic Noise Model*, Version 2.5, U.S. Department of Transportation, February 2004.

7. *Traffic Impact Analysis Report*, Dyar, 2010.

8. *Highway Traffic Noise Analysis and Abatement Policy and Guidance*, U.S. Department of Transportation, Federal Highways Administration, June 1995.

TABLE 1
Predicted Traffic Noise Levels and Resulting Increases Due to the Project[1]

Noise levels shown in the table were calculated by the Traffic Noise Model where the future year is defined as 2038.

	Location: TMK	Distance to Road[2] (ft)	2006[3] (dBA)		2038 No-Build Alternative (dBA)		2038 Build Alternative 4+5 (dBA)		Future Increase Without Project (dB)		Future Increase With Project (dB)		Future Increase Due to Project (dB)	
			AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM
Opukahaia/Shower Dr.	1-6-04:47	113	70.2	70.5	70.6	72.3	71.5	73.0	0.4	1.8	1.3	2.5	0.9	0.7
	1-6-04:51	132	69.0	69.7	69.5	71.1	70.7	72.0	0.5	1.4	1.7	2.3	1.2	0.9
	1-6-03:2	138	68.8	68.2	69.0	69.6	70.8	70.6	0.2	1.4	2.0	2.4	1.8	1.0
	1-6-03:74	96	70.9	70.3	71.1	71.6	73.6	72.9	0.2	1.3	2.7	2.6	2.5	1.3
	1-6-64:289	291	64.6	65.1	65.1	66.4	66.9	67.7	0.5	1.3	2.3	2.6	1.8	1.3
	1-5-36:117	130	69.3	69.1	69.6	70.3	71.6	71.4	0.3	1.2	2.3	2.3	2.0	1.1
	1-6-64:288	278	64.8	65.4	65.3	66.7	67.1	67.9	0.5	1.3	2.3	2.5	1.8	1.2
	1-5-36:116	131	68.9	68.7	69.2	69.9	71.2	71.0	0.3	1.2	2.3	2.3	2.0	1.1
	1-6-64:287	217	66.3	66.9	66.8	68.1	68.4	69.4	0.5	1.2	2.1	2.5	1.6	1.3
	1-6-64:286	166	67.7	68.3	68.1	69.6	69.8	70.9	0.4	1.3	2.1	2.6	1.7	1.3
	1-5-36:120	89	71.2	70.6	71.4	71.9	73.6	73.0	0.2	1.3	2.4	2.4	2.2	1.1
	1-6-64:284	141	68.2	68.9	68.7	70.2	70.4	71.6	0.5	1.3	2.2	2.7	1.7	1.4
	1-6-64:283	149	68.1	68.8	68.7	69.9	70.3	71.5	0.6	1.1	2.2	2.7	1.6	1.6
	1-5-36:121	117	69.8	69.5	70.1	70.6	72.2	71.8	0.3	1.1	2.4	2.3	2.1	1.2
Shower Dr./Pohaku Pl.	1-6-64:269	203	66.6	67.1	67.2	68.0	68.8	70.0	0.6	0.9	2.2	2.9	1.6	2.0
	1-6-64:267	230	65.8	66.3	66.3	67.1	68.0	69.2	0.5	0.8	2.2	2.9	1.7	2.1
	1-6-64:266	163	67.6	68.2	68.2	68.9	69.8	71.2	0.6	0.7	2.2	3.0	1.6	2.3
	1-6-64:265	178	67.1	67.6	67.6	68.3	69.3	70.5	0.5	0.7	2.2	2.9	1.7	2.2
	1-6-64:264	273	64.7	65.1	65.2	65.9	67.0	68.1	0.5	0.8	2.3	3.0	1.8	2.2
	1-6-64:263	151	67.9	68.4	68.5	69.1	70.1	71.5	0.6	0.7	2.2	3.1	1.6	2.4
	1-5-36:153	68	72.1	72.2	72.6	72.9	75.0	74.6	0.5	0.7	2.9	2.4	2.4	1.7
	1-6-64:261	172	67.1	67.6	67.7	68.3	69.3	70.6	0.6	0.7	2.2	3.0	1.6	2.3
	1-5-36:151	91	70.9	71.0	71.3	71.8	73.8	73.5	0.4	0.8	2.9	2.5	2.5	1.7

[1] The noise level calculations were based on the peak hour traffic volumes from the Traffic Impact Analysis Report [Reference 8].
[2] The approximate distance is from the façade of the building to the centerline of the existing Keaau-Pahoa Road alignment.
[3] The 2006 traffic noise levels are calculated values based on predictions from the Traffic Noise Model.

TABLE 1 (cont.)
Predicted Traffic Noise Levels and Resulting Increases Due to the Project[1]

	Location: TMK	Distance to Road[2] (ft)	2006[3] (dBA)		2038 No-Build Alternative (dBA)		2038 Build Alternative 4+5 (dBA)		Future Increase Without Project (dB)		Future Increase With Project (dB)		Future Increase Due to Project (dB)	
			AM	PM	AM	PM	AM	AM	PM	PM	AM	PM	AM	PM
Shower Dr./Pohaku Pl. (cont.)	1-5-36:150	153	68.1	68.3	68.5	69.0	70.7	70.8	0.4	0.7	2.6	2.5	2.2	1.8
	1-6-64:260	156	67.7	68.2	68.3	68.9	69.9	71.2	0.6	0.7	2.2	3.0	1.6	2.3
	1-6-64:258	243	65.7	66.1	66.2	66.8	67.9	69.0	0.5	0.7	2.2	2.9	1.7	2.2
	1-5-36:148	164	67.5	67.7	68.0	68.5	70.1	70.3	0.5	0.8	2.6	2.6	2.1	1.8
	1-6-64:257	168	67.5	68.0	68.1	68.7	69.7	71.0	0.6	0.7	2.2	3.0	1.6	2.3
	1-6-64:256	154	68.1	68.6	68.7	69.3	70.3	71.6	0.6	0.7	2.2	3.0	1.6	2.3
	1-6-64:255	126	69.0	69.5	69.5	70.2	71.2	72.6	0.5	0.7	2.2	3.1	1.7	2.4
	1-5-36:145	218	66.0	66.3	66.5	67.0	68.5	68.8	0.5	0.7	2.5	2.5	2.0	1.8
	1-5-36:144	271	64.8	65.1	65.4	65.8	67.4	67.8	0.6	0.7	2.6	2.7	2.0	2.0
	1-5-36:143	280	64.6	64.8	65.1	65.6	67.2	67.6	0.5	0.8	2.6	2.8	2.1	2.0
	1-6-64:253	230	65.9	66.4	66.5	67.2	68.2	69.3	0.6	0.8	2.3	2.9	1.7	2.1
	1-5-36:142	344	63.0	63.3	63.6	64.1	65.9	66.2	0.6	0.8	2.9	2.9	2.3	2.1
	1-5-35:148	98	70.5	70.5	71.0	71.3	73.5	73.1	0.5	0.8	3.0	2.6	2.5	1.8
	1-6-64:251	115	69.4	70.0	70.1	70.8	71.7	73.3	0.7	0.8	2.3	3.3	1.6	2.5
	1-5-35:149	92	70.3	70.4	71.0	71.2	73.5	73.0	0.7	0.8	3.2	2.6	2.5	1.8
	1-6-64:249	173	67.0	67.7	67.9	68.5	69.5	70.7	0.9	0.8	2.5	3.0	1.6	2.2
Pohaku Pl./Kaloli Dr.	1-6-10:268	270	63.9	65.0	65.5	65.8	67.2	67.9	1.6	0.8	3.3	2.9	1.7	2.1
	1-5-35:182	92	69.3	70.1	71.1	71.0	73.4	72.7	1.8	0.9	4.1	2.6	2.3	1.7
	1-6-10:269	242	64.4	65.6	66.2	66.4	67.7	68.5	1.8	0.8	3.3	2.9	1.5	2.1
	1-6-10:270	168	66.2	67.5	68.0	68.3	69.6	70.4	1.8	0.8	3.4	2.9	1.6	2.1
	1-5-35:181	98	69.1	70.0	70.9	70.9	73.1	72.5	1.8	0.9	4.0	2.5	2.2	1.6
	1-5-35:180	207	65.3	66.4	67.1	67.2	69.0	68.9	1.8	0.8	3.7	2.5	1.9	1.7
	1-6-10:271	158	66.5	67.7	68.3	68.5	69.8	70.7	1.8	0.8	3.3	3.0	1.5	2.2
	1-5-35:184	111	68.6	69.5	70.4	70.4	72.6	72.1	1.8	0.9	4.0	2.6	2.2	1.7
	1-6-10:273	70	70.7	72.1	72.5	72.9	73.9	75.4	1.8	0.8	3.2	3.3	1.4	2.5
	1-6-10:274	138	67.4	68.7	69.2	69.5	70.8	71.7	1.8	0.8	3.4	3.0	1.6	2.2

[1] The noise level calculations were based on the peak hour traffic volumes from the Traffic Impact Analysis Report [Reference 8].
[2] The approximate distance is from the façade of the building to the centerline of the existing Keaau-Pahoa Road alignment.
[3] The 2006 traffic noise levels are calculated values based on predictions from the Traffic Noise Model.

TABLE 1 (cont.)
Predicted Traffic Noise Levels and Resulting Increases Due to the Project[1]

	Location: TMK	Distance to Road[2] (ft)	2006[3] (dBA)		2038 No-Build Alternative (dBA)		2038 Build Alternative 4+5 (dBA)		Future Increase Without Project (dB)		Future Increase With Project (dB)		Future Increase Due to Project (dB)	
			AM	PM	AM	PM	AM	AM	PM	PM	AM	PM	AM	PM
(cont.)	1-5-35:185	127	68.0	68.9	69.8	69.8	71.9	71.5	1.8	0.9	3.9	2.6	2.1	1.7
	1-6-10:275	138	67.1	68.4	68.9	69.2	70.4	71.4	1.8	0.8	3.3	3.0	1.5	2.2
	1-5-35:186	100	69.3	70.1	71.2	71.1	73.4	72.7	1.9	1.0	4.1	2.6	2.2	1.6
	1-5-35:187	103	69.0	69.8	70.9	70.7	73.1	72.3	1.9	0.9	4.1	2.5	2.2	1.6
	1-6-10:276	192	65.7	67.0	67.5	68.6	69.9	70.7	1.8	1.6	4.2	3.7	2.4	2.1
Kaloli Dr./Pohaku C.	1-6-10:281	171	66.2	67.5	68.5	68.3	70.1	70.3	2.3	0.8	3.9	2.8	1.6	2.0
	1-6-10:284	214	64.9	66.2	67.4	66.9	69.0	68.9	2.5	0.7	4.1	2.7	1.6	2.0
	1-5-34:215	129	67.0	68.1	69.5	68.9	71.6	70.6	2.5	0.8	4.6	2.5	2.1	1.7
	1-6-10:286	168	66.0	67.3	68.5	68.0	70.1	70.1	2.5	0.7	4.1	2.8	1.6	2.1
	1-6-10:287	208	65.0	66.3	67.5	67.0	69.1	69.0	2.5	0.7	4.1	2.7	1.6	2.0
	1-6-10:288	123	67.5	68.8	70.0	69.5	71.6	71.8	2.5	0.7	4.1	3.0	1.6	2.3
	1-5-34:212	242	64.1	65.2	66.6	66.0	68.5	67.6	2.5	0.8	4.4	2.4	1.9	1.6
	1-5-34:211	238	64.2	65.3	66.7	66.1	68.6	67.7	2.5	0.8	4.4	2.4	1.9	1.6
	1-5-34:210	118	67.8	68.7	70.3	69.6	72.5	71.2	2.5	0.9	4.7	2.5	2.2	1.6
Poahaku C./Orchidland Dr.	1-6-10:111	218	64.5	65.6	67.1	66.5	68.7	68.3	2.6	0.9	4.2	2.7	1.6	1.8
	1-6-10:114	226	64.5	65.5	67.2	66.5	68.7	68.2	2.7	1.0	4.2	2.7	1.5	1.7
	1-6-10:115	297	62.7	63.8	65.4	64.8	67.2	66.6	2.7	1.0	4.5	2.8	1.8	1.8
	1-6-10:116	241	64.2	65.2	66.8	66.2	68.4	67.8	2.6	1.0	4.2	2.6	1.6	1.6
	1-5-34:219	126	67.4	68.2	70.0	69.3	72.0	70.7	2.6	1.1	4.6	2.5	2.0	1.4
	1-5-34:220	159	66.3	67.1	68.9	68.2	70.8	69.6	2.6	1.1	4.5	2.5	1.9	1.4
	1-6-10:123	125	67.4	68.4	70.1	69.4	71.7	71.3	2.7	1.0	4.3	2.9	1.6	1.9
	1-6-10:124	147	66.7	67.7	69.4	68.7	70.9	70.4	2.7	1.0	4.2	2.7	1.5	1.7
	1-5-34:222	136	67.1	67.9	69.7	69.0	71.6	70.4	2.6	1.1	4.5	2.5	1.9	1.4
	1-5-33:221	172	65.9	66.7	68.5	67.8	70.3	69.1	2.6	1.1	4.4	2.4	1.8	1.3
	1-6-10:289	138	66.9	68.1	69.4	68.9	71.0	71.0	2.5	0.8	4.1	2.9	1.6	2.1
	1-5-34:218	83	69.5	70.2	72.1	71.3	74.3	72.7	2.6	1.1	4.8	2.5	2.2	1.4

[1] The noise level calculations were based on the peak hour traffic volumes from the Traffic Impact Analysis Report [Reference 8].
[2] The approximate distance is from the façade of the building to the centerline of the existing Keaau-Pahoa Road alignment.
[3] The 2006 traffic noise levels are calculated values based on predictions from the Traffic Noise Model.

TABLE 1 (cont.)
Predicted Traffic Noise Levels and Resulting Increases Due to the Project[1]

	Location: TMK	Distance to Road[2] (ft)	2006[3] (dBA)		2038 No-Build Alternative (dBA)		2038 Build Alternative 4+5 (dBA)		Future Increase Without Project (dB)		Future Increase With Project (dB)		Future Increase Due to Project (dB)	
			AM	PM	AM	PM	AM	AM	PM	PM	AM	PM	AM	PM
Poahaku C./ Orchidland Dr. (cont.)	1-6-10:126	134	67.0	68.1	69.7	69.1	71.3	70.9	2.7	1.0	4.3	2.8	1.6	1.8
	1-6-10:111	218	64.5	65.6	67.1	66.5	68.7	68.3	2.6	0.9	4.2	2.7	1.6	1.8
	1-6-10:127	124	67.4	68.4	70.1	69.5	71.7	71.3	2.7	1.1	4.3	2.9	1.6	1.8
	1-5-33:222	127	66.7	67.5	69.3	68.6	71.2	69.9	2.6	1.1	4.5	2.4	1.9	1.3
	1-6-10:129	135	67.0	68.0	69.7	69.1	71.3	70.8	2.7	1.1	4.3	2.8	1.6	1.7
	1-6-10:90	215	64.7	65.7	67.4	66.8	68.9	68.4	2.7	1.1	4.2	2.7	1.5	1.6
	1-5-33:254	68	70.7	71.3	73.3	72.5	75.5	73.8	2.6	1.2	4.8	2.5	2.2	1.3
	1-5-33:253	157	66.2	67.1	69.0	68.2	70.8	69.6	2.8	1.1	4.6	2.5	1.8	1.4
	1-6-10:134	136	67.0	68.0	69.8	69.1	71.3	70.8	2.8	1.1	4.3	2.8	1.5	1.7
	1-6-10:135	208	64.7	65.8	67.6	67.0	69.1	68.6	2.9	1.2	4.4	2.8	1.5	1.6
	1-5-33:252	164	62.6	63.7	65.9	65.2	67.5	66.6	3.3	1.5	4.9	2.9	1.6	1.4
Orchidland Dr./ Paradise Dr.	1-6-9:388-390	189	64.6	66.1	68.0	67.5	69.2	69.0	3.4	1.4	4.6	2.9	1.2	1.5
	1-6-9:391	98	68.0	69.6	71.5	71.1	72.7	72.8	3.5	1.5	4.7	3.2	1.2	1.7
	1-5-33:256	91	68.2	69.4	71.9	71.1	73.5	72.3	3.7	1.7	5.3	2.9	1.6	1.2
	1-5-33:257	114	67.2	68.4	70.9	70.1	72.4	71.3	3.7	1.7	5.2	2.9	1.5	1.2
	1-6-9-393	274	62.6	64.1	66.1	65.6	67.4	67.0	3.5	1.5	4.8	2.9	1.3	1.4
	1-6-9:397	263	62.8	64.3	66.4	65.9	67.5	67.2	3.6	1.6	4.7	2.9	1.1	1.3
	1-6-9:399	261	63.0	64.5	66.5	66.0	67.7	67.4	3.5	1.5	4.7	2.9	1.2	1.4
	1-6-9:401	140	66.3	67.7	69.7	69.2	70.9	70.8	3.4	1.5	4.6	3.1	1.2	1.6
	1-6-9:394	123	66.9	68.5	70.4	69.9	71.6	71.6	3.5	1.4	4.7	3.1	1.2	1.7
Paradise Dr./Aulii St.	1-6-9:402	126	66.9	68.3	70.2	69.8	71.5	71.4	3.3	1.5	4.6	3.1	1.3	1.6
	1-6-9:405	124	67.2	68.4	70.4	70.0	71.7	71.5	3.2	1.6	4.5	3.1	1.3	1.5
	1-5-17:143	104	68.0	68.8	71.1	70.4	72.7	71.6	3.1	1.6	4.7	2.8	1.6	1.2
	1-6-9:406	158	65.8	67.0	68.9	68.5	70.2	69.9	3.1	1.5	4.4	2.9	1.3	1.4
	1-6-9:409	192	64.9	66.0	68.0	67.5	69.2	68.8	3.1	1.5	4.3	2.8	1.2	1.3
	1-5-17:145	108	67.8	68.6	70.9	70.3	72.6	71.5	3.1	1.7	4.8	2.9	1.7	1.2

[1] The noise level calculations were based on the peak hour traffic volumes from the Traffic Impact Analysis Report [Reference 8].
[2] The approximate distance is from the façade of the building to the centerline of the existing Keaau-Pahoa Road alignment.
[3] The 2006 traffic noise levels are calculated values based on predictions from the Traffic Noise Model.

TABLE 1 (cont.)
Predicted Traffic Noise Levels and Resulting Increases Due to the Project[1]

	Location: TMK	Distance to Road[2] (ft)	2006[3] (dBA)		2038 No-Build Alternative (dBA)		2038 Build Alternative 4+5 (dBA)		Future Increase Without Project (dB)		Future Increase With Project (dB)		Future Increase Due to Project (dB)	
			AM	PM	AM	PM	AM	AM	PM	PM	AM	PM	AM	PM
Paradise Dr./ Aulii St. (cont.)	1-5-17:147	108	68.1	68.9	71.2	70.6	72.7	71.7	3.1	1.7	4.6	2.8	1.5	1.1
	1-5-17:148	126	67.2	68.1	70.3	69.7	71.8	70.8	3.1	1.6	4.6	2.7	1.5	1.1
	1-6-9:414	224	64.2	65.2	67.2	66.8	68.5	68.1	3.0	1.6	4.3	2.9	1.3	1.3
	1-5-14:150	120	67.4	68.2	70.4	69.9	71.9	71.0	3.0	1.7	4.5	2.8	1.5	1.1
	1-6-9:418	213	64.4	65.5	67.4	67.1	68.6	68.3	3.0	1.6	4.2	2.8	1.2	1.2
	1-5-17:153	319	62.0	62.7	64.9	64.5	66.4	65.8	2.9	1.8	4.4	3.1	1.5	1.3
	1-5-17:154	89	69.3	69.7	72.2	71.6	73.6	72.6	2.9	1.9	4.3	2.9	1.4	1.0
Aulii St./Makuu Dr.	1-6-9:214	111	67.9	68.6	70.3	70.6	70.9	71.6	2.4	2.0	3.0	3.0	0.6	1.0
	1-6-9:217	316	62.2	62.7	64.7	64.8	65.5	65.9	2.5	2.1	3.3	3.2	0.8	1.1
	1-6-9:218	390	60.7	61.2	63.2	63.3	64.3	64.6	2.5	2.1	3.6	3.4	1.1	1.3
	1-6-9:220	135	66.8	67.3	69.2	69.4	69.7	70.4	2.4	2.1	2.9	3.1	0.5	1.0
	1-6-9:222	144	66.7	67.1	69.1	69.2	69.6	70.3	2.4	2.1	2.9	3.2	0.5	1.1
	1-6-9:223	141	66.6	67.1	69.0	69.2	69.6	70.2	2.4	2.1	3.0	3.1	0.6	1.0
	1-5-16:174	110	67.8	68.1	70.3	70.2	70.9	71.0	2.5	2.1	3.1	2.9	0.6	0.8
	1-6-9:225	123	67.1	67.6	69.5	69.7	70.1	70.8	2.4	2.1	3.0	3.2	0.6	1.1
	1-6-9:227	118	67.4	67.9	69.8	70.0	70.4	71.1	2.4	2.1	3.0	3.2	0.6	1.1
	1-5-16:173	161	66.0	66.3	68.4	68.5	69.0	69.2	2.4	2.2	3.0	2.9	0.6	0.7
	1-6-9:228	111	67.8	68.3	70.2	70.4	70.8	71.5	2.4	2.1	3.0	3.2	0.6	1.1
	1-5-16:170	90	68.8	69.0	71.2	71.1	71.9	71.9	2.4	2.1	3.1	2.9	0.7	0.8
	1-6-9:233	154	66.1	66.6	68.5	68.7	69.1	69.7	2.4	2.1	3.0	3.1	0.6	1.0
	1-5-16:167	77	69.8	69.9	72.3	72.1	72.8	72.8	2.5	2.2	3.0	2.9	0.5	0.7
	1-6-9:236	162	65.9	66.4	68.3	68.5	68.8	69.5	2.4	2.1	2.9	3.1	0.5	1.0
	1-6-9:237	138	66.6	67.2	69.0	69.2	69.6	70.3	2.4	2.0	3.0	3.1	0.6	1.1
	1-5-16:166	258	63.5	63.8	65.9	65.9	66.5	66.8	2.4	2.1	3.0	3.0	0.6	0.9
	1-5-16:165	109	67.9	68.0	70.3	70.2	71.0	71.0	2.4	2.2	3.1	3.0	0.7	0.8

[1] The noise level calculations were based on the peak hour traffic volumes from the Traffic Impact Analysis Report [Reference 8].
[2] The approximate distance is from the façade of the building to the centerline of the existing Keaau-Pahoa Road alignment.
[3] The 2006 traffic noise levels are calculated values based on predictions from the Traffic Noise Model.

TABLE 1 (cont.)
Predicted Traffic Noise Levels and Resulting Increases Due to the Project[1]

	Location: TMK	Distance to Road[2] (ft)	2006[3] (dBA)		2038 No-Build Alternative (dBA)		2038 Build Alternative 4+5 (dBA)		Future Increase Without Project (dB)		Future Increase With Project (dB)		Future Increase Due to Project (dB)	
			AM	PM	AM	PM	AM	AM	PM	PM	AM	PM	AM	PM
(cont.)	1-5-16:164	122	67.5	67.6	69.9	69.8	70.5	70.6	2.4	2.2	3.0	3.0	0.6	0.8
	1-6-9:238	148	66.4	67.0	68.8	69.0	69.3	70.0	2.4	2.0	2.9	3.0	0.5	1.0
	1-6-9:239	181	65.4	65.9	67.8	68.0	68.3	68.9	2.4	2.1	2.9	3.0	0.5	0.9
	1-6-9:241	103	68.3	69.1	70.7	71.1	71.3	72.1	2.4	2.0	3.0	3.0	0.6	1.0
	1-6-9:243	122	67.5	68.1	69.9	70.2	70.4	71.1	2.4	2.1	2.9	3.0	0.5	0.9
	1-5-16:163	256	63.7	63.9	66.1	66.0	66.8	67.0	2.4	2.1	3.1	3.1	0.7	1.0
Makuu Dr./ Ilima St.	1-6-9:168	110	68.0	68.2	70.1	70.3	71.2	71.7	2.1	2.1	3.2	3.5	1.1	1.4
	1-5-15:179	233	64.1	64.1	66.3	66.2	67.4	67.4	2.2	2.1	3.3	3.3	1.1	1.2
	1-5-15:178	246	63.6	63.7	65.9	65.8	67.1	67.1	2.3	2.1	3.5	3.4	1.2	1.3
	1-5-15:177	212	64.4	64.5	66.7	66.6	67.8	67.8	2.3	2.1	3.4	3.3	1.1	1.2
	1-5-15:176	232	63.8	64.0	66.3	66.3	67.4	67.4	2.5	2.3	3.6	3.4	1.1	1.1
	1-6-9:166	114	67.9	68.2	70.2	70.4	71.1	71.6	2.3	2.2	3.2	3.4	0.9	1.2
Ilima St./ Ainaloa Blvd.	1-5-15:175	110	67.3	67.5	70.0	70.0	71.2	71.0	2.7	2.5	3.9	3.5	1.2	1.0
	1-5-15:174	196	64.6	65.0	67.4	67.5	68.4	68.3	2.8	2.5	3.8	3.3	1.0	0.8
	1-5-15:173	245	63.4	63.8	66.2	66.3	67.1	67.0	2.8	2.5	3.7	3.2	0.9	0.7
	1-5-15:172	282	62.5	62.9	65.4	65.4	66.4	66.3	2.9	2.5	3.9	3.4	1.0	0.9
	1-6-9:158	126	66.8	67.4	69.7	70.0	70.2	70.5	2.9	2.6	3.4	3.1	0.5	0.5
	1-5-15:171	310	61.8	62.4	64.8	64.9	66.0	65.9	3.0	2.5	4.2	3.5	1.2	1.0
	1-5-15:181	301	61.8	62.4	64.8	64.9	66.1	66.0	3.0	2.5	4.3	3.6	1.3	1.1
Ainaloa Blvd./ Ka Ohuwalu Dr.	1-5-15:182	133	66.0	67.2	69.5	69.4	71.5	71.2	3.5	2.2	5.5	4.0	2.0	1.8
	1-6-99:6	73	68.9	70.2	72.4	72.6	71.6	71.8	3.5	2.4	2.7	1.6	-0.8	-0.8
	1-6-99:4	241	63.1	64.4	66.6	66.7	66.9	67.0	3.5	2.3	3.8	2.6	0.3	0.3
	1-6-99:3	201	64.0	65.4	67.6	67.7	67.8	67.9	3.6	2.3	3.8	2.5	0.2	0.2
	1-6-99:2	68	69.5	70.9	73.1	73.2	72.7	73.0	3.6	2.3	3.2	2.1	-0.4	-0.2
	1-6-99:31	301	61.5	62.9	65.1	65.2	66.0	66.1	3.6	2.3	4.5	3.2	0.9	0.9
	1-5-15:187	162	64.7	66.1	68.3	68.3	69.2	69.1	3.6	2.2	4.5	3.0	0.9	0.8

[1] The noise level calculations were based on the peak hour traffic volumes from the Traffic Impact Analysis Report [Reference 8].
[2] The approximate distance is from the façade of the building to the centerline of the existing Keaau-Pahoa Road alignment.
[3] The 2006 traffic noise levels are calculated values based on predictions from the Traffic Noise Model.

TABLE 1 (cont.)
Predicted Traffic Noise Levels and Resulting Increases Due to the Project[1]

	Location: TMK	Distance to Road[2] (ft)	2006[3] (dBA)		2038 No-Build Alternative (dBA)		2038 Build Alternative 4+5 (dBA)		Future Increase Without Project (dB)		Future Increase With Project (dB)		Future Increase Due to Project (dB)	
			AM	PM	AM	PM	AM	AM	PM	PM	AM	PM	AM	PM
cont.	1-5-10:17	208	63.6	65.1	67.3	67.2	68.0	67.9	3.7	2.1	4.4	2.8	0.7	0.7
Ka Ohuw./ Kaluahine	1-5-118:24	164	65.1	65.3	68.5	68.0	69.3	68.6	3.4	2.7	4.2	3.3	0.8	0.6
	1-5-118:17	188	64.9	64.8	68.2	67.6	69.1	68.2	3.3	2.8	4.2	3.4	0.9	0.6
	1-5-119:45	243	63.5	63.4	66.8	66.4	67.6	67.0	3.3	3.0	4.1	3.6	0.8	0.6
	1-5-119:44	317	61.7	61.6	65.0	64.6	66.1	65.4	3.3	3.0	4.4	3.8	1.1	0.8
	1-5-118:49	233	63.8	63.5	66.9	66.4	67.7	67.0	3.1	2.9	3.9	3.5	0.8	0.6
Kaluahine St./ Pahoa Village Junction	1-5-7:13	66	69.7	69.4	72.5	72.5	73.3	72.9	2.8	3.1	3.6	3.5	0.8	0.4
	1-5-7:73	107	67.4	66.9	70.0	70.0	71.1	70.4	2.6	3.1	3.7	3.5	1.1	0.4
	1-5-7:75	60	69.3	69.2	71.9	71.8	73.3	72.5	2.6	2.6	4.0	3.3	1.4	0.7
	1-5-7:12	87	68.4	68.1	71.2	71.3	72.2	71.9	2.8	3.2	3.8	3.8	1.0	0.6
	1-5-7:15	69	69.0	68.5	71.6	71.6	72.4	71.7	2.6	3.1	3.4	3.2	0.8	0.1
	1-5-7:52	61	70.0	69.4	72.6	72.6	73.0	72.3	2.6	3.2	3.0	2.9	0.4	-0.3
	1-5-7:11	135	66.1	65.7	68.8	68.9	69.9	69.5	2.7	3.2	3.8	3.8	1.1	0.6
	1-5-7:67	348	60.9	60.5	63.6	63.7	65.1	64.5	2.7	3.2	4.2	4.0	1.5	0.8
	1-5-7:68	125	66.6	66.3	69.4	69.5	70.9	70.5	2.8	3.2	4.3	4.2	1.5	1.0
	1-5-7:78	129	66.6	66.1	69.3	69.2	69.7	69.1	2.7	3.1	3.1	3.0	0.4	-0.1
	1-5-7:53	93	68.0	67.5	70.7	70.6	71.0	70.3	2.7	3.1	3.0	2.8	0.3	-0.3
	1-5-7:10	89	68.3	68.2	71.1	71.1	72.3	72.0	2.8	2.9	4.0	3.8	1.2	0.9
	1-5-7:17	199	64.2	63.9	66.9	66.9	67.6	67.1	2.7	3.0	3.4	3.2	0.7	0.2
	1-5-7:9	193	64.4	64.0	67.1	67.2	68.0	67.6	2.7	3.2	3.6	3.6	0.9	0.4
	1-5-7:19	102	68.3	67.7	70.9	70.8	71.6	71.0	2.6	3.1	3.3	3.3	0.7	0.2
	1-5-7:80	149	65.1	64.8	68.0	68.0	68.8	68.5	2.9	3.2	3.7	3.7	0.8	0.5

[1] The noise level calculations were based on the peak hour traffic volumes from the Traffic Impact Analysis Report [Reference 8].
[2] The approximate distance is from the façade of the building to the centerline of the existing Keaau-Pahoa Road alignment.
[3] The 2006 traffic noise levels are calculated values based on predictions from the Traffic Noise Model.

TABLE 1 (cont.)
Predicted Traffic Noise Levels and Resulting Increases Due to the Project[1]

	Location: TMK	Distance to Road[2] (ft)	2006[3] (dBA)		2038 No-Build Alternative (dBA)		2038 Build Alternative 4+5 (dBA)		Future Increase Without Project (dB)		Future Increase With Project (dB)		Future Increase Due to Project (dB)	
			AM	PM	AM	PM	AM	AM	PM	PM	AM	PM	AM	PM
Pahoa Village Jct / Kapoho Rd.	1-5-7:20	171	64.3	64.2	67.2	67.5	67.6	67.9	2.9	3.3	3.3	3.7	0.4	0.4
	1-5-7:79	311	61.1	61.0	63.9	64.2	64.6	64.7	2.8	3.2	3.5	3.7	0.7	0.5
	1-5-7:21	208	63.3	63.4	66.2	66.5	66.6	66.9	2.9	3.1	3.3	3.5	0.4	0.4
	1-5-116:19	86	67.0	67.5	69.2	69.5	69.8	70.3	2.2	2.0	2.8	2.8	0.6	0.8
	1-5-06:05	80	67.1	67.5	68.9	69.2	69.6	70.2	1.8	1.7	2.5	2.7	0.7	1.0
	1-5-06:26	243	61.7	61.3	63.4	62.6	64.4	64.4	1.7	1.3	2.7	3.1	1.0	1.8
	1-5-04:05	268	59.2	59.6	61.0	60.2	61.7	61.4	1.8	0.6	2.5	1.8	0.7	1.2
	1-5-2:25	214	61.0	61.3	62.7	62.0	63.5	63.2	1.7	0.7	2.5	1.9	0.8	1.2

[1] The noise level calculations were based on the peak hour traffic volumes from the Traffic Impact Analysis Report [Reference 8].
[2] The approximate distance is from the façade of the building to the centerline of the existing Keaau-Pahoa Road alignment.
[3] The 2006 traffic noise levels are calculated values based on predictions from the Traffic Noise Model.

TABLE 2a
2006 Predicted Traffic Noise Impacts[1]

Noise levels shown in the table were calculated by the Traffic Noise Model

Intersection	Location: TMK	Distance to Road[2] (ft)	Land Use Category	Maximum Peak Hour Traffic Noise Levels[3] (dBA)
Opukahaia to Shower Dr.	1-6-04:47	113	B	70.5
	1-5-36:117	130	B	69.3
	1-5-36:116	131	B	68.9
	1-6-64:287	217	B	66.9
	1-6-64:286	166	B	68.3
	1-5-36:120	89	B	71.2
	1-6-64:284	141	B	68.9
	1-6-64:283	149	B	68.8
	1-5-36:121	117	B	69.8
Shower Dr. to Pohaku Pl.	1-6-64:269	203	B	67.1
	1-6-64:267	230	B	66.3
	1-6-64:266	163	B	68.2
	1-6-64:265	178	B	67.6
	1-6-64:263	151	B	68.4
	1-5-36:153	68	B	72.2
	1-6-64:261	172	B	67.6
	1-5-36:151	91	B	71.0
	1-5-36:150	153	B	68.3
	1-6-64:260	156	B	68.2
	1-6-64:258	243	B	66.1
	1-5-36:148	164	B	67.7
	1-6-64:257	168	B	68.0

[1] The noise level calculations were based on the peak hour traffic volumes from the Traffic Impact Analysis Report [Reference 8].
[2] The approximate distance is from the façade of the building to the centerline of the existing Keaau-Pahoa Road alignment.
[3] Noise levels that will "approach or exceed" the FHWA/HDOT noise abatement criteria for each Land Use Category.

TABLE 2a (cont.)
2006 Predicted Traffic Noise Impacts[1]

Intersection	Location: TMK	Distance to Road[2] (ft)	Land Use Category	Maximum Peak Hour Traffic Noise Levels[3] (dBA)
Shower Dr. to Pohaku Pl. (cont.)	1-6-64:256	154	B	68.6
	1-6-64:255	126	B	69.5
	1-5-36:145	218	B	66.3
	1-6-64:253	230	B	66.4
	1-5-35:148	98	B	70.5
	1-6-64:251	115	B	70.0
	1-5-35:149	92	B	70.4
	1-6-64:249	173	B	67.7
Pohaku Pl. to Kaloli Dr.	1-5-35:182	92	B	70.1
	1-6-10:270	168	B	67.5
	1-5-35:181	98	B	70.0
	1-5-35:180	207	B	66.4
	1-6-10:271	158	B	67.7
	1-5-35:184	111	B	69.5
	1-6-10:273	70	B	72.1
	1-6-10:274	138	B	68.7
	1-5-35:185	127	B	68.9
	1-6-10:275	138	B	68.4
	1-5-35:186	100	B	70.1
	1-5-35:187	103	B	69.8
	1-6-10:276	192	B	67.0
Kaloli Dr. to Pohaku Cir.	1-6-10:281	171	B	67.5
	1-6-10:284	214	B	66.2
	1-5-34:215	129	B	68.1
	1-6-10:286	168	B	67.3
	1-6-10:287	208	B	66.3
	1-6-10:288	123	B	68.8
	1-5-34:210	118	B	68.7

[1] The noise level calculations were based on the peak hour traffic volumes from the Traffic Impact Analysis Report [Reference 8].
[2] The approximate distance is from the façade of the building to the centerline of the existing Keaau-Pahoa Road alignment.
[3] Noise levels that will "approach or exceed" the FHWA/HDOT noise abatement criteria for each Land Use Category.

TABLE 2a (cont.)
2006 Predicted Traffic Noise Impacts[1]

Intersection	Location: TMK	Distance to Road[2] (ft)	Land Use Category	Maximum Peak Hour Traffic Noise Levels[3] (dBA)
Poahaku Cir. to Orchidland Dr.	1-5-34:219	126	B	68.2
	1-5-34:220	159	B	67.1
	1-6-10:123	125	B	68.4
	1-6-10:124	147	B	67.7
	1-5-34:222	136	B	67.9
	1-5-33:221	172	B	66.7
	1-6-10:289	138	B	68.1
	1-5-34:218	83	B	70.2
	1-6-10:126	134	B	68.1
	1-6-10:127	124	B	68.4
	1-5-33:222	127	B	67.5
	1-6-10:129	135	B	68.0
	1-5-33:254	68	B	71.3
	1-5-33:253	157	B	67.1
	1-6-10:134	136	B	68.0
Orchidland Dr. to Paradise Dr.	1-6-9:388-390	189	B	66.1
	1-6-9:391	98	B	69.6
	1-5-33:256	91	B	69.4
	1-5-33:257	114	B	68.4
	1-6-9:401	140	B	67.7
	1-6-9:394	123	B	68.5

[1] The noise level calculations were based on the peak hour traffic volumes from the Traffic Impact Analysis Report [Reference 8].
[2] The approximate distance is from the façade of the building to the centerline of the existing Keaau-Pahoa Road alignment.
[3] Noise levels that will "approach or exceed" the FHWA/HDOT noise abatement criteria for each Land Use Category.

TABLE 2a (cont.)
2006 Predicted Traffic Noise Impacts[1]

Intersection	Location: TMK	Distance to Road[2] (ft)	Land Use Category	Maximum Peak Hour Traffic Noise Levels[3] (dBA)
Paradise Dr. to Aulii St.	1-6-9:402	126	B	68.3
	1-6-9:405	124	B	68.4
	1-5-17:143	104	B	68.8
	1-6-9:406	158	B	67.0
	1-5-17:145	108	B	68.6
	1-5-17:147	108	B	68.9
	1-5-17:148	126	B	68.1
	1-5-14:150	120	B	68.2
	1-5-17:154	89	B	69.7
Aulii St. to Makuu Dr.	1-6-9:214	111	B	68.6
	1-6-9:220	135	B	67.3
	1-6-9:222	144	B	67.1
	1-6-9:223	141	B	67.1
	1-5-16:174	110	B	68.1
	1-6-9:225	123	B	67.6
	1-6-9:227	118	B	67.9
	1-5-16:173	161	B	66.3
	1-6-9:228	111	B	68.3
	1-5-16:170	90	B	69.0
	1-6-9:233	154	B	66.6
	1-5-16:167	77	B	69.9
	1-6-9:236	162	B	66.4
	1-6-9:237	138	B	67.2
	1-5-16:165	109	B	68.0
	1-5-16:164	122	B	67.6
	1-6-9:238	148	B	67.0
	1-6-9:241	103	B	69.1
	1-6-9:243	122	B	68.1

[1] The noise level calculations were based on the peak hour traffic volumes from the Traffic Impact Analysis Report [Reference 8].
[2] The approximate distance is from the façade of the building to the centerline of the existing Keaau-Pahoa Road alignment.
[3] Noise levels that will "approach or exceed" the FHWA/HDOT noise abatement criteria for each Land Use Category.

TABLE 2a (cont.)
2006 Predicted Traffic Noise Impacts[1]

Intersection	Location: TMK	Distance to Road[2] (ft)	Land Use Category	Maximum Peak Hour Traffic Noise Levels[3] (dBA)
Makuu Dr. to Ilima St.	1-6-9:168	110	B	68.2
	1-6-9:166	114	B	68.2
Ilima St. to Ainaloa Blvd.	1-5-15:175	110	B	67.5
	1-6-9:158	126	B	67.4
Ainaloa Blvd. to Ka Ohuwalu Dr.	1-5-15:182	133	B	67.2
	1-6-99:6	73	B	70.2
	1-6-99:2	68	B	70.9
	1-5-15:187	162	B	66.1
Kaluahine St. to Pahoa Village Junction	1-5-7:13	66	B	69.7
	1-5-7:73	107	B	67.4
	1-5-7:75	60	B	69.3
	1-5-7:12	87	B	68.4
	1-5-7:52	61	B	70.0
	1-5-7:11	135	B	66.1
	1-5-7:68	125	B	66.6
	1-5-7:78	129	B	66.6
	1-5-7:53	93	B	68.0
	1-5-7:10	89	B	68.3

[1] The noise level calculations were based on the peak hour traffic volumes from the Traffic Impact Analysis Report [Reference 8].
[2] The approximate distance is from the façade of the building to the centerline of the existing Keaau-Pahoa Road alignment.
[3] Noise levels that will "approach or exceed" the FHWA/HDOT noise abatement criteria for each Land Use Category.

TABLE 2b
2038 No Build Predicted Traffic Noise Impacts[1]

Noise levels shown in the table were calculated by the Traffic Noise Model

Intersection	Location: TMK	Distance to Road[2] (ft)	Land Use Category	Maximum Peak Hour Traffic Noise Levels[3] (dBA)
Opukahaia to Shower Dr.	1-6-04:51	132	C	71.1
	1-6-03:74	96	C	71.6
	1-6-64:289	291	B	66.4
	1-6-64:288	278	B	66.7
Pohaku Pl. to Kaloli Dr.	1-6-10:269	242	B	66.4
Kaloli Dr. to Pohaku Cir.	1-5-34:212	242	B	66.6
	1-5-34:211	238	B	66.7
Pohaku Cir.to Orchidland Dr.	1-6-10:111	218	B	67.1
	1-6-10:114	226	B	67.2
	1-6-10:116	241	B	66.8
	1-6-10:90	215	B	67.4
	1-6-10:135	208	B	67.6
Orchidland Dr.to Paradise Dr.	1-6-9-393	274	B	66.1
	1-6-9:397	263	B	66.4
	1-6-9:399	261	B	66.5
Paradise Dr. to Aulii St.	1-6-9:409	192	B	68.0
	1-6-9:414	224	B	67.2
	1-6-9:418	213	B	67.4
Aulii St. to Makuu Dr.	1-6-9:239	181	B	68.0
	1-5-16:163	256	B	66.1
Makuu Dr. to Ilima St.	1-5-15:179	233	B	66.3
	1-5-15:177	212	B	66.7
	1-5-15:176	232	B	66.3
Ilima St. to Ainaloa Blvd.	1-5-15:174	196	B	67.5
	1-5-15:173	245	B	66.3

[1] The noise level calculations were based on the peak hour traffic volumes from the Traffic Impact Analysis Report [Reference 8].
[2] The approximate distance is from the façade of the building to the centerline of the existing Keaau-Pahoa Road alignment.
[3] Noise levels that will "approach or exceed" the FHWA/HDOT noise abatement criteria for each Land Use Category.

TABLE 2b
2038 No Build Predicted Traffic Noise Impacts[1]

Intersection	Location: TMK	Distance to Road[2] (ft)	Land Use Category	Maximum Peak Hour Traffic Noise Levels[3] (dBA)
Ainaloa Blvd. to Ka Ohuwalu Dr.	1-6-99:4	241	B	66.7
	1-6-99:3	201	B	67.7
	1-5-10:17	208	B	67.3
Ka Ohuwalu Dr. to Kaluahine St.	1-5-118:17	188	B	68.2
	1-5-119:45	243	B	66.8
	1-5-118:49	233	B	66.9
Kaluahine St. to Pahoa Village Junction	1-5-7:15	69	C	71.6
	1-5-7:9	193	B	67.2

[1] The noise level calculations were based on the peak hour traffic volumes from the Traffic Impact Analysis Report [Reference 8].
[2] The approximate distance is from the façade of the building to the centerline of the existing Keaau-Pahoa Road alignment.
[3] Noise levels that will "approach or exceed" the FHWA/HDOT noise abatement criteria for each Land Use Category.

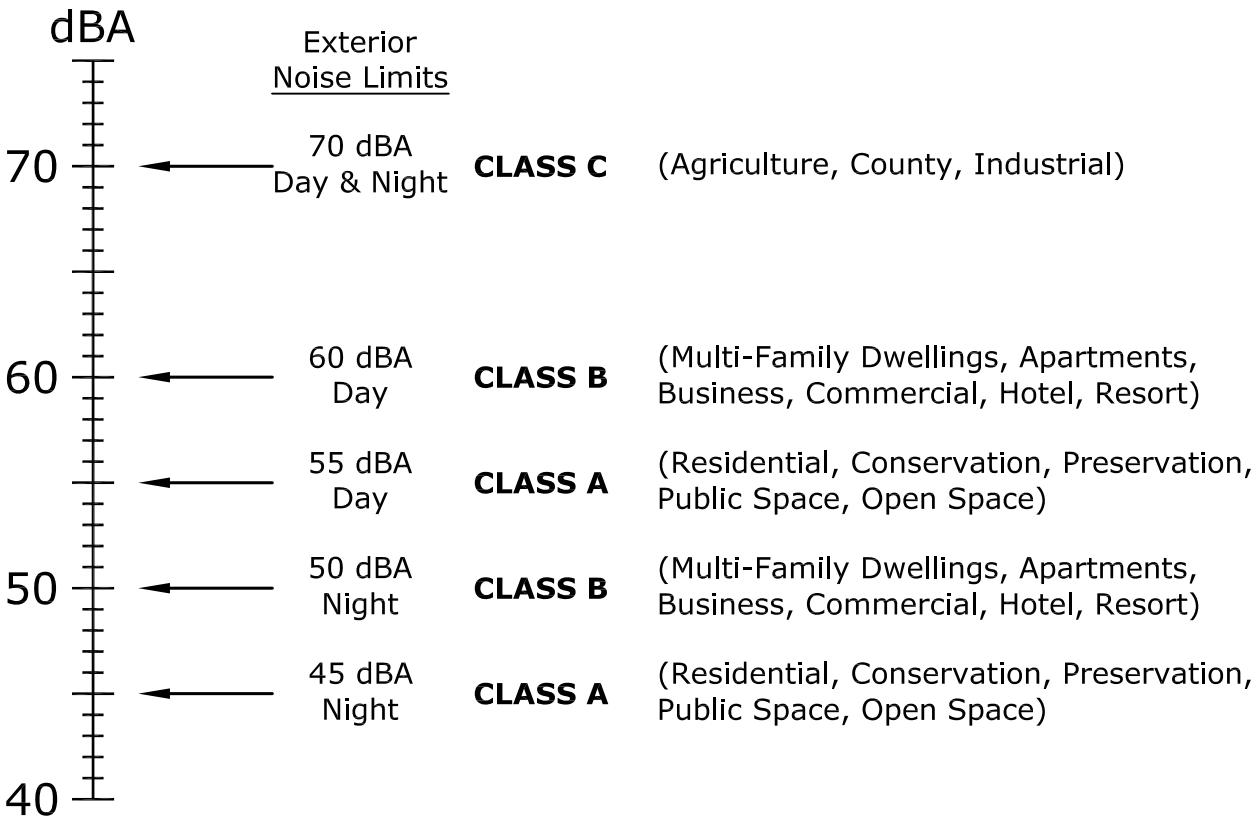
TABLE 2c
2038 Alternative 4+5 Predicted Traffic Noise Impacts[1]

Noise levels shown in the table were calculated by the Traffic Noise Model

Intersection	Location: TMK	Distance to Road[2] (ft)	Land Use Category	Maximum Peak Hour Traffic Noise Levels[3] (dBA)
Shower Dr. to Pohaku Pl.	1-6-64:264	273	B	71.1
	1-5-36:144	271	B	71.6
	1-5-36:143	280	B	66.4
	1-5-36:142	344	B	66.7
Pohaku Pl.to Kaloli Dr.	1-6-10:268	270	B	66.4
Pohaku Cir. to Orchidland Dr.	1-6-10:115	297	B	66.6
	1-5-33:252	164	B	66.7
Paradise Dr. to Aulii St.	1-5-17:153	319	B	67.1
Aulii St. to Makuu Dr.	1-5-16:166	258	B	67.2
Makuu Dr. to Ilima St.	1-5-15:178	246	B	66.8
Ilima St.to Ainaloa Blvd.	1-5-15:172	282	B	67.4
	1-5-15:171	310	B	67.6
	1-5-15:181	301	B	66.1
Ainaloa Blvd. to Ka Ohuwalu Dr.	1-6-99:31	301	B	66.4
Ka Ohuwalu Dr. to Kaluahine St.	1-5-119:44	317	B	66.5
	1-5-7:19	102	C	68.0

[1] The noise level calculations were based on the peak hour traffic volumes from the Traffic Impact Analysis Report [Reference 8].
[2] The approximate distance is from the façade of the building to the centerline of the existing Keaau-Pahoa Road alignment.
[3] Noise levels that will "approach or exceed" the FHWA/HDOT noise abatement criteria for each Land Use Category.

Zoning District	Day Hours (7 AM to 10 PM)	Night Hours (10 PM to 7 AM)
CLASS A Residential, Conservation, Preservation, Public Space, Open Space	55 dBA (Exterior)	45 dBA (Exterior)
CLASS B Multi-Family Dwellings, Apartments, Business, Commercial, Hotel, Resort	60 dBA (Exterior)	50 dBA (Exterior)
CLASS C Agriculture, Country, Industrial	70 dBA (Exterior)	70 dBA (Exterior)



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Hawaii Maximum Permissible Sound Levels for Various Zoning Districts

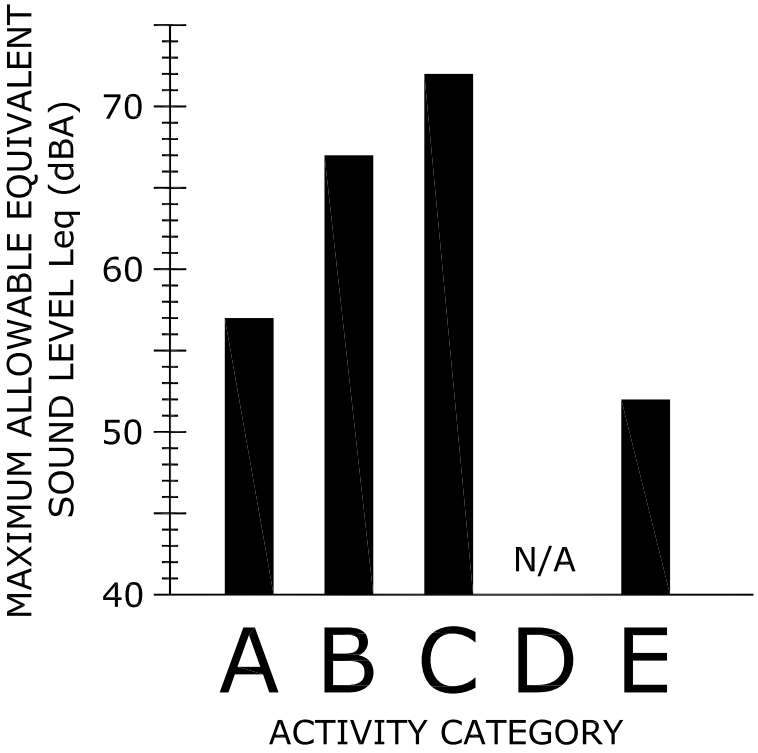
Keaau-Pahoa Road Improvements

Not to Scale

Figure No 1

Date	Project No.	Drawn By
January 2010	06-36	TRB

ACTIVITY CATEGORY	ACTIVITY CATEGORY DESCRIPTION	MAXIMUM EQUIVALENT SOUND LEVEL $L_{eq(h)}$
A	LANDS ON WHICH SERENITY AND QUIET ARE OF EXTRAORDINARY SIGNIFICANCE AND SERVE AN IMPORTANT PUBLIC NEED AND WHERE THE PRESERVATION OF THOSE QUALITIES IS ESSENTIAL IF THE AREA IS TO CONTINUE TO SERVE ITS INTENDED PURPOSE.	57 dBA (EXTERIOR)
B	PICNIC AREAS, RECREATION AREAS, PLAYGROUNDS, ACTIVE SPORT AREAS, PARKS, RESIDENCES, MOTELS, HOTELS, SCHOOLS, CHURCHES, LIBRARIES, AND HOSPITALS.	67 dBA (EXTERIOR)
C	DEVELOPED LANDS, PROPERTIES, OR ACTIVITIES NOT INCLUDED IN ACTIVITY CATEGORIES A OR B ABOVE.	72 dBA (EXTERIOR)
D	UNDEVELOPED LAND	N/A
E	RESIDENCES, MOTELS, HOTELS, PUBLIC MEETING ROOMS, SCHOOLS, CHURCHES, LIBRARIES, HOSPITALS, AND AUDITORIUMS.	52 dBA (INTERIOR)



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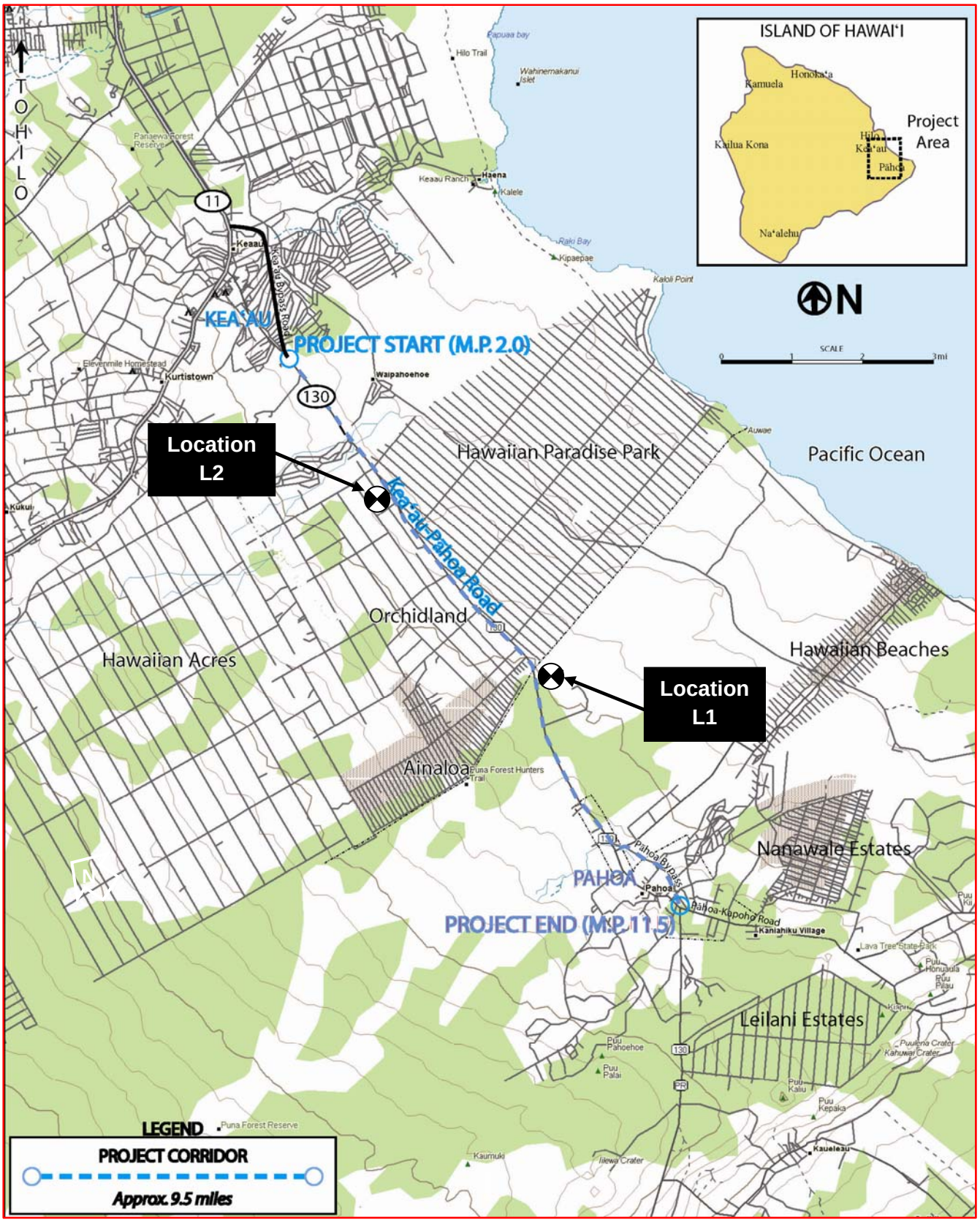
Federal Highways Administration Recommended Equivalent Hourly Sound Levels Based on Land Use

Keaau-Pahoa Road Improvements

Not to Scale

Figure No 2

Date	Project No.	Drawn By
January 2010	06-36	TRB



*Source: DeLorne 3-D TopoQuads

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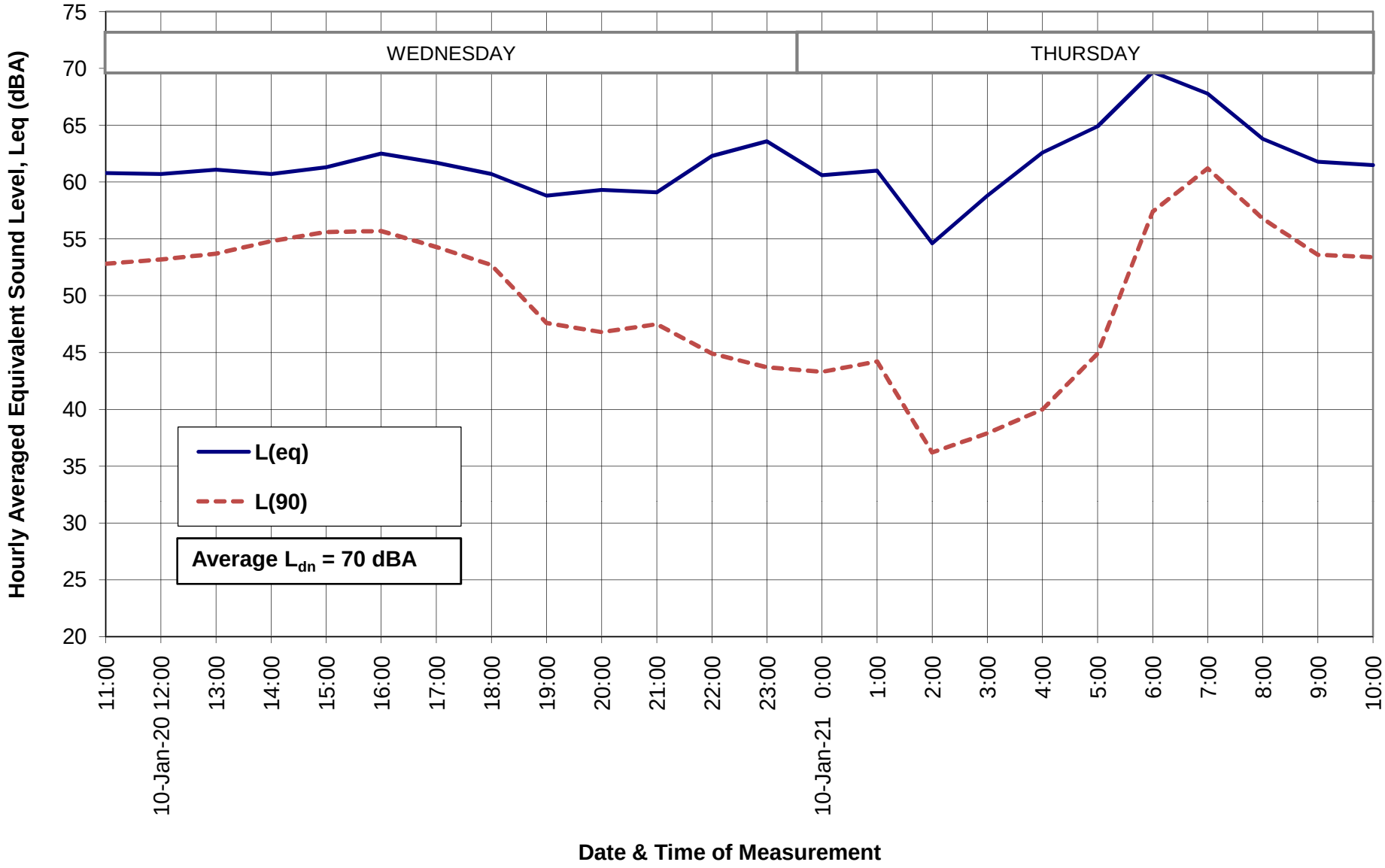
Long-Term Noise Measurement Locations

January 2010	06-36	KMF
Date	Project No.	Drawn By

Figure No
3



Location L1 - Long Term Noise Measurement Results

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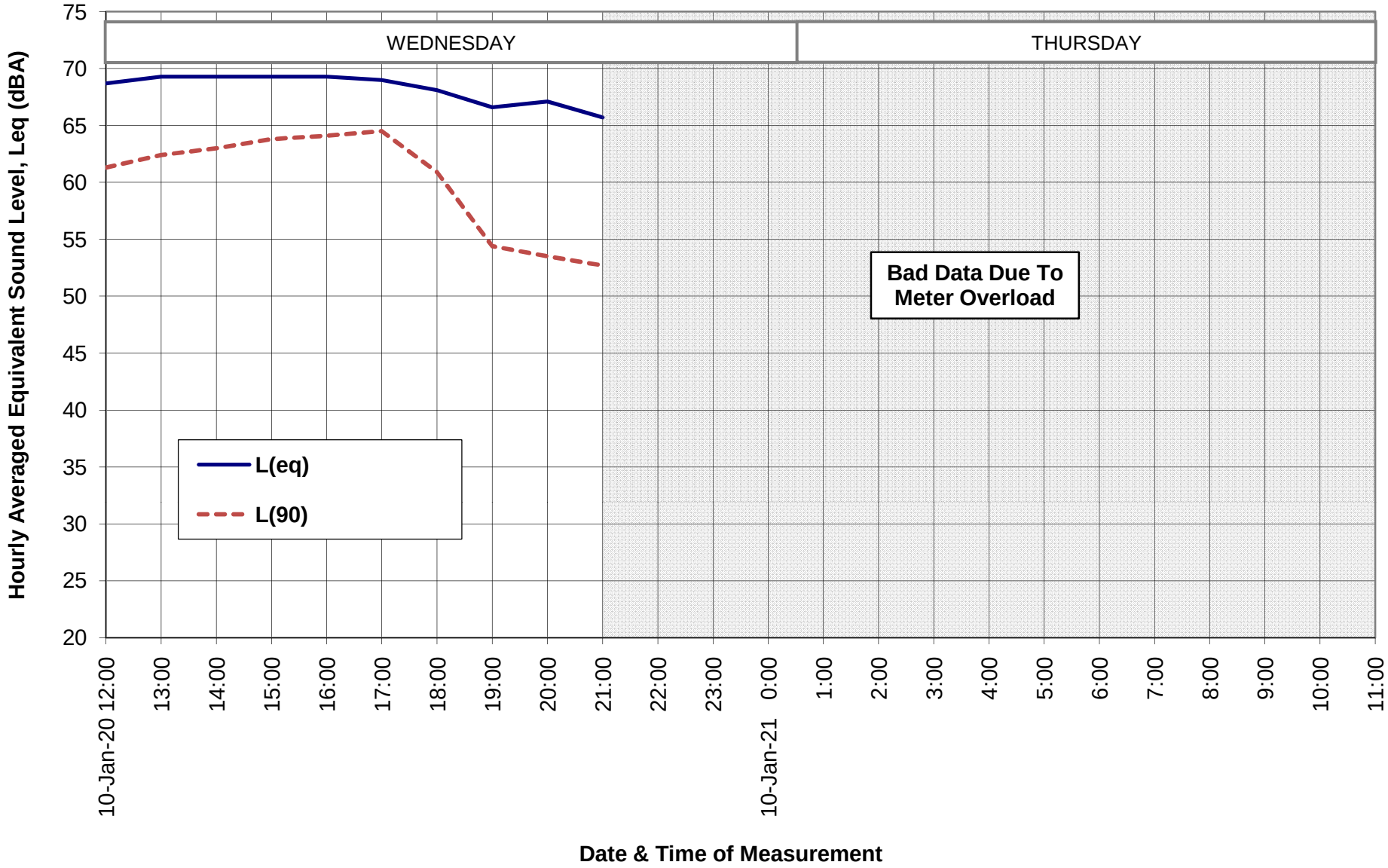
Figure No 4



Location L2 - Long Term Noise Measurement Results

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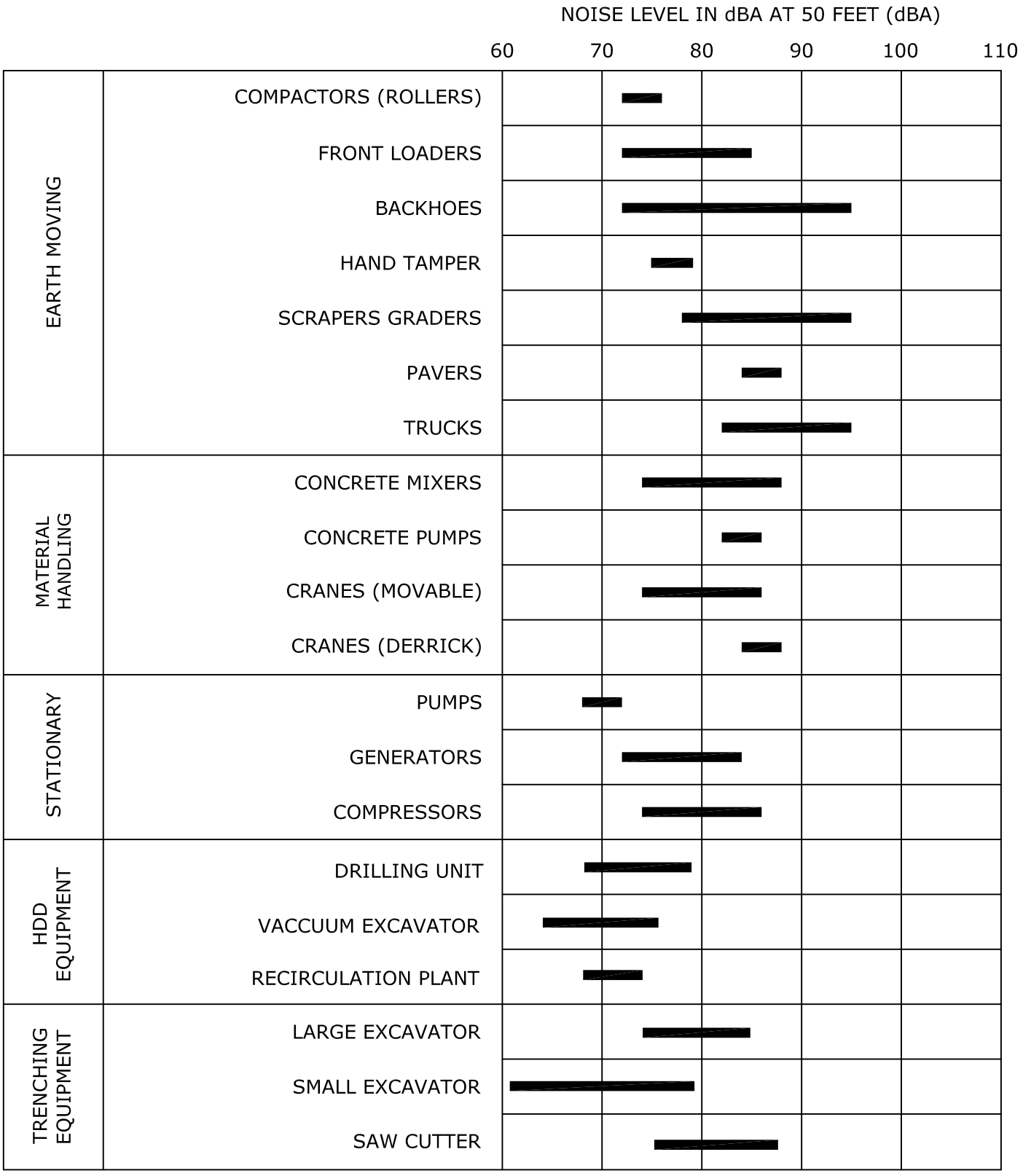
Figure No 5



NOTE: BASED ON LIMITED AVAILABLE DATA SAMPLES

Typical Sound Levels from Construction Equipment

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Keaau-Pahoa Road Improvements

Not to Scale

Figure No 6

Date	Project No.	Drawn By
January 2010	06-36	TRB

APPENDIX A

Acoustic Terminology

Acoustic Terminology

Sound Pressure Level

Sound, or noise, is the term given to variations in air pressure that are capable of being detected by the human ear. Small fluctuations in atmospheric pressure (sound pressure) constitute the physical property measured with a sound pressure level meter. Because the human ear can detect variations in atmospheric pressure over such a large range of magnitudes, sound pressure is expressed on a logarithmic scale in units called decibels (dB). Noise is defined as "unwanted" sound.

Technically, sound pressure level (SPL) is defined as:

$$SPL = 20 \log (P/P_{ref}) \text{ dB}$$

where P is the sound pressure fluctuation (above or below atmospheric pressure) and P_{ref} is the reference pressure, 20 μPa, which is approximately the lowest sound pressure that can be detected by the human ear. For example:

If P = 20 μPa, then SPL = 0 dB
If P = 200 μPa, then SPL = 20 dB
If P = 2000 μPa, then SPL = 40 dB

The sound pressure level that results from a combination of noise sources is not the arithmetic sum of the individual sound sources, but rather the logarithmic sum. For example, two sound levels of 50 dB produce a combined sound level of 53 dB, not 100 dB. Two sound levels of 40 and 50 dB produce a combined level of 50.4 dB.

Human sensitivity to changes in sound pressure level is highly individualized. Sensitivity to sound depends on frequency content, time of occurrence, duration, and psychological factors such as emotions and expectations. However, in general, a change of 1 or 2 dB in the level of sound is difficult for most people to detect. A 3 dB change is commonly taken as the smallest perceptible change and a 6 dB change corresponds to a noticeable change in loudness. A 10 dB increase or decrease in sound level corresponds to an approximate doubling or halving of loudness, respectively.

A-Weighted Sound Level

Studies have shown conclusively that at equal sound pressure levels, people are generally more sensitive to certain higher frequency sounds (such as made by speech, horns, and whistles) than most lower frequency sounds (such as made by motors and engines)[1] at the same level. To address this preferential response to frequency, the A-weighted scale was developed. The A-weighted scale adjusts the sound level in each frequency band in much the same manner that the

[1] D.W. Robinson and R.S. Dadson, "A Re-Determination of the Equal-Loudness Relations for Pure Tones," *British Journal of Applied Physics*, vol. 7, pp. 166 - 181, 1956. (Adopted by the International Standards Organization as Recommendation R-226.

human auditory system does. Thus the A-weighted sound level (read as "dBA") becomes a single number that defines the level of a sound and has some correlation with the sensitivity of the human ear to that sound. Different sounds with the same A-weighted sound level are perceived as being equally loud. The A-weighted noise level is commonly used today in environmental noise analysis and in noise regulations. Typical values of the A-weighted sound level of various noise sources are shown in Figure A-1.

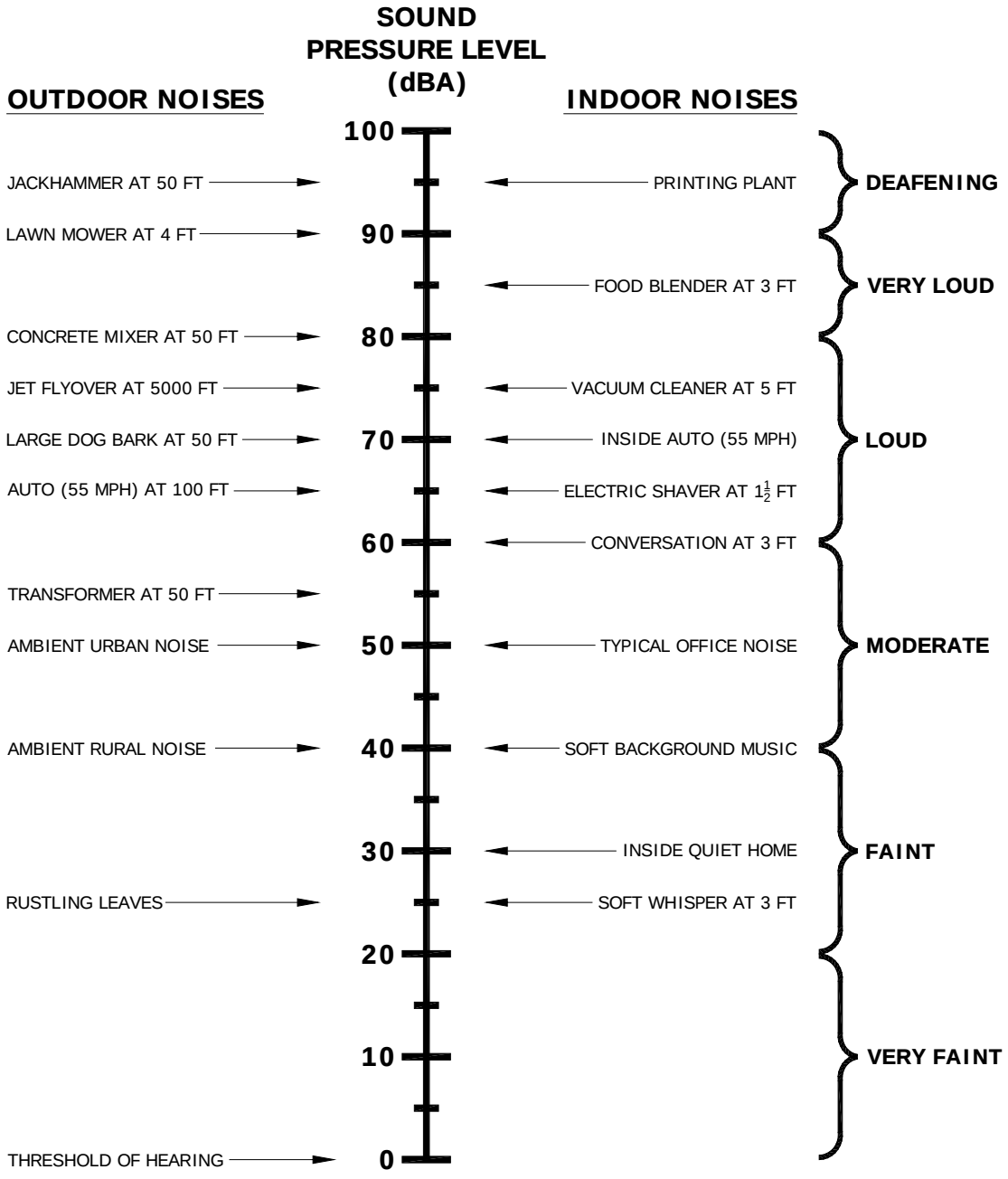

Figure A-1. Common Outdoor/Indoor Sound Levels

Equivalent Sound Level

The Equivalent Sound Level (L_{eq}) is a type of average which represents the steady level that, integrated over a time period, would produce the same energy as the actual signal. The actual *instantaneous* noise levels typically fluctuate above and below the measured L_{eq} during the measurement period. The A-weighted L_{eq} is a common index for measuring environmental noise. A graphical description of the equivalent sound level is shown in Figure A-2.

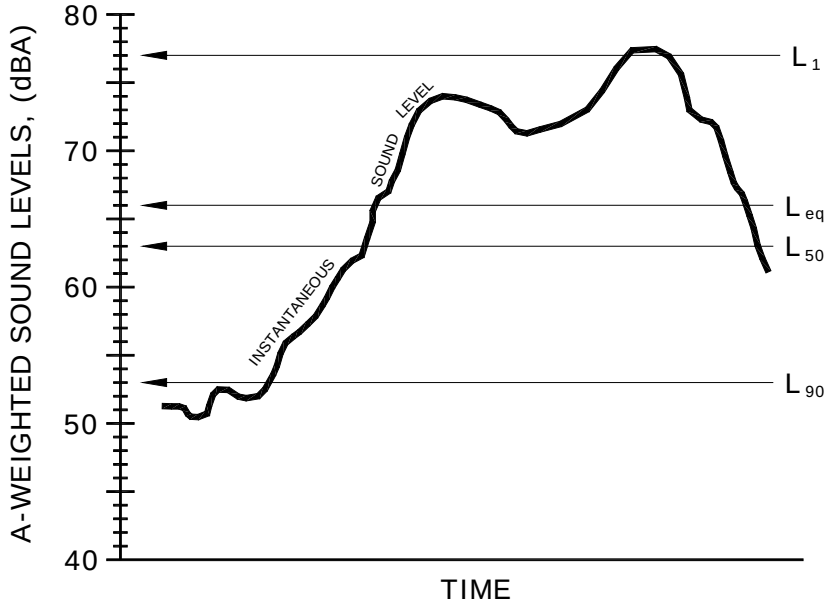

Figure A-2. Example Graph of Equivalent and Statistical Sound Levels

Statistical Sound Level

The sound levels of long-term noise producing activities such as traffic movement, aircraft operations, etc., can vary considerably with time. In order to obtain a single number rating of such a noise source, a statistically-based method of expressing sound or noise levels has been developed. It is known as the Exceedence Level, L_n. The L_n represents the sound level that is exceeded for n% of the measurement time period. For example, L_{10} = 60 dBA indicates that for the duration of the measurement period, the sound level exceeded 60 dBA 10% of the time. Typically, in noise regulations and standards, the specified time period is one hour. Commonly used Exceedence Levels include L_{01}, L_{10}, L_{50}, and L_{90}, which are widely used to assess community and environmental noise. A graphical description of the equivalent sound level is shown in Figure A-2.

Day-Night Equivalent Sound Level

The Day-Night Equivalent Sound Level, L_{dn}, is the Equivalent Sound Level, L_{eq}, measured over a 24-hour period. However, a 10 dB penalty is added to the noise levels recorded between 10 p.m. and 7 a.m. to account for people's higher sensitivity to noise at night when the background noise level is typically lower. The L_{dn} is a commonly used noise descriptor in assessing land use compatibility, and is widely used by federal and local agencies and standards organizations.

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