Appendix I

Noise Data

Appendix I1:
Wilson Ihrig & Associates Acoustical Report

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CCR TITLE 24 NOISE STUDY

THE TERRACES OF LAFAYETTE MULTIFAMILY PROJECT

LAFAYETTE, CALIFORNIA

16 June 2011

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Introduction

This report presents an acoustical evaluation of the exterior noise and exterior to interior sound isolation for the proposed The Terraces of Lafayette multi-family residential project to be constructed at the intersection of Pleasant Hill Road and SR24 in the City of Lafayette, CA. The proposed project is a two and three story residential development of 315 units across 14 buildings.

This study concludes that, with the proposed mitigation measures in place, the project will not have any significant unavoidable impacts related to exterior-to-interior noise. Noise mitigation recommendations for exterior glazing, exterior assemblies, and exterior doors are presented, along with important installation details. The proposed mitigation measures are common and widely used in projects located in similar noise environments.

The purpose of this noise study is to assess the exterior noise environment of the subject property and to provide recommendations on the control of exterior-to-interior noise with respect to the requirements of the California Code of Regulations (CCR), Title 24 (included in the 2010 California Building Code Section 1207 - Sound Transmission) and the City of Lafayette Noise Element of its General Plan, adopted by the City Council on October 28, 2002. This report provides a description of the environmental noise survey methodology, a discussion of applicable noise standards, noise survey results, future noise level projections, and exterior-to-interior noise mitigation recommendations for the proposed residential development.

Inter-unit noise mitigation provisions, also required by CCR Title 24, include acoustical design and installation details for party walls, corridor walls, floor-ceiling assemblies, and other components. Recommendations relating to these interior items are typical and will be provided as the project's design details are developed. The current Study is based on the Schematic Design Architectural Set dated 3/21/2011 by LCA Architects.

The project site's existing noise environment is primarily dominated by vehicle traffic along Pleasant Hill Road on the east side and along SR-24 on the south and west sides, and secondary sources such as BART and I-680 on the southern and eastern sides. This study predicts a very slight net increase in future noise levels due to expected increases in traffic volumes.

Applicable Noise Standards – Noise Study Criteria

The California Code of Regulations (CCR) Title 24 –"Sound Transmission Control" requires an acoustical analysis for any new residential building located in an area where the annual Day-Night Noise level (L_{dn}) exceeds 60 decibels. Please see the "*Description of Acoustical Terms Relevant to Title 24 Projects*" in Appendix B at the end of this report for a definition of this and other acoustical terms.

The report resulting from this analysis is required to show the topographical relationship of noise sources and dwelling sites, and state the predicted noise exposure levels at the exterior of the proposed dwelling structures, considering present and future conditions as the basis for the predictions. The report is to identify noise attenuation measures to be applied and provide an analysis demonstrating that the proposed buildings could be designed to limit intruding noise.

The City of Lafayette Noise Element of the General Plan, under Policy N-1.2, Program N-1.4.2 uses an even stricter rule of 55 L_{dn} or greater in the determination for the need of a noise study report:

> *Program N-1.4.2: Require an acoustical study for all new residential projects with a future L_{dn} noise exposure of 55 L_{dn} or greater. The study shall describe how the project will comply with the Noise and Land Use Compatibility Standards. The studies shall also satisfy the requirements set forth in Title 24, part 2 of the California Government Code, Noise Insulation Standards, for multi-family attached dwellings, hotels, motels, etc. regulated by Title 24.*

Exterior noise

The City of Lafayette, in the *Noise Element* of its General Plan provides specific land use compatibility standards and policies aimed at controlling exterior noise in residential projects. Specifically, land uses and their compatibility with various noise criteria is stated graphically in Figure 1, below, reproduced from the Noise Element.

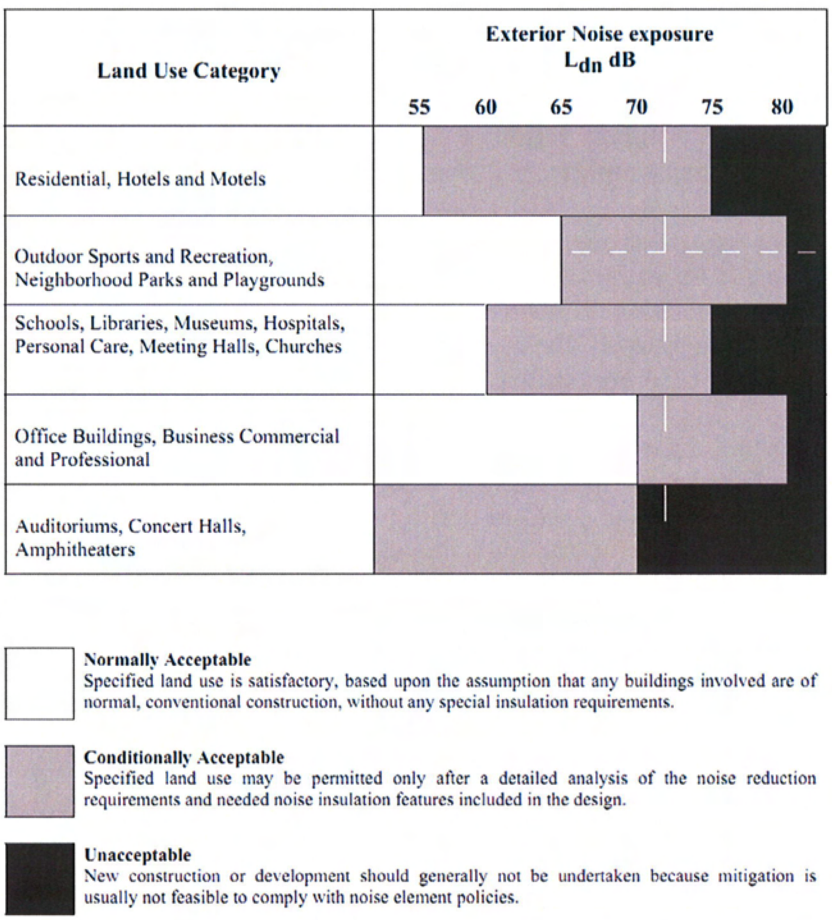

Figure 1: Land Use/Noise Compatibility Chart. Lafayette's Noise Element, page VII-6)

Interior noise due to exterior sources

Title 24 of the CCR specifies the maximum level of interior noise in any habitable room due to exterior sources allowable for new multifamily residential developments as 45 (L_{dn}) or lower. The Noise Element extends such requirement to single-family developments also. Title 24 further requires that the building be oriented, shielded, and designed to have sufficient sound insulation so as to meet such maximum level attributable to exterior sources in any habitable room with all exterior doors and windows in the closed position. The City's Noise Element requirements for interior noise are contained in Policy N-1.2, Program N-1.4

> *Policy N-1.4 Residential and Noise Sensitive Land Use Standards: Require a standard of 40 - 45 L_{dn} (depending on location) for indoor noise level for all new residential development including hotels and motels, and a standard of 55 L_{dn} for outdoor noise, except near the freeway. These limits shall be reduced by 5 dB for senior housing and residential care facilities.*

However, no indication is given in the Element as to which locations require mitigation of interior noise to 40 L_{dn}; therefore, this study uses a 45 L_{dn} criteria for interior noise, which is consistent with the requirements of the California Code of Regulations Title 24.

Additional Sound Isolation Requirements

Section 1207 – Sound Transmission – of the 2007 CBC includes requirements related to both exterior and interior project assemblies, penetrations therein, and entry doors:

> *All walls and floor-ceiling assemblies separating dwelling units or guest rooms from each other and from public space such as interior corridors and service areas shall provide an airborne sound insulation equal to that required to meet STC 50 (45 if field tested). Such floor-ceilings are further required to provide impact insulation of at least IIC 50 (45 if field tested). Floor coverings used to provide the required IIC rating must be retained as a permanent part of the floor-ceiling assemblies. They may then only be replaced by another covering providing equal or greater impact insulation.*
>
> *Penetrations or openings in construction assemblies for piping; electrical devises; recessed cabinets; bathtubs; soffits; or heating, ventilation or exhaust ducts shall be sealed, lined, insulated or otherwise treated to maintain the required ratings.*
>
> *Entrance doors from interior corridors together with their perimeter seals shall have a laboratory-tested STC rating of not less than 26, and such perimeter seals shall be maintained in good operating conditions. Acoustical requirements for exterior doors must be assessed separately, based on the composite sound transmission performance of the assembly in which they are included.*

Ventilation Requirements

Item 1207.12 of the CBC includes the following regarding ventilation of dwellings:

> *If interior allowable noise levels are met by requiring that windows be unopenable or closed, the design for the structure must also specify a*

ventilation or air-conditioning system to provide a habitable interior environment. The ventilation system must not compromise the dwelling unit or guest room noise reduction.

Environmental Noise Survey Methodology

The Environmental Noise Survey consisted of both short-term noise recordings and long-term noise measurement efforts at several locations in the project vicinity. Table I summarizes the noise measurement locations, with distances to adjacent sources and the types of measurements performed at each. Figure 1 presents this information in graphical form.

Long-Term Measurements

Long-term, statistical noise levels were measured at the site by means of three precision, calibrated, Type I logging sound level meters left unattended to monitor for over seven complete days between Thursday, 19 May and Wednesday, 25 May 2011, inclusive. Long-term meters were placed at the locations indicated in Table I and Figure 2 (indicated as LT-1 to LT-3), where they could be secured to a light poles and trees. Microphone heights are approximately 12 ft above grade in this mounting arrangement. The sound meters monitored noise levels continuously during the survey period, providing hourly-averaged and statistical noise levels over four 7? complete days at the three locations. The hourly equivalent noise data (L_{eq}) were then used to calculate the daily and typical Day-Night Levels (L_{dn}), as required by the CCR Title 24 and the City of Lafayette Noise Element.

Short-Term Measurement

At short-term locations ST-1 to ST-3, calibrated, digital audio tape (DAT) recordings were made for approximately 15 minutes to determine the spectral content of the noise.

Table I: Environmental Noise Survey Measurement Locations

Label	Measurement Type*	Location Description**
LT-A & ST-A	Long & Short-Term	On tree, near west end of site at approx. setback for Bldg 'A' ~ 310' from SR-24 CL. Location affected by noise from SR-24 and BART exclusively. Representative of south exposure for Bldgs A, H, I & J before shielding
ST-C	Short-Term	By edge of 460' elevation plateau; ~ 700' fr SR-24 CL. Representative of south exposure for Bldgs B, C & D before shielding by terrain and other Bldgs.
ST-K	Short-Term	By edge of 400' elevation plateau; ~ 550' fr SR-24 CL. Representative of south exposure for Bldgs K & L.
LT-M & ST-M	Long & Short-Term	On tree behind (e) house, approx. setback for Bldg 'M' ~ 130' from Pleasant Hill Rd. CL
LT-N & ST-N	Long & Short-Term	LT-N on telephone pole ~ 40' from Pleasant Hill Rd. CL; ST-N by Bldg 'N' setback, ~ 100' from PVR CL.
Notes: * See descriptions of measurement types above ** Distances and directions are for plan view		

Environmental Noise Survey Results

Existing noise levels were determined by analyzing short-term and long-term measurement data obtained at the site; future noise levels were extrapolated from existing noise levels based on proposed building configurations and expected future increases and changes in street traffic. Subsequently, future noise level contours were developed to assess the project's noise mitigation requirements.

Measured Existing Noise Levels

The results of the environmental noise survey reveal that existing noise levels across the perimeter of the site are already consistently above the 60 L_{dn} threshold used by Title 24 to determine the need for mitigation measures. Figure 4 to Figure 6 present the hourly-averaged L_{eq} and calculated L_{dn} sound levels from the long-term survey for over seven complete days. Long-term results show slightly higher noise levels on weekdays, when car and truck traffic are greater.

Frequency spectra for the energy-equivalent (L_{eq}) and frequently occurring maxima (L_{10}) noise levels from the five short-term measurements conducted are consistent with those from other noise environments dominated by freeway and collector road traffic and can be seen in Figure 7 to Figure 11. A-weighted levels also were consistent with those obtained from the long-term measurements.

Projected Future Noise Levels

Figure 12 and shows the projected future noise contours after development of the project site and takes into account the shielding provided by surrounding structures and the proposed lot grading perimeter. Table II also summarizes the existing and future noise level results. Predictions of future traffic noise due to SR-24 were based on Vehicle Miles of Travel (VMT) predictions by Caltrans for Contra Costa County, while those for Pleasant Hill Road and Deer Hill Rd. were based on a typical assumption of a 3% per annum increase for the next 10 years. Based on published traffic volume data for the City of Lafayette, and the fact that neighborhoods served by this collector road are well developed already, we assumed a maximum 1% annual increase in daily traffic volumes as a "worst case" over the next 10 years. This is a standard assumption in noise analyses, which also corresponds with our observations.

Note that a 1% annual increase will result in a 10% cumulative increase in traffic volume over 10 years, which will increase noise by approximately 0.4 L_{dn} decibel because levels expressed in decibels are logarithmically related to increases in traffic volume. Therefore, a worst case 1 L_{dn} decibel increase was assumed. This increase also assumes, of course, that there will be no significant improvements in tire, pavement, and/or engine technologies which would serve to reduce the overall noise emission from vehicular traffic, as it has been the case in the past.

Table II: Summary of Measured Existing and Predicted Future Day-Night Noise Levels By Measurement Location (See Figure 4 to Figure 6)

	Location LT-A	**Location LT-M**	**Location LT-N**
L_{dn} – Thu, 19 May	68	66	73
L_{dn} – Fri, 20 May	69	67	74
L_{dn} – Sat, 21 May	68	66	72
L_{dn} – Sun, 22 May	67	65	71
L_{dn} – Mon, 23 May	68	66	73
L_{dn} – Tue, 24 May	68	66	73
L_{dn} – Wed, 25 May	69	66	73
Measured, present L_{dn}	68	66	73
Future Predicted (yr 2021) L_{dn}	**69**	**67**	**74**

Noise Mitigation Recommendations

Outdoor Areas

The level of exterior noise projected from our noise study exceeds the 60 L_{dn} acoustical study threshold in CCR Title 24 across the most of the site in its current state. Once the site is graded and with the buildings in place, virtually all open areas behind the proposed structures will have noise exposures of less than 60 L_{dn} thanks to the barrier effect to be created by the edges of the graded plateaus and by the building themselves. With the exception of Building 'N' by Pleasant Hill Road, all other buildings will be located at fairly high elevations and significant setbacks from the sources of noise so that very effective noise shielding in excess of 15 decibels will take place at areas behind them. Please refer to Figure 2 and Figure 3 below. Therefore, given the high degree of shielding predicted, it is not necessary to erect sound walls or fences to mitigate noise in outdoor areas.

For perimeter units that are exposed directly to noise from adjacent roadways, it is not common or aesthetically desirable to provide mitigating features to reduce noise levels at the project facades because of space limitations, building height, and restriction of views, fresh air, and light. However, such design features are not necessary to provide compliant interior noise levels, because specifying acoustical designs for glazing and window types, exterior walls, exterior entrances, and supplemental ventilation systems can provide the mitigation necessary to achieve a code-compliant interior noise environment.

Exterior Glazing

Windows are inherently the weak link of a residential project's exterior acoustical envelope. Therefore, proper selection and installation of exterior glazing elements are paramount to achieving CCR Title 24 interior noise limits. Frames of windows and doors must be caulked with resilient, acoustical sealant to provide an airtight seal. Also, a bead of resilient, acoustical caulking must be applied to window casings before installation. Manufacturer's instructions for installation of acoustically rated window assemblies must be followed carefully, so that installed windows retain their rated acoustical performance.

Recommendations are presented in terms of the Outdoor-Indoor Transmission Class (OITC) and Sound Transmission Class (STC) acoustical performance ratings, *both of which should be met by the window manufacturer by providing laboratory test data for the specific window assembly types submitted for this project.* Laboratory test reports should include third octave band sound isolation performance data for the specific glazing system proposed. Window manufacturers may provide alternative glazing configurations which might be more appropriate for this project, provided that these possess the minimum recommended OITC ratings.

Traditionally, manufacturers of exterior doors and windows have used the single-number Sound Transmission Class (STC) metric to rate the acoustical performance of their products. However, STC is a metric optimized for the spectral shape (or tonal quality) of human speech, as it was originally developed as a means to rate the degree of sound isolation between dwelling units in the late 1950's. The Outdoor-Indoor Transmission Class (OITC), as defined in the ASTM Standard E1332, is the *preferred metric* for rating the sound performance of building shell materials. OITC ratings are tied to a typical noise spectrum shape from transportation sources, which are rich in low frequency, bass-type sounds, as opposed to the frequencies of human speech or television audio. Both OITC and STC rating values are calculated from 1/3-octave band transmission loss data for specific building shell components.

Our acoustical glazing recommendations for the project are shown in Figure 12 for units in Buildings M and N and in Figure 13 for units in Buildings A through L. These recommendations are only for habitable rooms within residential units ("R" occupancy) and do not apply to corridors, public stair wells, storage areas, commercial spaces, Fitness Center, Club House, etc. All other façade sections where no specific OITC/STC recommendations are given do not require acoustically-rated glazing, as it is assumed that thermally insulating, dual pane glazing will be used throughout. Such glazing typically possesses OITC/STC ratings in excess of 20 which is sufficient to mitigate exterior noise at or below the 45 Ldn criteria.

Further, these recommendations are based on the assumption that all habitable spaces facing the noisy areas will be fully carpeted. Wall to wall carpet will have the effect of absorbing sound within the room hence reducing the average level of exterior noise which will be transferred through the exterior wall and windows. Should these rooms be fitted with acoustically reflective flooring such as hardwood or ceramic tile for more than 30% of the room area, then exterior glazing with higher sound isolating properties will be necessary at rooms with large fenestrations and/or volumes in order to meet the interior noise criteria. Acoustical calculations specific to those rooms revealed that if hard floor surfaces are used, then the minimum recommended glazing rating must be increased by two OITC/STC points for windows serving those rooms.

Two classes of exterior glazing are indicated for windows, sliding glass doors and unit entry doors in Figure 12 and Figure 13:

- Glazing Class 1 with a minimum OITC 24 / STC 28 rating
- Glazing Class 2 with a minimum OITC 21 / STC 25 rating

Many glazing configurations are produced that meet the above categories. In addition, glazing systems with dissimilar thickness panes are strongly recommended, unless one of the layers is made out of *laminated glass*.

Entry Doors

According to Section 1208A of the 2001 California UBC, the following applies to residential unit entry doors from interior corridors:

> *Entrance doors . . . together with their perimeter seals shall have STC ratings not less than 26. Such tested doors shall operate normally with commercially available seals. Solid-core wood-slab doors 1 3/8 inches (35 mm) thick minimum or 18 gage insulated steel-slab doors with compression seals all around, including the threshold, may be considered adequate without other substantiating information.*

Often, higher acoustical ratings can be achieved with a standard door that is supplied with improved acoustical gaskets at the jambs and threshold, although any supplier must provide an acoustical performance submittal. It is typical for an acoustically-rated exterior entry to include side and head jamb gaskets of the non-porous kind, such as Pemko™ Siliconseal (S88) or approved equal, to avoid flanking transmission of sound into the project units. Double rows of S88 seals are common at high sound insulating doors. The door bottom should be fitted with a fully gasketed, lap joint type threshold or with another form of door bottom/threshold with gasket that provides a proper acoustical seal. Carefully caulk thresholds and frames of all exterior doors before setting.

Overlapping thresholds can be used in place of automatic door bottoms to provide an acoustical seal, except where ADA compliance must be maintained. However, Pemko's 2005AS threshold incorporates an overlap that is less than 1/4" and is listed to be ADA compliant. Please consult with Pemko on this issue further, if desired. Where a compression seal (such as an overlapping threshold) cannot be provided, the threshold itself must use an automatic door bottom or other compression-producing system to achieve STC 36 performances or better.

Exterior Walls

Given the relatively modest levels of exterior noise to which the proposed buildings will be exposed, no special designs will be required for the exterior walls. As the project is still in an early design stage, this report assumes a typical exterior wall assembly consisting of 7/8" stucco over plywood shear sheathing, 4" to 6" deep studs, fiberglass batt insulation in the stud cavity, and at least one layer of 5/8" gypsum board on the interior face of the wall. Assemblies similar to this have been tested to have a sound insulation rating of at least OITC 38 (comparable to STC 50), which will not compromise the sound isolation of the building envelope, making it suitable for all noise exposures expected with this project.

The ultimate degree of sound isolation provided by the building shell is highly dependent on the quality of workmanship and attention to detail that is followed during construction. The following recommendations are aimed at delivering the full sound isolating potential of the building shell:

- If possible, avoid electrical outlets in exterior walls. If this is not possible, apply outlet box pads such as those manufactured by Lowry's or Dottie (#68 pads) to all electrical boxes in exterior walls, as one would in all corridor, party and other sound rated interior walls. Thoroughly caulk around all edges of electrical outlet boxes and other penetrations with non-hardening acoustical sealant. Penetrations larger than 4 square inches should be boxed in with gypsum board and acoustically caulked.

- Carefully caulk the intersection between the interior layer of GWB at the floor and ceiling with resilient, non-hardening acoustical sealant.

- Fully fill the stud cavities with batt insulation, as the improvement in sound isolation provided by the partition is directly proportional to the percentage of the cavity filled with insulation.

Supplemental Ventilation

Mitigation requirements are based on noise levels of 69-70 L_{dn} at the project facades with the highest noise exposures. A typical bedroom/living room window will allow for a reduction of approximately 15 decibels when partially open. Therefore, it will not be possible for interior noise requirements to be met with exterior windows in the open position. Supplemental ventilation must be provided for all of the project's residential units requiring glazing of Classes I and II. Acoustical performance for such supplemental ventilation should be equal to the STC rating required for a specific unit's exterior glazing, as shown in Figure 12 and Figure 13, less 5 points for an opening of small size (<1 sq ft).

Supplemental ventilation can be provided in several forms. For units defined by "Class I", supplemental ventilation should be provided by a ducted fresh air system which could be incorporated into the HVAC system. Other projects have used passive, ducted air inlets that extend from the building's rooftop to soffits within each unit. Ducted air inlets should be acoustically lined through the first 10 ft in length away from the exterior opening and incorporate one or more 90-degree bends between openings, so as not to compromise the noise insulating performance of the residential unit's exterior envelope. Instead of serving unit stacks with a vertical duct drawing air from the roof, air could also be drawn through the floor-ceiling assembly to a register in the ceiling. In either system, ducts should be located within gypsum shafts so as not to create a direct noise path from exterior penetration to the unit interior. We will gladly review and comment on designs provided by the project's architect or mechanical engineer.

Another means of providing fresh air ventilation without compromising the degree of acoustical isolation is to incorporate a "Z-duct" fresh air intake device in the building facade. If a Z-duct method is chosen to provide outside air intake at individual units, the vertical duct should be at least 5 ft in length, and lined with 1/2" or 1" thick acoustical liner. These requirements are essential to make the Z-duct provide adequate noise insulation and not compromise the noise insulating performance of the window and wall assemblies. Commercially available units include:

- the Quiet-vent silencer manufactured by Industrial Acoustics Company (IAC - http://www.iacsilencers.com), or

- the Vibro-Acoustics model CT silencer (http://www.vibro-acoustics.com/).

For units exposed to more moderate noise levels, lower acoustic performance fresh air transfer devices may be used. The Thermastor type Fresh 80-dB units (see http://www.thermastor.com) is an example of a ventilation device that will provide adequate noise reduction to meet minimum code within these residential units.

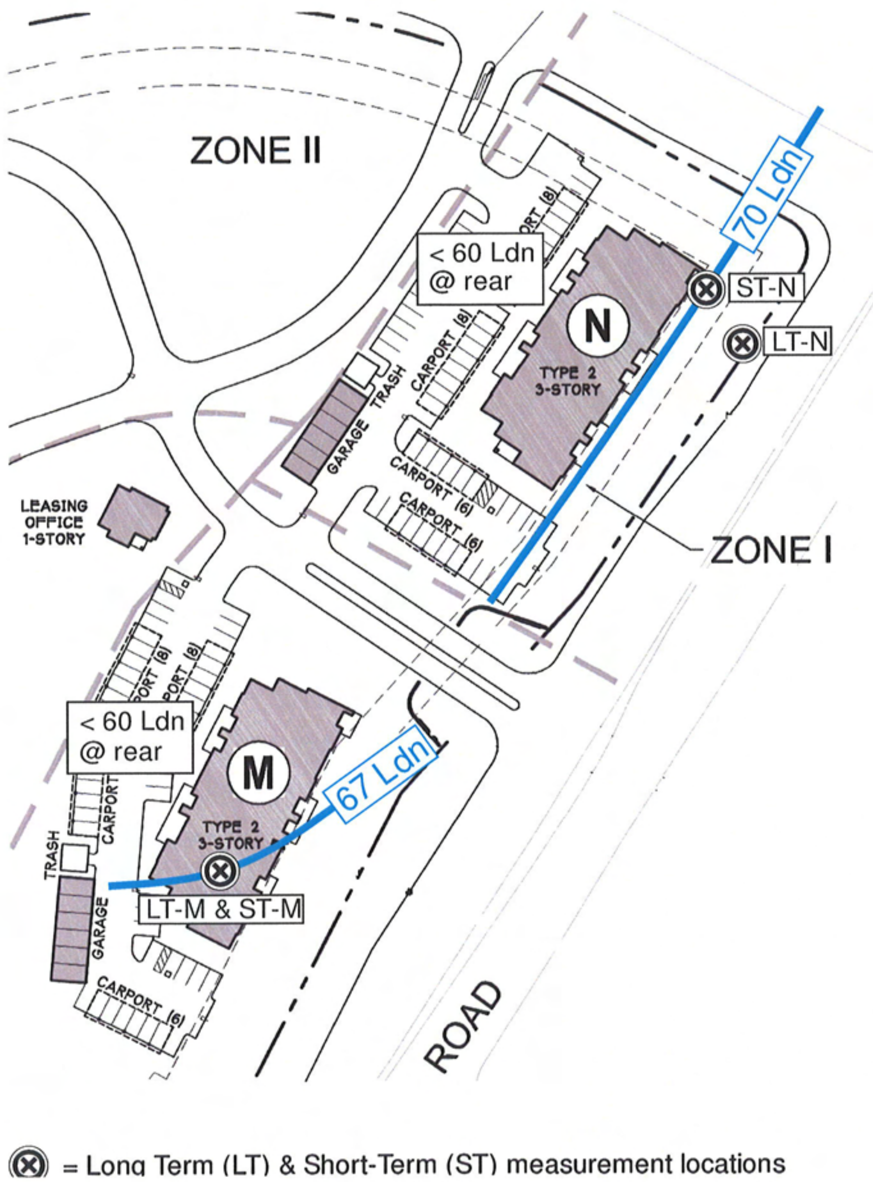

Figure 2: **Expected Future (2021) Day-Night Levels (Ldn) with buildings M and N in place and noise survey locations.**

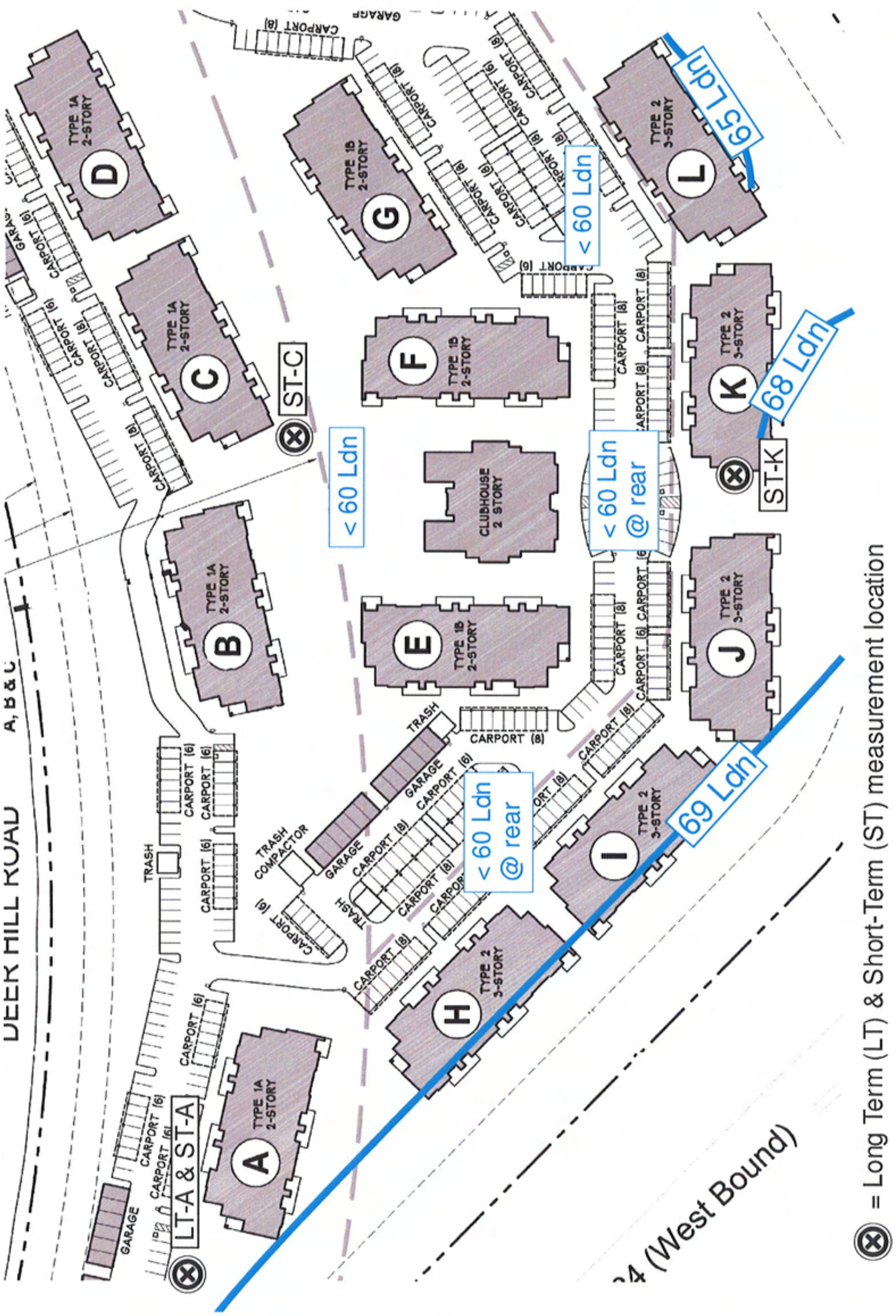

Figure 3: **Expected Future (2021) Day-Night Levels (Ldn) with buildings A through L in place and noise survey locations.**

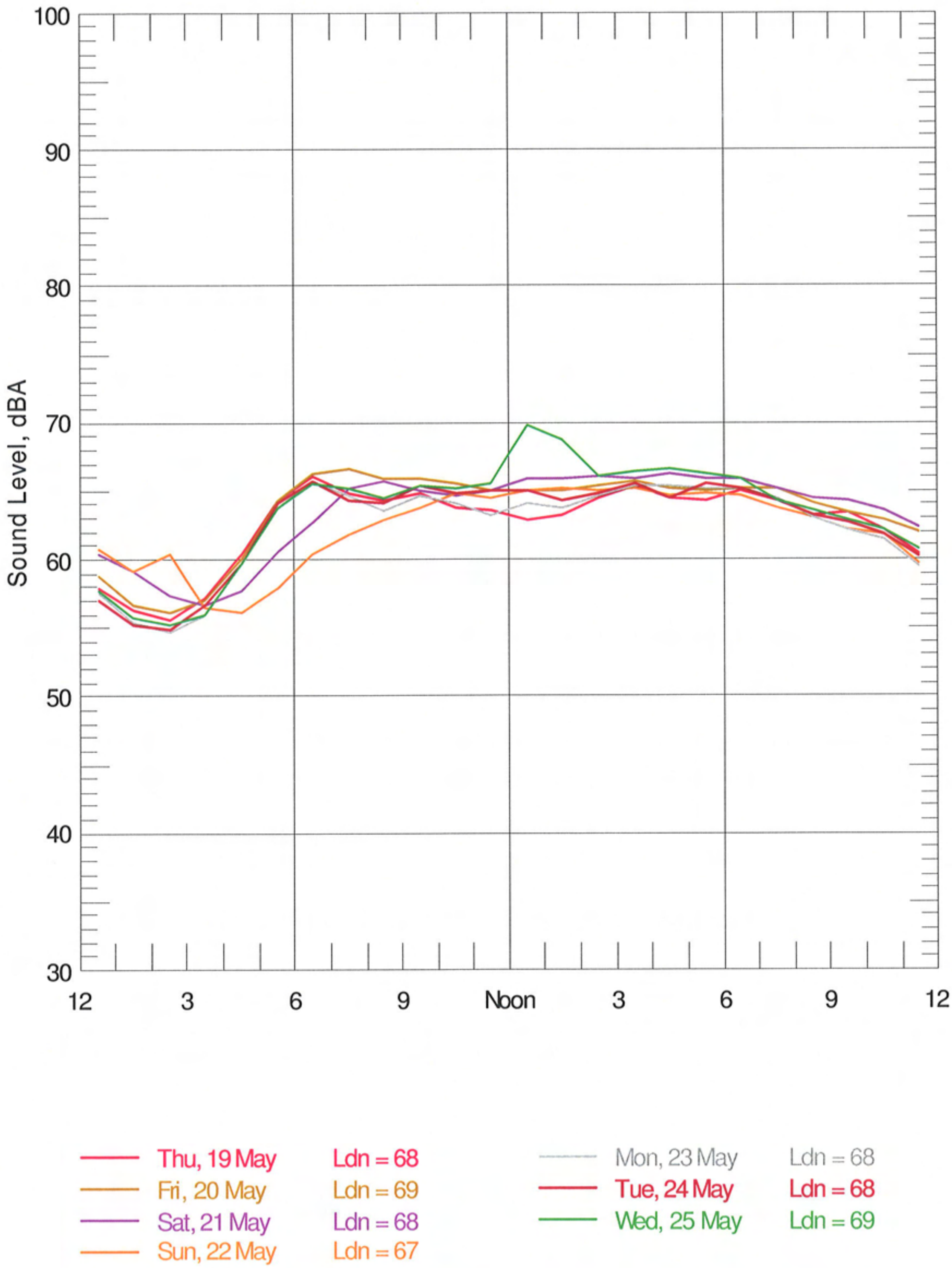

Figure 4: **Hourly Equivalent (Leq) and Day-Night (L_{dn}) Levels measured at Location LT-A, facing SR-24, by Building A setback.**

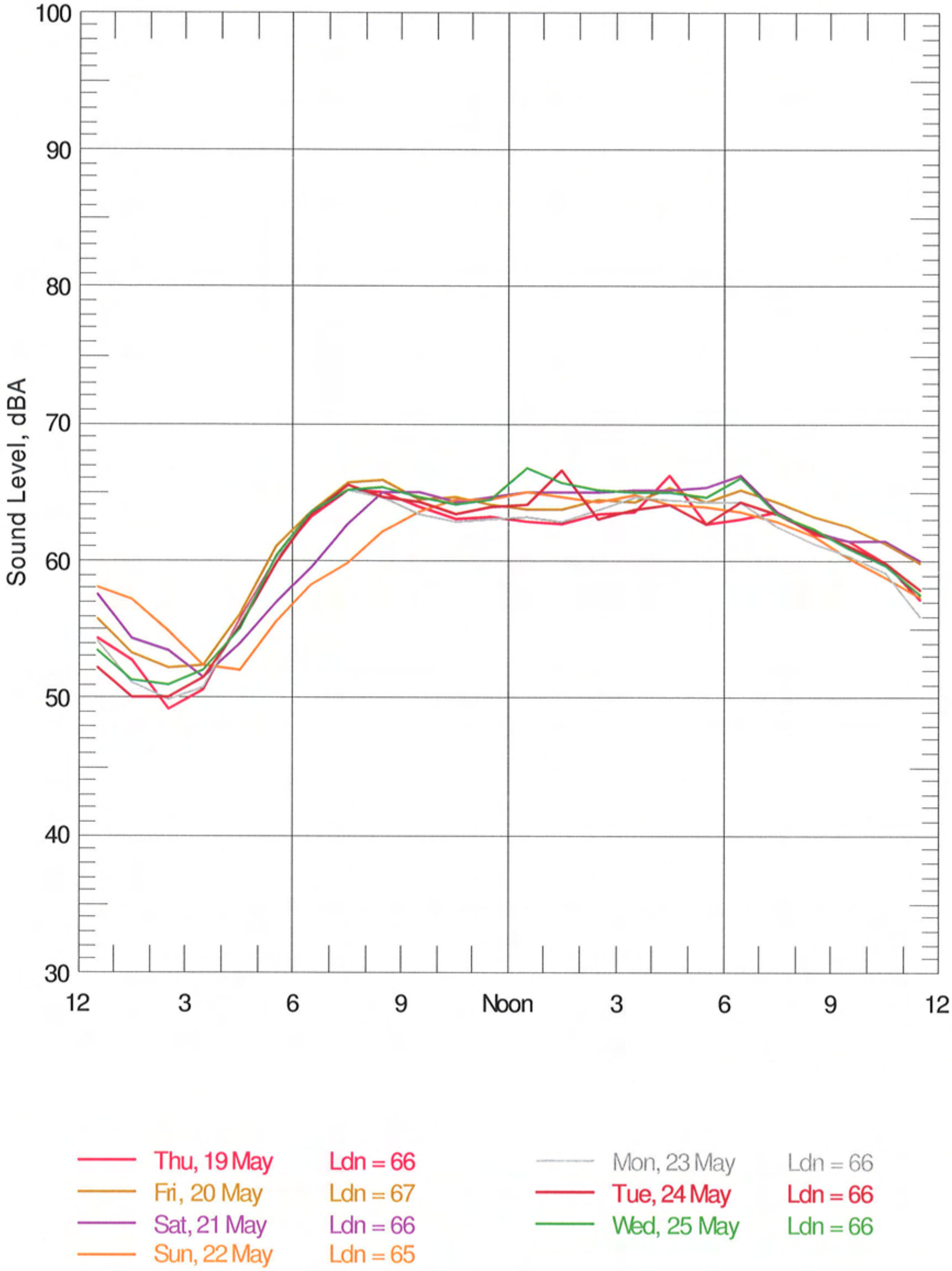

Figure 5: Hourly Equivalent (L_{eq}) and Day-Night (L_{dn}) Levels measured at Location LT-M, near Building 'M' setback.

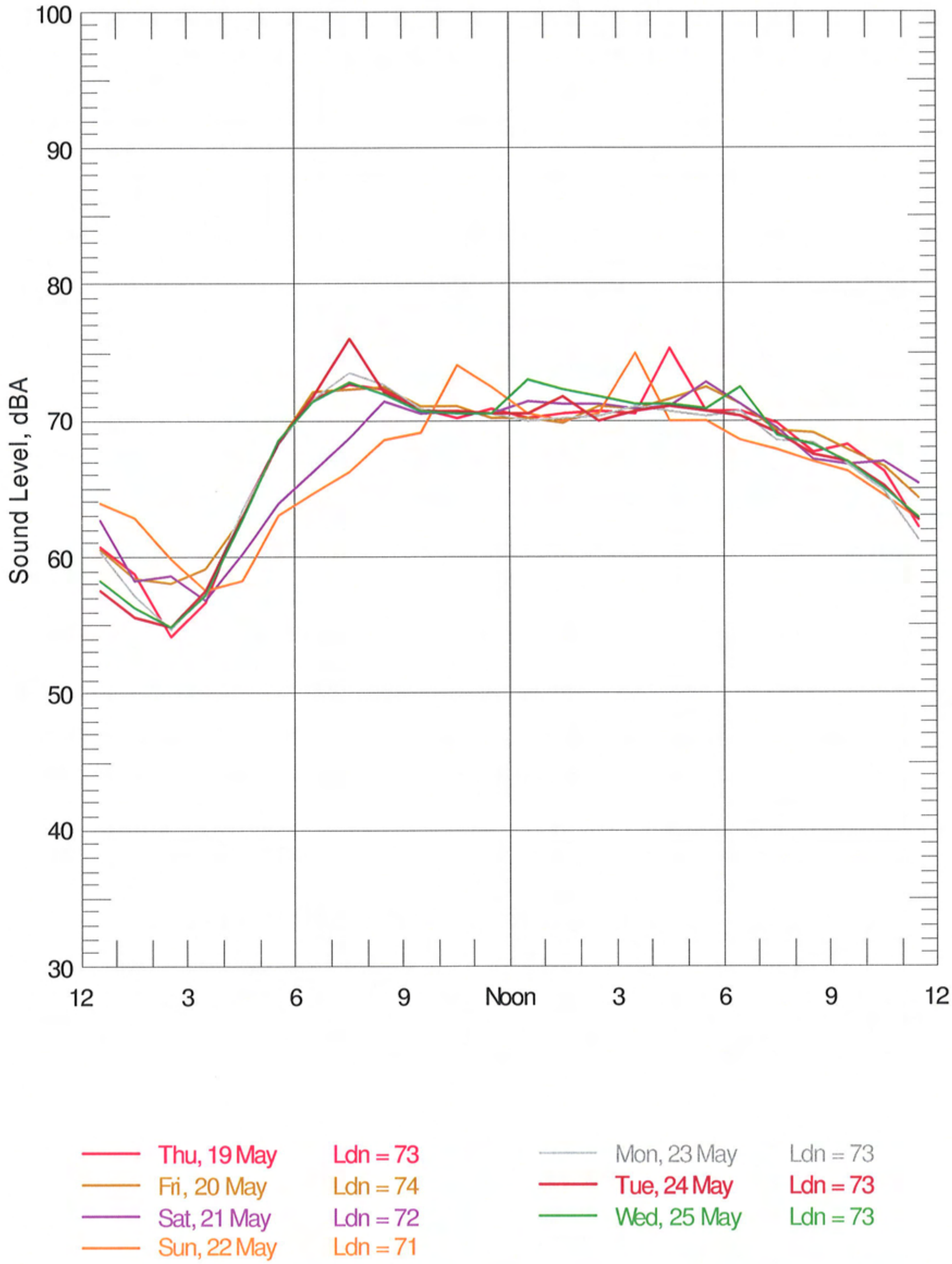

Figure 6: **Hourly Equivalent (L_{eq}) and Day-Night (L_{dn}) Levels measured at Location LT-N, approx. 40' from Pleasant Hill Rd. CL**

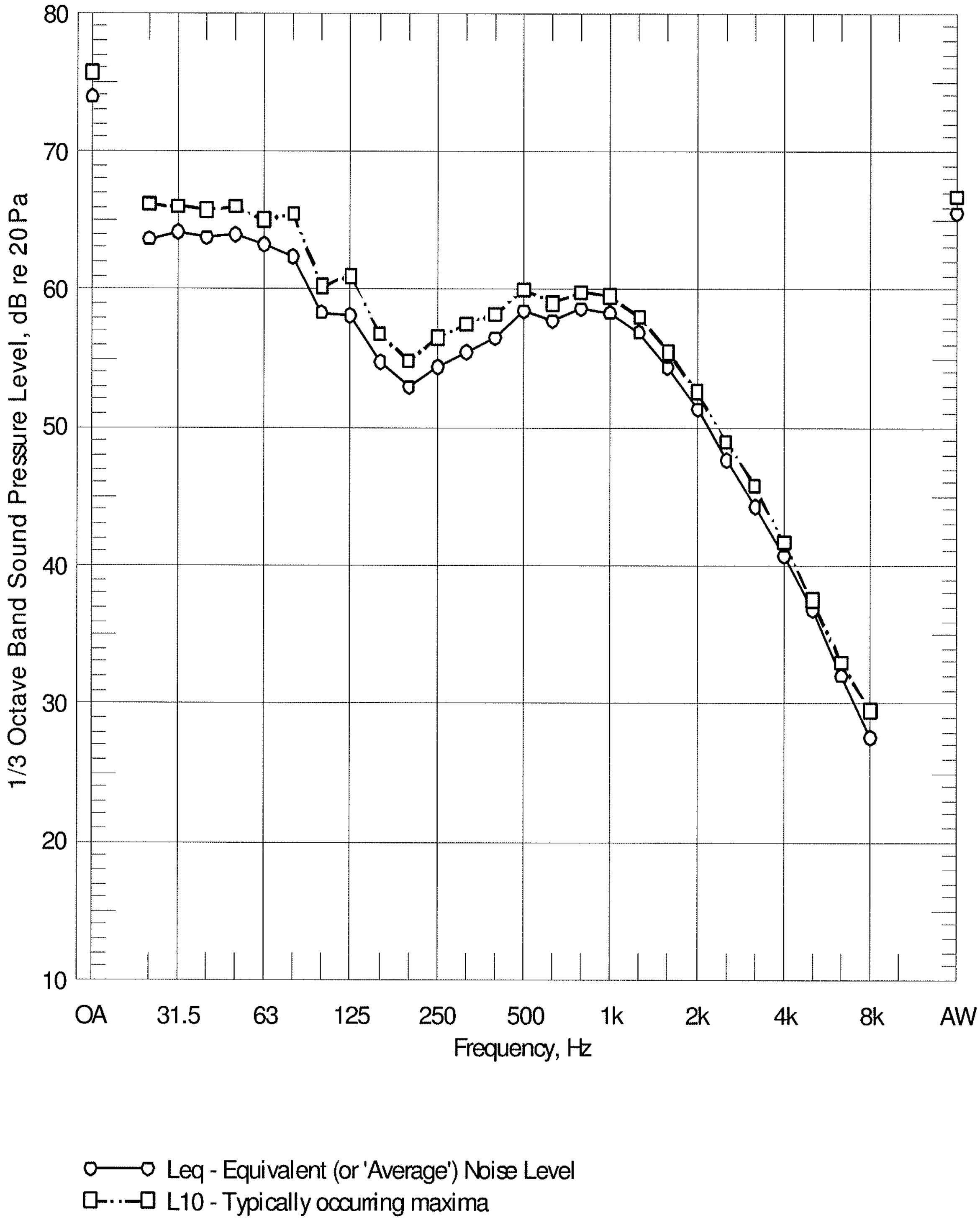

Figure 7: **Equivalent Level (L_{eq}) and L_{10} Noise Frequency Spectrum Measured at Location ST-A. 15 minute sample**

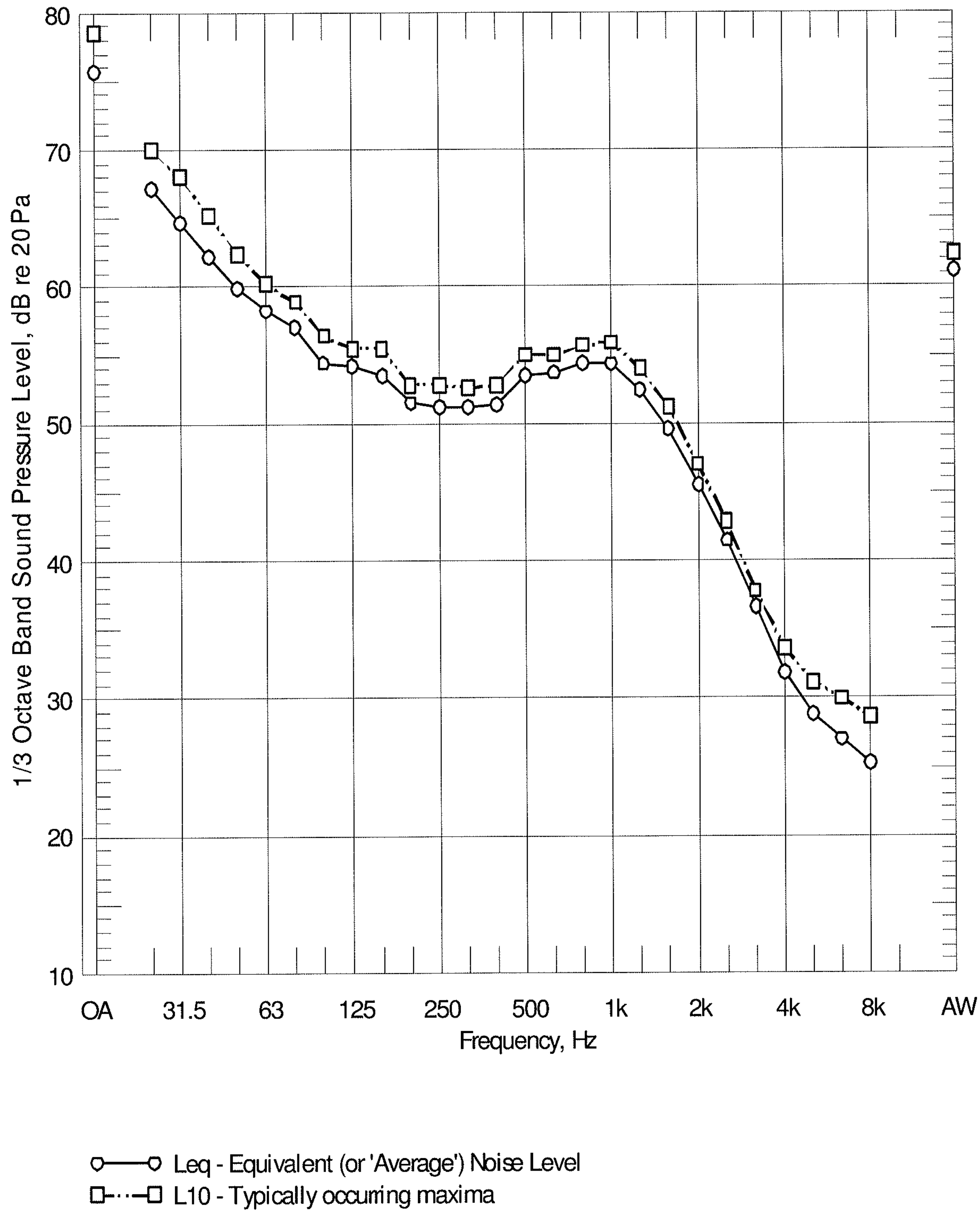

Figure 8: **Equivalent Level (L_{eq}) and L_{10} Noise Frequency Spectrum Measured at Location ST-B. 15 minute sample**

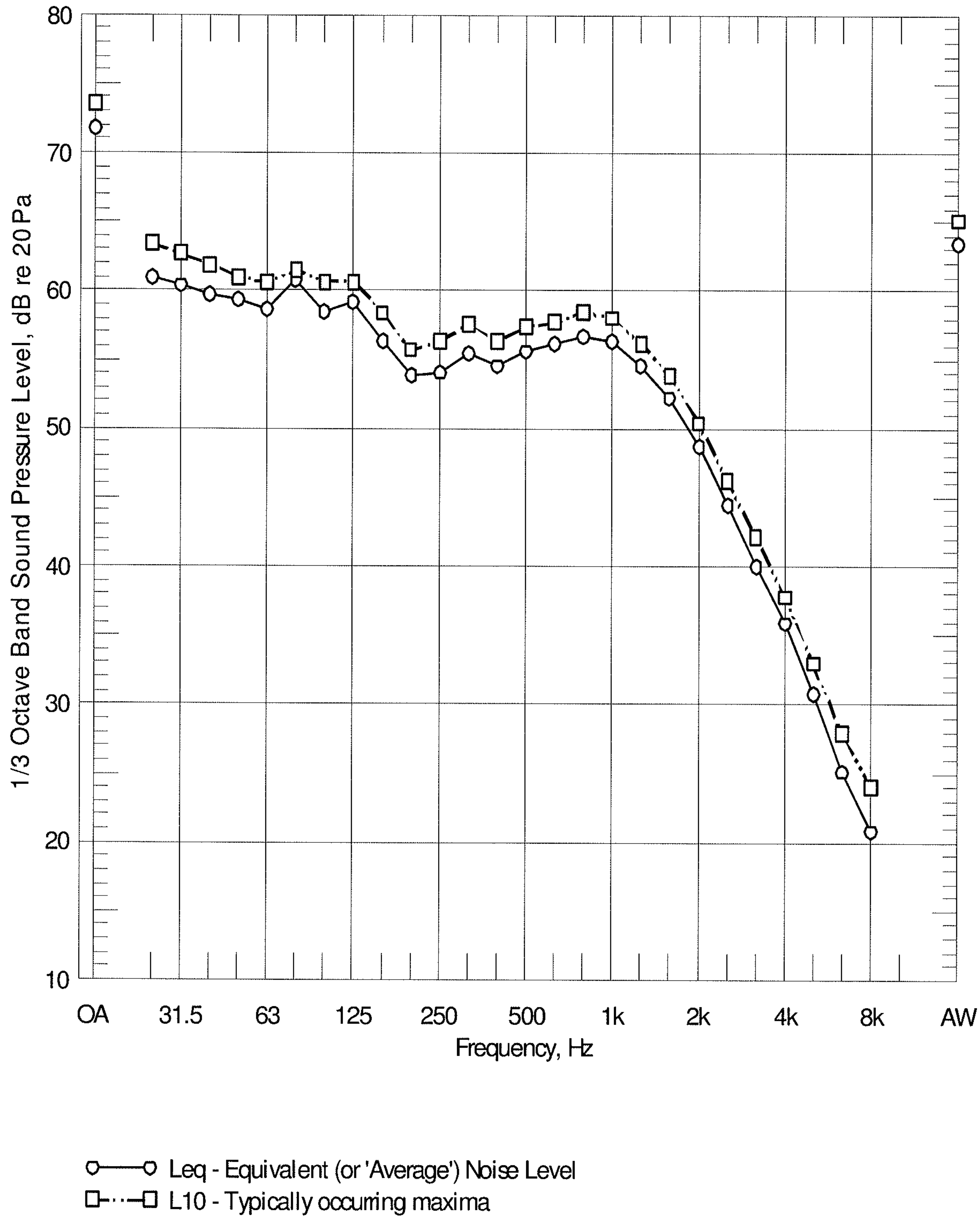

Figure 9: **Equivalent Level (L_{eq}) and L_{10} Noise Frequency Spectrum Measured at Location ST-K. 15 minute sample**

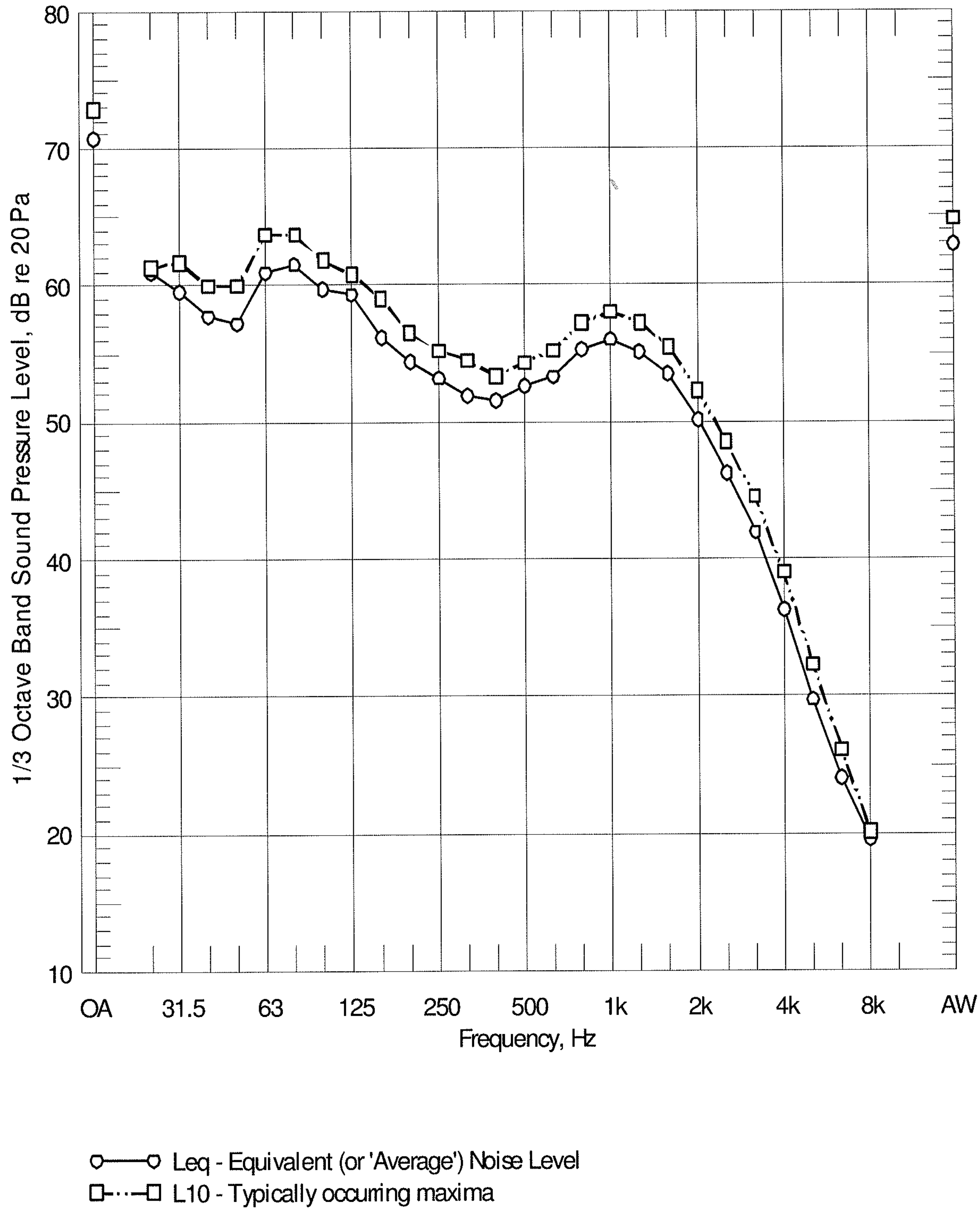

Figure 10: **Equivalent Level (L_{eq}) and L_{10} Noise Frequency Spectrum Measured at Location ST-M. 15 minute sample**

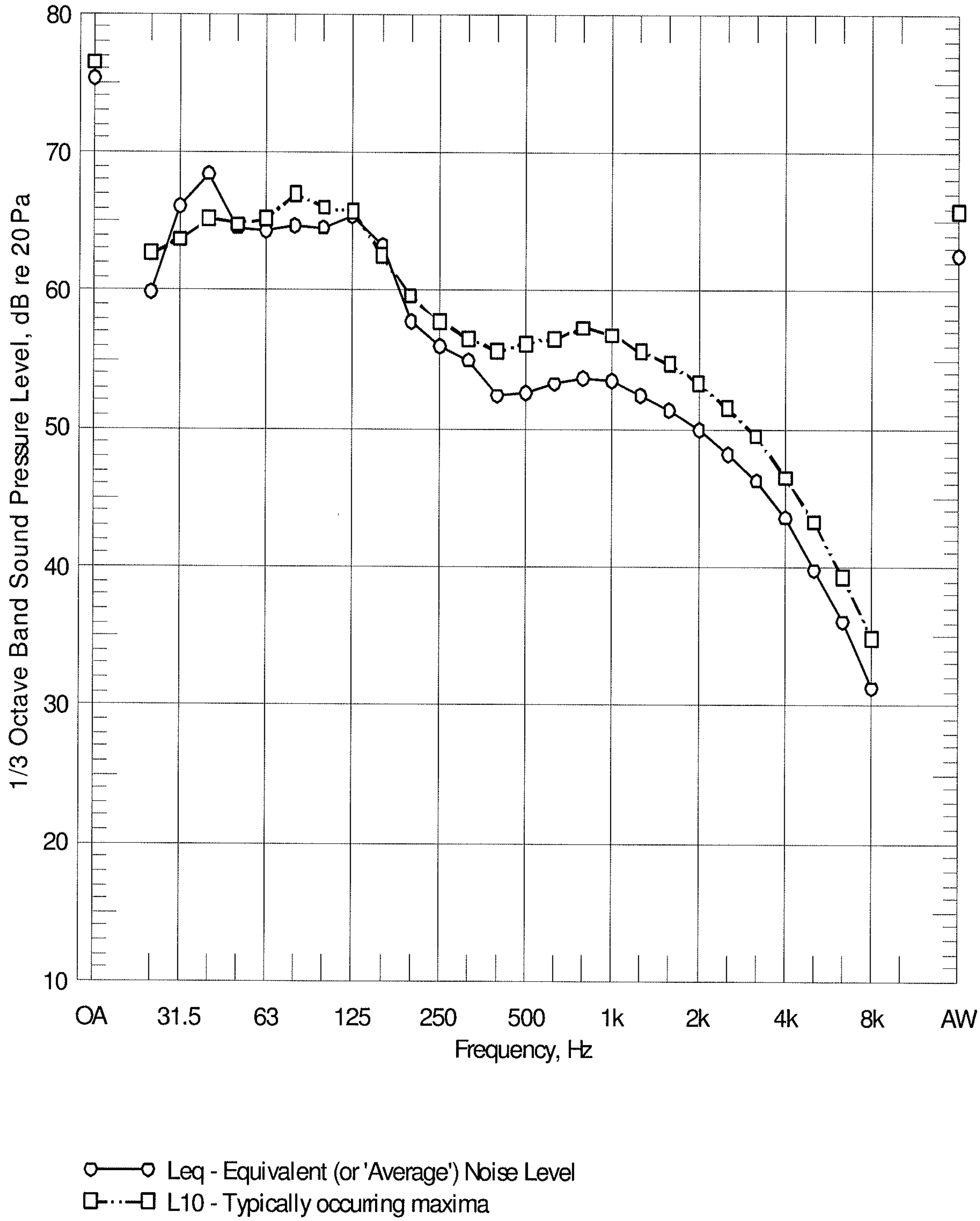

Figure 11: **Equivalent Level (L_{eq}) and L_{10} Noise Frequency Spectrum Measured at Location ST-N. 15 minute sample**

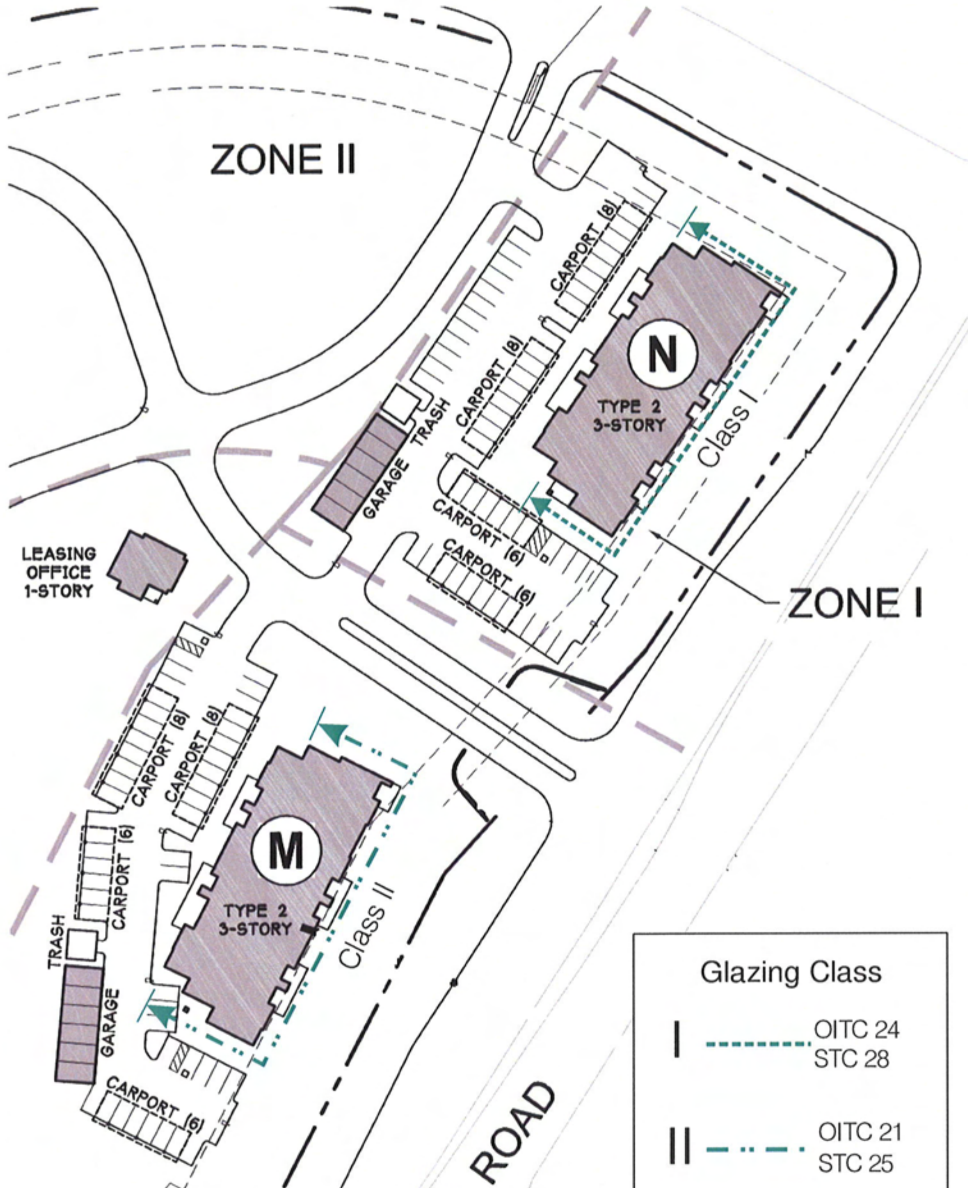

Figure 12: Minimum recommended glazing ratings for units at all floors in Buildings M and N. Facades not rated do not require acoustically-rated glazing.

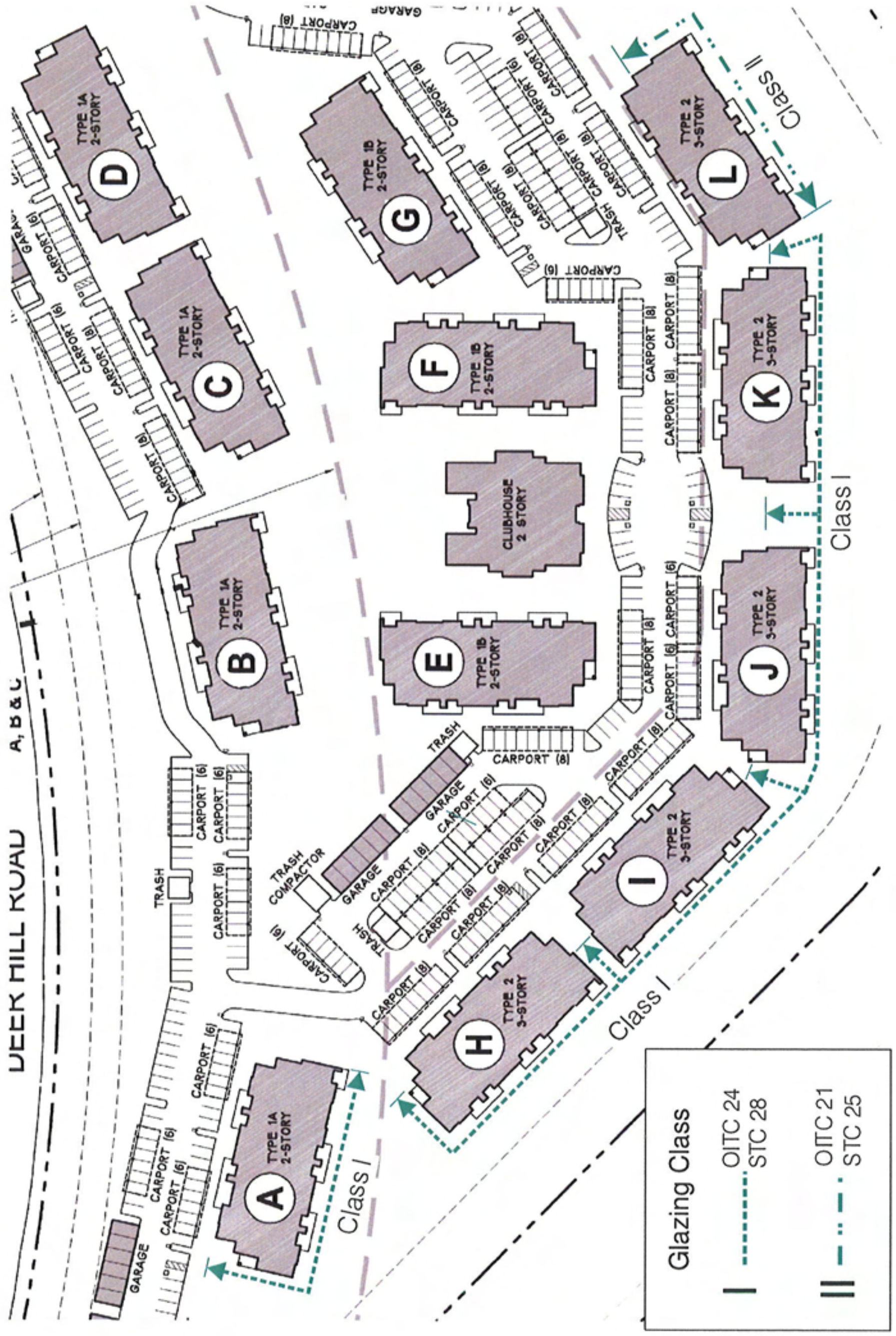

Figure 13: Minimum recommended glazing ratings for units at all floors in Buildings A through L. Facades not rated do not require acoustically-rated glazing.

APPENDIX ~~B~~ A

DESCRIPTION OF ACOUSTICAL TERMS

A-Weighted Sound Level (dBA):

The sound pressure level in decibels as measured on a sound level meter using the internationally standardized A-weighting filter or as computed from sound spectral data to which A-weighting adjustments have been made. A-weighting de-emphasizes the low and very high frequency components of the sound in a manner similar to the response of the average human ear. A-weighted sound levels correlate well with subjective reactions of people to noise and are universally used for community noise evaluations.

Airborne Sound:

Sound that travels through the air, as opposed to structure-borne sound.

Ambient Noise:

The prevailing general noise existing at a location or in a space, which usually consists of a composite of sounds from many sources near and far.

Community Noise Equivalent Level (CNEL):

The L_{eq} of the A-weighted noise level over a 24-hour period with a 5 dB penalty applied to noise levels between 7 p.m. and 10 p.m. and a 10 dB penalty applied to noise levels between 10 p.m. and 7 a.m.

Day-Night Sound Level (L_{dn}):

The L_{eq} of the A-weighted noise level over a 24-hour period with a 10 dB penalty applied to noise levels between 10 p.m. and 7 a.m.

Decibel (dB):

The decibel is a measure on a logarithmic scale of the magnitude of a particular quantity (such as sound pressure, sound power, sound intensity) with respect to a reference quantity.

Energy Equivalent Level (L_{eq}):

The level of a steady noise which would have the same energy as the fluctuating noise level integrated over the time period of interest. L_{eq} is widely used as a single-number descriptor of environmental noise. L_{eq} is based on the logarithmic or energy summation and it places more emphasis on high noise level periods than does L_{50} or a straight arithmetic average of noise level over time. This energy average is not the same as the average sound pressure levels over the period of interest, but must be computed by a procedure involving summation or mathematical integration.

Field Impact Insulation Class (FIIC):

A single number rating similar to the IIC except that the impact sound pressure levels are measured in the field.

Field Sound Transmission Class (FSTC):

A single number rating similar to STC, except that the transmission loss values used to derive the FSTC are measured in the field. All sound transmitted from the source room to the receiving room is assumed to be through the separating wall or floor-ceiling assembly.

Frequency (Hz):

The number of oscillations per second of a periodic noise (or vibration) expressed in Hertz (abbreviated Hz). Frequency in Hertz is the same as cycles per second.

Impact Isolation Class (IIC):

A single number rating used to compare the effectiveness of floor-ceiling assemblies in providing reduction of impact generated sounds such as footsteps. It is derived from the measurement of impact sound pressure levels across a series of 16 test bands using a standardized tapping machine.

Noise Isolation Class (NIC):

A single number rating derived from measured values of noise reduction between two enclosed spaces that are connected by one or more paths. The NIC is not adjusted or normalized to a standard reverberation time.

Normalized Noise Isolation Class (NNIC):

A single number rating similar to the NIC, except that the measured noise reduction values are normalized to a reverberation time of 1/2 second.

Outdoor-Indoor Transmission Class (OITC):

A single number classification, specified by the American Society for Testing and Materials (ASTM E 1332 issued 1994), that establishes the A-weighted sound level reduction provided by building facade components (walls, doors, windows, and combinations thereof), based upon a reference sound spectra that is typical of air, road, and rail transportation sources. The OITC is the preferred rating when exterior facade components are exposed to noise environments dominated by transportation sources.

Octave Band - 1/3 Octave Band:

One octave is an interval between two sound frequencies that have a ratio of two. For example, the frequency range of 200 Hz to 400 Hz is one octave, as is the frequency range of 2000 Hz to 4000 Hz. An octave band is a frequency range that is one octave wide. A standard series of octaves is used in acoustics, and they are specified by their center frequencies. In acoustics, to increase resolution, the frequency content of a sound or vibration is often analyzed in terms of 1/3 octave bands, where each octave is divided into three 1/3 octave bands.

Sound Absorption Coefficient (α):

The absorption coefficient of a material is the ratio of the sound absorbed by the material to that absorbed by an equivalent area of open window. The absorption coefficient of a perfectly absorbing surface would be 1.0 while that for concrete or marble slate is approximately 0.01 (a perfect reflector would have an absorption of 0.00).

Sound Pressure Level (SPL):

The sound pressure level of sound in decibels is 20 times the logarithm to the base of 10 of the ratio of the RMS value of the sound pressure to the RMS value of a reference sound pressure. The standard reference sound pressure is 20 micro-pascals as indicated in ANSI S1.8-1969, "Preferred Reference Quantities for Acoustical Levels".

Sound Transmission Class (STC):

STC is a single number rating, specified by the American Society for Testing and Materials, which can be used to measure the sound insulation properties for comparing the sound transmission capability, in decibels, of interior building partitions for noise sources such as speech, radio, and television. It is used extensively for rating sound insulation characteristics of building materials and products.

Structure-Borne Sound:

Sound propagating through building structure. Rapidly fluctuating elastic waves in gypsum board, joists, studs, etc.

Statistical Distribution Terms:

L_{99} and L_{90} are descriptors of the typical minimum or "residual" background noise (or vibration) levels observed during a measurement period, normally made up of the summation of a large number of sound sources distant from the measurement position and not usually recognizable as individual noise sources. Generally, the prevalent source of this residual noise is distant street traffic. L_{90} and L_{99} are not strongly influenced by occasional local motor vehicle passbys. However, they can be influenced by stationary sources such as air conditioning equipment.

L_{50} represents a long-term statistical median noise level over the measurement period and does reveal the long-term influence of local traffic.

L_{10} describes typical or average levels for the maximum noise levels occurring, for example, during nearby passbys of trains, trucks, buses and automobiles, when there is relatively steady traffic. Thus, while L_{10} does not necessarily describe the typical maximum noise levels observed at a point, it is strongly influenced by the momentary maximum noise level occurring during vehicle passbys at most locations.

L1, the noise level exceeded for 1% of the time is representative of the occasional, isolated maximum or peak level which occurs in an area. L1 is usually strongly influenced by the maximum short-duration noise level events which occur during the measurement time period and are often determined by aircraft or large vehicle passbys.

Appendix I2:
TJKM Technical Memorandum

TJKM
Transportation Consultants

TECHNICAL MEMORANDUM

Date: November 1, 2011 *Project No.:* 007-027

To: Leah Greenblat, Transportation Planner City of Lafayette

cc: Ann Merideth, Special Projects Manager City of Lafayette

From: Rich Haygood Senior Associate *Jurisdiction:* Lafayette

Subject: **Terraces EIR Traffic Analysis – Trip Generation and Assignment Assumptions**

This memorandum presents the project trip generation, distribution, and assignment assumptions for the proposed Terraces of Lafayette development that TJKM proposes to use in the traffic impact analysis for the EIR, pending City staff review and approval.

Project Trip Generation

The project proposes 315 apartment units in new buildings at the site, which is south of Deer Hill Road and west of Pleasant Hill Road. Project trip generation was calculated based on data presented in *ITE Trip Generation*, 8th Edition and the guidelines in the ITE *Trip Generation Handbook*. No trip reductions were applied because the site is not within reasonable walking distance of public transit services or significant complementary land uses, based on published research data. Table 1 below summarizes the project trip generation results.

Table I: Terraces Project Trip Generation

Land Use (ITE Code)	Size	Daily		A.M. Peak Hour					Midday Peak Hour					P.M. Peak Hour				
		Rate[2]	Trips	Rate[2]	In:Out %	In	Out	Total	Rate[3]	In:Out %	In	Out	Total	Rate[2]	In:Out %	In	Out	Total
Apartments (220)[1]	315 DU	6.45	2,032	0.50	20:80	32	126	158	0.47	48:52	71	77	148	0.61	65:35	124	67	191

Notes: DU = Dwelling Units

[1.] Source – *ITE Trip Generation*, 8th Edition, Regression Equations

[2.] Rates calculated based on Total trips from regression equation divided by Size:

Daily: Total trips = 6.06 (DU) + 123.56

A.M. Peak: Total trips = 0.49 (DU) + 3.73

P.M. Peak: Total trips = 0.55 (DU) + 17.65

[3.] Midday Peak Rate is the same proportion of the Daily Rate as that used in the *Lafayette Downtown Specific Plan Draft EIR* for residential land use, based on Urban Land Institute (ULI) published data and other available traffic studies

Based on ITE *Trip Generation Handbook* guidelines, the ITE regression equations for the apartment land use (ITE Code 220) were used instead of average rates. The ITE trip data for apartments meets the following criteria for use of the regression equations: data points from more than 20

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925.463.3690 fax

Fresno
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Fresno, CA
93704-2515
559.325.7530
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Sacramento
980 Ninth Street
16th Floor
Sacramento, CA
95814-2736
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Santa Rosa
1400 N. Dutton Avenue
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95401-4643
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survey sites, statistical correlation of equation to data points has $R^2 > 0.75$, and the graph plot shows the line corresponding to the equation falls within the cluster of data points at the size of the proposed development (315 units). The a.m. and p.m. peak hour trip generation used the ITE regression equations and in vs. out percentages for the peak hour of adjacent street traffic.

Use of ITE trip rates based on the number of dwelling units to estimate residential trip generation is standard professional practice for traffic impact studies throughout the Bay Area. The number of dwelling units is a known project quantity that doesn't require additional assumptions about occupancy or vehicle ownership rates, and the number of sites observed for the ITE dwelling unit data (78-90 sites) is 3-4 times more than observed for the ITE data using number of persons (26-28 sites) or number of vehicles (21-23 sites). Also, in relation to the Terraces project, the 315 units is within reasonable range of the average size of the dwelling unit survey sites, while only three of the survey sites that recorded the number of persons had more than 600 persons. Note that trip rates based on number of bedrooms are not available.

The Midday Peak Hour trips generated by the project will be added to existing school p.m. peak hour volumes as determined by counts to be performed between 2:00 and 4:00 p.m. at the study intersections.

Distribution and Assignment of Project Trips

Trips that would be generated by the Terraces project are assigned to the adjacent roadway network based on the land use distribution and prevailing traffic patterns in the surrounding area, as well as the location of freeway ramp connections and the proposed project access driveways. The resulting percentage distribution of project-generated trips is presented in *The Terraces of Lafayette Traffic Impact Study* by Abrams Associates (Abrams TIS), dated June 30, 2011, and is shown in the attached Figure 1. TJKM generally concurs with this project trip distribution.

However, based on our peer review, TJKM recommends using the Project Trip Generation estimate described in Table 1 instead of that presented in the Abrams TIS, which changes the number of trips to be assigned to the roadway network. Therefore, TJKM has adjusted the Abrams TIS project trip assignments, and the results are shown in Figure 1.

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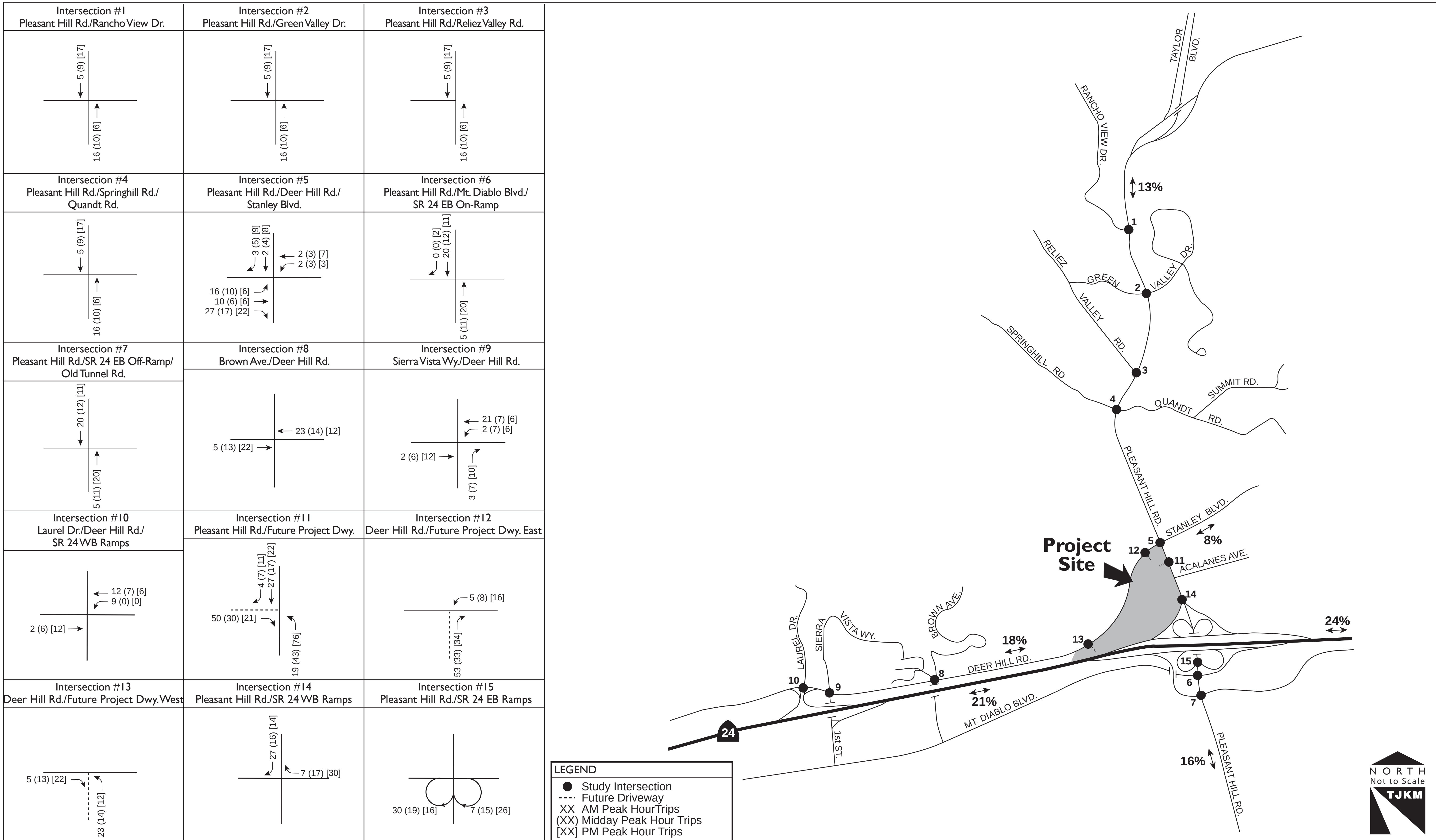
City of Lafayette - The Terraces of Lafayette EIR

Project Trip Distribution and Assignment

Figure 1



7-027 - 11/2/11 - RH

Appendix I3:
Noise Monitoring Results for Off-Site Locations

Noise Monitoring - Terraces of Lafayette (Off-site Noise Monitoring Locations)

Site	Meas. Location	Date	Time	Duration (s)	**Leq**	SEL	**Lmax**	**Lmin**	Peak	Uwpk	L(2)	L(8)	L(16)	L(25)	L(50)	L(90)
1	Terraces_Lafayette	12/6/2011	9:53:43	900	**53.7**	83.2	**66.2**	**42.4**	81.0	91.2	60.4	56.8	55.5	54.4	51.9	47.7
2	Terraces_Lafayette	12/6/2011	10:27:44	900	**66.4**	95.9	**85.7**	**46.8**	99.1	108.1	73.5	69.7	67.5	65.8	61.0	52.7
3	Terraces_Lafayette	12/6/2011	10:51:47	900	**66.6**	96.2	**80.2**	**49.0**	97.3	99.9	74.5	71.6	69.7	67.8	60.4	52.5

APPENDIX I4:
TRAFFIC NOISE CALCULATIONS

From TJKM Technical Memo of 11/1/11

PM PEAK

EXISTING INTERSECTION PM PEAK HOUR TURN-MOVEMENT COUNTS — ROADWAY SEGMENT **PM** PEAK HOUR VOLUMES

INT ID	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR	NB Leg	SB Leg	EB Leg	WB Leg
1	18	1898			724	17			19				2639	2659	0	54
2	3	1854	21	11	706	4	7		3	12		16	2598	2599	60	17
3	182	1864			718	26	20		103				2628	2867	0	331
4	123	2017	33	14	846	24	19	2	67	22		6	2926	3108	77	235
5	40	1408	183	106	640	181	646	89	51	184	67	150	3131	2506	779	1074
6	207	915	411		605	341	389	241	192				2250	2330	652	1370
7		1272	27	121	570		35	64	175	17		31	2029	2061	260	274
8	57	8	107	61	12	19	46	612	49	104	292	85	231	337	1261	1075
9	166	14	116	5	24	9	21	560	1296	84	234	2	75	1700	1001	2286
10	510	6	783	19	1	9	17	1109	248	176	224	3	55	1724	2314	2117
11													0	0	0	0
12													0	0	0	0
13													0	0	0	0
14		1727	43		893							12	2632	2663	55	0
15		1193			538	353							2084	1731	0	353
16		1193	298		538								1731	2029	298	0
17		726			829	262							1817	1555	0	262

PROJECT VOLUMES

5	0	0	0	0	8	9	6	6	22	3	7	0	TJKM	23	33	16	50
													% increase=	**0.7%**	**1.3%**	**2.0%**	**4.4%**

AM PEAK

EXISTING INTERSECTION AM PEAK HOUR TURN-MOVEMENT COUNTS — ROADWAY SEGMENT **AM** PEAK HOUR VOLUMES

INTID	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR	NWR	SER	NB Leg	SB Leg	EB Leg	WB Leg
1	15	521			1331	9			34						1861	1901	0	58
2		586	12	7	1481	1	2		5	17		9			2086	2101	45	8
3	94	587			1574	10	22		224						2193	2479	0	350
4	94	587	25	10	1825	20	26	3	137	23	3	27			2495	2691	91	283
5	152	585	184	148	1380	728	92	54	20	170	72	32			2965	2491	660	1118
6	224	688	396		492	528	212	216	60						1920	1860	612	1240
7		1020	20	80	448		16	32	132	12		136			1700	1632	280	180
8	85	12	76	28	8	52	26	200	48	172	645	36			162	401	1157	1056
9	261	13	81	8	21	26	25	240	900	140	445	3			96	1416	917	1897
10	822	8	537	18	6	9	1	540	284	288	480	3			45	1945	1866	2136
11															0	0	0	0
12															0	0	0	0
13															0	0	0	0
14		948	75		1680							49			2677	2703	124	0
15		726			811	940							239		2477	1537	0	940
16		726	501		811									623	1537	2038	501	0
17		900			1103	331							327		2334	2003	0	331

ADT

AM Peak Volume =	2491	>>>	2491	x	5 =	12455	
						Volume sum=	**24985** **≈ ADT**
PM Peak Volume =	2506	>>>	2506	x	5 =	12530	

APPENDIX I5:
CONSTRUCTION VIBRATION CALCULATIONS

Construction Vibration Impact Assessment

Analyses from FTA_{2006} manual, page 12-11

Common values:

hoe ram/bulldozer/jack-hammer:

vib emissions re damage ≤	0.1	PPV at	25	feet
vib emissions re annoyance ≤	87	VdB at	25	feet

1. House near west corner	Dist. 1 to bldgs =	240	feet
2. Chicken Ranch to north	Dist. 2 to bldgs =	195	feet

DAMAGE ASSESSMENT

$PPV_{equip} = PPV_{ref}$ x (25/D)^1.5 PPV, in/sec

Dist 1:	=	0.1	x	(25/240)^1.5
	=	0.1	x	0.03362
PPV_{equip} = I		**0.0034**		PPV, in/sec

Dist 2:	=	0.1	x	(25/195)^1.5
	=	0.1	x	0.045905
PPV_{equip} = I		**0.0046**		PPV, in/sec

ANNOYANCE ASSESSMENT

Lv(D) = Lv(25') - 30 $\log_{10}$ (D/25) VdB

Dist 1:					
	=	87	-	30 $\log_{10}$(	240/25)
	=	87	-	30 $\log_{10}$(	9.600)
	=	87	-	29.5	
Lv(240)	=	**57.5**	**VdB**		

Dist 2:					
	=	87	-	30 $\log_{10}$(	195/25)
	=	87	-	30 $\log_{10}$(	7.800)
	=	87	-	26.8	
Lv(240)	=	**60.2**	**VdB**		