Environmental Noise Assessment

Highland Park Residential

City of Redding, California

Job # 2007-104

Prepared For:

S & J Development, Inc.

19207 Pinnacle Court
Redding, CA 96003

Attn: Mr. Jeb Allen

Prepared By:

j.c. brennan & associates, Inc.

Luke Saxelby

Luke Saxelby
Senior Consultant
Member, Institute of Noise Control Engineering

October 24, 2007

j.c. brennan & associates
consultants in acoustics

P.O. Box 6748 - 263 Nevada Street - Auburn, California 95603 -p: (530) 823-0960 -f: (530) 823-0961

INTRODUCTION

The Highland Park residential project is located east of Interstate 5 and north of Hilltop Drive in the City of Redding. Due to the proximity of I-5 to the project site, the City of Redding requested that an acoustical analysis be prepared to demonstrate that exterior and interior noise levels at the proposed residential uses do not exceed acceptable limits. The intent of this analysis is to determine the future traffic noise exposure at the project site, and to provide mitigation measures where future noise levels are predicted to exceed the City of Redding General Plan noise level standards. Figure 1 shows the project site.

The project consists of the construction of approximately 205 single family residential uses in traditional lots ranging in size from approximately 35' x 70' to 70' x 110' and 48 cluster home arrangements. 111 multi-family townhomes are also proposed.

BACKGROUND ON NOISE AND ACOUSTICAL TERMINOLOGY[1]

Noise is often described as unwanted sound. Sound is defined as any pressure variation in air that the human ear can detect. If the pressure variations occur frequently enough (at least 20 times per second) they can be heard, and are called sound. The number of pressure variations per second is called the frequency of sound, and is expressed as cycles per second, called Hertz (Hz).

Measuring sound directly in terms of pressure would require a very large and awkward range of numbers. To avoid this, the decibel scale was devised. The decibel scale uses the hearing threshold (20 micropascals of pressure), as a point of reference, defined as 0 dBA. Other sound pressures are then compared to the reference pressure, and the logarithm is taken to keep the numbers in a practical range. The decibel scale allows a million-fold increase in pressure to be expressed as 120 dBA. Another useful aspect of the decibel scale is that changes in decibel levels correspond closely to human perception of relative loudness. Figure 2 illustrates common noise levels associated with various sources.

[1] For an explanation of these terms, see Appendix A: "Acoustical Terminology"

Figure 1

Highland Park Residential – City of Redding, California

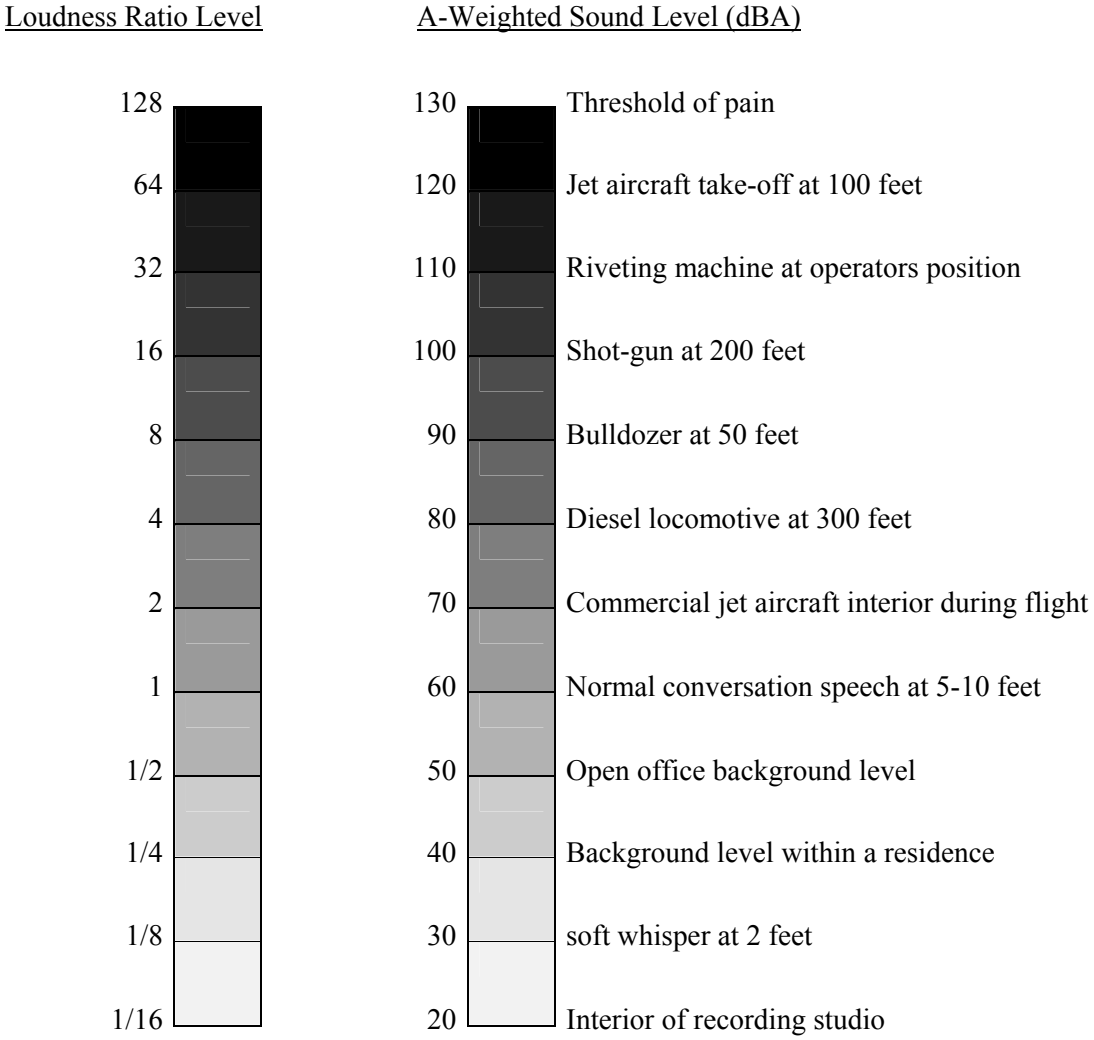
Site Plan, Noise Measurement Locations, and Receiver Groupings

△ # : Noise Measurement Site

(L#) : Receiver Grouping Location Number

j.c. brennan & associates
consultants in acoustics

Figure 2
Typical A-Weighted Sound Levels of Common Noise Sources



The perceived loudness of sounds is dependent upon many factors, including sound pressure level and frequency content. However, within the usual range of environmental noise levels, perception of loudness is relatively predictable, and can be approximated by weighing the frequency response of a sound level meter by means of the standardized A-weighing network. There is a strong correlation between A-weighted sound levels (expressed as dBA) and community response to noise. For this reason, the A-weighted sound level has become the standard tool of environmental noise assessment. All noise levels reported in this section are in terms of A-weighted levels.

Community noise is commonly described in terms of the "ambient" noise level, which is defined as the all-encompassing noise level associated with a given noise environment. A common statistical tool to measure the ambient noise level is the average, or equivalent, sound level (L_{eq}). The L_{eq} is the foundation of the day/night average noise descriptor, L_{dn}, and shows very good correlation with community response to noise.

The Day-night Average Level (Ldn) is based upon the average noise level over a 24-hour day, with a +10 decibel weighing applied to noise occurring during nighttime (10:00 p.m. to 7:00 a.m.) hours. The nighttime penalty is based upon the assumption that people react to nighttime noise exposures as though they were twice as loud as daytime exposures. Because Ldn represents a 24-hour average, it tends to disguise short-term variations in the noise environment.

CRITERIA FOR ACCEPTABLE NOISE EXPOSURE

State

The State Building Code, Title 24, Part 2 of the State of California Code of Regulations establishes uniform minimum noise insulation performance standards to protect persons within new buildings which house people, including hotels, motels, dormitories, apartment houses and dwellings other than single-family dwellings. Title 24 mandates that interior noise levels attributable to exterior sources shall not exceed 45 dB Ldn or CNEL in any habitable room. Title 24 also mandates that for structures containing noise-sensitive uses to be located where the Ldn or CNEL exceeds 60 dB, an acoustical analysis must be prepared to identify mechanisms for limiting exterior noise to the prescribed allowable interior levels. If the interior allowable noise levels are met by requiring that windows be kept close, the design for the structure must also specify a ventilation or air conditioning system to provide a habitable interior environment.

City of Redding General Plan Noise Element:

The City of Redding General Plan Noise Element establishes goals, policies and criteria for determining land use compatibility with major noise sources within the community. The following provides the applicable goals, policies and criteria for evaluating the feasibility and potential noise impacts associated with the proposed Glenbrook Estates.

Goal N1 - Protect residents from the harmful and annoying effects of exposure to excessive noise.

> *Policy N1C - Require an acoustical analysis for new development in locations where exterior and/or interior noise levels will likely exceed the City's noise standards to determine appropriate mitigation measures.*
>
> *Policy N1D - Encourage the use of site planning and building materials/design as primary methods of noise attenuation.*

Policy N1F - Discourage use of noise barriers and walls constructed exclusively for noise attenuation purposes, where possible. In instances where noise barriers cannot be avoided, require the use of site planning and building material/design features in conjunction with barriers to mitigate visual impacts and reduce the size of barriers.

Goals N2 - Protect residents from exposure to excessive transportation-related noise.

Policy N2A - Update existing and projected noise contours periodically for all transportation noise sources.

Policy N2C - Mitigate noise created by new transportation noise sources consistent with the levels specified in Table 5-4 (Table 1 of this report) *in outdoor activity areas and interior spaces of existing noise-sensitive land uses.*

Table 1
(Table 5-4 of the City of Redding General Plan Noise Element)
Maximum Allowable Noise Exposure
Transportation Noise Sources

Land Use	Outdoor Activity Areas[1] L_{dn}/CNEL, dB	Interior Spaces	
		L_{dn}/CNEL, dB	Leq, dB[2]
Residential	60[3]	45	--
Transient Lodging	60[3]	45	--
Hospitals, Nursing Homes	60[3]	45	--
Theaters, Auditoriums, Music Halls	--	--	35
Churches, Meeting Halls	60[3]	--	40
Office Buildings	--	--	45
Schools, Libraries, Museums	--	--	45
Playgrounds, Neighborhood Parks	70	--	--

[1] The exterior noise level standard shall be applied to the outdoor activity area of the receiving land use. Outdoor activity areas are normally located near or adjacent to the main structure and often occupied by porches, patios, balconies, etc.

[2] As determined for a typical worst-case hour during periods of use.

[3] Where it is not possible to reduce noise in outdoor activity areas to 60 dB L L_{dn}/CNEL or less, using a practical application of the best-available noise reduction measures, higher noise levels may be allowed provided that practical exterior noise-level reduction measures have been implemented and that interior noise levels are in compliance with this table.

EVALUATION OF TRAFFIC NOISE LEVELS AT THE PROJECT SITE

Traffic Noise Prediction Methodology:

j.c. brennan & associates, Inc., employs the Federal Highway Administration (FHWA) Highway Traffic Noise Prediction Model (FHWA RD-77-108) for the prediction of traffic noise levels. The model is based upon the CALVENO noise emission factors for automobiles, medium trucks and heavy trucks, with consideration given to vehicle volume, speed, roadway configuration, distance to the receiver, topography and the acoustical characteristics of the site.

Existing Traffic Noise:

On June 10, 2005, j.c. brennan & associates, Inc., staff conducted short-term noise level measurements and concurrent traffic counts for I-5 and Hilltop Drive on the project site. The purpose of the short-term traffic noise level measurement is to determine the accuracy of the FHWA model in describing the existing noise environment on the project site, while accounting for shielding from existing intervening structures and topographic features, actual travel speeds, and roadway grade. Noise measurement results were compared to the FHWA model results by entering the observed traffic volume, speed, and distance as inputs to the FHWA model. See Figure 1 for noise measurement locations.

Instrumentation used for the noise measurement was a Larson Davis Laboratories (LDL) Model 820 precision integrating sound level meter which was calibrated in the field before use with an LDL CAL-200 acoustical calibrator. Table 2 shows the results of the traffic noise calibrations. A complete listing of the FHWA calibration model inputs is provided in Appendix B.

Table 2
Comparison of FHWA Model to Measured Traffic Noise Levels
Highland Park Residential – City of Redding, California

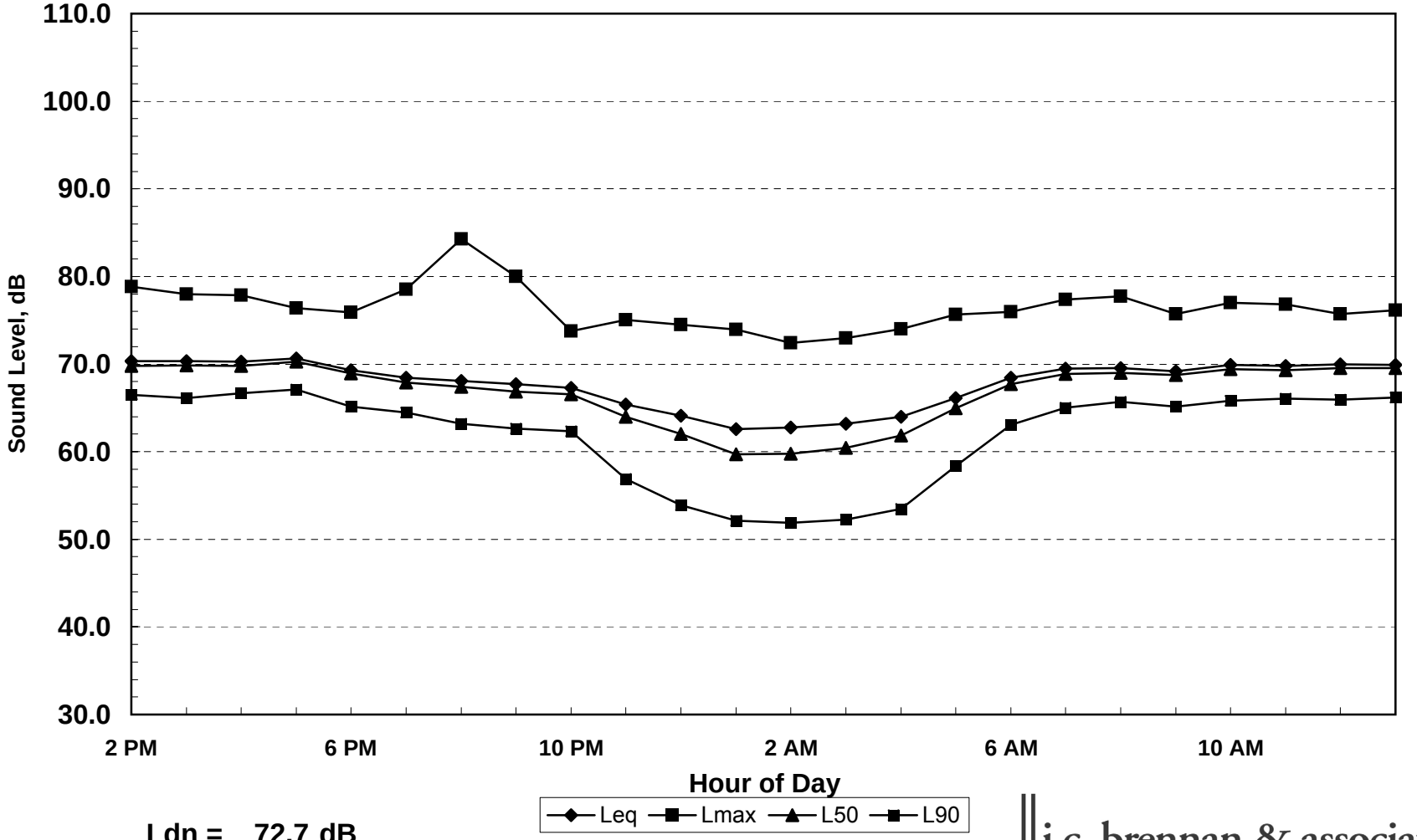
Location		Observed Speed (mph)	Dist. (Feet)*	Measured L_{eq}, dB	Modeled L_{eq}, dB**	Difference	Relative Elevation
Roadway Name	Site						
Interstate 5	1	60	360	64.5	66.9	-2.4 dB	-20
	2	60	390	60.4	66.7	-6.3 dB	20
	3	60	415	63.7	66.9	-3.2 dB	10
Hilltop Dr.	4	30	65	59.9	61.3	-1.4 dB	5

*The noise measurement location is measured from the roadway centerline.
**Acoustically "soft" site assumed

Based upon the calibration results, the FHWA Model was found to over-predict I-5 traffic noise levels by 2.4 - 6.3 dB. The difference between measured and modeled traffic noise levels on the project site is attributed to shielding provided by intervening topography between the roadway and the noise measurement locations for I-5. To remain conservative, a -2 dB offset has been applied to the FHWA model for future I-5 traffic noise levels.

In addition to the traffic noise calibration measurements, continuous 24-hour noise level measurements were conducted on June 9-10, 2005. The purpose of the continuous noise measurement was to determine the effective day/night traffic split for I-5. Figure 1 shows the location of the continuous noise measurement site, labeled as Site A. Figure 3 graphically shows the results of the continuous noise monitoring for Thursday/Friday June 9-10, 2005.

Figure 3
24hr Continuous Noise Monitoring - Site A
Highland Park Residential - City of Redding, California
June 9-10, 2005



Ldn = 72.7 dB

j.c. brennan & associates
consultants in acoustics

Future Exterior Traffic Noise Levels:

To predict the future traffic noise levels at the project site, j.c. brennan & associates, Inc., used traffic information provided by the CalTrans Office of Travel Forecasting and Modeling.

Some of the outdoor activity areas on the project site will receive shielding from intervening building facades. This shielding is accounted for in the modeling of exterior noise levels, to the degree feasible. These shielding effects are discussed in the Caltrans Technical Noise Supplement (Section N-2144, Caltrans 1998 Technical Noise Supplement, TeNS).

> Depending on the site geometry, the first row of houses or buildings next to a highway may shield the second and successive rows. This is often the case where the facility is at-grade or depressed. The amount of noise reduction varies with house or building sizes, spacing of houses or buildings, and site geometry. Generally, for an at-grade facility in an average residential area where the first row houses cover at least 40% of total area (i.e. no more than 60% spacing), the reduction provided by the first row is reasonably assumed at 3 dBA, and 1.5 dBA for each additional row. For example, behind the fist row we may expect a 3 dBA noise reduction, behind the second row 4.5 dBA, third row 6 dBA, etc. For houses or buildings "packed" tightly, (covering about 65-90% of the area, with 10-35% open space), the first row provides about 5 dBA reduction. Successive rows still reduce 1.5 dBA per row.

In some areas on the project site, the construction of proposed residential buildings will provide acoustical shielding for a number of residential outdoor activity areas. Therefore, a conservative adjustment was applied at the common outdoor activity areas where this occurs to shield outdoor activity areas.

Table 3 shows the predicted future I-5 traffic noise levels on the project site, while accounting for shielding, as discussed. A complete listing of the FHWA traffic noise prediction model inputs is provided in Appendix C.

Table 3
Predicted Future Traffic Noise Levels
Highland Park Residential – City of Redding, California

Group #	Lot Grouping	Distance to Roadway Centerline	Model Adjustments			Predicted Ldn at Outdoor Activity
			Calibration	Building Facades[1]	Partial View[1]	
1	Townhouses 254-255- Patios	475’	-2 dB	NA	-3 dB	66 dB
2	Townhouses 268-279 - Patios	215’	-2 dB	NA	-3 dB	71 dB
3	Townhouses 280-290- Patios	210’	-2 dB	NA	-3 dB	71 dB
4	SF Lot 1 - Backyard	440’	-2 dB	NA	-3 dB	67 dB
5	SF Lots 21-23- Backyards	370’	-2 dB	-5 dB	NA	66 dB
6	Townhouses 291-299- Patios	240’	-2 dB	NA	-3 dB	71 dB
7	Townhouses 300-310- Patios	250’	-2 dB	NA	-3 dB	70 dB
8	Townhouses 311-322- Patios	250’	-2 dB	NA	-3 dB	70 dB
9	Townhouses 323-334- Patios	240’	-2 dB	NA	-3 dB	71 dB
10	Townhouses 335-346- Patios	250’	-2 dB	NA	-3 dB	70 dB
11	Townhouses 347-358- Patios	255’	-2 dB	NA	-3 dB	70 dB
12	Townhouses 359-364- Patios	250’	-2 dB	NA	-3 dB	70 dB
13	Cluster Homes 214-221- Backyards	250’	-2 dB	NA	NA	73 dB
14	Cluster Homes 222-229- Backyards	255’	-2 dB	NA	NA	73 dB
15	Cluster Homes 230-237- Backyards	260’	-2 dB	NA	NA	73 dB
16	Cluster Homes 238-245- Backyards	260’	-2 dB	NA	NA	73 dB
17	Cluster Homes 246-253- Backyards	260’	-2 dB	NA	NA	73 dB
18	SF Lots 178-181 - Backyards	545’	-2 dB	-5 dB	NA	63 dB

Source: j.c. brennan & associates, Inc. 2007
[1]Based upon shielding from proposed buildings to be constructed on the project site.

Table 3 data indicates that future traffic noise levels attributed to I-5 are predicted to exceed the 60 dB Ldn noise level standard at the nearest residential outdoor activity areas adjacent to I-5. In order to achieve compliance with the City of Redding’s 60 dB Ldn exterior noise level standard, mitigation measures will be required.

Mitigation for Exterior Traffic Noise Levels:

j.c. brennan & associates, Inc., conducted a noise barrier performance analysis to determine the insertion loss and resulting noise levels provided by varying barrier heights at the outdoor activity areas closest to I-5.

Appendix D shows a complete listing of inputs used in the FHWA noise barrier model. The results are summarized in Table 4.

Table 4
Predicted I-5 Future Traffic Noise Levels with Various Noise Barrier Heights
Highland Park Residential – City of Redding, California

Group #	Pad Elevation	Base of Barrier Elevation	Noise Levels Without Barriers (Ldn)	Noise Level with Varying Property Line Barrier Heights (dB, Ldn)										
				6’	7’	8'	9'	10'	11'	12'	13'	14'	15'	16’
1	629.5’	615’-632’ 623.5’-Avg	66 dB	64	63	62	61	61	61	61	61	61	**60**	60
2	632.5’	635’	71 dB	65	65	64	63	63	62	61	61	**60**	60	59
3	639’	661’	71 dB	**56**	56	55	55	55	55	55	54	54	54	54
4	645’	641’	67 dB	64	63	62	62	62	61	61	61	61	61	**60**
5	660’	655’	66 dB	61	61	**60**	60	60	59	59	58	58	57	57
6	687’	692’	71 dB	**58**	58	57	57	57	56	56	56	56	55	55
7	683’	690’	70 dB	**58**	57	57	56	56	56	55	55	55	55	54
8	680’	687’	70 dB	**59**	58	57	57	57	56	56	56	55	55	55
9	682.5’	683’	71 dB	63	62	61	**60**	59	58	57	57	56	56	55
10	683’	683’	70 dB	63	62	61	**60**	59	58	57	57	56	56	55
11	681’	681’	70 dB	64	62	61	**60**	59	58	57	57	56	56	55
12	684’	684’	70 dB	63	62	61	**60**	59	59	58	57	57	56	56
13	686’	686’	73 dB	66	65	64	63	62	61	**60**	60	59	59	58
14	684’	684’	73 dB	66	65	64	63	62	61	**60**	60	59	59	58
15	680’	683’	73 dB	63	63	62	62	61	61	**60**	60	59	59	59
16	674’	675’	73 dB	66	65	64	64	63	63	62	62	61	61	**60**
17	668’	668’	73 dB	67	67	66	65	64	63	63	62	62	61	**60**
18	657’	657’	63 dB	**58**	58	58	58	57	57	57	56	56	55	55

Source: j.c. brennan & associates, Inc. with FHWA-RD-77-108
Barrier heights are relative to building pad elevations and base of barrier elevations, as listed above.
Bold numbers indicate compliance with the City of Redding exterior noise level standard of 60 dB Ldn.

The results of the barrier analysis shown in Table 4 indicate that the construction of a solid noise barrier adjacent to I-5 can be utilized to comply with the City of Redding 60 dB Ldn exterior noise level standard. The noise barrier would need to be designed and built according to the project grading plan and assumptions as listed in Table 4.

If attainment of the 60 dB Ldn standard is not feasible through the proposed wall heights, other alternative barrier locations and corresponding wall heights may be available. Also, the City of Redding may apply the conditionally acceptable 65 dB Ldn exterior noise level standard in cases where practical mitigation measures cannot be uses to achieve 60 dB Ldn.

Barrier locations and heights to achieve the 60 dB Ldn standard and conditionally acceptable 65 dB Ldn standard and are shown on Figure 4. Figure 5 shows the generalized traffic noise contours before and after implementation of exterior mitigation measures. It is recommended that the final barrier design break line of site to heavy trucks, a Caltrans requirement for highway noise barriers. All sound walls are calculated to break line of site to heavy trucks, unless otherwise indicated in Figure 4. In these cases, a minimum wall height is a given in brackets to indicate the minimum wall height required to break line of site to heavy trucks.

Future Interior Noise Levels:

Standard residential construction (wood siding or two-coat stucco siding, STC-26 windows, door weatherstripping, exterior wall insulation, composition plywood roof, etc.), results in an exterior to interior noise reduction of 25 dB with windows closed, and approximately 15 dB with windows open. Generally, second floor facades will be exposed to traffic noise levels approximately 2-3 dB higher than first floor facades. This is due to the lack of excess ground attenuation. Also, second floor receivers would not benefit from shielding due to sound walls.

Table 5 shows the predicted 2nd floor exterior noise exposure for the first row of residential uses adjacent to I-5.

Table 5
Predicted Future Interior Noise Levels
Highland Park Residential Project – City of Redding, California

#	Lot Grouping	Distance to Roadway Centerline	Exterior Noise Level	Predicted Interior Noise Level	Noise Reduction Needed to Achieve 45 dB
1	Townhouses 254-255	475’	72 dB	47 dB	27 dB
2	Townhouses 268-279	215’	77 dB	52 dB	32 dB
3	Townhouses 280-290	210’	77 dB	52 dB	32 dB
4	SF Lot 1	440’	70 dB	45 dB	25 dB
5	SF Lots 21-23	370’	74 dB	49 dB	29 dB
6	Townhouses 291-299	240’	77 dB	52 dB	32 dB
7	Townhouses 304-310	250’	76 dB	51 dB	31 dB
8	Townhouses 311-322	250’	76 dB	51 dB	31 dB
9	Townhouses 323-334	240’	77 dB	52 dB	32 dB
10	Townhouses 335-346	250’	76 dB	51 dB	31 dB
11	Townhouses 347-358	255’	76 dB	51 dB	31 dB
12	Townhouses 359-364	250’	76 dB	51 dB	31 dB
13	Cluster Homes 214-221	250’	76 dB	51 dB	31 dB
14	Cluster Homes 222-229	255’	76 dB	51 dB	31 dB
15	Cluster Homes 230-237	260’	76 dB	51 dB	31 dB
16	Cluster Homes 238-245	260’	76 dB	51 dB	31 dB
17	Cluster Homes 246-253	260’	76 dB	51 dB	31 dB
18	SF Lots 178-181	545’	71 dB	46 dB	26 dB

Source: j.c. brennan & associates, Inc. 2007
[1]Based upon shielding from proposed buildings to be constructed on the project site.

Based upon the Table 5 data, exterior-to-interior noise level reductions of 26-32 dB would be required to achieve compliance with an interior noise level standard of 45 dB Ldn. In order to achieve these levels of noise reduction, a detailed analysis of interior noise levels will be need to be conducted when building plans are available for the proposed project. The analysis should specify the methods required to achieve an interior noise level not exceeding 45 dB Ldn.

Additionally, it should be noted that for multi-family residential units, Title 24 requires that if the interior noise level standard is met by requiring that windows be kept closed, the design for the structure must also specify a ventilation or air conditioning system to provide a habitable interior environment.

Figure 5 – Contours

CONCLUSIONS

The first row of residential units adjacent to I-5 in the Highland Park development project site will be exposed to future traffic noise levels in excess of the City of Redding 60 dB Ldn standard for new residential developments. The following noise mitigation measures could be utilized to achieve compliance with the City noise standards:

- In order to ensure compliance with the City of Redding's exterior noise level standard of 60 dB Ldn for outdoor activity areas on the project site, j.c. brennan & associates, Inc., recommends the construction of a solid noise barrier along the western project boundary line adjacent to I-5. The barrier height should be constructed to the heights shown on Figure 4. These heights are based upon the grading assumptions listed in Table 4.

  If attainment of the 60 dB Ldn standard is not feasible through the proposed wall heights, other alternative barrier locations and corresponding wall heights may be available. Also, the City of Redding may apply the conditionally acceptable 65 dB Ldn exterior noise level standard in cases where practical mitigation measures cannot be uses to achieve 60 dB Ldn.

  It is recommended that the final barrier design break line of site to heavy trucks, a Caltrans requirement for highway noise barriers. All sound walls are calculated to break line of site to heavy trucks, unless otherwise indicated in Figure 4. In these cases, a minimum wall height is a given in brackets to indicate the minimum wall height required to break line of site to heavy trucks.

- Barriers should be constructed of an earth berm, concrete or masonry block, or precast concrete. Wood is not recommended due to eventual warping and shrinking of materials which results in openings and cracks which compromise the barrier longevity. Barriers may be constructed on top of earth berms to achieve the overall required barrier height.

- A detailed analysis of interior noise levels will be need to be conducted when building plans are available for the proposed project. The analysis should specify the methods required to achieve an interior noise level not exceeding 45 dB Ldn.

  Additionally, it should be noted that for multi-family residential units, Title 24 requires that if the interior noise level standard is met by requiring that windows be kept closed, the design for the structure must also specify a ventilation or air conditioning system to provide a habitable interior environment.

These conclusions are based upon the noise level data collected by j.c. brennan & associates, Inc., and future traffic data provided by Caltrans. Variations from the proposed site plans or traffic projections could cause noise levels at the project site to differ from those predicted in this analysis. j.c. brennan & associates, Inc., is not responsible for degradation of acoustical performance due to failure to adhere to the recommendations or applicable building code requirements.