Environmental Consulting Services **18488 Prospect Road – Suite 1, Saratoga, CA 95070**
Phone: (408) 257-1045 stanshell99@toast.net

September 7, 2022

Ms. Jun Zhang
Silicon Valley WZSV Capital LLC
353 Castello Dr.
Los Altos, CA 94024

Potential Noise Impacts and Acoustical Design for 8 Townhouse Project,
444 Old San Francisco Road, Sunnyvale.

Dear Ms. Zhang,

I have reviewed the acoustical aspects of the subject project design and evaluated the noise environment of the project site in Sunnyvale. This report presents the results of the noise study, which includes on-site noise monitoring, projection of future noise levels at the project site, and a general description of architectural elements required to meet the noise performance criteria of the California Building Code for multi-family construction, including Useable Open Space requirements.

A. PROJECT DESCRIPTION [1]

The project plan is to demolish an existing one-story single-family home on an 18,590 sq. ft. lot at 444 Old San Francisco Road and construct a multifamily structure with 8 townhouses. See Exhibits 1 and 2.

The primary source of ambient noise at the project site is moderate traffic on both Cezanne Drive and Old San Francisco Road, two major two-lane arterials adjacent to the project site, and to a lesser extent traffic on El Camino Real two blocks south of the site. Vehicle passby noise levels are 55-70 dBA at 35 feet for vehicles on Old SF Road and Cezanne Drive. Trucks, motorcycles, and poorly-muffled vehicles produce levels 5 to 15 dBA higher on passby. Small aircraft overflights create sporadic noise incidents of 55 to 60 dBA. The CalTrain tracks are approximately 2/3 of a mile north of the site, but noise from the trains is mitigated by the significant distance and intervening structures.

Potential noise impact receptor locations include residential developments east of the project on Old San Francisco Road, south of the project on Cezanne Drive, and the Life's Garden Senior Housing facility adjacent to the site to the east and south.

This study involves an evaluation of the potential project noise by the project on nearby sensitive residential receptors, as well as an evaluation of the noise environment of the site for the planned multi-family residential project, and provides acoustic building design criteria to provide an acceptable interior environment for the proposed use.

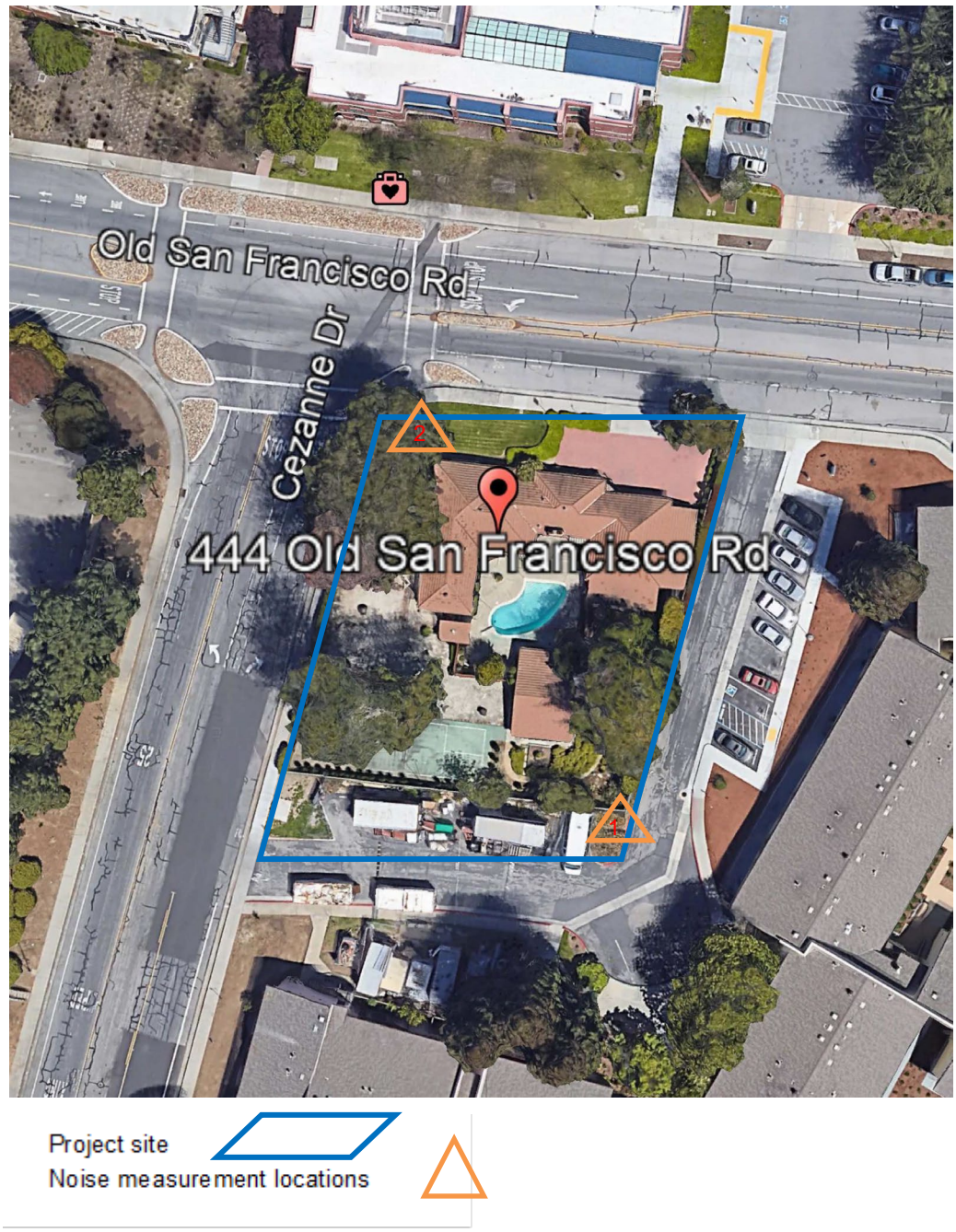

Exhibit 1 – 444 Old San Francisco Road site and area

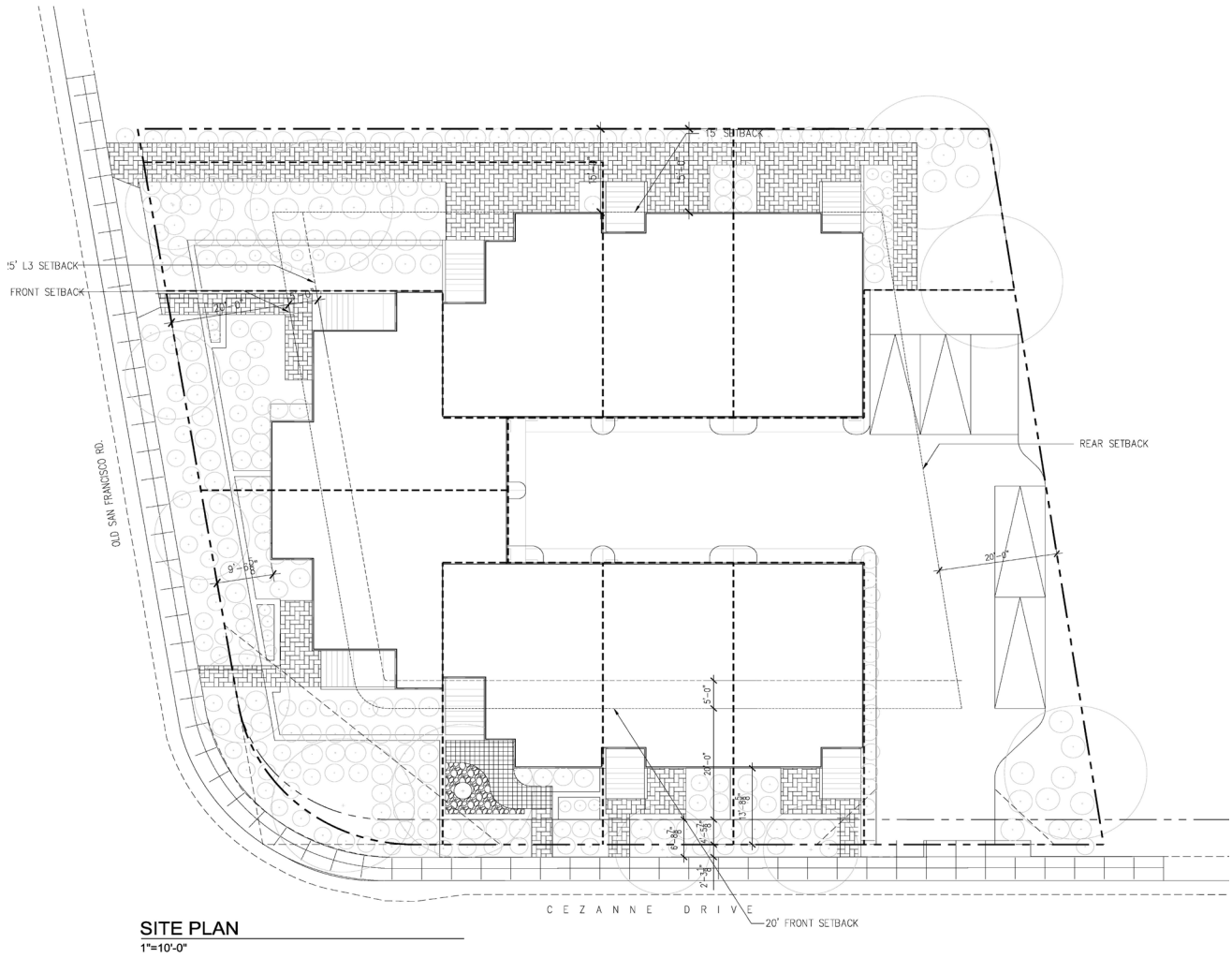

Exhibit 2 – 444 Old San Francisco Road Homes Project [4]

NOISE MONITORING AND NOISE LEVEL ANALYSIS

Ambient noise measurements were made during morning and afternoon periods on January 10, 2020 with a CEL-440 Precision Noise Meter and Analyzer, calibrated with a B & K Model 4230 Sound Level Calibrator. Measurement locations were chosen to represent typical noise level exposures of the project building and also nearby residential receptor locations. Measurements were made for 30 to 40 minutes at a 5-foot height at the following locations. See Exhibit 1 for on-site measurement locations.

- Measurement 1 (morning) - southeast corner of project site
- Measurement 2A (morning) – at the northwest corner of the project site, approximately 35 feet from the nearest lanes of Cezanne and Old San Francisco Road.
- Measurement 2B (afternoon) – same location as measurement 2A.
- Measurement 3 (afternoon) – at the front of the large multi-family residential unit two blocks east of the project on Old San Francisco Road, approximately 60 feet from the nearest lane.
- Measurement 4 (afternoon) – in front of a multi-family residential unit two blocks south of the project on Cezanne Drive, approximately 35 feet from the nearest lane.

Existing Noise Levels

Noise levels were measured and are reported using percentile noise descriptors as follows: L_{90} (the background noise level exceeded 90 % of the time), L_{50} (the median noise level exceeded 50% of the time), L_1 (the peak level exceeded 1% of the time), and L_{eq} (the average energy-equivalent noise level). The Ldn noise levels were computed as the long-term average of the L_{eq} using the daily traffic distribution in the area, with standard weighted penalties for the nighttime hours, and modeled with an enhanced version of the National Cooperative Highway Research Board traffic noise model [3]. Measured noise levels are presented in Exhibit 3.

EXHIBIT 3
EXISTING NOISE LEVELS (dBA)
Multi-Family Homes Project, Old San Francisco Road

Noise Measurement Locations	L90	L50	Leq	L1	Ldn
1 – SE corner of project site (am)	47	50	51.4	60	53
2A – NW corner of project site (am)	55	60	63.3	72	66
2B - NW corner of project site (pm)	58	63	64.1	71	66
3 – Residential receptor 2 blocks east on Old SF Road (pm)	54	61	62.5	70	64
4 - Residential receptor 2 blocks south on Cezanne Drive (pm)	55	61	62.3	70	65

As expected, ambient noise levels are relatively high at locations close to the high-volume traffic, both at the site and at the similar receptor locations east and south of the site. Only location 1 at the back corner of the site is protected from direct traffic noise by significant distance and buildings. Traffic speeds are relatively high when the light at Old San Francisco Road is green, in the 30-35 mph range, and at receptor locations two blocks away, creating higher noise levels. When the traffic lights are red at the intersection, vehicles idle adjacent to the site. The project living units exposed to the highest noise levels would be those along the north and west sides of the building facing Old San Francisco and Cezanne Drive, approximately 40-45 feet from the nearest traffic lanes.

B. POTENTIAL PROJECT NOISE IMPACTS

Project Traffic Noise

There are 8 units and 16 parking spaces available to project residents, 2 per unit, and the estimated maximum number of trips generated per day would be 6 per unit-- 3 per unit during the peak hour. Existing volumes on Old San Francisco Road are approximately 650 during peak hour, and 600 on Cezanne Drive, based on vehicle counts during field noise measurements. The estimated 24 maximum number of project trips during peak hour (12 on each adjacent street) would only increase volumes on Old San Francisco Road and Cezanne Drive by about 2%, which would increase traffic noise at residential receptors on these streets much less than 1 dB. Project traffic noise impacts on the adjacent Life's Garden facility would be negligible, since project vehicles park in an underground garage, and enter/ exit directly to/from Cezanne Drive.

Project Operational Noise

There are no significant outdoor noise sources or activities associated with the project, except perhaps sporadic lawn and walk maintenance activities, which would be similar to those associated with the existing Life's Garden facilities next door.

C. Useable Open Space Noise Requirements

A majority of the Useable Open Space is shown along Old San Francisco Road and Cezanne Drive, between the streets and the building. The noise levels in these areas are in the range of 60 to 65 dBA Ldn, depending on distance from the roads. The acceptable residential exterior noise level, per the City Noise Element is 60 dBA Ldn and below. For this reason, to bring these designated Useable Open Space areas into compliance, some type of protection from the traffic noise must be provided. In general, this means installing solid noise fences or walls at least 6 feet high between the property lines adjacent to Old SF Road and Cezanne Drive and the patios or Useable Open Space Areas. These noise walls should be wrapped around the protected areas, and also the corners at the ends of the walls and any openings by at least 6 feet, to cut off any direct noise path between vehicles and the protected areas. This would bring the ground floor Useable Open Space areas down to the 60 dBA noise compliance level.

Note that some combination of solid wood or masonry, with the top 1-2 feet composed of Plexiglas or tempered glass, can be used to improve the aesthetic and appearance qualities.

D. Temporary Demolition & Construction Noise Impacts and Mitigation Measures [6]

This section describes potential noise levels of vehicles, heavy equipment and powered tools that are typically used for demolition, site preparation and construction tasks. Unless otherwise noted, noise levels are stated at a distance of 50 feet. Construction equipment noise level data are based on reference 6.

The primary receptor locations affected by the construction phases include the adjacent senior residential facilities. Typical noise levels for demolition and construction equipment are listed in Exhibit 4 (next page), along with the "usage" level, the portion of the time that the equipment is generally used. In addition, each of the tasks is supported by some heavy truck traffic to and from the site.

a. Equipment, Brush and Tree Removal

There are a number of trees and bushes on the project site that must be removed, requiring the use of gas engine chain saws, which typically produce sound levels of 82-87 dBA. The smaller branches could be ground up on site using a tree chipper, which produces a noise level of 87-90 dBA. The tree cutting and chipping tasks would last a day at most.

b. Blacktop and Concrete Removal

Blacktop and concrete paving and curbs must be broken and removed during the demolition stage, requiring use of pneumatic jackhammers, loaders and heavy trucks.

c. Site Clearing and Grading

Site preparation could bring various types of heavy demolition and excavation machines to the site, such as small bulldozers, backhoes, graders and haul trucks. These have large diesel engines and typically produce noise levels of 85 to 90 dBA under full load and 80 to 84 dBA while idling.

d. Wood Construction and Concrete Work

A number of construction tasks involve working with wood and carpentry tools, such as building forms for concrete foundations and walls, and installing structural framing for new buildings. These tasks require both manual and electrical carpentry tools, which produce noise levels of 75 to 85 dBA, and also powered lifts and tractors to move and install framing members for the multiple story building. Following construction of forms, concrete mixer trucks and pumps would be required, which produce noise levels of 80 to 85 dBA.

e. Completion of Structure and Interior Details

Final construction phases include erection of exterior wall panels, windows, and roof followed by completion of interior walls, installation of equipment, plumbing and lighting. The highest noise levels during this period would be from material haul trucks and cranes, with miscellaneous pumps and auxiliary engines providing the background noise at 60 to 70 dBA. The final stages generally would not cause significant noise disturbances.

Exhibit 4
Typical Construction Noise Levels – 50 feet (dBA)

Equipment	Noise Level	Usage %
Mobile Equipment		
Front Loader	75-80	0.4
Backhoe	75-85	0.2
Bulldozers, tractors	75-85	0.4
Scraper	80-90	0.4
Grader	75-85	0.1
Truck	75-90	0.4
Paver	80-90	0.1
Materials Handling		
Concrete mixer	75-85	0.4
Concrete pump	75-80	0.4
Crane	75-85	0.2
Derrick	75-90	0.2
Stationary Equipment		
Pumps	70-75	1.0
Generators	75-80	1.0
Compressors	75-80	1.0
Saws	75-80	0.05
Impact Equipment		
Pile drivers	95-100	0.05
Jackhammers	75-90	0.1
Rock drills	80-100	0.05
Pneumatic tools	80-85	0.2

Analysis of Temporary Construction Noise and Mitigation Measures

Demolition and construction noise would be intermittent and of limited duration, rather than continuous, since equipment is used sporadically over a number of days. During site preparation and construction, equipment could be within 40-60 feet of the nearest receptor locations, so the maximum noise exposure of this location could be over 75 dBA without mitigation.

General Construction Noise Mitigation Measures

The following general noise mitigation measures are suggested to minimize disturbance for those residences close to the site during demolition and construction.

1. Install solid perimeter 8-foot plywood fences around the site during the demolition and construction phase to provide a noise reduction of 6 to 8 dBA for nearby businesses and residences.
2. Install superior mufflers and engine enclosure panels as needed on gas, diesel or pneumatic impact machines.
3. Choose construction equipment that is of quiet design, has a high-quality muffler system, and is well maintained. This includes trucks used to haul materials.
4. Restrict construction hours to normal daytime working hours.
5. Eliminate unnecessary idling of machines when not in use.
6. Use good maintenance and lubrication procedures to reduce operating noise.
7. If possible, locate equipment as far from adjacent residences as possible.

E. ANALYSIS OF FUTURE PROJECT NOISE EXPOSURE LEVELS

The Design Noise Level (DNL) is the potential maximum hourly Leq noise level expected at the site within the next ten years (2030), for the units experiencing the highest noise exposure — the peak hourly Leq noise level that the elements of the building structure must mitigate. Worst-case future DNL noise level exposures to the building are determined by looking at the existing measured noise levels on site and then making corrections to the present measured levels for the following parameters, in order to obtain the future building exposures:

- Distance to building (in this case somewhat more than the measurement distance)
- Traffic at peak volume time of day
- Traffic at peak time of year (with schools in session)
- Estimated future traffic volume increases in next 10 years (only small increases expected)
- Upper floor increase in traffic noise relative to ground floor noise levels

Noise levels for different traffic conditions were computed using typical daily commute-dominated traffic distribution in the area, with standard weighted penalties for the nighttime hours, with modeling based on an enhanced version of the National Cooperative Highway Research Board traffic noise model [5]. After all of the contributions described above are applied to the existing noise levels at the site, the Design Noise Level exposure for the building exterior is 68 dBA (maximum hourly Leq) for units facing Old San Francisco Road and Cezanne Drive. Units facing in other directions would have maximum exposures 3-5 dBA lower.

F. MEETING INTERIOR DESIGN STANDARDS

Design measures are focused on meeting interior Cal Building Code section 1207.4 [5], which is as follows:

> **Allowable interior noise levels**. Interior noise levels attributable to exterior sources shall not exceed 45 dB in any habitable room. The noise metric shall be either the day-night average sound level (Ldn) or the community noise equivalent level (CNEL), consistent with the noise element of the local general plan.

In addition to Cal Bldg. Code standards that specify building shell elements required to provide an interior maximum hourly Ldn noise level of 45 dBA or less, good noise construction practices require that all party wall assemblies between residential units and public spaces must have a minimum 50 STC (Sound Transmission Class) rating, and floor-ceiling assemblies should have an IIC rating of 50. Standard STC ratings for different types of party wall constructions are documented in References 7 and 8, as well as in many vendor specifications.

G. RECOMMENDATIONS TO MEET SUNNYVALE DESIGN NOISE CRITERIA

Following are recommendations for meeting the primary criteria for good residential noise insulation design by the development:

1. WINDOWS AND EXTERIOR WALL ELEMENTS. Windows, exterior walls, and roof should have a tested and certified STC ratings of at least 23 dBA to meet interior CBC standards, as described in Section E. This specification is easily met by all roofs and standard thermal double pane windows. However, for better performance against all types of intrusive vehicular noise, such as trucks and motorcycles, windows with an STC of at least 30 dB should be chosen.

2. EXTERIOR DOORS. Any outside doors leading into residential rooms, such as those accessing the decks along the arterial streets, should meet a tested STC rating of 30 to achieve good overall exterior sound transmission criteria.

3. PARTY WALL AND FLOOR-CEILING ASSEMBLIES. For minimizing disturbances from noise transmitted between attached units, party wall assemblies should have several inches of air space, fiberglass insulation, minimal direct structural connections, and also be fitted with resilient channel on one side of the party wall assembly, in order to meet or exceed a 50 dBA Sound Transmission Class (STC) requirement.
   Floor-ceiling assemblies between residential rooms should meet an IIC impact rating of 50 dBA to meet state standards. Acceptable types of party wall and floor-ceiling assemblies are described in References 7 and 8, as well as in many vendor specifications.
   In addition, any fire stops between units should ***not*** provide a strong structural connection. That is, they should be of lightweight material, such as sheet metal or fiberglass, which cannot conduct low-frequency sound and vibration between units.

5. ROOF ASSEMBLIES. To minimize disturbances from noise transmitted through the roof assemblies to resident rooms, an STC rating of at least 30 is required, as with other exterior building elements.

5. VENTILATION. Mitigation of outside noise is based upon windows that are closed in order to provide the required noise protection. Therefore, all units in high exposure building sections must have a ventilation system that provides a habitable interior air quality environment with the windows closed, regardless of outside temperature.

6. GENERAL DESIGN AND CONSTRUCTION PRACTICES. Good noise design must be implemented by good field construction practices or the design performance will not be achieved. This includes minimizing all penetrations of and connections between party wall and floor/ceiling assemblies, and acoustical sealant around any necessary penetrations.

If I may be of further assistance on this project, please do not hesitate to contact me.

Respectfully submitted,

Stanton Shelly

H. Stanton Shelly
Acoustical Consultant
Board Certified Member (1982),
Institute of Noise Control Engineering

REFERENCES

1. Project description and Planning Division requirements, City of Sunnyvale; 2022.
2. Satellite map, Google Earth, Jan 2020.
3. *Highway Noise - A Design Guide for Highway Engineers*, National Cooperative Highway Research Program Report 117, Highway Research Board, National Academy of Sciences, Washington, D.C., 1971 (model enhanced and field validated by ECS)
4. Project Drawing Set, 444 Old San Francisco Road Homes Project, Z S D Architects, Inc, Los Altos, CA; Feb 2020 Revised.
5. Section 1207.4 of California Building Code.
6. *Noise from Construction Equipment and Operations, Building Equipment, and Home Appliances*, Office of Noise Abatement and Control, U.S. Environmental Protection Agency, Washington, D.C.; December 1971.
7. *Catalog of STC and IIC Ratings for Wall and Floor/Ceiling Assemblies*, DuPree, Russell B., California Dept. of Health Services, Office of Noise Control, Berkeley, CA, Feb. 1980.
8. *Fire Resistance Design Manual, Sound Control, Gypsum Systems*, 21st Edition, Gypsum Association, Hyattsville, MD, 2015.