APPENDIX 5

Noise & Groundborne Vibration Impact Analysis

Noise & Groundborne Vibration Impact Analysis

For

Fresno City College Parking & Facilities Expansion Project

State Center Community College District Fresno, CA

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LIST OF COMMON TERMS AND ACRONYMS

ANSI	Acoustical National Standards Institute, Inc.
Caltrans	California Department of Transportation
CEQA	California Environmental Quality Act
CNEL	Community Noise Equivalent Level
dB	Decibels
dBA	A-Weighted Decibels
FHWA	Federal Highway Administration
FTA	Federal Transit Administration
Hz	Hertz
HVAC	Heating Ventilation & Air Conditioning
in/sec	Inches per Second
L_{dn}	Day-Night Level
L_{eq}	Equivalent Sound Level
L_{max}	Maximum Sound Level
ppv	Peak Particle Velocity
U.S. EPA	United States Environmental Protection Agency

INTRODUCTION

This report discusses the existing setting, identifies potential noise impacts associated with implementation of the proposed project. Noise mitigation measures are recommended where the predicted noise levels would exceed applicable noise standards.

PROPOSED PROJECT SUMMARY

The proposed project includes expansion of various onsite parking and facilities at Fresno City College. The project location is depicted in Figures 1 and 2. The following facilities and activities are planned as part of the project. Development of the facilities would occur over the next five years.

- Construction of a parking structure on the south side of Cambridge Avenue west of Blackstone Avenue located north of the existing district office building. The proposed parking structure would have capacity for up to 1,000 parking spaces, include up to five levels of parking, and include ingress/egress points at Weldon Avenue and potentially Cambridge Avenue.
- Construction of a three-story Science Building (approximately 95,000 square feet) located near the southwest corner of Blackstone and Weldon Avenues. The new Science Building is proposed to include 6 biology labs, 3 anatomy and physiology labs, 5 chemistry labs, 2 physics labs, 2 engineering labs, a computer lab, 3 general educational classrooms, 4 Design Science (Middle College) classrooms, welcome center, tutorial space, and 34 faculty offices. Surface parking would also be added adjacent to the building. Existing Maintenance & Operations facilities located in this area would be removed and relocated to a different area of the campus (see below).
- Replacement of the existing one-story, 5,255 square-foot Child Development Center with a new one-story, 16,480 square-foot Child Development Center at its current location.
- Construction of a one-story, 10,000 square-foot Maintenance & Operations building plus a parking and storage area on the west side of San Pablo Avenue northwest of the existing Health Sciences Building.
- Repurposing of the existing District administration building located on the north side of Weldon Avenue to accommodate the SCCCD Police Department.

EXISTING SETTING

CONCEPTS AND TERMINOLOGY

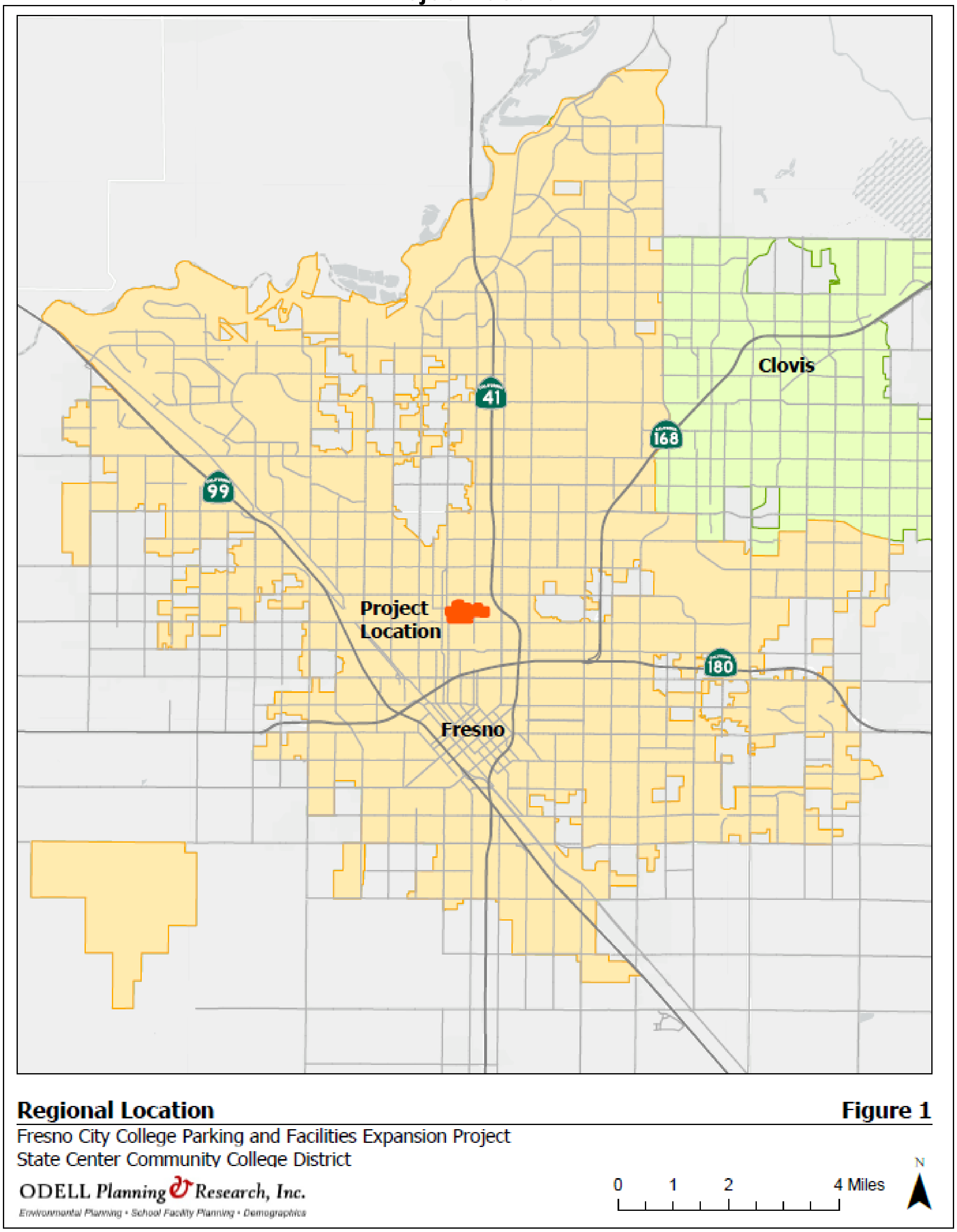
ACOUSTIC FUNDAMENTALS

Noise is generally defined as sound that is loud, disagreeable, or unexpected. Sound is mechanical energy transmitted in the form of a wave because of a disturbance or vibration. Sound levels are described in terms of both amplitude and frequency.

Amplitude

Amplitude is defined as the difference between ambient air pressure and the peak pressure of the sound wave. Amplitude is measured in decibels (dB) on a logarithmic scale. For example, a 65-dB source of sound, such as a truck, when joined by another 65 dB source results in a sound amplitude of 68 dB, not 130 dB (i.e., doubling the source strength increases the sound pressure by 3 dB). Amplitude is interpreted by the ear as corresponding to different degrees of loudness. Laboratory measurements correlate a 10 dB increase in amplitude with a perceived doubling of loudness and establish a 3-dB change in amplitude as the minimum audible difference perceptible to the average person.

Figure 1
Project Location



Source: OPR 2019

Figure 2
Project Site Boundaries and Proposed Facilities

Source: OPR 2019

Frequency

The frequency of a sound is defined as the number of fluctuations of the pressure wave per second. The unit of frequency is the Hertz (Hz). One Hz equals one cycle per second. The human ear is not equally sensitive to sound of different frequencies. For instance, the human ear is more sensitive to sound in the higher portion of this range than in the lower and sound waves below 16 Hz or above 20,000 Hz cannot be heard at all. To approximate the sensitivity of the human ear to changes in frequency, environmental sound is usually measured in what is referred to as "A-weighted decibels" (dBA). On this scale, the normal range of human hearing extends from about 10 dBA to about 140 dBA (U.S. EPA 1971). Common community noise sources and associated noise levels, in dBA, are depicted in Figure 3.

Addition of Decibels

Because decibels are logarithmic units, sound levels cannot be added or subtracted through ordinary arithmetic. Under the decibel scale, a doubling of sound energy corresponds to a 3-dB increase. In other words, when two identical sources are each producing sound of the same loudness, the resulting sound level at a given distance would be 3 dB higher than one source under the same conditions. For example, if one automobile produces a sound level of 70 dB when it passes an observer, two cars passing simultaneously would not produce 140 dB; rather, they would combine to produce 73 dB. Under the decibel scale, three sources of equal loudness together would produce an increase of 5 dB.

Sound Propagation & Attenuation

Geometric Spreading

Sound from a localized source (i.e., a point source) propagates uniformly outward in a spherical pattern. The sound level decreases (attenuates) at a rate of approximately 6 decibels for each doubling of distance from a point source. Highways consist of several localized noise sources on a defined path, and hence can be treated as a line source, which approximates the effect of several point sources. Noise from a line source propagates outward in a cylindrical pattern, often referred to as cylindrical spreading. Sound levels attenuate at a rate of approximately 3 decibels for each doubling of distance from a line source, depending on ground surface characteristics. For acoustically hard sites (i.e., sites with a reflective surface between the source and the receiver, such as a parking lot or body of water,), no excess ground attenuation is assumed. For acoustically absorptive or soft sites (i.e., those sites with an absorptive ground surface between the source and the receiver, such as soft dirt, grass, or scattered bushes and trees), an excess ground-attenuation value of 1.5 decibels per doubling of distance is normally assumed. When added to the cylindrical spreading, the excess ground attenuation for soft surfaces results in an overall attenuation rate of 4.5 decibels per doubling of distance from the source.

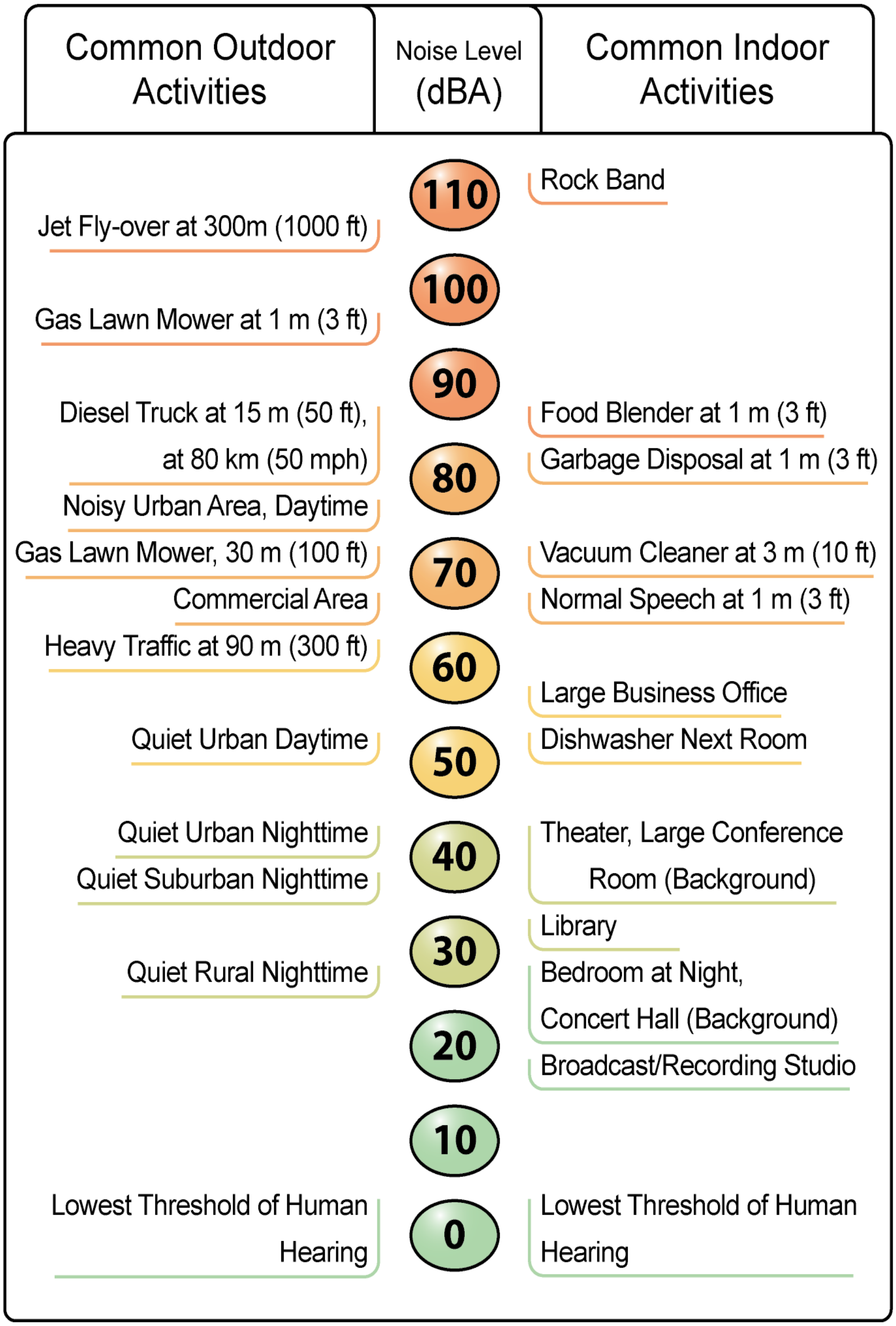
Atmospheric Effects

Receptors located downwind from a source can be exposed to increased noise levels relative to calm conditions, whereas locations upwind can have lowered noise levels. Sound levels can be increased at large distances (e.g., more than 500 feet) from the highway due to atmospheric temperature inversion (i.e., increasing temperature with elevation). Other factors such as air temperature, humidity, and turbulence can also have significant effects.

Shielding by Natural or Human-Made Features

A large object or barrier in the path between a noise source and a receiver can substantially attenuate noise levels at the receiver. The amount of attenuation provided by shielding depends on the size of the object and the frequency content of the noise source. Natural terrain features (e.g., hills and dense woods) and human-made features (e.g., buildings and walls) can substantially reduce noise levels. Walls are often

Figure 3
Common Community Noise Sources & Noise Levels



Source: Caltrans 2018

constructed between a source and a receiver specifically to reduce noise. A barrier that breaks the line of sight between a source and a receiver will typically result in minimum 5 dB of noise reduction. Taller barriers provide increased noise reduction.

Noise reductions afforded by building construction can vary depending on construction materials and techniques. Standard construction practices typically provide approximately 15 dBA exterior-to-interior noise reductions for building facades, with windows open, and approximately 20-30 dBA, with windows closed. With compliance with current Title 24 energy efficiency standards, which require increased building insulation and inclusion of an interior air ventilation system to allow windows on noise-impacted façades to remain closed, exterior-to-interior noise reductions typically average approximately 25 dBA. The absorptive characteristics of interior rooms, such as carpeted floors, draperies and furniture, can result in further reductions in interior noise.

NOISE DESCRIPTORS

The decibel scale alone does not adequately characterize how humans perceive noise. The dominant frequencies of a sound have a substantial effect on the human response to that sound. Although the intensity (energy per unit area) of the sound is a purely physical quantity, the loudness or human response is determined by the characteristics of the human ear.

Human hearing is limited in the range of audible frequencies as well as in the way it perceives the sound-pressure level in that range. In general, people are most sensitive to the frequency range of 1,000–8,000 Hz, and perceive sounds within that range better than sounds of the same amplitude in higher or lower frequencies. To approximate the response of the human ear, sound levels of individual frequency bands are weighted, depending on the human sensitivity to those frequencies, which is referred to as the "A-weighted" sound level (expressed in units of dBA). The A-weighting network approximates the frequency response of the average young ear when listening to most ordinary sounds. When people make judgments of the relative loudness or annoyance of a sound, their judgments correlate well with the A-scale sound levels of those sounds. Other weighting networks have been devised to address high noise levels or other special problems (e.g., B-, C-, and D-scales), but these scales are rarely used in conjunction with environmental noise.

The intensity of environmental noise fluctuates over time, and several descriptors of time-averaged noise levels are typically used. For the evaluation of environmental noise, the most commonly used descriptors are L_{eq}, L_{dn}, CNEL and SEL. The energy-equivalent noise level, L_{eq}, is a measure of the average energy content (intensity) of noise over any given period. Many communities use 24-hour descriptors of noise levels to regulate noise. The day-night average noise level, L_{dn}, is the 24-hour average of the noise intensity, with a 10-dBA "penalty" added for nighttime noise (10 p.m. to 7 a.m.) to account for the greater sensitivity to noise during this period. CNEL, the community equivalent noise level, is similar to L_{dn} but adds an additional 5-dBA penalty for evening noise (7 p.m. to 10 p.m.) Another descriptor that is commonly discussed is the single-event noise exposure level, also referred to as the sound-exposure level, expressed as SEL. The SEL describes a receiver's cumulative noise exposure from a single noise event, which is defined as an acoustical event of short duration (0.5 second), such as a backup beeper, the sound of an airplane traveling overhead, or a train whistle. Common noise level descriptors are summarized in Table 1.

HUMAN RESPONSE TO NOISE

The human response to environmental noise is subjective and varies considerably from individual to individual. Noise in the community has often been cited as a health problem, not in terms of actual physiological damage, such as hearing impairment, but in terms of inhibiting general well-being and contributing to undue stress and annoyance. The health effects of noise in the community arise from interference with human activities, including sleep, speech, recreation, and tasks that demand concentration or coordination. Hearing loss can occur at the highest noise intensity levels. When community noise interferes with human activities or contributes to stress, public annoyance with the noise source increases. The acceptability of noise and the threat to public well-being are the basis for land use planning policies preventing exposure to excessive community noise levels.

Table 1
Common Acoustical Descriptors

Descriptor	Definition
Energy Equivalent Noise Level (L_{eq})	The energy mean (average) noise level. The instantaneous noise levels during a specific period of time in dBA are converted to relative energy values. From the sum of the relative energy values, an average energy value (in dBA) is calculated.
Minimum Noise Level (L_{min})	The minimum instantaneous noise level during a specific period of time.
Maximum Noise Level (L_{max})	The maximum instantaneous noise level during a specific period of time.
Day-Night Average Noise Level (DNL or L_{dn})	The DNL was first recommended by the U.S. EPA in 1974 as a "simple, uniform and appropriate way" of measuring long term environmental noise. DNL takes into account both the frequency of occurrence and duration of all noise events during a 24-hour period with a 10 dBA "penalty" for noise events that occur between the more noise-sensitive hours of 10:00 p.m. and 7:00 a.m. In other words, 10 dBA is "added" to noise events that occur in the nighttime hours to account for increases sensitivity to noise during these hours.
Community Noise Equivalent Level (CNEL)	The CNEL is similar to the L_{dn} described above, but with an additional 5 dBA "penalty" added to noise events that occur between the hours of 7:00 p.m. to 10:00 p.m. The calculated CNEL is typically approximately 0.5 dBA higher than the calculated L_{dn}.
Sound Exposure Level (SEL)	The level of sound accumulated over a given time interval or event. Technically, the sound exposure level is the level of the time-integrated mean square A-weighted sound for a stated time interval or event, with a reference time of one second.

Unfortunately, there is no completely satisfactory way to measure the subjective effects of noise or of the corresponding reactions of annoyance and dissatisfaction. This is primarily because of the wide variation in individual thresholds of annoyance and habituation to noise over differing individual experiences with noise. Thus, an important way of determining a person's subjective reaction to a new noise is the comparison of it to the existing environment to which one has adapted: the so-called "ambient" environment. In general, the more a new noise exceeds the previously existing ambient noise level, the less acceptable the new noise will be judged. Regarding increases in A-weighted noise levels, knowledge of the following relationships will be helpful in understanding this analysis:

- Except in carefully controlled laboratory experiments, a change of 1 dB cannot be perceived by humans;
- Outside of the laboratory, a 3-dB change is considered a just-perceivable difference;
- A change in level of at least 5 dB is required before any noticeable change in community response would be expected. An increase of 5 dB is typically considered substantial;
- A 10-dB change is subjectively heard as an approximate doubling in loudness and would almost certainly cause an adverse change in community response.

Effects of Noise on Human Activities

The extent to which environmental noise is deemed to result in increased levels of annoyance, activity interference, and sleep disruption varies greatly from individual to individual depending on various factors, including the loudness or suddenness of the noise, the information value of the noise (e.g., aircraft overflights, child crying, fire alarm), and an individual's sleep state and sleep habits. Over time, adaptation to noise events and increased levels of noise may also occur. In terms of land use compatibility, environmental noise is often evaluated in terms of the potential for noise events to result in increased levels of annoyance, sleep disruption, or interference with speech communication, activities, and learning. Noise-related effects on human activities are discussed in more detail, as follows:

Speech Communication

For most noise-sensitive land uses, an interior noise level of 45 dB L_{eq} is typically identified for the protection of speech communication in order to provide for 100-percent intelligibility of speech sounds. Assuming a minimum 20-dB reduction in sound level between outdoors and indoors, with windows closed, this interior noise level of 45 dB L_{eq} would equate to an exterior noise level of 65 dBA L_{eq}. For outdoor voice communication, an exterior noise level of 60 dBA L_{eq} allows normal conversation at distances up to 2 meters with 95 percent sentence intelligibility (U.S. EPA 1974.) Based on this information, speech interference begins to become a problem when steady noise levels reach approximately 60 to 65 dBA. Within interior noise environments, an average-hourly background noise level of 45 dBA L_{eq} is typically recommended for noise-sensitive land uses, such as educational facilities (Caltrans 2002).

Learning

Closely related to speech interference are the effects of noise on learning and, more broadly, on cognitive tasks. Recent studies have shown a strong relationship between noise and children's reading ability. Children's attention spans also appear to be adversely affected by noise. Adults are affected as well. Some studies indicate that, in a noisy environment, adults have increased difficulty accomplishing complex tasks. One of the issues associated with assessment of these effects is which noise metric correlates most closely with the impacts. For example, the average-daily noise level (i.e., CNEL/L_{dn}), which incorporates a nighttime weighting, may not be the best measure of noise impacts on schools given that operational activities are often limited to the daytime hours (Caltrans 2002).

Various standards and recommended criteria have been developed to specifically address classroom noise. For instance, with regard to transportation sources, the California Department of Transportation has adopted abatement criteria that limit the maximum interior average-hourly noise level within classrooms and other noise-sensitive interior uses, to 52 dBA L_{eq}. In June 2002, the American National Standards Institute, Inc. (ANSI) released a new classroom acoustics standard entitled Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools" (ANSI S12.60-2002). For schools exposed to intermittent background noise sources, such as airport and other transportation noise, the ANSI standards recommend that interior noise levels not exceed 40 dBA L_{eq} during the noisiest hour of the day. At present complying with the ANSI-recommended standard is voluntary in most locations.

Annoyance & Sleep Disruption

With regard to potential increases in annoyance, activity interference, and sleep disruption, land use compatibility determinations are typically based on the use of the cumulative noise exposure metrics (i.e., CNEL or L_{dn}). Perhaps the most comprehensive and widely accepted evaluation of the relationship between noise exposure and the extent of annoyance was one originally developed by Theodore J. Schultz in 1978. In 1978 the research findings of Theodore J. Schultz provided support for L_{dn} as the descriptor for environmental noise. Research conducted by Schultz identified a correlation between the cumulative noise exposure metric and individuals who were highly annoyed by transportation noise. The Schultz curve, expressing this correlation, became a basis for noise standards. When expressed graphically, this relationship is typically referred to as the Schultz curve. The Schultz curve indicates that approximately 13 percent of the population is highly annoyed at a noise level of 65 dBA L_{dn}. It also indicates that the percent of people describing themselves as being highly annoyed accelerates smoothly between 55 and 70 dBA L_{dn}. A noise level of 65 dBA L_{dn} is a commonly referenced dividing point between lower and higher rates of people describing themselves as being highly annoyed (Caltrans 2002).

The Schultz curve and associated research became the basis for many of the noise criteria subsequently established for federal, state, and local entities. Most federal and state of California regulations and policies related to transportation noise sources establish a noise level of 65 dBA CNEL/L_{dn} as the basic limit of acceptable noise exposure for residential and other noise-sensitive land uses. For instance, with respect to aircraft noise, both the Federal Aviation Administration (FAA) and the State of California have identified a noise level of 65 dBA L_{dn} as the dividing point between normally compatible and normally incompatible residential land use generally applied for determination of land use compatibility. For noise-sensitive land uses exposed to aircraft noise, noise levels in excess of 65 dBA CNEL/L_{dn} are typically considered to result in a potentially significant increase in levels of annoyance (Caltrans 2002).

Allowing for an average exterior-to-interior noise reduction of 20 dB, an exterior noise level of 65 dBA CNEL/L_{dn} would equate to an interior noise level of 45 dBA CNEL/L_{dn}. An interior noise level of 45 dB CNEL/L_{dn} is generally considered sufficient to protect against activity interference at most noise-sensitive land uses, including residential dwellings, and would also be sufficient to protect against sleep interference (U.S. EPA 1974.) Within California, the California Building Code establishes a noise level of 45 dBA CNEL as the maximum acceptable interior noise level for residential uses (other than detached single-family dwellings). Use of the 45 dBA CNEL threshold is further supported by recommendations provided in the State of California Office of Planning and Research's *General Plan Guidelines*, which recommend an interior noise level of 45 dB CNEL/L_{dn} as the maximum allowable interior noise level sufficient to permit "normal residential activity."

The cumulative noise exposure metric is currently the only noise metric for which there is a substantial body of research data and regulatory guidance defining the relationship between noise exposure, people's reactions, and land use compatibility. However, when evaluating environmental noise impacts involving intermittent noise events, such as aircraft overflights and train passbys, the use of cumulative noise metrics may not provide a thorough understanding of the resultant impact. The general public often finds it difficult to understand the relationship between intermittent noise events and cumulative noise exposure metrics. In such instances, supplemental use of other noise metrics, such as the L_{eq} or L_{max} descriptor, may be helpful as a means of increasing public understanding regarding the relationship between these metrics and the extent of the resultant noise impact (Caltrans 2002).

AFFECTED ENVIRONMENT

NOISE-SENSITIVE LAND USES

Noise-sensitive land uses are generally considered to include those uses where noise exposure could result in health-related risks to individuals, as well as places where quiet is an essential element of their intended purpose. Residential dwellings are of primary concern because of the potential for increased and prolonged exposure of individuals to both interior and exterior noise levels. Additional land uses such as parks, historic sites, cemeteries, and recreation areas are also considered sensitive to increases in exterior noise levels. Schools, churches, hotels, libraries, and other places where low interior noise levels are essential are also considered noise-sensitive land uses.

Sensitive land uses located in the vicinity of the proposed project site consist predominantly of residential land uses. The nearest residential land uses are generally located north of the project site, north of E. Cambridge and E. Yale Avenues.

AMBIENT NOISE ENVIRONMENT

To document existing ambient noise levels in the project area, short-term ambient noise measurements were conducted on May 21, 2019 using a Larson Davis Laboratories, Type I, Model 820 integrating sound-level meter. The meter was calibrated before use and is certified to be in compliance with ANSI specifications. Measured ambient noise levels are summarized in Table 2.

As indicated in Table 2, measured ambient noise levels in the project area ranged from approximately 54 to 67 dBA L_{eq}. Ambient noise levels within the project area are predominantly influenced by vehicle traffic on area roadways. Ambient noise levels during the evening and nighttime hours are generally 5 to 10 dB lower than daytime noise levels.

Table 2
Summary of Measured Ambient Noise Levels

Location	Monitoring Period	Noise Levels (dBA)	
		L_{eq}	L_{max}
N. Calaveras Street. Approximately 25 feet north of E. University Avenue	0710-0720	58.2	69.3
E. University Avenue. Approximately xx feet west of N. Blackstone Avenue	0730-0740	59.6	70.2
1607 E. Cambridge Avenue	0750-0800	56.9	68.3
1305 E. Yale Avenue, Approximately 190 feet west of N. San Pablo Avenue	0810-0820	53.8	56.7
N. Blackstone Avenue at Yale Avenue, Approximately 80 feet from N. Blackstone Avenue centerline	0830-0840	67.3	79.4
Ambient noise measurements were conducted on May 21, 2019 using a Larson Davis Laboratories, Type I, Model 820 integrating sound-level meter.			

REGULATORY FRAMEWORK

NOISE

State of California

The State of California regulates vehicular and freeway noise affecting classrooms, sets standards for sound transmission and occupational noise control, and identifies noise insulation standards and airport noise/land-use compatibility criteria.

California General Plan Guidelines

The *State of California General Plan Guidelines*, published by the Governor's Office of Planning and Research (OPR 2003), also provides guidance for the acceptability of projects within specific CNEL/L_{dn} contours. The guidelines also present adjustment factors that may be used in order to arrive at noise acceptability standards that reflect the noise control goals of the community, the particular community's sensitivity to noise, and the community's assessment of the relative importance of noise pollution. For school land uses, the *State of California General Plan Guidelines* identify a "normally acceptable" exterior noise level of up to 70 dBA CNEL/L_{dn}. Schools are considered "conditionally acceptable" within noise environments of 60 to 70 dBA CNEL/L_{dn} and "normally unacceptable" within exterior noise environments of 70 to 80 CNEL/L_{dn} and "clearly unacceptable" within exterior noise environments in excess of 80 dBA CNEL/L_{dn}. Assuming a minimum exterior-to-interior noise reduction of 20 dB, an exterior noise environment of 65 dBA CNEL/L_{dn} would allow for a normally acceptable interior noise level of 45 dBA CNEL/L_{dn}.

City of Fresno

The *Fresno General Plan Noise and Safety Element* includes noise standards for both stationary and transportation noise sources for determination of land use compatibility. In accordance with General Plan policies, new noise-sensitive land uses impacted by existing or projected future transportation or stationary noise sources shall include mitigation measures so that resulting noise levels do not exceed these standards (City of Fresno 2014). The land use compatibility noise standards for non-transportation (stationary) and transportation noise sources are summarized in Tables 3 and 4, respectively. In addition, Policy NS-1-a of the *Fresno General Plan Noise and Safety Element* also establishes an exterior noise standard of 60 dBA CNEL/L_{dn} for new non-transportation noise sources that impinge on noise-sensitive land uses, such as residential dwellings. This noise standard is applied at the property line of the noise-sensitive land use.

The City of Fresno has also adopted a noise ordinance that contains additional limitations intended to prevent noise which may create dangerous, injurious, noxious, or otherwise objectionable conditions. As opposed to the City's General Plan noise standards, the City's noise ordinance is primarily used for the regulation of existing uses and activities, including construction activities, and are not typically used as a basis for land use planning. Construction activities occurring during the daytime hours of 7:00 a.m. to 10:00 p.m., Monday through Saturday, are typically considered exempt from the City's noise ordinance requirements (City of Fresno 2016). In accordance with Section 15-2506(H) of the City's noise ordinance, the sounding of school bells and school-sanctioned outdoor activities such as pep rallies, sports games, and band practices are exempt from the City's noise ordinance standards.

Table 3
City of Fresno General Plan Noise Standards - Stationary Noise Sources

Noise Descriptor	Noise Level Standards (dBA)[1]	
	Daytime (7 am - 10 pm)	Nighttime (10 pm – 7 am)
Hourly Equivalent Sound Level (L_{eq})	50	45
Maximum Sound Level (L_{max})	70	65

Notes:

1. The Department of Development and Resource Management Director, on a case-by-case basis, may designate land uses other than those shown in this table to be noise-sensitive, and may require appropriate noise mitigation measures.

2. As determined at outdoor activity areas. Where the location of outdoor activity areas is unknown or not applicable, the noise exposure standard shall be applied at the property line of the receiving land use. When ambient noise levels exceed or equal the levels in this table, mitigation shall only be required to limit noise to the ambient plus five dB.

Source: City of Fresno 2014

Table 4
City of Fresno General Plan Noise Standards - Transportation Noise Sources

Land Use[1]	Outdoor Activity Areas[2,3] (CNEL/L_{dn} dBA)	Interior Spaces (dBA)[3]	
		Average Daily (CNEL/L_{dn})	Average Hourly (L_{eq})[2]
Residential	65	45	--
Transient Lodging	65	45	--
Hospitals, Nursing Homes	65	45	--
Theaters, Auditoriums, Music Halls	--	--	35
Churches, Meeting Halls	65	--	45
Office Buildings	--	--	45
Schools, Libraries, Museums	--	--	45

1. Where the location of outdoor activity areas is unknown or is not applicable, the exterior noise level standard shall be applied to the property line of the receiving land use.

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

3. Noise standards do not apply to aircraft noise.

Source: City of Fresno 2014

GROUNDBORNE VIBRATION

Vibration is like noise in that it involves a source, a transmission path, and a receiver. While vibration is related to noise, it differs in that noise is generally considered to be pressure waves transmitted through air, whereas vibration usually consists of the excitation of a structure or surface. As with noise, vibration consists of an amplitude and frequency. A person's perception to the vibration will depend on their individual sensitivity to vibration, as well as the amplitude and frequency of the source and the response of the system which is vibrating. Vibration can be measured in terms of acceleration, velocity, or displacement.

The effects of groundborne vibration levels, with regard to human annoyance and structural damage, is influenced by various factors, including ground type, distance between source and receptor, and duration. Overall effects are also influenced by the type of the vibration event, defined as either continuous or transient. Continuous vibration events would include most construction equipment, including pile drivers, and compactors; whereas, transient sources of vibration create single isolated vibration events, such as demolition ball drops and blasting. Threshold criteria for continuous and transient events are summarized in Tables 5 and 6, respectively.

Table 5
Damage Potential to Buildings at Various Groundborne Vibration Levels

Structure and Condition	Vibration Level (in/sec ppv)	
	Transient Sources	Continuous/Frequent Intermittent Sources
Extremely Fragile Historic Buildings, Ruins, Ancient Monuments	0.12	0.08
Fragile Buildings	0.2	0.1
Historic and Some Old Buildings	0.5	0.25
Older Residential Structures	0.5	0.3
New Residential Structures	1.0	0.5
Modern Industrial/Commercial Buildings	2.0	0.5

Note: Transient sources create a single isolated vibration event, such as blasting or drop balls. Continuous/frequent intermittent sources include impact pile drivers, pogo-stick compactors, crack-and-seat equipment, vibratory pile drivers, and vibratory compaction equipment.

Source: Caltrans 2013

Table 6
Annoyance Potential to People at Various Groundborne Vibration Levels

Human Response	Vibration Level (in/sec ppv)	
	Transient Sources	Continuous/Frequent Intermittent Sources
Barely Perceptible	0.04	0.01
Distinctly Perceptible	0.25	0.04
Strongly Perceptible	0.9	0.10
Annoying to People in Buildings	--	0.2
Severe	2.0	0.4

Note: Transient sources create a single isolated vibration event, such as blasting or drop balls. Continuous/frequent intermittent sources include impact pile drivers, pogo-stick compactors, crack-and-seat equipment, vibratory pile drivers, and vibratory compaction equipment.

-- Not Available

Source: Caltrans 2013

As indicated in Table 5, the threshold at which there is a risk to normal structures from continuous events is 0.5 in/sec ppv for newer building construction. A threshold of 0.5 in/sec ppv also represents the structural damage threshold applied to older structures for transient vibration sources. With regard to human perception (refer to Table 6), vibration levels would begin to become distinctly perceptible at levels of 0.04 in/sec ppv for continuous events and 0.25 in/sec ppv for transient events. Continuous vibration levels are considered annoying for people in buildings at levels of 0.2 in/sec ppv.

IMPACTS AND MITIGATION MEASURES

METHODOLOGY

Short-Term Construction Noise

Short-term noise impacts associated with construction activities were analyzed based on typical construction equipment noise levels and distances to the nearest noise-sensitive land uses. Noise levels were predicted based on an average noise-attenuation rate of 6 dB per doubling of distance from the source.

Long-term Operational Noise

Roadway Traffic Noise

Traffic noise levels were calculated using the Federal Highway Administration (FHWA) roadway noise prediction model (FHWA-RD-77-108) based on California vehicle reference noise levels and traffic data obtained from the traffic analysis prepared for this project. Additional input data included day/night percentages of autos, medium and heavy trucks, vehicle speeds, ground attenuation factors, and roadway widths. The project's contribution to traffic noise levels along area roadways was determined by comparing the predicted noise levels with and without project-generated traffic. The compatibility of the proposed land uses were evaluated based on predicted future on-site noise conditions and in comparison to the City of Fresno's interior noise standard of 45 dBA CNEL/L_{dn} for school uses (refer to Table 4).

The *CEQA Guidelines* do not define the levels at which temporary and permanent increases in ambient noise are considered "substantial." As discussed previously in this section, a noise level increase of 3 dBA is barely perceptible to most people, a 5 dBA increase is readily noticeable, and a difference of 10 dBA would be perceived as a doubling of loudness. For purposes of this analysis, a significant increase in ambient noise levels would be defined as an increase of 3 dBA, or greater. Significant increases in ambient noise levels that would exceed applicable noise standards would be considered to have a potentially significant impact.

Non-Transportation Noise

Noise levels associated with vehicle parking areas were calculated in accordance with FHWA's *Transit Noise and Vibration Impact Assessment Guidelines* (2006) assuming a reference noise level of 92 dBA SEL. Average-hourly noise levels were calculated based on hourly on-campus student attendance data provided by the project applicant. Based on the student attendance data provided, maximum on-campus hourly student attendance for the campus was 3,633 students during the daytime hours (7:00 a.m. to 10:00 p.m.) Daytime operational noise levels were calculated based on the total capacity of the parking garage (1,000 spaces) and assuming that all parking spaces could be accessed over a one-hour period. Nighttime operational noise levels were conservatively based on the highest hourly on-campus student attendance for the evening hours (7:00 p.m. to 10:00 p.m.) of 301 students and assuming that all students would utilize the parking garage and depart the structure after 10:00 p.m. Hourly on-campus student attendance for the early morning hours (5:00 a.m. to 7:00 a.m.) are less (i.e., 167 students, or less). As a result, predicted operational noise levels during these early morning hours would be less. Noise levels generated by other on-site noise sources, including on-site building mechanical equipment and recreational uses were assessed based on representative noise data obtained from similar land uses.

Groundborne Vibration

The *CEQA Guidelines* also do not define the levels at which groundborne vibration levels would be considered excessive. For this reason, Caltrans' recommended groundborne vibration thresholds were used for the evaluation of impacts based on increased potential for structural damage and human annoyance, as identified in Table 5 and Table 6, respectively. Based on these levels, groundborne vibration levels would be considered to have a potentially significant impact with regard to potential structural damage if levels would exceed a 0.5 in/sec ppv.

PROJECT IMPACTS

Impact Noise-A:	***Would the project result in the generation of a substantial temporary or permanent increase in ambient noise levels in the vicinity of the project in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies?***

Noise generated by the proposed project would occur during short-term construction and long-term operation. Noise-related impacts associated with short-term construction and long-term operations of the proposed project are discussed separately, as follows:

Short-term Construction Noise Levels

Construction noise typically occurs intermittently and varies depending upon the nature or phase (e.g., demolition/land clearing, grading and excavation, erection) of construction. Noise generated by construction equipment, including earth movers, material handlers, and portable generators, can reach high levels. Although noise ranges were found to be similar for all construction phases, the initial site preparation phases, including demolition and grading/excavation activities, tend to involve the most equipment and result in the highest average-hourly noise levels.

Noise levels commonly associated with construction equipment are summarized in Table 7. As noted in Table 7, instantaneous noise levels (in dBA L_{max}) generated by individual pieces of construction equipment typically range from approximately 80 dBA to 85 dBA L_{max} at 50 feet (FTA 2006). Typical operating cycles may involve 2 minutes of full power, followed by 3 or 4 minutes at lower settings. Average-hourly noise levels for individual equipment generally range from approximately 73 to 82 dBA L_{eq}. Based on typical off-road equipment usage rates and assuming multiple pieces of equipment operating simultaneously within a localized area, such as soil excavation activities, average-hourly noise levels could reach levels of approximately 80 dBA L_{eq} at roughly 100 feet.

Table 7
Typical Construction Equipment Noise Levels

Equipment	Typical Noise Level (dBA) at 50 feet from Source	
	L_{max}	L_{eq}
Compactor, Concrete Vibratory Mixer	80	73
Backhoe/Front-End Loader, Air Compressor	80	76
Generator	82	79
Crane, Mobile	85	77
Jack Hammer, Roller	85	78
Dozer, Excavator, Grader, Concrete Mixer Truck	85	81
Paver, Pneumatic Tools	85	82
Sources: FTA 2006		

The City has not adopted noise standards that apply to short-term construction activities. However, based on screening noise criteria commonly recommended by federal agencies, construction activities would generally be considered to have a potentially significant impact if average-hourly daytime noise levels would exceed 80 dBA L_{eq} at noise-sensitive land uses, such as residential land uses (FTA 2006). Depending on the location and types of activities conducted (e.g., building demolition, soil excavation, grading), predicted noise levels at the nearest residences, which are located adjacent to and west of the project site, could potentially exceed 80 dBA L_{eq}. Furthermore, with regard to residential land uses, activities occurring during the more noise-sensitive evening and nighttime hours could result in increased levels of annoyance and potential sleep disruption. For these reasons, noise-generating construction activities would be considered to have a ***potentially significant*** short-term noise impact.

Mitigation Measure Noise-1: The following measures shall be implemented to reduce construction-generated noise levels:

a. Construction activities (excluding activities that would result in a safety concern to the public or construction workers) shall be limited to between the hours of 7:00 a.m. and 10:00 p.m. Construction activities shall be prohibited on Sundays and legal holidays.

b. Construction truck trips shall be scheduled, to the extent feasible, to occur during non-peak hours and truck haul routes shall be selected to minimize impacts to nearby residential dwellings.

c. Construction equipment shall be properly maintained and equipped with noise-reduction intake and exhaust mufflers and engine shrouds, in accordance with manufacturers' recommendations. Equipment engine shrouds shall be closed during equipment operation.

d. Stationary construction equipment (e.g., portable power generators) should be located at the furthest distance possible from nearby residences. If deemed necessary, portable noise barriers shall be erected sufficient to shield nearby residences from direct line-of-sight of stationary construction equipment.

e. When not in use, all equipment shall be turned off and shall not be allowed to idle. Provide clear signage that posts this requirement for workers at the entrances to the site.

Significance After Mitigation: Use of mufflers would reduce individual equipment noise levels by approximately 10 dBA. Implementation of the above mitigation measures would limit construction activities to the less noise-sensitive periods of the day. With implementation of the above mitigation measures, this impact would be considered ***less than significant***.

Long-term Operational Noise Levels

Potential long-term increases in noise associated with the proposed project would be primarily associated with the operation of building equipment, such as heating, ventilation, and air conditioning (HVAC) units, outdoor recreational activities, and vehicle use within onsite parking lots.

Maintenance Facility

The proposed project includes the construction of a maintenance and operations center, to be located adjacent to and west of N. San Pablo Avenue, north of E. Cambridge Avenue. Noise generated by maintenance and operations center would be primarily associated with the installation of an air compressor. Additional sources of noise may include the use of pneumatic tools within the automotive shop area. Noise levels commonly associated with air compressors typically average approximately 76 dBA Leq at 50 feet. Pneumatic tools can generate noise levels of approximately 82 dBA L_{eq} at 50 feet, with intermittent noise levels reaching approximately 85 dBA L_{max} at 50 feet. Based on the preliminary plans prepared for the project, the air compressor would be enclosed and shielded from direct line-of-sight of the nearest residential land uses by intervening buildings. The automotive service bay would, likewise, be shielded from the nearest residential land uses by intervening onsite structures. Based on the operational noise levels noted above and assuming 15-dB reductions for the air compressor enclosure and intervening structures, combined operational noise levels would be approximately 54 dBA L_{eq} at the property line of residential uses located to the north, across E. Yale Avenue, and approximately 48 dBA L_{eq} at the property line of residential uses located to the east, across N. San Pablo Avenue. Predicted operational noise levels would exceed the City's daytime and nighttime noise standards (i.e., 50 and 45 dBA L_{eq}) at the property line of residential land uses to the north, and the City's nighttime noise standard at the property line of residential land uses to the east. Maximum instantaneous noise levels associated with the use of pneumatic tools would be approximately 67 dBA L_{max} at the nearest residential property line, which would exceed the City's nighttime noise standard of 65 dBA L_{max}. As a result, this impact would be considered ***potentially significant***.

Building Maintenance & Mechanical Equipment

Proposed structures, including the proposed maintenance and operations center, child development center, science building, and parking structure would be anticipated to include the use of building mechanical equipment, such as air conditioning units and exhaust fans.

The specific building mechanical equipment to be installed and the locations of such equipment have not yet been identified. Building mechanical equipment (e.g., air conditioning units, exhaust fans) would typically be located within the structures, enclosed, or placed on rooftop areas away from direct public exposure. Exterior air conditioning units and exhaust fans can generate noise levels up to approximately 65 dBA L_{eq} at 10 feet. Depending on type and location of onsite equipment, predicted operational noise levels at nearby residential land uses could exceed the City's applicable exterior daytime and nighttime noise standards of 50 and 45 dBA L_{eq}, respectively (refer to Table 3).

In addition to building mechanical equipment operations, landscape maintenance and waste-collection activities may also result in significant increases in ambient noise levels at nearby residential land uses, particularly if such activities were to occur during the more noise-sensitive nighttime hours. As a result, noise generated by onsite building maintenance and mechanical equipment would be considered to have a **potentially-*significant*** impact.

Recreational Facilities

The proposed project includes the construction of a child development center, which would be anticipated to include outdoor recreational-use facilities, such as playgrounds. Noise generated by small playgrounds typically includes elevated children's voices and occasional adult voices. Based on measurement data obtained from similar land uses, noise levels associated with small playgrounds can generate intermittent noise levels of approximately 55-60 dBA L_{eq} at 50 feet. The proposed child development center would be constructed in the same general location of the existing child development center. As a result, operational noise levels associated with exterior recreational facilities would be similar to noise levels associated recreational facilities at the existing use. As a result, significant increases in ambient noise levels would not be anticipated to occur. In addition, no noise-sensitive land use were identified in the vicinity of the proposed child development center that would be adversely affected by outdoor recreational noise events. Noise generated by recreational facilities would be considered to have a ***less-than-significant*** impact.

Vehicle Parking Areas & Structures

The proposed project includes the construction of various surface parking lots, as well as, an approximate 1,000-space parking garage. The parking garage would be located east of N. Glenn Avenue, between E. Cambridge Avenue and E. Weldon Avenue. Predicted operational noise levels for the parking lot are summarized in Table 8. Refer to Appendix A for modeling assumptions and results.

Based on a conservative assumption that all parking spaces within the parking garage were to be accessed over a one-hour period, predicted daytime noise levels at the property line of the nearest residential dwellings, which are located adjacent to and north of E. Cambridge Avenue, would be 47 dBA L_{eq}. During the nighttime hours, when student attendance is less, predicted parking garage noise levels are estimated to average approximately 41 dBA L_{eq}, or less. Predicted operational noise levels associated with other smaller surface parking areas would be less. During the daytime hours, predicted operational noise levels would be largely masked by ambient noise levels, which generally range from the low to mid 50's (in dBA L_{eq}) and are predominantly influenced by vehicle traffic noise on area roadways. Predicted noise levels would not exceed the City's daytime or nighttime noise standards of 50 and 45 dBA L_{eq}, respectively. As a result, this is considered a ***less-than-significant*** impact.

Table 8
Predicted Parking Garage Operational Noise Levels

Day of Week/Period of Day	Noise Level at the Nearest Residential Property Line (dBA L_{eq})	Exceeds Standards/ Significant Impact?[1]
Weekday – Daytime (7:00 a.m. to 10:00 p.m.)[2]	47	No
Weekday – Nighttime (10:00 p.m. to 7:00 a.m.)[3]	41	No
Saturday – Daytime (7:00 a.m. to 10:00 p.m.)[4]	36	No

Noise levels associated with vehicle parking areas were calculated in accordance with FHWA's Transit Noise and Vibration Impact Assessment Guidelines (2006).

1. *The City's daytime and nighttime noise standards are 50 and 45 dBA L_{eq}, respectively, applied at outdoor activity areas. To be conservative, predicted noise levels were calculated at the property line of the nearest residential land uses.*
2. *Based on the total capacity of the parking garage (1,000 spaces) and assuming that all parking spaces could be accessed over a one-hour period.*
3. *Based on the highest hourly on-campus student attendance for the evening hours (7:00 p.m. to 10:00 p.m.) of 301 students and assuming that all students would utilize the parking garage and depart the structure after 10:00 p.m. Based on student attendance data, hourly on-campus student attendance/parking garage use for the early morning hours (5:00 a.m. to 7:00 a.m.) would be less.*
4. *Based on the highest hourly on-campus student attendance of 93 students and assuming that all students would utilize the parking garage and depart the structure over a one-hour period. Based on student attendance data, use of the parking garage during Saturday nighttime hours and Sundays would be less.*

Source: FTA 2006

Roadway Traffic

Predicted existing traffic noise levels, with and without implementation of proposed project, are summarized in Table 9. In comparison to existing traffic noise levels, the proposed project would result in a predicted increase in traffic noise levels of 0.3 to 4.6 along area roadways.

Predicted increases in future cumulative traffic noise levels along nearby roadways for proposed project are summarized in Table 10. In future years, the project's contribution to cumulative traffic noise levels would be anticipated to decline slightly as increases in vehicle traffic due to surrounding development increases. Under future cumulative conditions, the proposed project would result in predicted increases in traffic noise levels of 0.3 to 4.5 along area roadways.

As noted earlier in this report, changes in ambient noise levels of approximately 3 dBA, or less, are typically not discernible to the human ear and would not be considered to result in a significant impact. Implementation of the proposed project would result in a significant increase (i.e., 3 dBA, or greater) in existing and projected future traffic noise levels along E. Cambridge Avenue, west of N. Blackstone Avenue. However, predicted traffic noise levels along this roadway segment would not be projected to exceed the City's exterior noise standard of 65 dBA CNEL at adjacent residential land uses. As a result, this impact would be considered ***less than significant***.

Table 9
Predicted Increases in Existing Traffic Noise Levels

Roadway Segment	Predicted Noise Level at 50 feet from Centerline of Near Travel Lane (dBA CNEL/L_{dn})[1]			
	Existing Without Project	Existing With Project	Difference[2]	Significant Impact?[3]
N. San Pablo Ave., South of E. Clinton Ave.	48.7	50.3	1.6	No
N. Glenn Ave., South of E. Clinton Ave.	51.6	52.9	1.3	No
E. Cambridge Ave., West of N. Blackstone Ave.	50.1	54.7	4.6	No
N. Blackstone Ave., South of E. Cambridge Ave.	66.4	66.8	0.3	No

1. Traffic noise levels were calculated using the FHWA roadway noise prediction model (FHWA-RD-77-108), based on data obtained from the traffic analysis prepared for this project.
2. Difference in noise levels reflects the incremental increase attributable to the proposed project.
3. Defined as a substantial increase in ambient noise levels in excess of the City's exterior noise standard of 65 dBA CNEL.

Table 10
Predicted Increases in Future Traffic Noise Levels

Roadway Segment	Predicted Noise Level at 50 feet from Centerline of Near Travel Lane (dBA CNEL/L_{dn})[1]			
	Future Without Project	Future With Project	Difference[2]	Significant Impact?[3]
N. San Pablo Ave., South of E. Clinton Ave.	48.7	50.3	1.6	No
N. Glenn Ave., South of E. Clinton Ave.	51.7	53.0	1.3	No
E. Cambridge Ave., West of N. Blackstone Ave.	50.2	54.7	4.5	No
N. Blackstone Ave., South of E. Cambridge Ave.	67.2	67.5	0.3	No

1. Traffic noise levels were calculated using the FHWA roadway noise prediction model (FHWA-RD-77-108), based on data obtained from the traffic analysis prepared for this project.
2. Difference in noise levels reflects the incremental increase attributable to the proposed project.
3. Defined as a substantial increase in ambient noise levels in excess of the City's exterior noise standard of 65 dBA CNEL.

Land Use Compatibility

The Fresno City General Plan Noise Element includes noise standards for determination of land use compatibility for new land uses. As previously discussed, the City's "normally acceptable" exterior noise standards for schools is 65 dBA CNEL/L_{dn}.

As noted earlier in this report, ambient noise levels in the project area are largely influenced by traffic noise on area roadways. Under future cumulative conditions, with project-generated vehicle traffic included, the predicted 65 dBA CNEL/L_{dn} noise contour for N. Blackstone Avenue would extend to 129 feet from the roadway centerline. Based on preliminary site plans, the proposed science building would be located approximately 85 feet from the centerline of N. Blackstone Avenue. Based on this setback distance, predicted traffic noise levels at the nearest building façade would be 68 dBA CNEL/L_{dn}. With compliance with current building insulation standards, average exterior-to-interior noise reductions for newly constructed buildings typically range from approximately 25-30 dB. Assuming an exterior noise level of 68 dBA CNEL/L_{dn} and a minimum exterior-to-interior noise reduction of 25 dB, predicted interior noise levels within the proposed science building would be approximately 43 dBA CNEL/L_{dn}, or less. Predicted interior noise levels would not exceed the City's applicable interior noise standard of 45 dBA CNEL/L_{dn}. The projected 65 dBA CNEL contour for other area roadways, including E. University Avenue and N. San Pablo Avenue, are not projected to extend beyond the roadway right-of-way. As a result, other proposed land uses, including the proposed child development center and maintenance and operations facilities, would not be projected to exceed applicable City noise standards for land use compatibility. As a result, this impact would be considered ***less than significant***.

Mitigation Measure Noise-2a: The following measures shall be implemented to reduce long-term operational noise impacts:

- An acoustical analysis shall be prepared for proposed onsite buildings/facilities prior to final design. The purpose of the acoustical analysis is to evaluate operational noise levels associated with on-site building mechanical equipment (e.g., air conditioning units, exhaust fans) in comparison to applicable City of Fresno's exterior daytime and nighttime noise standards of 50 and 45 dBA L_{eq}. The acoustical analysis shall identify noise-reduction measures to be incorporated sufficient to achieve applicable noise standards. Noise-reduction measures to be incorporated may include, but are not limited to, the selection of alternative or quieter equipment, use of equipment enclosures, site design, and construction of noise barriers (i.e., walls).
- Operation of the proposed maintenance and operations center shall be limited to between the hours of 7:00 a.m. to 10:00 p.m.
- Stationary equipment (e.g., air compressors) to be located at the proposed maintenance and operations center shall be enclosed and shielded from direct line-of-sight of nearby residential land uses.
- Exterior doors of the automotive service bay located within the proposed maintenance and operations center shall be closed when using noise-generating equipment (e.g., pneumatic tools).
- Landscape maintenance and waste-collection activities, shall be limited to between the hours of 7:00 a.m. to 10:00 p.m.
- Any stationary equipment (e.g., air compressors) to be installed at the proposed maintenance facility shall be enclosed, located at the furthest distance from nearby residential land uses, and shielded from direct line of sight of nearby residential land uses.

Significance After Mitigation

Implementation of Mitigation Measure Noise-2a would limit on-site maintenance activities including activities conducted at the proposed maintenance facility, landscape maintenance, and waste-collection activities, to the daytime hours of operation. Additional measures have been included to further reduce operational noise levels associated with the proposed maintenance and operations center. With mitigation, predicted noise levels associated with operation of the proposed maintenance and operations center would be reduced to 49 dBA L_{eq}, or less, at the nearest residential property lines. In addition, an acoustical analysis would also be required, prior to final site design, to further evaluate noise levels associated with building mechanical equipment (e.g., exhaust fans, air conditioning units) and to incorporate additional mitigation sufficient to achieve applicable City of Fresno noise standards. The proposed parking structure would be designed with a solid façade along the northern side of the structure. Assuming a minimum noise reduction of 5 dB for the proposed solid façade, predicted operational noise levels at the nearest residential land uses would be reduced to approximately 42 dBA L_{eq}. Predicted operational noise levels would not exceed the City's noise standards. In addition, vehicular access to the parking structure from E. Cambridge Avenue would be limited to the daytime hours of operation, which would further reduce operational noise levels at existing residential land uses located adjacent to and north of E. Cambridge Avenue. With mitigation, noise impacts associated with on-site non-transportation noise sources would be considered ***less than significant***.

Impact Noise-B.	***Would the project result in the generation of excessive groundborne vibration or groundborne noise levels?***

Long-term operational activities associated with the proposed project would not involve the use of any equipment or processes that would result in potentially significant levels of ground vibration. Increases in groundborne vibration levels attributable to the proposed project would be primarily associated with short-term construction-related activities. Construction activities associated with the proposed improvements would likely require the use of various off-road equipment, such as tractors, concrete mixers, and haul trucks. The use of major groundborne vibration-generating construction equipment, such as pile drivers, would not be required for this project.

Groundborne vibration levels associated with representative construction equipment are summarized in Table 11. As depicted, ground vibration generated by construction equipment would be approximately 0.089 in/sec ppv, or less, at 25 feet. Predicted vibration levels at the nearest existing structures would not be anticipated to exceed commonly applied criteria for structural damage or human annoyance (i.e., 0.5 and 0.2 in/sec ppv, respectively). In addition, no fragile or historic structures have been identified in the project area. As a result, this impact would be considered ***less than significant*.**

Table 11
Representative Vibration Source Levels for Construction Equipment

Equipment	Peak Particle Velocity at 25 Feet (In/Sec)
Large Bulldozer	0.089
Loaded Truck	0.076
Jackhammer	0.035
Small Bulldozer	0.003
Source: FTA 2006, Caltrans 2004	

Impact Noise-C. ***For a project located within the vicinity of a private airstrip or an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?***

The nearest airports in the project vicinity include the Fresno Yosemite International Airport and the Fresno Chandler Downtown Airport, which are located approximately 3.1 and 2.6 miles to the east and southwest, respectively. The proposed project is not located within the projected 60 dBA CNEL/L_{dn} noise contours of these airports (City of Fresno 2014). No private airstrips were identified within two miles of the project site. Implementation of the proposed project would not result in the exposure of sensitive receptors to aircraft noise levels nor would the proposed project affect airport operations. This impact is considered ***less than significant***.

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APPENDIX A

Noise Prediction Modeling & Supportive Documentation

PARKING GARAGE NOISE MODELING ASSUMPTIONS

STUDENT HOURLY HEAD COUNT

	STUDENT HEAD COUNT BY HOUR OF DAY (SECTION START TIME)																	DAYTIME (7AM-10PM)	NIGHTTIME (10PM-7AM)
DAY	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	MAX. HOURLY	MAX. HOURLY
MONDAY	0	156	1,060	3,506	3,393	2,111	3,351	3,016	2,140	2,400	1,397	1,040	605	2,315	392	180	106	3,506	180
TUESDAY	0	63	1,072	3,501	3,194	2,362	3,578	2,515	2,112	2,547	1,538	1,079	613	2,662	538	203	167	3,578	203
WEDNESDAY	0	167	1,102	3,633	3,509	2,180	3,432	3,047	2,267	2,423	1,441	1,034	788	2,278	461	191	257	3,633	257
THURSDAY	12	143	968	3,432	3,160	2,255	3,413	2,626	2,161	2,610	1,479	1,064	615	2,420	416	301	177	3,432	301
FRIDAY	0	93	426	1,091	1,081	643	773	384	564	197	122	0	24	27	24	0	0	1,091	93
SATURDAY	0	0	24	195	194	51	51	48	0	0	0	0	0	0	0	0	0	195	0
Based on data provided by the project applicant.																		5.4%	

ESTIMATED PARKING GARAGE VEHICLE USE

PARKING GARAGE MAX. CAPACITY:	1,000	SPACES
WEEKDAY - DAYTIME:	1,000	*BASED ON MAXIMUM CAPACITY.*
WEEKDAY - NIGHTTIME:	301	*BASED ON WEEKDAY STUDENT HEAD COUNT RANGE OF ~5-9% OF DAYTIME HOURLY MAX. REFER TO ABOVE TABLE.*
SATURDAY - DAYTIME:	93	*BASED ON MAXIMUM SATURDAY STUDENT HEAD COUNT FOR DAYTIME HOURS. REFER TO ABOVE TABLE.*
SATURDAY - NIGHTTIME:	N/A	*N/A, PER STUDENT HEAD COUNT*

PREDICTED PARKING GARAGE NOISE LEVELS

Distance from Source Center to Residential Property Line: 125 feet

	dBA Leq	Threshold	Exceeds
WEEKDAY - DAYTIME:	47	50	No
WEEKDAY - NIGHTTIME:	41	45	No
SATURDAY - DAYTIME:	36	50	No
SATURDAY - NIGHTTIME:	NA	NA	NA

**Calculated in accordance with FTA guidance using FTA's Noise Impact Assessment Spreadsheet (2018).*

SUMMARY OF PREDICTED NOISE LEVELS

SCENARIO	ROADWAY SEGMENT	VOLUME (ADT)	SPEED (MPH)	AHW	CNEL AT 50' FROM NTLCL	DISTANCE TO NOISE CONTOURS (FEET FROM ROAD CENTERLINE)			
						70	65	60	55
EXISTING WITHOUT PROJECT									
	SAN PABLO AVENUE, SOUTH OF CLINTON AVENUE	630	25	6	48.7	0	0	0	0
	GLENN AVENUE, SOUTH OF CLINTON AVENUE	1,230	25	6	51.6	0	0	0	0
	CAMBRIDGE AVENUE, WEST OF BLACKSTONE AVENUE	860	25	6	50.1	0	0	0	0
	BLACKSTONE AVENUE, SOUTH OF CAMBRIDGE AVENUE	22,150	40	44	66.4	0	112.5	227.3	482.4
EXISTING WITH PROJECT									
	SAN PABLO AVENUE, SOUTH OF CLINTON AVENUE	900	25	6	50.3	0	0	0	0
	GLENN AVENUE, SOUTH OF CLINTON AVENUE	1,660	25	6	52.9	0	0	0	0
	CAMBRIDGE AVENUE, WEST OF BLACKSTONE AVENUE	2,500	25	6	54.7	0	0	0	53.5
	BLACKSTONE AVENUE, SOUTH OF CAMBRIDGE AVENUE	23,810	40	44	66.8	66.9	117.2	238.1	506
FUTURE CUMULATIVE WITHOUT PROJECT									
	SAN PABLO AVENUE, SOUTH OF CLINTON AVENUE	630	25	6	48.7	0	0	0	0
	GLENN AVENUE, SOUTH OF CLINTON AVENUE	1,240	25	6	51.7	0	0	0	0
	CAMBRIDGE AVENUE, WEST OF BLACKSTONE AVENUE	880	25	6	50.2	0	0	0	0
	BLACKSTONE AVENUE, SOUTH OF CAMBRIDGE AVENUE	26,370	40	44	67.2	69.6	124.3	254.3	541.3
FUTURE CUMULATIVE WITH PROJECT									
	SAN PABLO AVENUE, SOUTH OF CLINTON AVENUE	900	25	6	50.3	0	0	0	0
	GLENN AVENUE, SOUTH OF CLINTON AVENUE	1,670	25	6	53.0	0	0	0	0
	CAMBRIDGE AVENUE, WEST OF BLACKSTONE AVENUE	2,520	25	6	54.7	0	0	0	53.8
	BLACKSTONE AVENUE, SOUTH OF CAMBRIDGE AVENUE	28,030	40	44	67.5	71.4	128.9	264.6	563.7

CHANGES IN PREDICTED TRAFFIC NOISE LEVELS WITH PROJECT IMPLEMENTATION

ROADWAY SEGMENT	CNEL AT 50' FROM NEAR-TRAVEL-LANE CENTERLINE					
	EXISTING WITHOUT PROJECT	EXISTING WITH PROJECT	CHANGE	FUTURE CUMULATIVE WITHOUT PROJECT	FUTURE CUMULATIVE WITH PROJECT	CHANGE
SAN PABLO AVENUE, SOUTH OF CLINTON AVENUE	48.7	50.3	1.6	48.7	50.3	1.6
GLENN AVENUE, SOUTH OF CLINTON AVENUE	51.6	52.9	1.3	51.7	53.0	1.3
CAMBRIDGE AVENUE, WEST OF BLACKSTONE AVENUE	50.1	54.7	4.6	50.2	54.7	4.6
BLACKSTONE AVENUE, SOUTH OF CAMBRIDGE AVENUE	66.4	66.8	0.3	67.2	67.5	0.3

NOISE MEASUREMENT SURVEY FORM

DATE:	21-May-19
NOISE MONITORING LOCATION	FRESNO CITY COLLEGE

MET CONDITIONS:	TEMP: 55-58 F. HUMIDITY: 67-70% WIND SPEED: 5-7 MPH SKY: OVERCAST GROUND: DRY
NOISE MONITORING EQUIPMENT:	LARSON DAVIS MODEL 820 LXT, TYPE I SLM

CALIBRATED PRIOR TO AND UPON COMPLETION OF MEASUREMENTS: YES

LOCATION	MONITORING PERIOD	LOCATION DESCRIPTION	NOISE LEVEL LEQ		LMAX	NOTES
1	0710-0720	N.CALAVERAS ST N. OF E. UNIV. AVE, AT PROPERTY LINE	58.2		69.3	VEH. TRAFFIC PRIMARY
2	0730-0740	E. UNIV. AVE, AT PROPERTY LINE	59.6		70.2	VEH. TRAFFIC PRIMARY
3	0750-0800	1607 E CAMBRIDGE AVE, AT PROPERTY LINE	56.9		68.3	VEH. TRAFFIC PRIMARY
4	0810-0820	1305 E YALE AVE, ~190' W. OF N. SAN PABLO AVE	53.8		56.7	BIRDS. DISTANT MECHANICAL EQUIPMENT
5	0830-0840	BLACKSTONE AVE AT E YALE AVE, ~80' FROM BLACKSTONE AVE CENTERLINE	67.3		79.4	VEH. TRAFFIC PRIMARY