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October 28, 2009
Project No. 41-039

Mr. Rick Moe
2657 North Rodeo Gulch Road
Soquel, CA 95073

Subject: Noise Assessment Study for the Planned "Ocean Street Extension
Apartments, Ocean Street Extension, Santa Cruz

Dear Mr. Moe:

This report presents the results of a noise assessment study for the planned "Ocean Street Extension Apartments" along Ocean Street Extension in Santa Cruz, as shown on the Site Plan, Ref. (a). The noise exposures at the site were evaluated against the standards of the City of Santa Cruz Noise Element, Ref. (b), and the State of California Code of Regulations, Title 24, Ref. (c). The analysis of the on-site sound level measurements indicates that the existing noise environment is due primarily to vehicular traffic sources on Graham Hill Road. The results of the study indicate that noise exposure excesses occur and mitigation measures will be required.

Sections I and II of this report contain a summary of our findings and recommendations, respectively. Subsequent sections contain the site, traffic and project descriptions, analyses and evaluations. Attached hereto are Appendices A, B and C, which include the list of references, descriptions of the applicable standards, definitions of the terminology, descriptions of the acoustical instrumentation used for the field survey, ventilation requirements, general building shell controls, and the on-site noise measurement data and calculation tables.

I. Summary of Findings

The noise assessment results presented in the findings were evaluated against the standards of the City of Santa Cruz Noise Element, which utilize the Day-Night Level (DNL) descriptor. The Noise Element standards specify an exterior limit of 65 dB DNL for multi-family residential land use. Exterior noise exposure limits are typically applied to exterior living spaces, such as rear yards, patios, balconies (depending upon architecture) and common open spaces. An interior limit of 45 dB DNL is specified for living spaces.

The Title 24 standards also use the DNL descriptor and are applicable to all new multi-family developments. Title 24 utilizes an exterior noise criterion of 60 dB DNL for the requirement of an acoustical analysis. The analysis must provide the mitigation to limit interior noise exposures to 45 dB DNL or lower.

The noise exposures shown below are without the application of mitigation measures and represent the noise environment for project site conditions.

A. Exterior Noise Exposures

- The existing exterior noise exposure at the most impacted planned building setback from Graham Hill Road (50 ft. from the centerline) is 61 dB DNL. Under future conditions, the noise exposure is estimated to increase to 63 dB DNL. Thus, the noise exposures will be up to 3 dB in excess of the Title 24 criterion.
- The future 60 dB DNL noise contour is 80 ft. from the centerline of Graham Hill Road and where there is a line-of-sight to the roadway. Only the second floors of Buildings 7 and 8 have a view to the road. All remaining second floors and all garage level and first floors of the project are below the road surface and are adequately shielded by the elevated shoulder of the road.

- The existing exterior noise exposure at the most impacted planned balcony (3rd floor of Building 7) is 53 dB DNL. Under future conditions, the noise exposure is estimated to increase to 55 dB DNL. Thus, the noise exposures will be within the limits of the standards of the City of Santa Cruz Noise Element.
- The fans at the adjacent Santa Cruz Memorial Cemetery crematorium generate an operational sound level of 58 dBA and a noise exposure of 55 dB DNL at the nearest proposed building setback (80 ft. from the fans) during normal business hours. Under a worst-case scenario, the fan operation could increase up to 60 dB DNL at the most impacted planned building setback. Although noise from the fans is within the limits of the standards, they may be a source of annoyance for residents of the project.

The noise exposures at the site exceed the 60 dB DNL exterior noise criterion of Title 24, therefore, as acoustical analysis is required. This report is intended to satisfy that requirement.

B. Interior Noise Exposures

- The interior noise exposures in the most impacted living spaces of units closest to Graham Hill Road will be 46 and 48 dB DNL under existing and future traffic conditions, respectively. Thus, the noise exposures will be up to 3 dB in excess of the City of Santa Cruz Noise Element and Title 24 standards.

As shown above, the exterior noise exposures will be within the limits of the standards. Mitigation measures for the exterior living spaces will not be required. However, interior noise exposure excesses will occur and mitigation for the interior spaces will be required to comply with the Title 24 standards. The recommended measures are described in Section II, below.

II. Recommendations

A. Interior Noise Controls

To achieve compliance with the 45 dB DNL standards of the City of Santa Cruz Noise Element and Title 24, the following noise control measures will be required. In addition, general construction measures affecting the building shell are also recommended, as described in Appendix B.

- Maintain closed at all times all windows of second floor living spaces within 80 ft. of the centerline of Graham Hill Road and with a direct or side view of the roadway. The noise impacted living spaces are those at the third floors of Buildings 7 and 8. These windows may have any type of glass, i.e., there is no sound rating requirement. Provide some type of mechanical ventilation.

All other windows and glass doors of the project and all bathroom windows may have any type of glazing and may be kept opened as desired unless the bathroom is an integral part of a living space without a closeable door.

When windows are maintained closed for noise control, some type of mechanical ventilation to assure a habitable environment must be provided. The mechanical ventilation requirements specified by the Uniform Building Code (UBC) are described in Appendix B. The windows specified to be maintained closed are to be operable, as the requirement does not imply a "fixed" condition.

The windows and doors shall be installed in an acoustically-effective manner. To achieve an acoustically-effective window construction, the sliding window panels must form an air-tight seal when in the closed position and the window frames must be caulked to the wall opening around their entire perimeter with a non-hardening caulking compound to prevent sound infiltration. Exterior doors must seal air-tight around the full perimeter when in the closed position.

Please be aware that many dual-pane window assemblies have inherent noise reduction problems in the traffic noise frequency spectrum due to resonance that occurs within the air space between the window lites, and the noise reduction capabilities vary from manufacturer to manufacturer. Therefore, the acoustical test report of all sound rated windows and doors should be reviewed by a qualified acoustician to ensure that the chosen windows and doors will adequately reduce traffic noise to acceptable levels.

The implementation of the above recommended measures will reduce excess noise exposures to achieve compliance with the interior standards of Title 24.

III. Site, Traffic and Project Descriptions

The planned development site is a vacant parcel located along east of Ocean Street Extension and on the west side of Graham Hill Road in Santa Cruz. The site slopes down from east to west. Surrounding land uses include the Santa Cruz Memorial Cemetery across Ocean Street Extension to the east and adjacent to the south, vacant land adjacent to the north and undeveloped land across Graham Hill Road to the east.

The on-site noise environment is controlled primarily by vehicle traffic sources on Graham Hill Road which carries an Average Daily Traffic (ADT) volume of 15,087 vehicles, as reported by the City of Santa Cruz, Ref. (d).

The Santa Cruz Memorial Cemetery crematorium fans operate from 8:00 a.m. to 5:00 p.m. Monday through Friday. A 2 hour cool down period occurs after the facility is closed. On rare occasion, the crematorium may be open until 10:00 p.m. with the cool down period occurring after, as reported by Santa Cruz Memorial Cemetery, Ref. (e).

The planned project includes the construction of 40 apartment units in 10 three story buildings. Private patios and balconies will be located on the sides of the buildings facing away from Graham Hill Road. Ingress and egress to the site will be by way of Ocean Street Extension.

IV. Analysis of the Noise Levels

A. Existing Noise Levels

To determine the existing noise environment at the site, continuous recordings of the sound levels were made on October 21-22, 2009 at location 5 ft. above the surface of Graham Hill Road and 27 ft. from the centerline. The sound levels were recorded and processed using a Larson-Davis Model 812 Precision Integrating Sound Level Meter. The meter yields, by direct readout, a series of descriptors of the sound levels versus time, as described in Appendix B, and the results are shown in the data table in Appendix C. The measured descriptors include the L_1 , L_{10} , L_{50} , and L_{90} , i.e., those levels exceeded for 1%, 10%, 50%, and 90% of the time. Also measured were the maximum and minimum levels and the continuous equivalent-energy levels (L_{eq}), which are used to calculate the DNL. The measurements were made for a continuous period of 24-hours and included representative hours of the daytime and nighttime periods of the DNL index.

As shown in the Appendix C data tables, the L_{eq} 's at the measurement location ranged from 61.1 to 65.0 dBA during the daytime and from 49.3 to 62.1 dBA at night.

In addition to the above long-term measurements, a short-term measurement of the Santa Cruz Memorial Cemetery crematorium fans was made at a distance of 108 ft. from the fan stack. The noise level was measured to be 55 dBA. At the nearest planned building setback distance of 80 ft. from the fans, the noise level will be 58 dBA.

Vehicular traffic noise dissipates at the rate of 3 to 6 dB for each doubling of distance from the source and contains a wide spectrum of frequency components (from 100 to 10,000 Hz), which are associated with engine, tire, drive-train, exhaust and other sources. These frequency components are centered primarily in the 500 and 1,000 Hz octave bands, and were used in determining the noise control measures recommended for this project.

B. Future Noise Levels

The future noise exposures were determined from future traffic volume information provided by the City of Santa Cruz. The City reported an annual growth rate of 2% per year. Applying this growth rate to the next 20 years, the 2029 ADT was calculated to increase from the existing 15,087 vehicles to 22,418 vehicles. This increase in traffic volume yields a 2 dB increase in the traffic noise levels.

V. Evaluations of the Noise Exposures

A. Exterior Noise Exposures

To evaluate the on-site noise exposures against the City of Santa Cruz standards and the Title 24 criterion, the DNL for the survey location was calculated by decibel averaging of the L_{eq} 's as they apply to the daily time periods of the DNL index. The DNL is a 24-hour noise descriptor that uses the measured L_{eq} values to calculate a 24-hour time-weighted average noise exposure. Adjustments were made to the measured noise levels to account for the increased setback distances of receptor locations from the measurement location using methods established by the Highway Research Board, Ref. (f). The formula used to calculate the DNL is described in Appendix B.

The results of the calculations indicate that the exterior noise exposure at the measurement location, 27 ft. from the centerline of Graham Hill Road and with an unobstructed view of the road, is 65 dB DNL under existing traffic conditions. At the planned minimum building setback of 50 ft. from the centerline and with a view to the road, the noise exposure was calculated to be 61 dB DNL. Under future traffic conditions, the noise exposure is expected to be 63 dB DNL. Thus, the noise exposures will be up to 3 dB in excess of the Title 24 criterion.

At the most impacted balcony (exterior living space) of the project (second floor of Building 7) the noise exposures were calculated to be 53 and 55 dB DNL under existing and future traffic conditions, respectively. Thus, the noise exposures are within the limits of the City of Santa Cruz Noise Element standards.

The crematorium fans generate a continuous sound level of 58 dBA at the nearest planned building setback. Under the normal operating scenario of 8:00 a.m. to 5:00 p.m. with a subsequent two-hour cool down, the noise exposure was calculated to be 55 dB DNL. Under a worst-case scenario of the crematorium operating until 10:00 p.m. with the cool down period extending into the nighttime hours of 10:00 p.m. to 12:00 a.m., the noise exposure was calculated to be 60 dB DNL. Thus, the noise exposures generated by the crematorium are within the limits of the standards of the City of Santa Cruz Noise Element and the criterion of Title 24.

B. Interior Noise Exposures

To evaluate the interior noise exposures in project living spaces against the standards of the City of Santa Cruz Noise Element and Title 24, a 15 dB reduction was applied to the exterior noise exposure to represent the attenuation provided by the building shell under *annual-average* conditions. The *annual-average* condition assumes that windows have single-pane, single-strength glass and are kept open 50% of the time for natural ventilation. The interior noise exposures in the most impacted living spaces closest to Graham Hill Road were calculated to be 46 and 48 dB DNL under existing and future traffic conditions, respectively. Thus, the interior noise exposures will be up to 3 dB in excess of the Title 24 standards.

The interior noise exposures in living spaces closest to the crematorium will be 40 dB DNL under the normal operating scenario and up to 45 dB DNL under the worst-case scenario. Thus, the noise exposures are within the limits of the Title 24 standards.

As shown by the above evaluations, the exterior noise exposures will be within the limits of the standards. Mitigation measures will not be required. Interior noise exposure excesses will occur at the second floors of Buildings 7 and 8. Mitigation measures for these spaces will be required. The recommended noise mitigation measures are described in Section II of this report.

This report presents the results of a noise assessment study for the planned "Ocean Street Extension Apartments" along Ocean Street Extension in Santa Cruz. The study findings for present conditions are based on field measurements and other data and are correct to the best of our knowledge. The future noise environment was determined from information provided by the City of Santa Cruz. Significant changes in the traffic volumes, speed limits, motor vehicle technology, noise regulations, or other changes beyond our control may produce long range noise results different from our estimates.

If you need any additional information or would like an elaboration on this report, please call me.

Sincerely,

EDWARD L. PACK ASSOC., INC.

A handwritten signature in black ink, appearing to read "Jeffrey K. Pack", is written over a horizontal line.

Jeffrey K. Pack
President

Attachments: Appendices A, B, and C

APPENDIX A

References:

- (a) Site Plan, Ocean Street Extension Apartments, by Dennis Diego, Architect, October 6, 2009
- (b) Noise Element of the General Plan 2030, City of Santa Cruz, Chapter 8- "Hazards, Safety & Noise", 2009
- (c) California Code of Regulations, Title 24, Part II, "Sound Transmission Control", Revised 1989
- (d) Information on Existing and Future Graham Hill Road Traffic Volumes Provided by Ms. Cheryl Schmitt, City of Santa Cruz Public Works Department, by email to Edward L. Pack Associates, Inc., October 27, 2009
- (e) Information on the Crematorium Operations at Santa Cruz Memorial Cemetery Provided by Mr. Randy, Santa Cruz Memorial Cemetery, by Telephone to Edward L. Pack Associates, Inc., October 28, 2009
- (f) Highway Research Board, "Highway Noise-A Design Guide for Highway Engineers", Report 117, 1971

APPENDIX B

Noise Standards, Terminology, Instrumentation, Ventilation Requirements and Building Shell Controls

1. Noise Standards

A. City of Santa Cruz Noise Element Standards

The Noise Element, as part of the “Hazards, Safety & Noise” Element of the General Plan 2030, adopted in 2009, contains Goal HZ3, which specifies noise standards for noise sensitive land uses. The standards identify an exterior noise exposure of 60 dB Day-Night Level (DNL) for single-family residential land use and 65 dB DNL for multi-family residential land use. The standards also reference the State Building Code noise standard of 45 dB DNL for multi-family interior living spaces and extend that limit to single-family homes.

B. Title 24 Noise Standards

The California Code of Regulations, "Sound Transmission Control", Title 24, Part II, applies to all new multi-family dwellings including condominiums, townhouses, apartments, hotels and motels. The standards, which utilize the Day-Night Level (DNL) descriptor, establish an exterior reference or criterion level of 60 dB DNL, and specify that multi-family buildings to be located within an annual DNL zone of 60 dB or greater require an acoustical analysis. The analysis report must show that the planned buildings provide adequate attenuation to limit intruding noise from exterior sources to an annual DNL of 45 dB or less in any habitable space. The Community Noise Equivalent Level (DNL) descriptor, which is similar to the DNL, may also be used, as the DNL and DNL are considered to be equivalent.

The Title 24 standards also establish minimum sound insulation requirements for interior partitions separating different dwelling units from each other and dwelling units from common spaces such as garages, corridors, equipment rooms, etc. The common interior walls and floor/ceiling assemblies must achieve a minimum Sound Transmission Class (STC) rating of 50 for airborne noise. Common floor/ceiling assemblies must achieve an Impact Insulation Class (IIC) rating of 50 for impact noise. These ratings are based on laboratory tested partitions. Field tested partitions must achieve ratings of NIC and FIIC 45.

2. Terminology

A. Statistical Noise Levels

Due to the fluctuating character of urban traffic noise, statistical procedures are needed to provide an adequate description of the environment. A series of statistical descriptors have been developed which represent the noise levels exceeded a given percentage of the time. These descriptors are obtained by direct readout of the sound measuring instruments. Some of the statistical levels used to describe community noise are defined as follows:

- | | | |
|----------|---|---|
| L_1 | - | A noise level exceeded for 1% of the time. |
| L_{10} | - | A noise level exceeded for 10% of the time, considered to be an "intrusive" level. |
| L_{50} | - | The noise level exceeded 50% of the time representing an "average" sound level. |
| L_{90} | - | The noise level exceeded 90 % of the time, designated as a "background" noise level. |
| L_{eq} | - | The continuous equivalent-energy level is that level of a steady noise having the same sound energy as a given time-varying noise. The L_{eq} represents the decibel level of the time-averaged value of sound energy or sound pressure squared and is the descriptor used to calculate the DNL and CNEL. |

B. Day-Night Level (DNL)

Noise levels utilized in the standards are described in terms of the Day-Night Level (DNL). The DNL rating is determined by the cumulative noise exposures occurring over a 24-hour day in terms of A-Weighted sound energy. The 24-hour day is divided into two subperiods for the DNL index, i.e., the daytime period from 7:00 a.m. to 10:00 p.m. and the nighttime period from 10:00 p.m. to 7:00 a.m. A weighting factor of 10 dBA is applied (added) to the noise levels occurring during the nighttime period to account for the greater sensitivity of people to noise during these hours. The DNL is calculated from the measured L_{eq} in accordance with the following mathematical formula:

$$DNL = [(L_d + 10 \log_{10} 15) \& (L_n + 10 + 10 \log_{10} 12)] - 10 \log_{10} 24$$

Where:

L_d = L_{eq} for the daytime (7:00 a.m. to 10:00 p.m.)

L_n = L_{eq} for the nighttime (10:00 p.m. to 7:00 a.m.)

24 indicates the 24-hour period

& denotes decibel addition.

C. A-Weighted Sound Level

The decibel measure of the sound level utilizing the "A" weighted network of a sound level meter is referred to as "dBA". The "A" weighting is the accepted standard weighting system used when noise is measured and recorded for the purpose of determining total noise levels and conducting statistical analyses of the environment so that the output correlates well with the response of the human ear.

3. Instrumentation

The on-site field measurement data were acquired by the use of one of the instruments specified below, which provides a direct readout of the L exceedance statistical levels including the equivalent-energy level (L_{eq}). Input to the instrument was provided by a microphone extended to a height of 5 ft. above the ground on using a tripod or mast. The "A" weighting network and the "Fast" response setting of the instruments were used in conformance with the applicable standards. The instruments conform to American National Standards Institute (ANSI) standard S1.4 for Type I instruments, and all instrumentation was acoustically calibrated before and after field tests to assure accuracy.

Instruments used for field surveys:

Larson-Davis Model 812 Integrating Sound Level Meter

Larson-Davis 2900 Real Time Analyzer

Bruel & Kjaer Model 2231 Precision Sound Level Meter

4. Ventilation Requirements

Ventilation requirements to be applied when windows are maintained closed for noise control are specified in the Uniform Building Code (UBC), 2001 edition, Section 12.03.3 as follows:

“In lieu of required exterior openings for natural ventilation, a mechanical ventilating system may be provided. Such system shall be capable of providing two air changes per hour in guest rooms, dormitories, habitable rooms, and in public corridors with a minimum of 15 cubic feet per minute (7L/s) of outside air per occupant during such time as the building is occupied.”

Based on our previous experience, a "summer switch" on the furnace fan is normally considered acceptable as a ventilation system by FHA and other agencies. Air-conditioning is also an acceptable system.

5. Building Shell Controls

The following additional precautionary measures are required to assure the greatest potential for exterior-to-interior noise attenuation by the recommended mitigation measures. These measures apply at those units where closed windows are required:

- Unshielded entry doors having a direct or side orientation toward the primary noise source must be 1-5/8" or 1-3/4" thick, insulated metal or solid-core wood construction with effective weather seals around the full perimeter. Mail slots should not be used in these doors or in the wall of a living space, as a significant noise leakage can occur through them.
- If any penetrations in the building shell are required for vents, piping, conduit, etc., sound leakage around these penetrations can be controlled by sealing all cracks and clearance spaces with a non-hardening caulking compound.
- Fireplaces should be provided with tight-fitting dampers.

APPENDIX C

On-Site Noise Measurement Data and Calculation Tables

DNL CALCULATIONS

CLIENT: RICK MOE
 FILE: 41-039
 PROJECT: OCEAN ST. EXTENSION APARTMENTS
 DATE: 10/21-22/2009
 SOURCE: GRAHAM HILL ROAD

LOCATION 1		Graham Hill Road	
Dist. To Source		27 ft.	
TIME	Leq	10 ^{Leq} /10	
7:00 AM	64.7	2951209.2	
8:00 AM	65.0	3162277.7	
9:00 AM	64.0	2511886.4	
10:00 AM	63.3	2137962.1	
11:00 AM	64.6	2884031.5	
12:00 PM	63.5	2238721.1	
1:00 PM	64.4	2754228.7	
2:00 PM	64.5	2818382.9	
3:00 PM	64.6	2884031.5	
4:00 PM	64.6	2884031.5	
5:00 PM	64.6	2884031.5	
6:00 PM	64.2	2630268.0	
7:00 PM	62.1	1621810.1	
8:00 PM	62.2	1659586.9	
9:00 PM	61.1	1288249.6	SUM= 37310709
10:00 PM	59.3	851138.0	Ld= 64.0
11:00 PM	57.9	616595.0	
12:00 AM	56.2	416869.4	
1:00 AM	55.0	316227.8	
2:00 AM	49.3	85113.8	
3:00 AM	50.4	109647.8	
4:00 AM	50.4	109647.8	
5:00 AM	57.8	602559.6	
6:00 AM	62.1	1621810.1	SUM= 4729609
			Ld= 57.2
Daytime Level=		75.8	
Nighttime Level=		76.7	
DNL=		65	
24-Hour Leq=		62.4	