FXG Redding California
Facility Acoustical Analysis

Draft 1 – June 1, 2021 – FOR CLIENT REVIEW ONLY

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Executive Summary

Cavanaugh Tocci Associates, Inc. (CTA) has been retained by 42 Real Estate, LLC to conduct an environmental sound study for a proposed FedEx Ground (FXG) shipping facility in Redding, California. In this report, the project is referred to as FXG Redding CA.

The specific purposes of this study are to:

1. Review applicable state and local regulations on facility sound emissions.
2. Develop design goals for facility sound based on applicable regulations and estimated existing conditions.
3. Estimate sound produced by facility activity using a computer model of sound propagation.
4. Compare receptor sound level predictions with design goals.
5. Develop noise control recommendations as needed to meet the project design goals.

The project is to be located on and accessed from Aviation Drive in Redding, CA. The site is bounded to the east by industial; to the south by industrial and public uses; to the west by industrial with residential beyond; and to the north by industrial uses. The nearest residential receptors are located west of the site along Bogie Lane.

The City of Redding residential limits are 55 dBA during the day and 45 dBA at night, defined as Time-Average (L_{eq}). In addition to the applicable limits on FXG facility sound, a design goal has been developed based on an estimate of ambient sound level in nearby residential areas. Design goals for sound were determined based on an assumed nighttime background sound level of 30 dBA.

A computer model of facility sound propagation was developed that takes into account reduction in facility sound pressure levels associated with distance, shielding provided by intervening structures and topography, and absorption of sound by the atmosphere and porous surfaces. Facility sound levels determined through computer modeling have been compared with the applicable regulations and suggested design goals.

On the basis of the study conducted, it has been determined that the FXG facility, as currently designed, will comply with all applicable regulations on sound. Further, it has been determined that the FXG facility will genearlly achieve the design goals recommended to avoid potentially distrubing nearby residents if a series of sound barrier walls are constructed along the west side of the facility with a total length of 610 feet and heights ranging from 10 to 12 feet.

Table of Contents

Introduction

Cavanaugh Tocci Associates, Inc. (CTA) has been retained by 42 Real Estate, LLC to conduct an environmental sound study for a proposed FedEx Ground (FXG) shipping facility in Redding, California. In this report, the project is referred to as FXG Redding CA. Figure 1 is a locus map showing the proposed FXG facility site and nearby roads.

The project is to be located on and accessed from Aviation Drive in Redding, CA. The site is bounded to the east by industrial; to the south by industrial and public uses; to the west by Industrial with residential beyond; and to the north by industrial uses. The nearest residential receptors are located west of the site along Bogie Lane.

Figure 1 is an aerial image showing the approximate location of the facility with respect to nearby residential receptors. The site and its environs are mostly flat with some rolling hills, with variations in elevation of approximately +/- 30 feet over the study area.

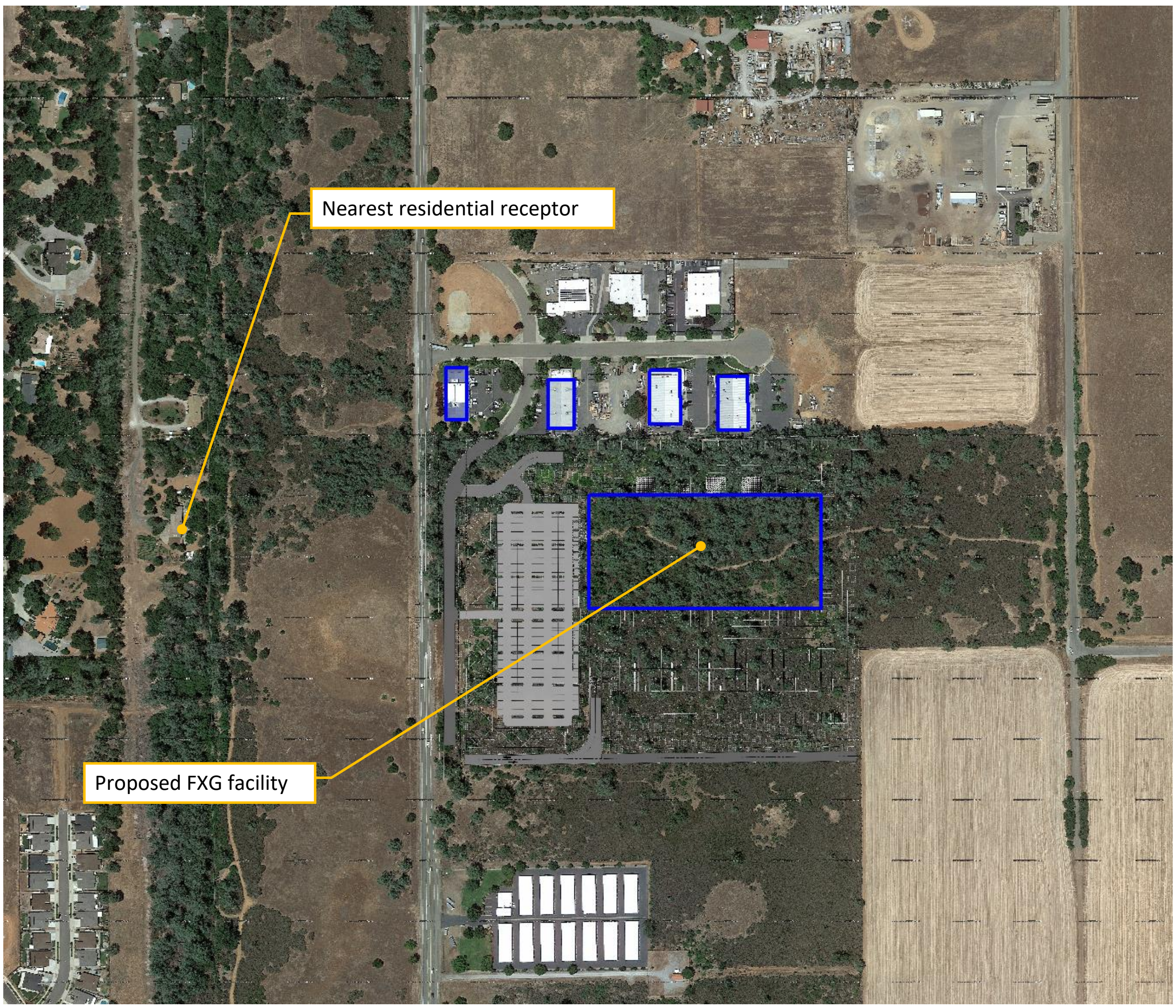

Figure 1. Aerial photo showing proposed site and FXG building outline
FXG Redding CA

Trucks will deliver packages to and from the FXG facility 24 hours per day. The FXG facility will contain a conveyor system that will sort incoming packages and load them into outgoing trailers and vans. Doors to the FXG building will typically be closed, and sound produced by activities and equipment inside the building and transmitted to the community will be negligible. Major sources of noise are trucks entering and leaving the property, linehaul trucks dropping and removing trailers, and trailers being maneuvered by a switcher tractor, as well as back-up alarms.

The specific purposes of this study are to:

1. Review applicable state and local regulations on facility sound emissions.
2. Develop design goals for facility sound based on applicable regulations and estimated existing conditions.
3. Estimate sound produced by facility activity using a computer model of sound propagation.
4. Compare receptor sound level predictions with design goals.
5. Develop noise control recommendations as needed to meet the project design goals.

The first section of this report discusses potentially relevant codes, regulations, and guidelines used in this study for evaluating FXG Redding CA sound. The second section discusses the development of a recommended design goal for facility sound that would minimize impact on the community and comply with regulations identified in the first section. The third section discusses computer modeling used to estimate sound levels in the vicinity of the proposed FXG facility. This section includes a discussion of computer model inputs such as source and receiver locations and source sound power levels.

On the basis of the study conducted, it has been determined that the FXG facility, as currently designed, will comply with all applicable regulations on sound. Further, it has been determined that the FXG facility will genearlly achieve the design goals recommended to avoid potentially distrubing nearby residents if a series of sound barrier walls are constructed along the west side of the facility with a total length of 610 feet and heights ranging from 10 to 12 feet.

Appendix A of the report contains a glossary of acoustical terminology. Appendix B contains links to state and local noise regulations discussed in this report. Appendix C contains additional technical information related to computer modeling. Appendix D contains the full data results tables from computer modeling. Appendix E contains information on sound barrier wall systems and materials. Appendix F contains information on broadband backup alarms.

State of California

We are not aware of any State of California regulation on noise directly applicable to the project that establishes specific, measurable limits on sound. However, the California Noise Control Act of 1973 (California Health and Safety Code, Division 28. Noise Control Act) authorizes local jurisdictions to enact noise elements in their codes for purposes of controlling sound in their communities.

In general, California Health and Safety Code 46000 states that "*All Californians are entitled to a peaceful and quiet environment without the intrusion of noise which may be hazardous to their health or welfare*." More specifically, Section 65302 (f) of the California Government Code requires that jurisdictions prepare a General Development Plan that includes a "noise element"[1] that identifies and appraises noise problems in the community.

Redding CA Municipal Code of Ordinances

Section 18.40.100 of the Redding Code of Ordinances sets noise limits on sound based on receiving land use category as presented in Schedule 18.40.100-A:

Schedule 18.40.100-A: Exterior Noise Standards

Receiving Land Use Category	Time Period	Noise Level (Hourly L_{eq}/dB)
Residential	10 p.m.—7 a.m.	45
	7 a.m.—10 p.m.	55
Office/commercial	10 p.m.—7 a.m.	55
	7 a.m.—10 p.m.	65
Industrial	10 p.m.—7 a.m.	N/A [1]
	7 a.m.—10 p.m.	N/A [1]

[1] Industrial noise shall be measured at the property line of any nonindustrial district.

Redding CA Zoning Code

Figure 2 is an excerpt from the Redding CA Zoning Map[2]. The proposed facility is located in the Industry zone. Nearest residential receptors are located west of the site.

[1] http://leginfo.legislature.ca.gov/faces/codes_displaySection.xhtml?lawCode=GOV&sectionNum=65302.
[2] https://gispub.cityofredding.org/reddingmap/

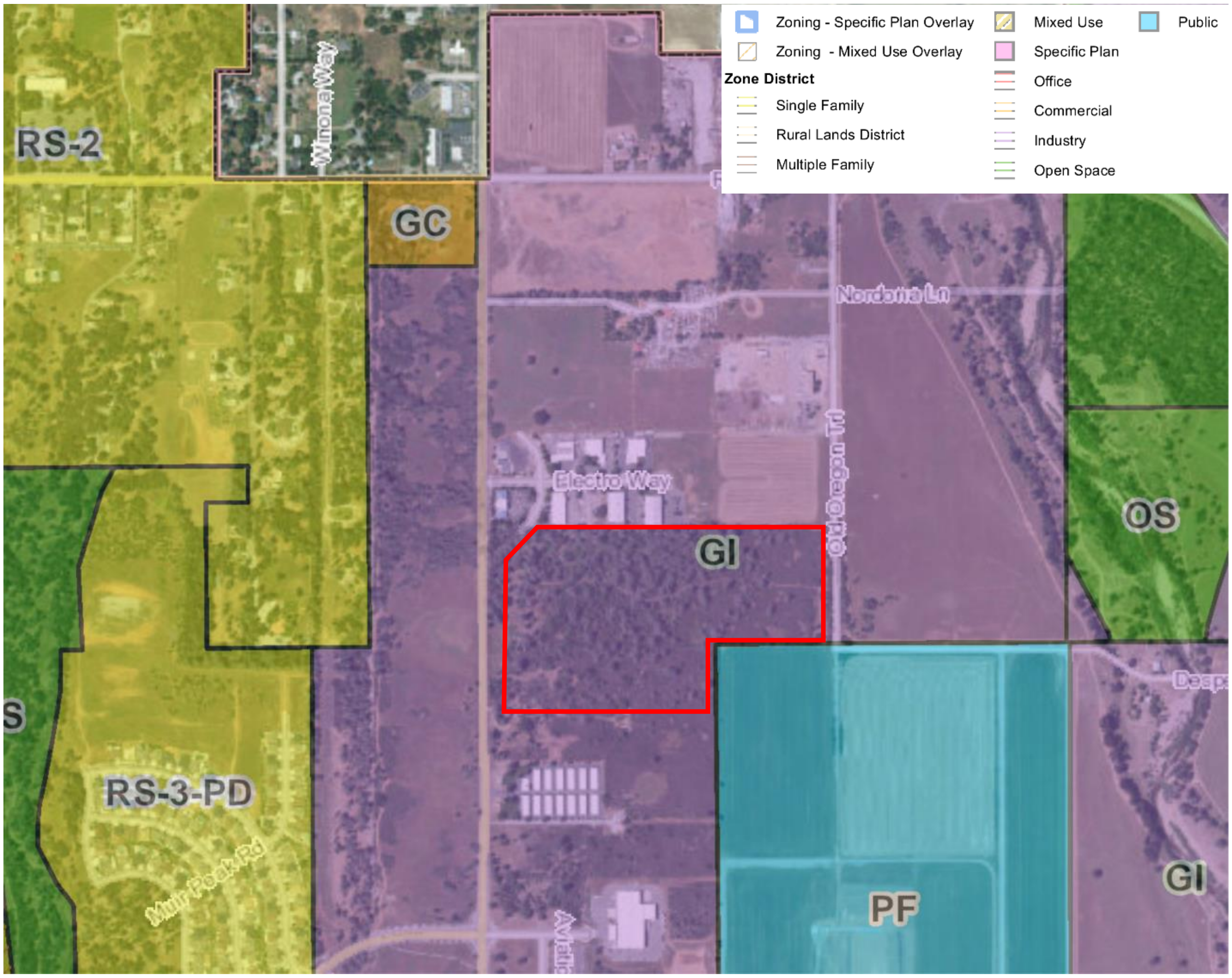

Figure 2. Excerpt from Redding CA Zoning Map
FXG Redding CA

Summary of Noise Regulations

Section 18.40.100 of the Redding Code of Ordinances sets hourly L_{eq} limits for FXG source sound at residential receptors of 55 dBA during daytime hours and 45 dBA during nighttime hours.

Section 2 – Noise Design Goal

Community Perception of Noise Impact

In addition to the applicable ordinance limits on FXG facility sound, a design goal has been developed based on an estimate of ambient sound level in nearby residential areas. The design goal addresses community perception of noise which is strongly related to the margin by which sound levels produced by a new source exceed the existing background sound level. Other factors which influence community perception include:

- Time-domain characteristics, such as “continuous” or “impulsive” features
- Frequency-domain characteristics, such as “broadband” or “tonal”
- The time the noise occurs, specifically as it relates to human sleeping hours
- The duration of the noise, as well as any modulations which may occur
- Whether the community is accustomed to sound of the type produced

In this study, “background sound level” means the lowest continuous sound level in the absence of short-term events such as vehicle pass-bys. For this desktop sound study, we have estimated the background level based on review of Google Earth aerials of the site surroundings and our experience with measured levels at similar locations. The report analysis compares highest estimated FXG facility sound levels with the estimated background sound level of 40/30 dBA day/night.

Design Goals for Sound Based on the Existing Background

For this report, recommended design goals for facility sound are based on existing background sound level. These design goals are not legal limits, they are voluntary, and are provided to minimize the risk of negative community response to new sound produced by the facility. Recommended design goals for sound are the background sound level plus margins ranging between 5 and 15 dB depending on source type. These margins are as follows:

- For continuous sound sources (e.g. truck pass-by events), a margin of 10 dB is recommended, i.e. a <u>design goal for continuous sound of 50/40 dBA for day/night</u>.
- Tonal sound sources (e.g. beeping back-up alarms) are often perceived as “louder” than non-tonal sources which produce the same A-weighted sound level. As such, the recommended margin for these sources is 5 dB, i.e. a <u>design goal for tonal sound of 45/35 dBA for day/night</u>.
- Brief sound events (e.g. trailer disconnects) are often perceived as “quieter” than continuous sources of the same level. The recommended margin for these sources of transient sound is 15 dB, i.e. a <u>design goal for impact sound of 55/45 dBA for day/night</u>.

These design goals are voluntary and are intended to minimize the risk of negative community response to FXG sound.

Ultimately, the FXG facility must meet two primary objectives. These are to:

- Comply with sound level limits based on applicable codes.
- Enable the FXG facility to operate as a good neighbor by achieving design goals based on existing ambient sound levels.

Table 1 summarizes the applicable regulations and design goals for FXG Redding, CA sound. Design goals are applied to maximum sound levels produced at the facility, while the City of Redding limits are applied to energy equivalent sound levels.

Land Use	City of Redding Limit (energy equivalent[1])	Design Goal (dBA)		
		Continuous [4]	*Impulsive* [5]	*Tonal* [6]
Residential, Day [2]	55 dBA (L_{eq})	50	55	45
Residential, Night [3]	45 dBA (L_{eq})	40	45	35

[1] Energy-equivalent noise level (hourly L_{eq})
[2] 7:00 AM to 10:00 PM
[3] 10:00 PM to 7:00 AM
[4] Estimated background L_{A90} plus 10 dB
[5] Estimated background L_{A90} plus 15 dB
[6] Estimated background L_{A90} plus 5 dB

Table 1. Applicable limits and recommended design goals for FXG facility sound
FXG Redding CA

Section 3 – Computer Modeling

Sound produced by equipment and activities of the proposed FXG facility have been estimated using a computer model of sound propagation from facility sources to representative study locations. This section presents general information on the computer modeling technique, as well as specific information for modeling FXG Redding sound levels at nearby study locations.

Modeling Technique

Modeling of facility sound was completed using Cadna/A (Datakustik GmbH, Version 2021 MR1, 32-bit). Cadna/A is a computer program that implements the modeling techniques of ISO 9613-1 and ISO 9613-2 to estimate source sound levels at community receptor locations. In calculating sound levels at receptor locations, the Cadna model accounts for reductions in facility sound pressure levels associated with propagation distance, shielding by intervening structures and topography, and absorption of sound by the atmosphere and porous surfaces.

Sound Power

The Cadna model requires sound power levels for all sources modeled. Sound power level quantifies the amount of sound energy produced by a source and is expressed in decibels referenced to 1 picoWatt (pW or 10^{-12} watts). The distinction between "sound power" and "sound pressure" is quite important and is as follows:

> *Sound power* is analogous to the power rating in watts of a light bulb.
>
> *Sound pressure* is analogous to the light intensity (perceived as brightness) at a given distance from a light bulb.

The shorter the distance from the bulb, the greater the light intensity or perceived brightness at a particular location. Conversely, the longer the distance from the bulb, the less the light intensity or perceived brightness at a particular location. Note that the bulb's power rating does not change with viewing distance from the bulb; however the light intensity and apparent brightness do. Similarly, the sound power of a source does not change with distance from the source, but the sound pressure does.

FXG Sound Power Data

Sound power level is determined from calibrated measurements of sound pressure combined with measurement distance and other conditions influencing sound propagation. Sound power levels for common FXG facility equipment and activities have been determined through sound measurements made at an FXG facility in Willington, CT. The equipment studied at the Willington facility is the same as that expected at the Redding facility. The facility sound events discussed in this report have been selected for analysis as they are among the loudest sources expected. The sound power spectra used in computer modeling are provided in Appendix C.

FXG Reference Sound Pressure Levels

When sound propagates over hard, flat ground, the sound pressure level at 50 feet is typically 32 dB lower numerically than the sound power level. This relationship is known as divergence, and does not include other propagation losses such as screening by barriers, reflection and absorption, atmospheric effects, etc. The 50-foot sound pressure levels for sources in this study are presented in Figure 3. The octave band sound power levels used in computer modeling that correspond to the 50-foot A-weighted sound pressure levels in Figure 3 are provided in Appendix C. Facility source characteristics—continuous, tonal, and impulsive—are identified in the insert legend of Figure 3 for each source.

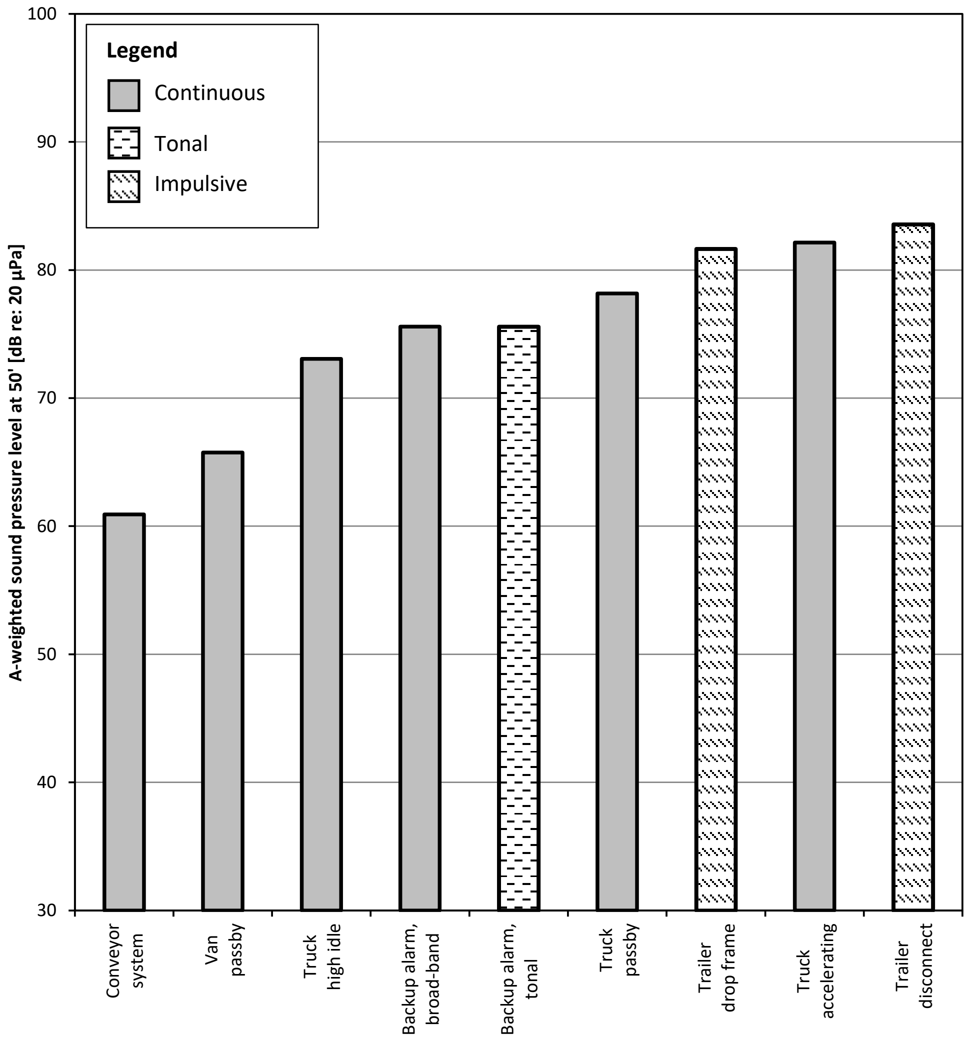

Figure 3. Reference source sound pressure levels at 50 feet
FXG Redding CA

FXG Source and Community Receptor Locations

The computer modeling of receptor sound levels requires that the location of sources, receptors, and attenuating elements be defined. For this analysis, the source locations selected are those likely closest to residential receptors to develop a "worst-case" evaluation of the project's possible acoustic impact.

Figure 4a shows fourteen receptor locations R1-R14 used in facility computer modeling, as well as the locations where ambient sound was monitored. Figure 4b shows seventeen facility sound source groups SL1-SL17 used in computer modeling. A source group is the location of one or more specific sources. For example, a source group may have a trailer disconnect, back-up alarm, and truck pass-by, all occurring at about the same physical location on-site.

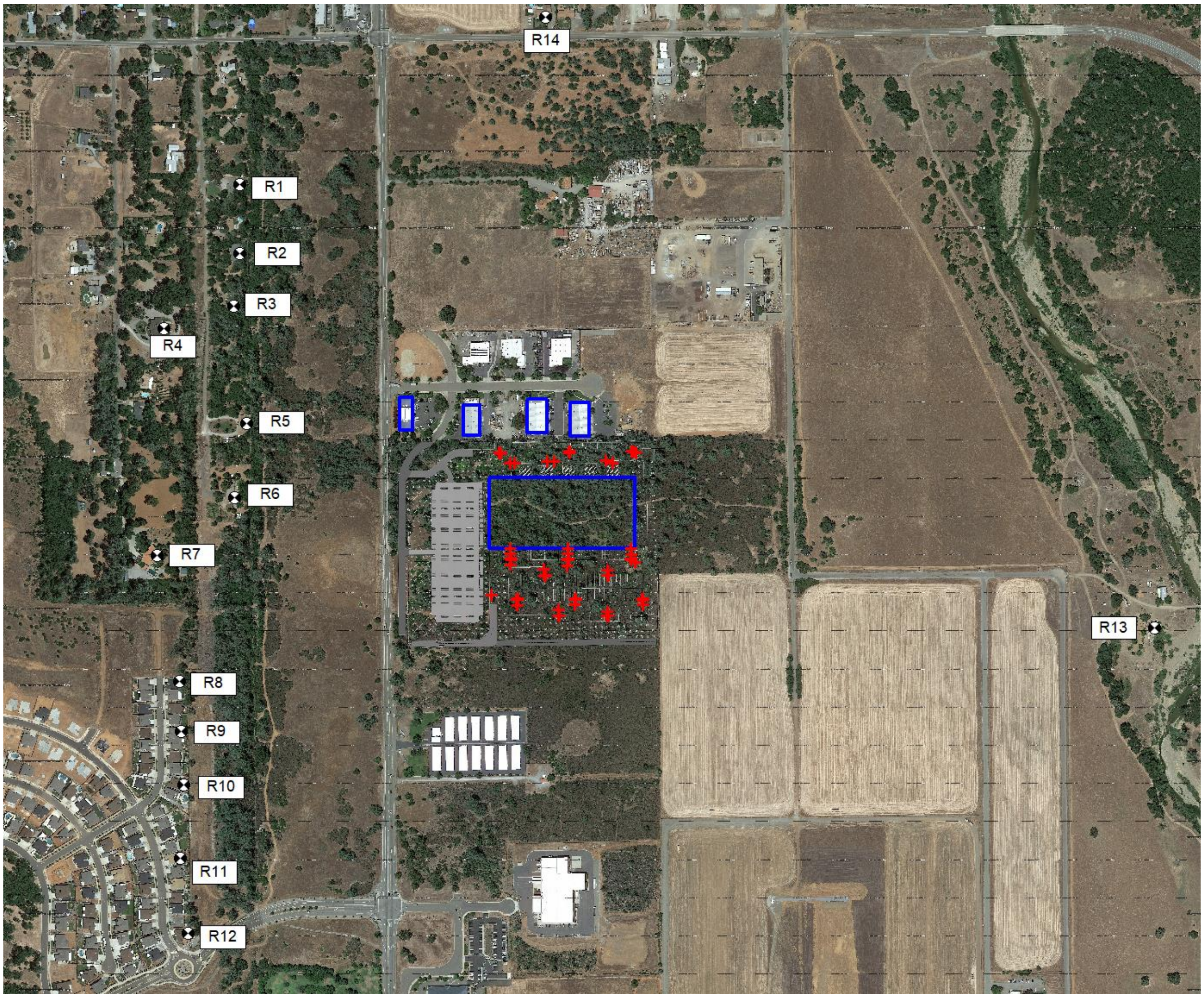

Figure 4a. Aerial photo showing receptor locations used in computer modeling
FXG Redding CA

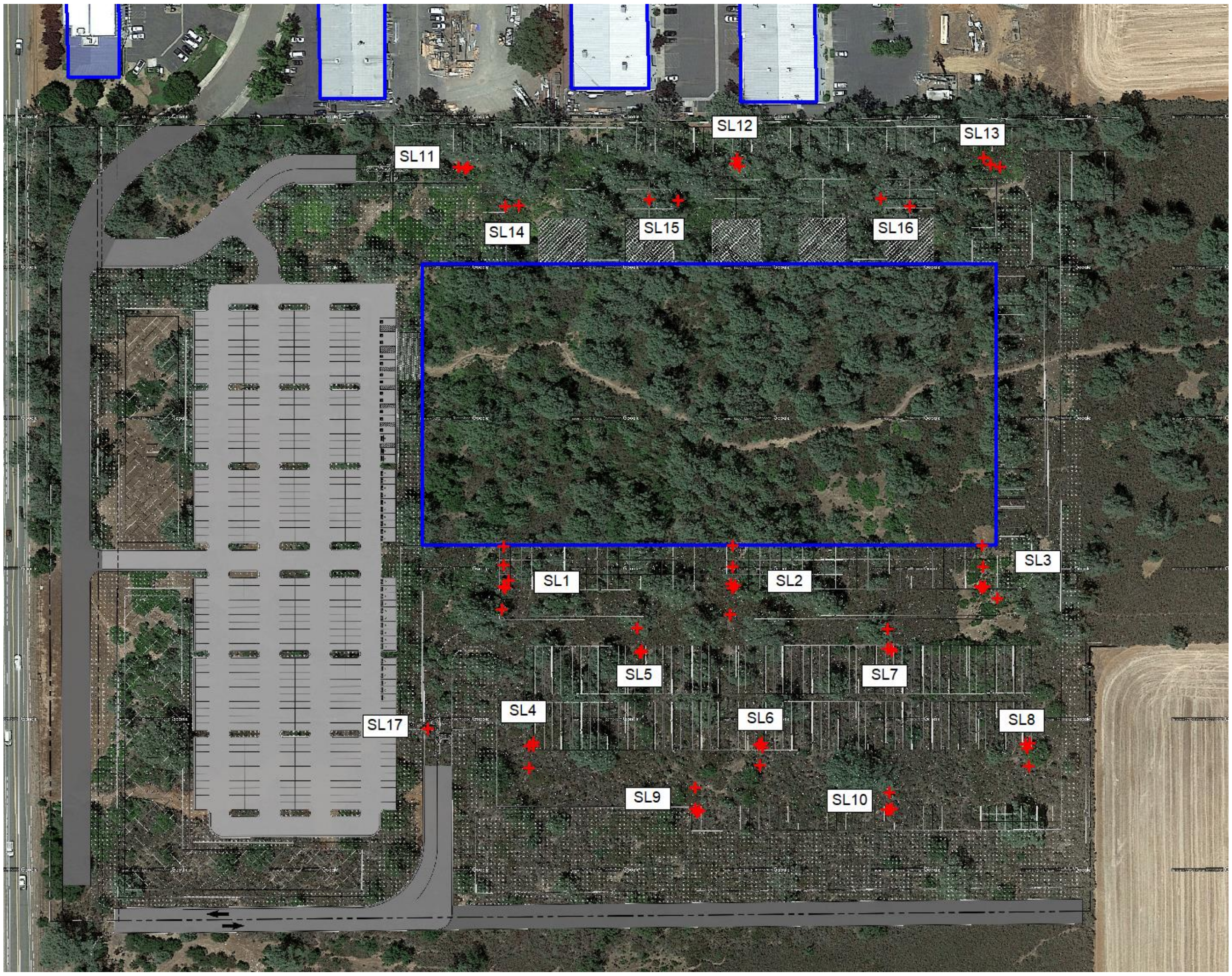

Figure 4b. Aerial photo showing sound source locations used in computer modeling
FXG Redding CA

Additional Computer Model Parameters

The primary sources of FXG sound are trucks and trailers. The elevation above grade of emitting components of sound sources varies; a typical truck source elevation of 8 feet has been used for modeling in this study. Van sound has been modeled at an elevation of 5 feet above grade; back-up alarms at an elevation of 3 feet above grade.

As sound propagates through the environment, it may encounter boundaries which reflect or absorb some fraction of the incident sound. In our computer model, we have assumed that buildings, sound barrier walls, and the FXG trucking yard itself are all acoustically reflective, except where specifically noted. To account for multiple reflectors, two orders of reflection have been included in computer modeling.

Based on review of Google Earth images of the site, we have assigned a Ground Attenuation Coefficient (G) of 1.0 (sound absorbing surface) for ground conditions outside of the FXG site and a G of 0.0 (sound reflecting surface) on the proposed FXG site, in accordance with the ISO standard. Topography of the surrounding area has been obtained from the United States Geological Survey (USGS) and included in computer modeling.

Residential receptors in the vicinity of the project site include one- and two-story structures. A receptor elevation of 7 feet above grade has been used in estimating sound levels at single-story receptors, and an elevation of 17 feet has been used for two-story receptors.

Section 4 – Analysis of Computer Modeling Results

The applicable City of Redding Code establishes energy equivalent sound levels limits over one-hour time periods that applies to all facility sound. Our recommended design goals have been used to evaluate potential maximum sound from individual FXG sources at nearest receptors. Energy equivalent analysis of facility sound is presented in this section followed by analysis for recommended design goals.

Applicable Regulations (Energy Equivalent Analysis)

Table 2 presents highest estimated hourly A-weighted equivalent sound levels for anticipated traffic activity on-site over a typical 24-hour day for the facility operating at future capacity.

	NIGHT							DAY															NIGHT	
City of Redding Limit $LA_{eq,1\text{-}hr}$ (dBA)	45	45	45	45	45	45	45	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	45	45
Time	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00
R1	7	17	22	23	20	25	27	26	28	31	23	28	23	26	30	31	26	32	31	29	32	23	24	22
R2	8	18	23	24	21	26	28	27	29	32	24	29	24	27	31	33	27	33	33	30	33	24	25	23
R3	9	19	24	25	22	27	29	27	29	32	24	29	24	27	31	33	27	34	33	30	34	24	26	24
R4	8	18	23	24	21	26	28	26	28	31	23	28	23	26	30	32	26	32	32	29	32	23	25	23
R5	12	22	27	28	25	30	32	30	32	35	27	32	27	30	34	36	30	36	36	33	36	27	29	27
R6	15	25	29	31	28	32	35	31	32	35	28	32	28	31	35	36	31	37	36	34	37	28	32	29
R7	11	21	26	27	24	29	31	27	29	32	24	29	24	27	31	33	27	33	33	30	33	24	28	26
R8	12	22	27	28	25	30	32	27	28	31	24	28	24	27	31	32	27	33	32	30	33	24	29	27
R9	12	22	27	28	25	30	32	26	28	31	23	28	23	26	30	31	26	32	31	29	32	23	29	27
R10	12	22	26	28	25	29	32	26	27	30	23	27	23	26	30	31	26	32	31	29	32	23	29	26
R11	12	22	27	28	25	30	32	26	27	30	23	27	23	26	30	31	26	32	31	29	32	23	29	27
R12	11	21	26	27	24	29	31	25	27	30	22	27	22	25	29	30	25	31	30	28	31	22	28	26
R13	9	19	24	25	22	27	29	24	25	28	21	25	21	24	28	29	24	30	29	27	30	21	26	24
R14	8	18	23	24	21	26	28	26	28	31	23	28	23	26	30	31	26	32	31	29	32	23	25	23

Table 2. Estimated hourly A-weighted equivalent sound levels at residential study locations R1-R14: Levels referenced to the City of Redding CA Code limits FXG Redding CA

On the basis of the study conducted, it has been determined that the FXG facility, as currently designed, will comply with the City of Redding Code Limits.

Design Goals (Point Source Analysis)

Tables 3a and 3b present estimated maximum sound levels at residential receptor locations R1-R14. Data presented in the tables have been computed with no sound mitigation measures such as barrier walls or acoustic enclosures. Sound levels in red text indicate levels exceeding the design goal. The full data set is presented in Appendix D.

Source	**Source Type**	**Design Goal**	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**
Tonal Backup Alarm	Tonal	35	35	**36**	**37**	**36**	**43**	**42**	**39**
Conveyor	Continuous	40	0	0	2	2	7	13	25
Drop Frame	Impulsive	45	24	27	29	30	35	**48**	44
Trailer Disconnect	Impulsive	45	41	41	45	42	**48**	**51**	**46**
Truck Accelerating	Continuous	40	37	39	40	40	**45**	**48**	**43**
Truck High Idle	Continuous	40	30	30	34	31	37	40	35
Truck Pass-by	Continuous	40	36	37	39	37	**43**	**45**	40
Van Pass-by	Continuous	40	23	23	24	22	26	27	23

Table 3a. Estimated sound levels at residential study locations R1-R7: no sound controls
FXG Redding CA

Source	**Source Type**	**Design Goal**	**R8**	**R9**	**R10**	**R11**	**R12**	**R13**	**R14**
Tonal Backup Alarm	Tonal	35	**40**	**39**	**36**	**38**	**37**	31	34
Conveyor	Continuous	40	24	22	22	23	22	16	0
Drop Frame	Impulsive	45	45	44	43	44	44	37	22
Trailer Disconnect	Impulsive	45	45	45	45	**46**	45	38	36
Truck Accelerating	Continuous	40	**43**	**42**	**41**	**41**	40	33	34
Truck High Idle	Continuous	40	34	35	34	35	35	27	26
Truck Pass-by	Continuous	40	39	39	38	40	40	32	36
Van Pass-by	Continuous	40	22	21	20	21	19	17	21

Table 3b. Estimated sound levels at residential study locations R8-R14: no sound controls
FXG Redding CA

On the basis of the study conducted, it has been determined that the FXG facility, as currently designed, will achieve the design goals recommended to avoid potentially distrubing nearby residents if noise control measures are implemented.

Sound Barrier Walls to Achieve Design Goals

Figure 5 presents a series of barrier walls on the west side of the facility that would generally achieve our recommended design goals, with minor exceptions. Estimated sound levels from computer modeling are presented in Tables 4a and 4b. In cases where estimates are in excess of the design goal, the exceedance is 1-3 dBA. Exceedances in this range would be relatively infrequent. The barrier design shown in Figure 5 has a total length of 610 feet, with heights varying from 10 to 12 feet, referenced to nearest facility pavement grades.

- Section 1 – 10' high by 80' long
- Section 2 – 10' high by 130' long
- Section 3 – 12' high by 230' long
- Section 4 – 10' high by 170' long

Figure 5 is an excerpt from the Cadna computer model showing the height and orientation of sound barrier walls.

Source	Source Type	Design Goal	R1	R2	R3	R4	R5	R6	R7
Tonal Backup Alarm	Tonal	35	35	**36**	**36**	35	**38**	**38**	**38**
Conveyor	Continuous	40	0	0	2	2	7	13	23
Drop Frame	Impulsive	45	24	27	29	30	36	**48**	42
Trailer Disconnect	Impulsive	45	39	40	41	40	**46**	45	43
Truck Accelerating	Continuous	40	37	38	39	38	**42**	**43**	**42**
Truck High Idle	Continuous	40	28	30	30	29	38	35	32
Truck Pass-by	Continuous	40	35	37	37	37	**41**	**42**	39
Van Pass-by	Continuous	40	23	23	24	22	26	27	23

Table 4a. Estimated sound levels at residential study locations R1-R7: no sound controls
FXG Redding CA

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Conveyor	Continuous	40	21	21	20	19	17	16	0
Drop Frame	Impulsive	45	43	43	42	41	40	37	22
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Truck High Idle	Continuous	40	33	34	33	33	32	27	26
Truck Pass-by	Continuous	40	38	38	38	38	37	32	36
Van Pass-by	Continuous	40	22	21	20	19	18	17	21

Table 4b. Estimated sound levels at residential study locations R8-R14: no sound controls
FXG Redding CA

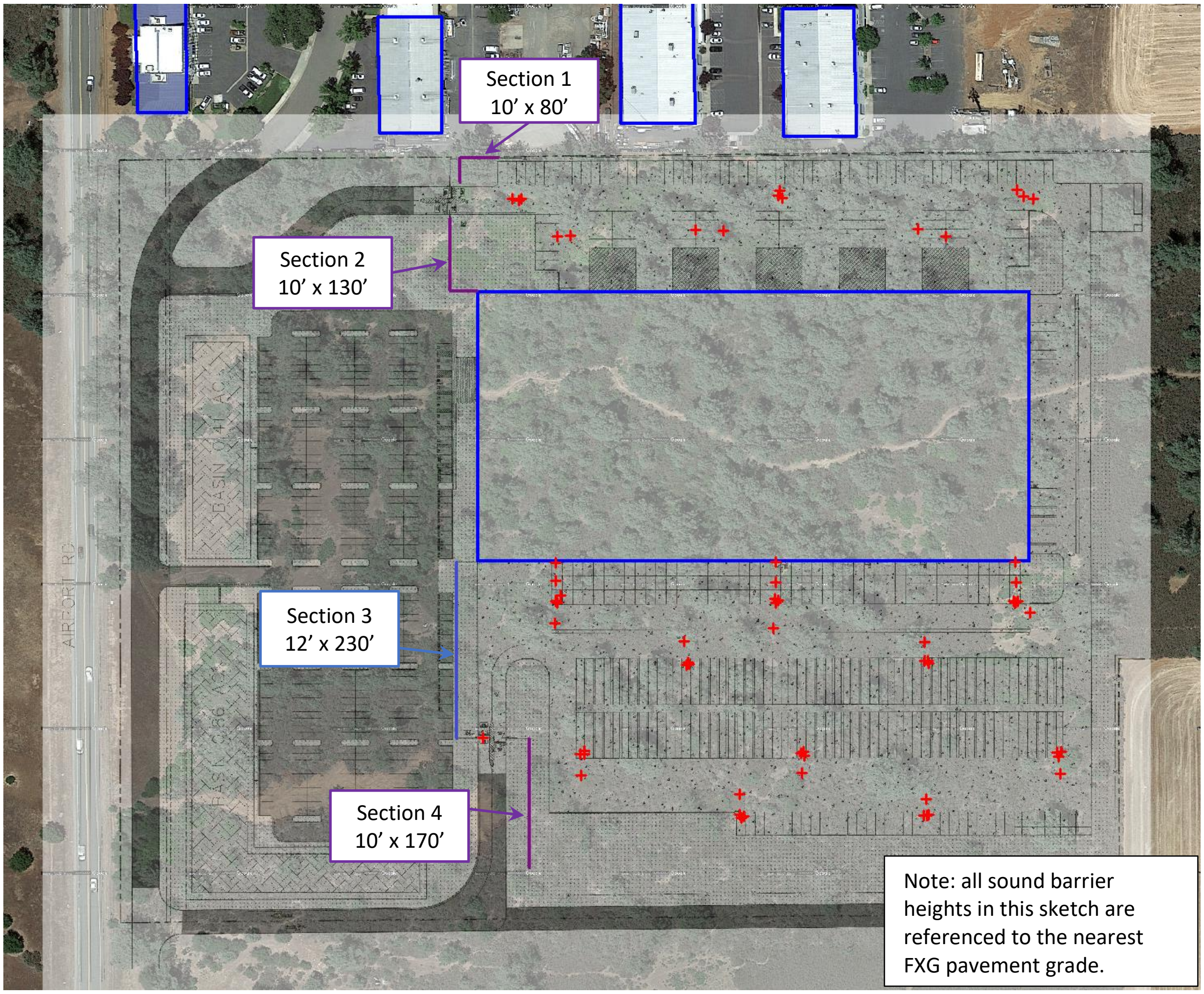

Figure 5. Sound barrier wall orientation and height
FXG Redding CA

Conclusion

On behalf of 42 Real Estate, LLC, Cavanaugh Tocci has completed an environmental sound study for a proposed FedEx Ground (FXG) shipping facility in Redding, California. In this report, the project is referred to as FXG Redding CA.

The project is to be located on and accessed from Aviation Drive in Redding, CA. The site is bounded to the east by industial; to the south by industrial and public uses; to the west by industrial with residential beyond; and to the north by industrial uses. The nearest residential receptors are located west of the site along Bogie Lane.

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Appendix A

Glossary

Appendix A - Glossary

The definitions of acoustical terms used in this publication are most often based on American National Standards Institute (ANSI) S1.1-1994 Acoustical Terminology. Some of the acoustical terms briefly defined below are explained in greater detail elsewhere in the *Solutia Acoustical Glazing Design Guide.*

A-Weighting (dBA)

The filtering of sound that replicates the human hearing frequency response. The human ear is most sensitivity to sound at mid frequencies (500 to 4,000 Hz) and is progressively less sensitive to sound at frequencies above and below this range. A-weighted sound level is the most commonly used descriptor to quantify the relative loudness of various types of sounds with similar or differing frequency characteristics.

Absorption

The attenuation (or reduction) of sound level that results when sound propagates through a medium (usually air) or through a dissipative material (sound absorptive material) such as glass fiber or open-cell foam. In the case of sound absorptive materials used in the building industry, attenuation of sound is produced by the conversion of molecular motion, which is sound, into thermal energy due to friction of air molecules with fibrous or cellular materials.

Acoustics

(1) Acoustics is the science of sound, including its production, transmission and effects.

(2) The acoustics of a room are those qualities that together determine its character with respect to the perception of sound.

Ambient Noise

Ambient noise encompasses all sound present in a given environment, being usually a composite of sounds from sources near and far.

Background Sound

The lowest sound level typically occurring during a monitoring period.

Band Pass Filter

The filtering of sound within specified frequency limits or frequency bands. The audible frequency range is often sub-divided into octave, one-third octave, or other fractions of octave bands.

Barriers

A solid obstacle that blocks the line-of-sight between a sound source and a receiver, thereby providing barrier attenuation, i. e., reducing sound level at the receptor. Sound attenuation provided by barriers is related to the transmission loss through the barrier material and diffraction of sound over and around the barrier.

Community Noise Exposure Level (CNEL)

The 24-hour energy average sound level where a 10 dB "penalty" is applied to sound occurring at night between 10:00 PM and 7:00 AM, and a 5 dB penalty is applied to sound occurring during evening hours between 7:00 PM and 10:00 PM. The penalties are intended to account for the increased sensitivity of a community to sound occurring during evening and nighttime hours.

Day Night Sound Level (DNL, L_{dn})

The 24-hour energy average sound level where a 10 dB "penalty" is applied to sound occurring at night between 10:00 PM and 7:00 AM. The 10 dB penalty is intended to account for the increased sensitivity of a community to sound occurring at night.

Decibel (dB)

A dimensionless unit which denotes the ratio between two quantities that are proportional to power, energy, or intensity. One of these quantities is a designated reference by which all other quantities of identical units are divided. The sound pressure level in decibels is equal to 10 times the logarithm (to the base 10) of the ratio between the pressure squared divided by the reference pressure squared. The reference pressure used in acoustics is 20 microPascals.

Energy Average Sound Level

In real-world circumstances, sound levels vary considerably over time. The L_{EQ} is the energy average or equivalent sound level over a monitoring time interval. It is a hypothetical continuous sound level that contains the same sound energy as the actual sound level occurring during the time interval. A letter symbol (such as A or C, i.e. LAEQ) typically implies frequency weighting (i.e., the energy average sound level in dBA). In addition, the duration of measurement is typically stated (i.e. $LA_{EQ,1\text{-hr.}}$).

Frequency

Frequency is the number of oscillations or cycles per unit time. In acoustics, frequency usually is expressed in units of Hertz (Hz), where one Hertz is equal to one cycle per second.

Noise

(1) Noise is undesired sound. By extension, noise is an unwanted disturbance within a useful frequency band, such as excessive traffic sound transmission into a sensitive building space.

(2) Noise is an erratic, intermittent or statistically random oscillation.

Octave

The ratio of a higher and lower frequencies that equals two.

Octave Band

Groups of frequencies defined by standards where the upper frequency of each band is equal to twice the lower frequency of each band. Octave bands are usually named by their geometric center frequency. For example, the octave band extending between 44.7 Hz and 89.1 Hz is called the 63 Hz octave band. The octave band extending between 89.1 Hz and 178 Hz is called the 125 Hz octave band. The full complement of octave bands in the audible frequency range is as follows: 31, 63, 125, 250, 500, 1000, 2000, 4000, 8000, and 16,000 Hz.

Octave Band Sound Pressure Level

Sound pressure level for all sound contained within a specified octave band.

Percentile Sound Levels

Besides frequency and level, environmental sounds exhibit a time-varying or temporal characteristic. The temporal character of noise level can be illustrated by considering noise levels that occur near a highway. During the day, traffic sound levels are generally high, increasing to higher peaks when a noisy truck or multi-vehicle platoon passes and decreasing to a lower level between vehicle pass-bys. At night, when traffic volumes are lower, the same variation occurs, but is centered around a lower level.

Environmental sound descriptors are quantifications of sound that combine, into a single value, the three chief features of environmental sound: level, frequency and temporal characteristics.

The use of A-weighted sound pressure level combines the first two characteristics — level and frequency — into a single number. Then, by averaging A-weighted sound pressure levels over time in various fashions, acoustical descriptors that combine all three features can be developed.

Commonly used descriptors are percentile A-weighted sound levels, A-weighted sound pressure levels exceeded for specific percentages of time within a specific noise monitoring period. For example, the one-hour 50th percentile A-weighted noise level, symbolized as the L_{50} (1 hour), is the A-weighted sound level exceeded a total of 30 minutes out of a continuous 60-minute period. Likewise, the L_{10} (20 minutes) is the A-weighted sound level exceeded a total of two minutes out of a continuous 20 minute period.

Percentile A-weighted sound levels most often are used to assess the time-varying character of environmental sound. The residual sound level (defined as the nearly constant, low level of sound produced by distant motor vehicle traffic or industrial activity) is indicative of the lowest sound level in a monitoring period. The residual or background sound level is commonly defined as the L_{90}, i.e., the A weighted sound level exceeded 90% of a monitoring time period.

Sound

(1) Sound is an oscillation in pressure, stress, particle displacement, particle velocity, etc., in a medium.

(2) Sound is an auditory sensation evoked by the oscillation described above.

Sound Pressure

The sound pressure at a point is the total instantaneous pressure at that point, in the presence of a sound wave, minus the static pressure at that point.

Sound Pressure Level

The sound pressure level, in decibels, of a sound is 20 times the logarithm to the base 10 of the ratio of the sound pressure to the reference pressure. The reference pressure shall be explicitly stated and is defined by standards.

Unless otherwise specified, the sound fields on both sides of the partition are assumed to be diffuse.

Spectrum

A group of sound levels in frequency bands covering a wide frequency range. Generally, this term is used with some modifier indicating the resolution bandwidth, e.g., octave band spectrum or one-third octave band spectrum.

Appendix B

Regulation on Noise

Appendix B - FXG Redding CA Code Research Summary

City of Redding CA Code of Ordinances – Section 18.40.100 – Noise Standards

[*https://library.municode.com/ca/redding/codes/code_of_ordinances?nodeId=TIT18ZO_DIVIVREAPALDI_CH18.40DESIRE_18.40.100NOST*](https://library.municode.com/ca/redding/codes/code_of_ordinances?nodeId=TIT18ZO_DIVIVREAPALDI_CH18.40DESIRE_18.40.100NOST)

Appendix C

Computer Modeling
Source Sound Power Levels

Appendix C - Source Sound Power Spectra

Table C-1 presents the sound power spectrum of sources considered in facility computer modeling.

Name	Sound power spectrum									Overall sound power		
	31.5	*63*	*125*	*250*	*500*	*1000*	*2000*	*4000*	*8000*	*dBA*	*dBC*	*dBZ*
Conveyor system	93	91	90	87	88	88	86	82	78	93	97	98
Van pass-by	97	100	98	96	90	88	88	91	92	97	104	105
Truck high idle	100	104	102	103	103	99	97	92	85	105	110	110
Backup alarm, broad-band	54	75	88	95	97	104	102	97	89	107	107	107
Backup alarm, tonal	54	68	78	79	89	107	91	86	77	107	107	107
Truck pass-by	107	104	110	109	107	105	101	98	94	110	115	116
Trailer drop frame	112	117	116	112	113	107	103	98	91	113	121	122
Truck accelerating	117	127	121	110	104	106	105	105	108	114	128	128
Trailer disconnect	105	110	113	115	111	112	106	99	93	115	120	120

Table C-1. Sound power spectra of facility sources [dB]
FXG Redding CA

Appendix D

Computer Modeling
Results Tables

Appendix D - Computer Modeling Results Tables

Name	***SL***	***R1***	***R2***	***R3***	***R4***	***R5***	***R6***	***R7***	***R8***	***R9***	***R10***	***R11***	***R12***	***R13***	***R14***
Backup Alarm Tonal	SL01	14	18	21	24	33	**42**	**36**	**39**	**37**	**36**	**37**	**36**	27	10
Conveyor	SL01	0	0	2	2	7	13	25	24	22	22	22	22	14	0
Trailer Disconnect	SL01	28	31	33	37	**46**	**51**	**46**	44	45	45	**46**	45	37	25
Drop Frame	SL01	24	27	29	30	35	**48**	44	45	44	43	44	44	36	21
Truck High Idle	SL01	18	21	23	26	35	40	35	34	35	34	35	35	26	14
Truck Pass-by	SL01	26	30	34	37	**43**	**45**	40	39	38	37	40	40	31	23
Backup Alarm Tonal	SL02	13	15	17	18	22	31	33	**36**	35	35	34	32	31	11
Conveyor	SL02	0	0	0	0	2	7	21	22	21	20	23	22	15	0
Trailer Disconnect	SL02	26	27	29	30	33	41	42	45	44	44	44	43	37	24
Drop Frame	SL02	23	24	25	27	30	37	42	43	42	42	43	43	37	21
Truck High Idle	SL02	17	18	19	21	24	31	33	34	33	33	34	34	26	14
Truck Pass-by	SL02	26	27	28	30	32	**43**	38	39	38	38	39	38	31	23
Backup Alarm Tonal	SL03	13	14	15	16	21	28	31	33	33	33	32	31	29	12
Conveyor	SL03	0	0	0	0	0	4	17	20	19	19	18	17	16	0
Trailer Disconnect	SL03	26	28	28	30	33	39	40	43	42	42	41	40	37	25
Drop Frame	SL03	23	24	24	26	29	35	39	42	41	41	40	39	36	22
Truck High Idle	SL03	16	17	18	20	23	29	29	32	32	31	30	29	27	15
Truck Pass-by	SL03	23	24	24	26	29	35	34	37	36	36	35	34	32	23
Backup Alarm Tonal	SL04	32	**36**	**37**	**36**	**40**	**41**	**39**	**39**	35	35	**37**	**36**	27	24
Trailer Disconnect	SL04	41	41	45	42	**48**	**50**	45	45	44	43	44	43	36	36
Truck High Idle	SL04	30	30	34	31	37	39	34	34	33	33	33	32	25	25
Truck Pass-by	SL04	36	36	39	36	**42**	**44**	39	39	38	38	38	37	30	30
Backup Alarm Tonal	SL05	22	23	25	27	**37**	**40**	**38**	35	**36**	**36**	35	34	28	18
Trailer Disconnect	SL05	34	36	37	38	44	**49**	44	44	44	44	45	45	36	32
Truck High Idle	SL05	24	25	26	28	34	39	33	33	33	33	34	34	26	21
Truck Pass-by	SL05	27	29	30	31	35	**44**	39	39	39	38	39	39	31	24
Backup Alarm Tonal	SL06	27	29	30	31	**36**	**39**	**39**	**40**	**39**	35	**38**	**37**	28	25
Trailer Disconnect	SL06	37	39	40	40	**46**	**48**	43	43	42	43	44	43	37	36
Truck High Idle	SL06	27	28	29	29	36	38	32	32	33	32	33	32	26	25
Truck Pass-by	SL06	32	33	34	36	**41**	**43**	37	37	37	37	38	37	31	31
Backup Alarm Tonal	SL07	22	23	25	26	29	34	32	35	34	34	33	32	29	19
Trailer Disconnect	SL07	34	35	36	37	40	**48**	43	43	43	43	44	44	38	32
Truck High Idle	SL07	24	25	26	27	29	37	32	33	32	32	33	33	27	21
Truck Pass-by	SL07	27	28	30	31	33	39	37	38	37	37	38	38	32	25
Backup Alarm Tonal	SL08	27	28	29	29	32	33	31	31	33	33	33	34	30	26
Trailer Disconnect	SL08	37	38	38	38	40	**47**	41	41	42	42	43	42	38	36
Truck High Idle	SL08	26	27	28	27	30	36	30	31	31	31	32	31	27	26
Truck Pass-by	SL08	31	32	33	32	35	**41**	36	36	36	36	37	36	32	31
Backup Alarm Tonal	SL09	29	31	32	31	35	35	**37**	**40**	**38**	33	35	31	28	26
Trailer Disconnect	SL09	38	39	41	41	**46**	**49**	44	43	42	42	43	42	37	36
Truck High Idle	SL09	27	29	30	30	36	38	33	33	32	32	32	31	26	25
Truck Pass-by	SL09	32	34	37	35	38	**43**	38	38	37	37	38	37	31	31

Table D1a. Estimated sound levels at residential study locations R1-R14: no sound controls
FXG Redding CA

Name	*SL*	*R1*	*R2*	*R3*	*R4*	*R5*	*R6*	*R7*	*R8*	*R9*	*R10*	*R11*	*R12*	*R13*	*R14*
Backup Alarm Tonal	SL10	28	29	30	30	33	34	32	33	34	34	35	34	29	26
Trailer Disconnect	SL10	37	38	39	39	45	**48**	42	42	41	41	42	41	38	36
Truck High Idle	SL10	26	28	28	28	35	37	31	31	31	31	31	30	27	26
Truck Pass-by	SL10	32	33	33	33	39	**42**	36	36	36	37	37	36	32	31
Backup Alarm Tonal	SL11	29	28	28	31	**43**	**42**	**39**	**38**	33	32	34	33	21	34
Truck Pass-by	SL11	34	35	36	36	**41**	**42**	40	37	36	35	36	36	26	36
Van Pass-By	SL11	18	19	20	21	26	27	23	22	21	20	21	19	11	20
Backup Alarm Tonal	SL12	32	34	**36**	34	35	35	32	26	25	23	22	20	28	34
Truck Pass-by	SL12	35	37	37	36	39	39	36	33	31	30	29	28	31	36
Van Pass-By	SL12	20	22	22	21	24	24	21	17	16	15	14	13	16	20
Backup Alarm Tonal	SL13	33	34	34	33	34	33	32	27	25	24	23	22	29	34
Truck Pass-by	SL13	35	36	36	34	37	37	34	32	31	30	29	28	31	36
Van Pass-By	SL13	20	20	21	19	22	21	20	17	16	15	14	13	16	20
Backup Alarm Tonal	SL14	34	**36**	35	34	**37**	**38**	34	34	30	24	20	18	18	34
Van Pass-By	SL14	23	23	24	22	25	27	23	21	17	14	12	10	10	21
Backup Alarm Tonal	SL15	35	**36**	**36**	35	**36**	**36**	33	23	21	20	18	17	21	34
Van Pass-By	SL15	22	23	24	22	24	25	22	15	14	13	11	10	12	21
Backup Alarm Tonal	SL16	33	34	35	33	**36**	34	31	23	21	19	18	17	29	34
Van Pass-By	SL16	20	22	22	20	24	23	20	15	13	12	11	10	17	21
Truck Accelerating	SL17	37	39	40	40	**45**	**48**	**43**	**43**	**42**	**41**	**41**	40	33	34

Table D1b. Estimated sound levels at residential study locations R1-R14: no sound controls
FXG Redding CA

Name	*SL*	*R1*	*R2*	*R3*	*R4*	*R5*	*R6*	*R7*	*R8*	*R9*	*R10*	*R11*	*R12*	*R13*	*R14*
Backup Alarm Tonal	SL01	14	18	21	24	33	**38**	34	**37**	**36**	35	34	33	27	10
Conveyor	SL01	0	0	2	2	7	13	23	21	21	20	19	17	14	0
Trailer Disconnect	SL01	28	31	33	37	**46**	45	43	43	44	44	42	42	37	25
Drop Frame	SL01	24	27	29	30	36	**48**	42	43	43	42	41	40	36	21
Truck High Idle	SL01	18	21	23	26	38	35	32	32	34	33	32	31	26	14
Truck Pass-by	SL01	26	30	34	37	40	39	37	37	37	36	37	37	31	23
Backup Alarm Tonal	SL02	13	15	17	18	22	32	33	35	35	**36**	33	32	31	11
Conveyor	SL02	0	0	0	0	2	7	20	20	20	20	18	16	15	0
Trailer Disconnect	SL02	26	27	29	30	34	41	41	43	44	44	42	41	37	24
Drop Frame	SL02	23	24	25	27	30	37	40	42	43	42	40	39	37	21
Truck High Idle	SL02	17	18	19	21	24	32	30	32	33	33	32	30	26	14
Truck Pass-by	SL02	26	27	28	30	32	**41**	35	38	38	36	37	37	31	23
Backup Alarm Tonal	SL03	13	14	15	16	21	29	31	33	33	33	32	31	29	12
Conveyor	SL03	0	0	0	0	0	4	18	19	18	17	18	17	16	0
Trailer Disconnect	SL03	26	28	28	30	33	39	39	42	42	42	41	40	37	25
Drop Frame	SL03	23	24	24	26	29	36	39	41	40	40	40	39	36	22
Truck High Idle	SL03	16	17	18	20	23	29	29	32	31	31	30	29	27	15
Truck Pass-by	SL03	23	24	24	26	29	35	34	38	36	37	35	34	32	23
Backup Alarm Tonal	SL04	30	32	33	32	35	**36**	33	34	34	33	32	31	27	24
Trailer Disconnect	SL04	39	40	41	40	44	44	42	43	42	42	40	39	36	36
Truck High Idle	SL04	28	30	30	29	33	34	32	32	32	31	30	28	25	25
Truck Pass-by	SL04	33	34	35	34	38	39	37	37	37	36	35	33	30	30
Backup Alarm Tonal	SL05	22	23	25	27	**37**	**36**	33	**36**	**36**	35	33	32	28	18
Trailer Disconnect	SL05	34	36	37	38	45	44	42	44	44	43	41	40	36	32
Truck High Idle	SL05	24	25	26	28	34	33	31	33	33	32	31	30	26	21
Truck Pass-by	SL05	27	29	30	31	35	38	36	37	38	38	36	37	31	24
Backup Alarm Tonal	SL06	27	29	30	31	**37**	34	32	33	33	35	**38**	**37**	28	25
Trailer Disconnect	SL06	37	39	40	40	45	42	41	41	41	43	43	43	37	36
Truck High Idle	SL06	27	28	29	29	34	32	30	30	31	32	33	32	26	25
Truck Pass-by	SL06	32	33	34	36	37	37	35	36	37	37	38	37	31	31
Backup Alarm Tonal	SL07	22	23	25	26	29	**38**	31	35	34	35	32	32	29	19
Trailer Disconnect	SL07	34	35	36	37	40	45	40	42	41	42	43	42	38	32
Truck High Idle	SL07	24	25	26	27	29	35	29	30	30	32	32	32	27	21
Truck Pass-by	SL07	27	28	30	31	33	39	34	38	36	36	37	37	32	25
Backup Alarm Tonal	SL08	27	28	29	29	32	32	30	32	33	33	33	34	30	26
Trailer Disconnect	SL08	37	38	38	38	40	41	39	40	42	42	42	42	38	36
Truck High Idle	SL08	26	27	28	27	30	30	28	29	31	31	32	31	27	26
Truck Pass-by	SL08	31	32	33	32	35	35	33	36	36	36	36	35	32	31
Backup Alarm Tonal	SL09	29	31	32	31	34	35	33	34	**38**	33	35	31	28	26
Trailer Disconnect	SL09	38	39	41	39	42	43	41	41	42	42	43	42	37	36
Truck High Idle	SL09	27	29	30	28	31	32	30	31	32	32	32	31	26	25
Truck Pass-by	SL09	32	34	37	33	37	37	35	36	37	37	38	37	31	31

Table D2a. Estimated sound levels at residential study locations R1-R14: with sound controls
FXG Redding CA

Name	SL	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14
Backup Alarm Tonal	SL10	28	29	30	30	**37**	33	31	33	34	34	35	34	29	26
Trailer Disconnect	SL10	37	38	39	39	45	41	40	42	41	41	42	41	38	36
Truck High Idle	SL10	26	28	28	28	34	31	29	31	31	31	31	30	27	26
Truck Pass-by	SL10	32	33	33	33	39	36	34	37	36	36	37	36	32	31
Backup Alarm Tonal	SL11	28	29	30	30	**38**	**38**	**38**	33	32	31	30	29	19	34
Truck Pass-by	SL11	34	35	36	36	**41**	**42**	39	36	35	34	33	32	26	36
Van Pass-By	SL11	18	19	20	20	26	27	23	22	21	20	19	18	11	20
Backup Alarm Tonal	SL12	32	34	**36**	34	**38**	35	33	26	25	23	22	20	28	34
Truck Pass-by	SL12	35	37	37	36	40	37	35	33	31	30	29	28	31	36
Van Pass-By	SL12	20	22	22	21	25	24	21	17	16	15	14	13	16	20
Backup Alarm Tonal	SL13	33	34	34	33	33	33	32	27	25	24	23	22	29	34
Truck Pass-by	SL13	35	36	36	34	37	36	34	32	31	30	29	28	31	36
Van Pass-By	SL13	20	20	21	19	22	21	20	17	16	15	14	13	16	20
Backup Alarm Tonal	SL14	34	35	33	34	**37**	**37**	34	**37**	30	24	20	18	18	34
Van Pass-By	SL14	23	23	24	22	25	25	22	21	17	14	12	10	10	21
Backup Alarm Tonal	SL15	35	**36**	**36**	35	**36**	**36**	35	23	21	20	18	17	21	34
Van Pass-By	SL15	22	23	24	22	24	23	23	15	14	13	11	10	12	21
Backup Alarm Tonal	SL16	33	34	35	33	**36**	**36**	30	22	20	18	17	15	29	34
Van Pass-By	SL16	20	22	22	20	26	23	20	15	13	12	11	10	17	21
Truck Accelerating	SL17	37	38	39	38	**42**	**43**	**42**	**43**	**42**	**42**	**42**	**41**	33	34

Table D2a. Estimated sound levels at residential study locations R1-R14: with sound controls
FXG Redding CA

Appendix E

Sound Barrier Wall Information

Appendix E - Sound Barrier Wall Materials

Materials acceptable for sound barrier walls shall have a minimum surface weight of 4-6 lbs/square foot, which is met by most exterior barrier panel products available. In addition, barrier and panel joints must be sealed.

Some barrier systems are available with sound absorptive finishes as tested in accordance with *ASTM C423*. Using this test method, sound absorption is expressed in terms of either the Noise Reduction Coefficient (NRC) or the Sound Absorption Average (SAA). NRC and SAA range between 0 and 1, with a higher value denoting greater sound absorption performance. NRC and SAA are numerically close in value and may generally be used interchangeably. When a sound absorptive barrier is required, it should have an NRC or SAA rating of not less than 0.80 unless otherwise indicated. The acoustical analysis report will indicate which barrier face is to be provided with sound absorption as the proper orientation is critical to achieving the analysis goals.

The following are links to a variety of products and systems that may be considered for sound barrier walls. These include wood, masonry, metal, plastic, and fiberglass composite products.

- ❒ **Wood**
  - Plywall (from Hoover)
    http://plywall.com/
  - IES2000
    http://www.ies2000.com/walls-barrier.shtml
- ❒ **Concrete/Masonry**
  - Dura-Crete
    http://www.dura-crete.net/
  - Weiser
    https://wieserconcrete.com/product/noise-abatement-walls-posts-highway/
  - Faddis Concrete Products
    http://www.faddis.com
  - Aftec
    http://www.aftec.com/sound-wall-barriers.php
  - Fanwall
    http://reinforcedearth.com/products/13
- ❒ **Metal**
  - Empire Acoustical Systems
    http://www.empireacoustical.com
  - George Koch Sons
    https://www.kochllc.com/acoustical-noise-barriers
- ❒ **Wood/Cement Hybrid**
  - Durisol Precast Noise Barriers
    https://www.durisol.com/

- ❒ **Plastic**
  - AIL Sound Walls
    http://ailsoundwalls.com/en/home/default.aspx
  - Sound Fighter Systems
    http://www.soundfighter.com/noise-applications/roads-and-highways
  - Fibergrate Sound Barrier Walls
    http://www.fibergrate.com/products/sound-barrier-walls/
- ❒ **Fiberglass Composite**
  - Carsonite AcoustaShield Sound Barrier Walls
    http://www.carsonite.com/products/sound-barriers

Appendix F

Broadband Backup Alarm Information

Appendix F - Broadband Backup Alarms

Community Response to Tonal Sound

Audible backup alarms emit tonal sound (e.g. beeping) and used to alert workers in the path of a reversing vehicle that a hazard may exist. While an audible alarm is often necessary for workplace safety, the tonal characteristics of a typical backup alarm have the potential to instigate strong negative community response.

Backup alarms which emit broadband sound (commonly described as a "whooshing") have recently been developed. These devices are relatively inexpensive (i.e. $150-300) and are easily installed to replace an existing tonal alarm. It is our understanding that broadband backup alarms generally comply with all applicable workplace safety considerations in the United States, as discussed in the following section.

Applicable Regulations

Two requirements imposed by the US Occupational Safety and Health Administration (OSHA) relate to the use of back-up alarms, both of which are contained in Section 29 of the Code of Federal Regulations (CFR).

29 CFR 1926.601

(b) General requirements.

(4) No employer shall use any motor vehicle equipment having an obstructed view to the rear unless:

(i) The vehicle has a reverse signal alarm audible above the surrounding noise level or:

(ii) The vehicle is backed up only when an observer signals that it is safe to do so.

29 CFR 1926.602(a)(9)

(ii) No employer shall permit earthmoving or compacting equipment which has an obstructed view to the rear to be used in reverse gear unless the equipment has in operation a reverse signal alarm distinguishable from the surrounding noise level or an employee signals that it is safe to do so.

The following is excerpted from an official policy interpretation posted on the OSHA website: [3]

These provisions, by their terms, do not specify that a reverse signal alarm be of the single-tone type. However, we [ed. OSHA] have neither the data nor the resources to evaluate whether this particular device would be "audible above the surrounding noise level" as required by the standard. If it does meet this test -- that is, provides adequate warning to workers in the path of the vehicle, and to workers walking towards the path of the vehicle in time to avoid contact -- it would comply with §1926.601(b)(4).

[3] https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=INTERPRETATIONS&p_id=24854

Recommended Products

For FXG projects, we generally recommend the Brigade Smart Alarm[4] self-adjusting heavy-duty broadband backup alarm (model SA-BBS-107). This device continually adjusts to the ambient sound level in the vicinity of the truck in order that alarm audibility is maintained in changing acoustic environments. This mechanism also provides for an automatic reduction to audible alarm sound level during nighttime hours when ambient sound levels are generally lower.

Model	Part No:
WHITE SOUND® SMART REVERSING ALARM	
SA-BBS-107 - Self adjusting heavy duty - 87-107 Decibels	**1400**

bbs tek®

- **12-24 Volts**
- **IP68**
- **Size (WxHxD) 172 x 79 x 95mm**
- **Lifetime warranty**

Features
- Alarm continually adjusts to 5-10dB above ambient
- Multi frequency broadband sound
- Instantly locatable
- Sound confined to danger area
- Eliminates noise nuisance
- Sounder unit: Driver
- Hole centres (mm): 153

Power
- Current: Max 1 Amp

Durability & standards
- Mechanical vibration: 10G
- Operating temperature: -40 to +85°C
- CE marked
- SAE J994

[4] http://brigade-inc.com/product/reversing-warning-alarms/overview-was3/