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memorandum

date February 2, 2026

to BP Arlington
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cc

from Alan Sako, Principal, ESA

subject Memorandum on the adequacy of the Noise and Vibration Technical Report (2020) for the proposed Gas Station and Convenience Store

Introduction

Environmental Science Associates (ESA) prepared the *Noise and Vibration Technical Report (2020)* for BP Arlington for the proposed Arlington Project (the Project) located at the southeast corner of Arlington Avenue and Monroe Street in the City of Riverside, California. The report documented noise and groundborne vibration impacts resulting from the Project on nearby residences. A site plan was included in the *Noise and Vibration Technical Report* that depicted the features that would be constructed on the Project site including the proposed rectangular-shaped on-site building in a north-south orientation and positioned directly adjacent to Arlington Avenue.

Findings and Conclusions

The Project Applicant, BP Arlington, has notified ESA that the current design of the Project differs from the previous design that was analyzed in the *Noise and Vibration Technical Report*. The current design of the Project has the proposed rectangular-shaped on-site building rotated by 90 degrees in an east-west orientation. However, the building is in the same location as previously analyzed, which is directly adjacent to Arlington Avenue. The rotation of the building by 90 degrees would not result in any substantial changes to the Project's construction duration, construction or operational intensity, and would not alter the Project's noise or groundborne vibration sources and associated noise or groundborne vibration impacts that were analyzed in the *Noise and Vibration Technical Report*.

Therefore, this memorandum concludes that the analysis and findings in the *Noise and Vibration Technical Report* remain adequate for the Project and no revisions are warranted.

**GAS STATION AND COVENIENCE
STORE PROJECT
CITY OF RIVERSIDE, CALIFORNIA**
Noise and Vibration Impact Study

Prepared for
BP Arlington
7111 Indiana Avenue
Riverside, CA 92540

December 2020



ARLINGTON PROJECT CITY OF RIVERSIDE, CALIFORNIA

Noise and Vibration Impact Study

Prepared for
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RIVERSIDE ARLINGTON PROJECT

Noise and Vibration Impact Study

Executive Summary

BP Arlington is proposing to construct a 7-11 store with a taco restaurant on a 1.3-acre site at the southeast corner of Arlington Avenue and Monroe Street.

The purpose of this Noise and Vibration Impact Study is to assess and discuss the impacts of potential noise and vibration impacts that may occur with the implementation of the proposed project. The analysis describes the existing noise environment in the project area, estimates future projected noise levels at the noise-sensitive receptors proposed on the project site, and identifies the potential for significant noise and vibration impacts.

Project Construction

Based on City of Riverside Municipal Code Section 9.52.070, the project shall request exceptions to the standards set forth in Municipal Code Section 9.52.040 and 9.52.060 for construction-related events, to be approved by the City's Director of Building and Safety.

No mitigation measures for vibration impacts are required during project construction.

Project Operations

The following noise mitigation measures would be necessary for project operation:

1. A stand-alone noise barrier with a minimum height of 6 feet would be required along the eastern project property line to protect the outdoor active use areas, such as backyards, associated with the residences to the east of the project site.

No vibration mitigation measures would be necessary for project operation.

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RIVERSIDE ARLINGTON PROJECT

Noise and Vibration Impact Study

1. Introduction

This Noise and Vibration Impact Study is prepared by ESA to support a proposal for a 7-11 store with a taco restaurant, in the City of Riverside, California.

The project-specific analysis provided in this report assesses whether the implementation of the proposed project would have potentially significant noise impacts on existing residential uses adjacent to the project site.

1.1 Project Location

The project is located on the south side of Arlington Avenue on the southeast corner of the intersection of Arlington Avenue and Monroe Street in the City of Riverside, California (refer to **Figure 1**; all figures are provided in **Appendix A**).

1.2 Existing Conditions

The Project Site is bordered by Arlington Avenue to the north with commercial uses beyond, residential neighborhood to the east and south, and Monroe Street to the west with residences beyond.

1.3 Project Description

The project proposes to construct a 7-11 store with a taco restaurant on a 1.3-acre site. **Figure 2** shows the project's site plan. Access to the project site will be provided at Arlington Avenue and Monroe Street. Figure 2 illustrates the site access locations for the proposed project.

2. Noise Impact Study

2.1 Fundamentals of Noise

2.1.1 Noise Principles and Descriptors

Sound can be described as the mechanical energy of a vibrating object transmitted by pressure waves through a liquid or gaseous medium (e.g., air). Noise is generally defined as unwanted sound (i.e., loud, unexpected, or annoying sound). Acoustics is defined as the physics of sound. In acoustics, the fundamental scientific model consists of a sound (or noise) source, a receiver, and the propagation path between the two. The loudness of the noise source and obstructions, or atmospheric factors affecting the propagation path to the receiver determines the sound level and characteristics of the noise perceived by the receiver. Acoustics addresses primarily the propagation and control of sound.¹

Sound, traveling in the form of waves from a source, exerts a sound pressure level (referred to as sound level) that is measured in decibels (dB), which is the standard unit of sound amplitude measurement. The dB scale is a logarithmic scale that describes the physical intensity of the pressure vibrations that make up any sound, with 0 dB corresponding roughly to the threshold of human hearing and 120 to 140 dB corresponding to the threshold of feeling and pain, respectively. Pressure waves traveling through air exert a force registered by the human ear as sound.²

Sound pressure fluctuations can be measured in units of hertz (Hz), which correspond to the frequency of a particular sound. Typically, sound does not consist of a single frequency, but rather a broad band of frequencies varying in levels of magnitude, with audible frequencies of the sound spectrum ranging from 20 to 20,000 Hz. The sound pressure level, therefore, constitutes the additive force exerted by a sound corresponding to the sound frequency/sound power level spectrum.³ The typical human ear is not equally sensitive to this frequency range. As a consequence, when assessing potential noise impacts, sound is measured using an electronic filter that deemphasizes the frequencies below 1,000 Hz and above 5,000 Hz in a manner corresponding to the human ear's decreased sensitivity to these extremely low and extremely high frequencies. This method of frequency filtering, or weighting, is referred to as A-weighting, expressed in units of A-weighted decibels (dBA), which is typically applied to community noise measurements.⁴ Some representative common outdoor and indoor noise sources and their corresponding A-weighted noise levels are shown in **Figure 3**.

2.1.2 Noise Exposure and Community Noise

An individual's noise exposure is a measure of noise over a period of time; a noise level is a measure of noise at a given instant in time, as presented Figure 3. However, noise levels rarely persist at one level over a long period of time. Rather, community noise varies continuously over

¹ M. David Egan, *Architectural Acoustics* (1988), Chapter 1.

² M. David Egan, *Architectural Acoustics* (1988), Chapter 1.

³ M. David Egan, *Architectural Acoustics* (1988), Chapter 1.

⁴ M. David Egan, *Architectural Acoustics* (1988), Chapter 1.

a period of time with respect to the sound sources contributing to the community noise environment. Community noise is primarily the product of many distant noise sources, which constitute a relatively stable background noise exposure, with many of the individual contributors unidentifiable. The background noise level changes throughout a typical day, but does so gradually, corresponding with the addition and subtraction of distant noise sources, such as changes in traffic volume. What makes community noise variable throughout a day, besides the slowly changing background noise, is the addition of short-duration, single-event noise sources (e.g., aircraft flyovers, motor vehicles, sirens), which are readily identifiable to the individual.⁵

These successive additions of sound to the community noise environment change the community noise level from instant to instant, requiring the noise exposure to be measured over periods of time to legitimately characterize a community noise environment and evaluate cumulative noise impacts. The following noise descriptors are used to characterize environmental noise levels over time, which are applicable to the project.⁶

- L_{eq} : The equivalent sound level, is used to describe noise over a specified period of time in terms of a single numerical value; the L_{eq} of a time-varying signal and that of a steady signal are the same if they deliver the same acoustic energy over a given time. The L_{eq} may also be referred to as the average sound level.
- L_{max} : The maximum, instantaneous noise level experienced during a given period of time.
- L_{min} : The minimum, instantaneous noise level experienced during a given period of time.
- L_x : The noise level exceeded a percentage of a specified time period. For instance, L_{50} and L_{90} represent the noise levels that are exceeded 50 percent and 90 percent of the time, respectively.
- L_{dn} : The average A-weighted noise level during a 24-hour day, obtained after an addition of 10 dB to measured noise levels between the hours of 10 p.m. to 7 a.m. to account nighttime noise sensitivity. The L_{dn} is also termed the day-night average noise level (DNL).
- CNEL: The Community Noise Equivalent Level (CNEL) is the average A-weighted noise level during a 24-hour day that is obtained after an addition of 5 dB to measured noise levels between the hours of 7 p.m. to 10 p.m. and after an addition of 10 dB to noise levels between the hours of 10 p.m. to 7 a.m. to account for noise sensitivity in the evening and nighttime, respectively. CNEL and L_{dn} are close to each other, with CNEL being more stringent and generally 1 dB higher than L_{dn} .

⁵ California Department of Transportation, *Technical Noise Supplement (TeNS)* (September 2013), Section 2.2.2.1.

⁶ California Department of Transportation, *Technical Noise Supplement (TeNS)* (September 2013), Section 2.2.2.2.

2.1.3 Effects of Noise on People

Noise is generally loud, unpleasant, unexpected, or undesired sound that is typically associated with human activity that is a nuisance, or disruptive. The effects of noise on people can be placed into four general categories:

- Subjective effects (e.g., dissatisfaction, annoyance);
- Interference effects (e.g., communication, sleep, and learning interference);
- Physiological effects (e.g., startle response); and
- Physical effects (e.g., hearing loss).

Although exposure to high noise levels has been demonstrated to cause physical and physiological effects, the principal human responses to typical environmental noise exposure are related to subjective effects and interference with activities. Interference effects interrupt daily activities and include interference with human communication activities, such as normal conversations, watching television, telephone conversations, and interference with sleep. Sleep interference effects can include both awakening and arousal to a lesser state of sleep.⁷

With regard to the subjective effects, the responses of individuals to similar noise events are diverse and influenced by many factors, including the type of noise, the perceived importance of the noise, the appropriateness of the noise to the setting, the duration of the noise, the time of day and the type of activity during which the noise occurs, and individual noise sensitivity. Overall, there is no completely satisfactory way to measure the subjective effects of noise, or the corresponding reactions of annoyance and dissatisfaction on people. A wide variation in individual thresholds of annoyance exists, and different tolerances to noise tend to develop based on an individual's past experiences with noise. Thus, an important way of predicting a human reaction to a new noise environment is the way it compares to the existing environment to which one has adapted (i.e., comparison to the ambient noise environment). In general, the more a new noise level exceeds the previously existing ambient noise level, the less acceptable the new noise level will be judged by those hearing it. With regard to increases in A-weighted noise level, the following relationships generally occur:⁸

- Except in carefully controlled laboratory experiments, a change of 1 dBA in ambient noise levels cannot be perceived;
- Outside of the laboratory, a 3 dBA change in ambient noise levels is considered to be a barely perceivable difference;
- A change in ambient noise levels of 5 dBA is considered to be a readily perceivable difference; and
- A change in ambient noise levels of 10 dBA is subjectively heard as doubling of the perceived loudness.

⁷ California Department of Transportation, *Technical Noise Supplement (TeNS)* (September 2013), Section 2.2.1.

⁸ California Department of Transportation, *Technical Noise Supplement (TeNS)* (September 2013), Section 2.2.1.

These relationships occur in part because of the logarithmic nature of sound and the decibel scale. The human ear perceives sound in a non-linear fashion; therefore, the dBA scale was developed. Because the dBA scale is based on logarithms, two noise sources do not combine in a simple additive fashion, but rather logarithmically. Under the dBA scale, a doubling of sound energy corresponds to a 3 dBA increase. In other words, when two sources are each producing sound of the same loudness, the resulting sound level at a given distance would be approximately 3 dBA higher than one of the sources under the same conditions. For example, if two identical noise sources produce noise levels of 50 dBA, the combined sound level would be 53 dBA, not 100 dBA. Three sources of equal loudness together produce a sound level of approximately 5 dBA louder than one source, and 10 sources of equal loudness together produce a sound level of approximately 10 dBA louder than the single source.⁹

2.1.4 Noise Attenuation

When noise propagates over a distance, the noise level reduces with distance depending on the type of noise source and the propagation path. Noise from a localized source (i.e., point source) propagates uniformly outward in a spherical pattern, referred to as “spherical spreading.” Stationary point sources of noise, including stationary mobile sources such as idling vehicles, attenuate (i.e., reduce) at a rate between 6 dBA for acoustically “hard” sites and 7.5 dBA for “soft” sites for each doubling of distance from the reference measurement, as their energy is continuously spread out over a spherical surface (e.g., for hard surfaces, 80 dBA at 50 feet attenuates to 74 at 100 feet, 68 dBA at 200 feet, etc.). Hard sites are those with a reflective surface between the source and the receiver, such as asphalt, or concrete, surfaces, or smooth bodies of water. No excess ground attenuation is assumed for hard sites and the reduction in noise levels with distance (drop-off rate) is simply the geometric spreading of the noise from the source. Soft sites have an absorptive ground surface, such as soft dirt, grass, or scattered bushes and trees, which in addition to geometric spreading, provides an excess ground attenuation value of 1.5 dBA (per doubling distance).¹⁰

Roadways and highways consist of several localized noise sources on a defined path, and hence are treated as “line” sources, which approximate the effect of several point sources. Noise from a line source propagates over a cylindrical surface, often referred to as “cylindrical spreading.”¹¹ Line sources (e.g., traffic noise from vehicles) attenuate at a rate between 3 dBA for hard sites and 4.5 dBA for soft sites for each doubling of distance from the reference measurement.¹² Therefore, noise due to a line source attenuates less with distance than that of a point source with increased distance.

Additionally, receptors located downwind from a noise source can be exposed to increased noise levels relative to calm conditions, whereas locations upwind can have lowered noise levels. Atmospheric temperature inversion (i.e., increasing temperature with elevation) can increase

⁹ California Department of Transportation, *Technical Noise Supplement (TeNS)* (September 2013), Section 2.2.1.1.

¹⁰ California Department of Transportation, *Technical Noise Supplement (TeNS)* (September 2013), Section 2.1.4.2.

¹¹ California Department of Transportation, *Technical Noise Supplement (TeNS)* (September 2013), Section 2.1.4.1.

¹² California Department of Transportation, *Technical Noise Supplement (TeNS)* (September 2013), Section 2.1.4.1.

sound levels at long distances (e.g., more than 500 feet). Other factors such as air temperature, humidity, and turbulence can also have significant effects on noise levels.¹³

2.2 Existing Conditions

Some land uses are considered more sensitive to ambient noise levels than others are, due to the amount of noise exposure (in terms of both exposure duration and insulation from noise) and the types of activities typically involved. Residential areas are considered to be the most sensitive type of land use to noise and industrial/commercial areas are considered to be the least sensitive. Existing noise sensitive uses on the project site and in the immediate vicinity include:

- On-site: vacant land
- To the north: Arlington Avenue, then commercial uses; 100 feet
- To the south: residential uses; 50 feet
- To the west: Monroe Street, then residential uses; 100 feet
- To the east: Residential uses; 50 feet

2.2.1 Ambient Noise Levels

The predominant existing noise source on the Project Site and surrounding areas is traffic noise from Arlington Avenue and other secondary streets.

2.3 Regulatory Setting

A number of statutes, regulations, plans, and policies that address noise concerns have been adopted. Below is a discussion of the relevant regulatory setting and noise regulations, plans, and policies.

2.3.1 State

California Code of Regulations (CCR) Title 24 establishes the California Building Code (CBC). The most recent building standard adopted by the legislature and used throughout the state is the 2016 version, which took effect on January 1, 2017. The State of California's noise insulation standards are codified in the CBC (Title 24, Part 2, Chapter 12). These noise standards are for new construction in California for the purposes of interior compatibility with exterior noise sources. The regulations specify that acoustical studies must be prepared when noise-sensitive structures, such as residences, schools, or hospitals, are near major transportation noises, and where such noise sources create an exterior noise level of 60 dBA CNEL, or higher. Acoustical studies that accompany building plans must demonstrate that the structure has been designed to limit interior noise in habitable rooms to acceptable noise levels. For new residential buildings, schools, and hospitals, the acceptable interior noise limit for new construction is 45 dBA CNEL.

¹³ California Department of Transportation, *Technical Noise Supplement (TeNS)* (September 2013), Section 2.1.4.3.

2.3.2 Local

The proposed project is located within the City of Riverside. Applicable City of Riverside noise standards and policies are described below.

2.3.3 City of Riverside

Municipal Code Noise Ordinance. Chapter 7.25 - NUISANCE EXTERIOR SOUND LEVEL LIMITS of the City's Municipal Code establishes exterior noise level limits from operational or stationary sources.

Table 1 lists the exterior noise level limits. **Table 2** shows the Land Use Category/Zoning Matrix.

7.25.010 - Exterior sound level limits.

- A. Unless a variance has been granted as provided in this title, it shall be unlawful for any person to cause or allow the creation of any noise which exceeds the following:
 1. The exterior noise standard of the applicable land use category, up to five decibels, for a cumulative period of more than 30 minutes in any hour; or
 2. The exterior noise standard of the applicable land use category, plus five decibels, for a cumulative period of more than 15 minutes in any hour; or
 3. The exterior noise standard of the applicable land use category, plus ten decibels, for a cumulative period of more than five minutes in any hour; or
 4. The exterior noise standard of the applicable land use category, plus 15 decibels, for the cumulative period of more than one minute in any hour; or
 5. The exterior noise standard for the applicable land use category, plus 20 decibels or the maximum measured ambient noise level, for any period of time.
- B. If the measured ambient noise level exceeds that permissible within any of the first four noise limit categories, the allowable noise exposure standard shall be increased in five decibel increments in each category as appropriate to encompass the ambient noise level. In the event the ambient noise level exceeds the fifth noise limit category, the maximum allowable noise level under said category shall be increased to reflect the maximum ambient noise level.
- C. If possible, the ambient noise level shall be measured at the same location along the property line with the alleged offending noise source inoperative. If for any reason the alleged offending noise source cannot be shut down, then the ambient noise must be estimated by performing a measurement in the same general area of the source but at a sufficient distance that the offending noise is inaudible. If the measurement location is on the boundary between two different districts, the noise shall be the arithmetic mean of the two districts.
- D. Where the intruding noise source is an air-conditioning unit or refrigeration system which was installed prior to the effective date of this title, the exterior noise level when measured at the property line shall not exceed 60 dBA for units installed before 1-1-80 and 55 dBA for units installed after 1-1-80.

**TABLE 1
EXTERIOR NOISE STANDARDS**

Land Use Category	Time Period	Noise Level
Residential	Night (10:00 p.m. to 7:00 a.m.)	45 dBA
	Day (7:00 a.m. to 10:00 p.m.)	55 dBA
Office/commercial	Any time	65 dBA
Industrial	Any time	70 dBA
Community support	Any time	60 dBA
Public recreation facility	Any time	65 dBA
Nonurban	Any time	70 dBA

**TABLE 2
LAND USE CATEGORY/ZONING MATRIX**

Land Use Category	Underlying Zone
Residential	RE, RA-5, RR, RC, R-1-1/2 acre, R-1-13000, R-1-10500, R-1-8500, R-1-7000, R-3-2500, R-3-4000, R-3-3000, R-3-2000, R-3-1500, R-4
Office/commercial	O, CRC, CR-NC, CR, CG
Industrial	BMP, I, AIR
Community support	Any permitted zone
Nonurban	Any permitted zone

(Ord. 7489 § 20, 21(Exh. A), 2019; Ord. 6967 § 5, 2007; Ord. 6273 § 1 (part), 1996)

Chapter 7.30 - NUISANCE INTERIOR SOUND LEVEL LIMITS of the City's Municipal Code establishes interior noise level limits from operational or stationary sources. **Table 3** lists the interior noise level limits.

7.30.015 - Interior sound level limits.

- A. No person shall operate or cause to be operated, any source of sound indoors which causes the noise level, when measured inside another dwelling unit, school or hospital, to exceed:
1. The interior noise standard for the applicable land category area, up to five decibels, for a cumulative period of more than five minutes in any hour;
 2. The interior noise standard for the applicable land use category, plus five decibels, for a cumulative period of more than one minute in any hour;
 3. The interior noise standard for the applicable land use category, plus ten decibels or the maximum measured ambient noise level, for any period of time.
- B. If the measured interior ambient noise level exceeds that permissible within the first two noise limit categories in this section, the allowable noise exposure standard shall be increased in five decibel increments in each category as appropriate to reflect the interior ambient noise level. In the event the interior ambient noise level exceeds the third noise limit category, the maximum allowable interior noise level under said category shall be increased to reflect the maximum interior ambient noise level.

- C. The interior noise standard for various land use districts shall apply, unless otherwise specifically indicated, within structures located in designated zones with windows opened or closed as is typical of the season.

**TABLE 3
INTERIOR NOISE STANDARD**

Land Use Category	Time Period	Noise Level
Residential	Night (10 p.m. to 7 a.m.)	35 dBA
	Day (7 a.m. to 10 p.m.)	45 dBA
School	7 a.m. to 10 p.m. (while school is in session)	45 dBA
Hospital	Any time	45 dBA

Chapter 7.35 - EXEMPTIONS of the City's Municipal Code lists several occurrences of sound event that are exempt from the provisions of noise level limits identified in the Municipal Code, including construction activity during the permitted daytime hours.

7.35.020 - Exemptions.

Noise associated with construction activities that occur within the permitted hours shall be exempt from the provisions of the Municipal Code Noise Ordinance:

Construction. Noise sources associated with construction, repair, remodeling, or grading of any real property; provided a permit has been obtained from the City as required; and provided said activities do not take place between the hours of 7:00 p.m. and 7:00 a.m. on weekdays, between the hours of 5:00 p.m. and 8:00 a.m. on Saturdays, or at any time on Sunday or a federal holiday.

Noise Element of the General Plan. The California Government Code Section 65302(g) requires that a noise element be included in the General Plan of each county and city in the State. The Noise Element of the City of Riverside General Plan is intended to provide a systematic approach to identifying and appraising noise problems in the community; quantifying existing and projected noise levels; addressing excessive noise exposure; and community planning for the regulation of noise. The City's primary goal with regard to community noise is to ensure that noise-producing land uses would be compatible with adjacent land uses. To this end, the Noise Element establishes noise/land use compatibility guidelines based on cumulative noise criteria for outdoor noise. The City's Noise Element states that, the interior noise level in residential dwellings shall not exceed 45 dBA L_{dn} /CNEL. The exterior noise level shall not exceed 65 dBA L_{dn} /CNEL in outdoor active use areas. For commercial uses, the exterior noise threshold is 70 dBA CNEL under normally acceptable condition and 75 dBA CNEL under the conditionally acceptable condition.

2.4 Significance Thresholds

Pursuant to *CEQA Guidelines* Appendix G, the project would result in a significant impact related to noise and vibration if it would expose people to or generate noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies.

For the purposes of this analysis and consistency with *CEQA Guidelines* Appendix G, applicable local plans, and agency and professional standards, the project would have a significant impact to noise and/or ground-borne vibration if it would:

- Generate 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;
- Generate excessive ground-borne vibration or ground-borne noise levels; or
- Expose people residing or working in the project area to excessive noise levels (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) (refer to Environmental Checklist 13c in Appendix A, *Initial Study*).

The proposed project would result in no impacts relevant to airport land use plans, airports, or private airstrips; therefore, these issues do not require further analysis in this study.

2.5 Methodology

During operation of the project, noise levels would be generated from offsite mobile noise sources such as vehicular traffic and onsite stationary sources such as loading/unloading activities and vehicles in the parking areas. The noise levels generated by mobile noise sources are assessed in this study with the Federal Highway Administration (FHWA) approved traffic noise source noise modeling guidelines. For stationary sources, equipment source noise levels included in the FHWA Roadway Construction Noise Model (RCNM, FHWA 2006) are used for the impact analysis.

2.6 Environmental Impacts

The project would not result in the exposure of persons to, or generation of, noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies. (*Less-than-Significant Impact*)

2.6.1 Project Construction

This section includes an overview of the typical methods, equipment, and work force that would be used for construction of the Proposed Project. Unless otherwise noted, construction activities are anticipated to occur between the hours of 7 a.m. and 7 p.m., Monday through Friday, consistent with the City of Riverside Noise Ordinance. If construction is required on one of more Saturdays, construction activities will be limited to the hours between 8 a.m. and 5 p.m., also consistent with the Noise Ordinance.

Construction Phasing

Site preparation and grading activities will typically include the following construction equipment:¹⁴

- Dozer, Grader, Scraper, Jack hammer, Compactor, Work trucks, Haul/dump trucks, and Water trucks.

Below-grade construction activities will typically include the following construction equipment:

- Excavator, Backhoe, Cement truck, Work trucks, Haul/dump trucks, and Water trucks.

Above-grade construction activities will typically include the following construction equipment:

- Bucket truck or manlift, Line truck, Large Crane, Stringing rig, Portable generator, Work trucks, and Water trucks.

During construction, some phases would overlap (e.g., Below Grade, Above Grade, Paving), maximum daily construction vehicle trips would be as many as 130 trips (workers, haul trucks, etc.).

Typical Construction Equipment

Short-term noise impacts would be associated with excavation, grading, paving, and underground construction during construction of the proposed project. Construction-related short-term noise levels would be higher than existing ambient noise levels in the project area today but would no longer occur once construction of the project is completed.

Construction crew commutes and the transport of construction equipment and materials to the site for the proposed project would incrementally increase noise levels on access roads leading to the site. Although there would be a relatively high single-event noise-exposure potential causing intermittent noise nuisance (passing trucks at 50 feet would generate up to a maximum of 87 dBA L_{max}), the effect on longer-term (hourly or daily) ambient noise levels would be small. Therefore, short-term construction-related impacts associated with worker commute and equipment transport to the project site would be less than significant.

As stated earlier, maximum daily construction vehicle trips would be 130 trips. This level of vehicular trips would not contribute measurably to E. Arlington Avenue. Therefore, construction traffic would not result in any significant off-site noise impact.

The second type of short-term noise impact is related to noise generated during site preparation and onsite construction on the project site. Construction is completed in discrete steps, each of which has its own mix of equipment, and consequently, its own noise characteristics. These various sequential phases would change the character of the noise generated on the site, and therefore, the noise levels surrounding the site as construction progresses. Despite the variety in the type and size of construction equipment, similarities in the dominant noise sources and patterns of operation allow construction-related noise ranges to be categorized by work phase.

¹⁴ Not all equipment would necessarily be needed, and not all equipment would be used simultaneously.

Table 4 lists typical construction equipment noise levels recommended for noise impact assessments, based on a distance of 50 feet between the equipment and a noise receptor, taken from the FHWA Roadway Construction Noise Model (RCNM) (FHWA 2006).

TABLE 4
RCNM DEFAULT NOISE EMISSION REFERENCE LEVELS AND USAGE FACTORS

Equipment Description	Impact Device?	Acoustical Usage Factor	Spec. 721.560 L _{max} at 50 Feet (dBA, slow)	Actual Measured L _{max} at 50 Feet (dBA, slow)	Number of Actual Data Samples (Count)
All other equipment >5 HP	No	50	85	N/A	0
Auger drill rig	No	20	85	84	36
Backhoe	No	40	80	78	372
Bar bender	No	20	80	N/A	0
Blasting	Yes	N/A	94	N/A	0
Boring jack power unit	No	50	80	83	1
Chain saw	No	20	85	84	46
Clam shovel (dropping)	Yes	20	93	87	4
Compactor (ground)	No	20	80	83	57
Compressor (air)	No	40	80	78	18
Concrete batch plant	No	15	83	N/A	0
Concrete mixer truck	No	40	85	79	40
Concrete pump truck	No	20	82	81	30
Concrete saw	No	20	90	90	55
Crane	No	16	85	81	405
Dozer	No	40	85	82	55
Drill rig truck	No	20	84	79	22
Drum mixer	No	50	80	80	1
Dump truck	No	40	84	76	31
Excavator	No	40	85	81	170
Flatbed truck	No	40	84	74	4
Frontend loader	No	40	80	79	96
Generator	No	50	82	81	19
Generator (<25 kVA, variable-message signs)	No	50	70	73	74
Gradall	No	40	85	83	70
Grader	No	40	85	N/A	0
Grapple (on backhoe)	No	40	85	87	1
Horizontal boring hydraulic jack	No	25	80	82	6
Hydra break ram	Yes	10	90	N/A	0
Impact derive	Yes	20	95	101	11
Jackhammer	Yes	20	85	89	133
Man lift	No	20	85	75	23
Mounted impact hammer (hoe ram)	Yes	20	90	90	212

TABLE 4
RCNM DEFAULT NOISE EMISSION REFERENCE LEVELS AND USAGE FACTORS

Equipment Description	Impact Device?	Acoustical Usage Factor	Spec. 721.560 L_{\max} at 50 Feet (dBA, slow)	Actual Measured L_{\max} at 50 Feet (dBA, slow)	Number of Actual Data Samples (Count)
Pavement scarifier	No	20	85	90	2
Paver	No	50	85	77	9
Pickup truck	No	40	55	75	1
Pneumatic tools	No	50	85	85	90
Pumps	No	50	77	81	17
Refrigerator unit	No	100	82	73	3
Rivet buster/chipping gun	Yes	20	85	79	19
Rock drill	No	20	85	81	3
Roller	No	20	85	80	16
Sand blasting (single nozzle)	No	20	85	96	9
Scraper	No	40	85	84	12
Sheers (on backhoe)	No	40	85	96	5
Slurry plant	No	100	78	78	1
Slurry trench machine	No	50	82	80	75
Soil mix drill rig	No	50	80	N/A	0
Tractor	No	40	84	N/A	0
Vacuum excavator (vac-truck)	No	40	85	85	149
Vacuum street sweeper	No	10	80	82	19
Ventilation fan	No	100	85	79	13
Vibrating hopper	No	50	85	87	1
Vibratory concrete mixer	No	20	80	80	1
Vibratory pile driver	No	20	95	101	44
Warning horn	No	5	85	83	12
Welder/torch	No	40	73	74	5

SOURCE: Federal Highway Administration, *Highway Construction Noise Handbook* (2006), Table 9.1.

dBA = A-weighted decibels; HP = horsepower; N/A = not applicable

Construction of the proposed project is expected to require the use of various equipment that would be used on the project site. Based on the information in Table 4, the maximum noise level generated by each piece of equipment that could be used on the proposed project site is shown below:

- **Bulldozer:** 82 dBA L_{\max} at 50 feet, 40 percent usage factor
- **Water and pickup trucks:** 75 dBA L_{\max} at 50 feet, 40 percent usage factor
- **Concrete pump truck:** 81 dBA L_{\max} at 50 feet, 20 percent usage factor
- **Excavators:** 81 dBA L_{\max} at 50 feet, 40 percent usage factor
- **Concrete mix truck:** 79 dBA L_{\max} at 50 feet, 40 percent usage factor

- **Front-end loader:** 79 dBA L_{max} at 50 feet, 40 percent usage factor
- **Backhoe:** 78 dBA L_{max} at 50 feet, 40 percent usage factor
- **Forklift:** 75 dBA L_{max} at 50 feet, 40 percent usage factor
- **Grader:** 85 dBA L_{max} at 50 feet, 40 percent usage factor
- **Scraper:** 84 dBA L_{max} at 50 feet, 40 percent usage factor
- **Jack hammer:** 89 dBA L_{max} at 50 feet, 20 percent usage factor
- **Compactor:** 83 dBA L_{max} at 50 feet, 20 percent usage factor
- **Truck-mounted crane:** 75 dBA L_{max} at 50 feet, 16 percent usage factor
- **Large crane:** 81 dBA L_{max} at 50 feet, 16 percent usage factor
- **Portable generator:** 73 dBA L_{max} at 50 feet, 50 percent usage factor

The site preparation phase tends to generate the highest noise levels because the noisiest construction equipment is earthmoving equipment. Earthmoving equipment includes excavating machinery such as backfillers, bulldozers, and front loaders. Earthmoving and compacting equipment include compactors, scrapers, and graders. Typical operating cycles for these types of construction equipment may involve 1 or 2 minutes of full-power operation followed by 3 or 4 minutes at lower power settings. While the operating cycles may involve 1 or 2 minutes of full power operation (generating the maximum sound levels identified in Table 4), the equipment would be moving around and would not stay at a specific location for the entire cycle. Therefore, adjacent receivers would be exposed to the maximum noise level intermittently rather than continuously.

Site preparation and grading activities will typically include the following construction equipment: Dozer (82 dBA at 50 feet, 40 percent UF), Grader (85 dBA, 40 percent UF), Scraper (84 dBA, 40 percent UF), Jack hammer (89 dBA, 20 percent UF), Compactor (83 dBA, 20 percent UF), Work trucks (75 dBA, 40 percent UF), Haul/dump trucks (79 dBA, 40 percent UF), and Water trucks (75 dBA, 40 percent UF).

It is anticipated that up to six pieces of equipment would be in operation on the project site at the same time, even though not all six pieces of equipment would be operating at full power at the same time due to individual usage factor. Each doubling of the sound sources with equal strength increases the noise level by 3 dBA. Assuming that each piece of construction equipment operates at some distance from the other equipment, the worst-case combined noise level during this phase of construction would be $(79 + 82 + 83 + 84 + 85 + 89 = 93)$ dBA L_{max} at a distance of 50 feet from the active construction area. Including the individual usage factor for each piece of the equipment operating over a period of one hour, the combined equivalent continuous noise level from these six pieces of equipment would result in 87 dBA L_{eq} at a distance of 50 feet.

Existing noise sensitive uses (residences) in the immediate vicinity include:

- To the west: 100 feet
- To the south: 50 feet
- To the east: 50 feet

As stated previously, sound levels are generated from a source, and their decibel level decreases as the distance from that source increases. Sound dissipates exponentially with distance from the noise source. For a single point source, sound levels decrease approximately 6 dBA for each doubling of distance from the source. This drop-off rate is appropriate for noise generated by stationary equipment. If noise is produced by a line source, such as highway traffic or railroad operations, the sound decreases 3 dBA for each doubling of distance in a hard site environment. Line source noise in a relatively flat environment with absorptive vegetation decreases 4.5 dBA for each doubling of distance. Existing residential uses that are located at 100 feet (-6 dBA relative to the noise level at 50 feet) from the project site boundary would receive a noise reduction of 6 dBA with the distance attenuation.

Construction on the project site would expose the nearest noise-sensitive uses in the project vicinity to noise levels reaching up to 93 dBA L_{max} or 87 dBA Leq over a period of one hour for the existing residences to the east and south in the project vicinity. During other construction phases, noise associated with on-site activity would be lower than those during the grading period.

Construction noise is temporary and will cease to occur after completion of the project construction. It is considered best practice that all construction, maintenance, or demolition activities within the City's boundary be limited to the hours between 7 a.m. and 7 p.m., Monday through Friday, and 8 a.m. to 5 p.m. on Saturday. No construction work should occur on Sundays and federal holidays.

Project Design Features for Noise Abatement

The following Project Design Features measures apply to the proposed project and will help to reduce and avoid potential impacts related to noise:

PDF 2-1: Control of Construction Hours. Construction activities occurring as part of the project shall be subject to the limitations which states that construction activities may occur between 7:00 a.m. and 7:00 p.m. Mondays through Fridays, and between 8:00 a.m. and 5:00 p.m. on Saturdays. No construction activities shall be permitted outside of these hours or on Sundays and federal holidays unless a temporary waiver is granted by the Chief Building Official or his or her authorized representative.

PDF 2-2: Prior to issuance of grading permits, the City/project applicant shall incorporate the following measures as a note on the grading plan cover sheet to ensure that the greatest distance between noise sources and sensitive receptors during construction activities have been achieved.

- Construction equipment, fixed or mobile, shall be equipped with properly operating and maintained noise mufflers consistent with manufacturers' standards.
- Construction staging areas shall be located away from off-site sensitive uses during project construction.
- The project contractor shall place all stationary construction equipment so that emitted noise is directed away from sensitive receptors nearest the project site, whenever feasible.

2.6.2 Project Operations

This section describes the activities relating to operation of the Proposed Project; including project-related vehicular traffic and any onsite noise-generating equipment and activity.

Traffic Noise Impacts on Off-Site Land Uses

To characterize the project area's future day/night noise environment, the noise levels attributed to future traffic volumes on local roadways were estimated using a spreadsheet model developed based on the methodologies provided in FHWA Traffic Noise Model (TNM) Technical Manual.¹⁵ In addition, the Caltrans Technical Noise Supplement (TeNS) document states that the peak hour traffic noise level would be equivalent to the L_{dn} level based on the assumptions of (1) the peak hour traffic volume would be 10 percent of the average daily traffic volume, and (2) the split of daytime and nighttime average daily traffic volume is 85/15 percent.¹⁶ Further, the CNEL level would be 0.3 dBA higher than L_{dn} level based on the assumption of 80 percent in daytime and 5 percent in evening time.

According to City of Riverside 24 Hours Volume Counts (accessed on December 1, 2020), the average daily traffic count (ADT) on Arlington Avenue at Monroe-Adams Street was 26,998 vehicles, and the ADT on Monroe Street at Colorado Street Was 5,924 vehicles. The proposed project would generate a total of 5,555 daily trips, based on the adjusted average daily trips generated by the CalEEMod model in the air quality modeling with the proposed land uses on the project site. The project generated daily trips would contribute to 17 percent of the total ADT (32,553) on E. Arlington Avenue, and increase the traffic noise level 0.8 dBA. This level of noise increases is not perceptible to the human in an outdoor environment. Along Monroe Street, project-related traffic, if we assume the worst case scenario that the entire project daily trips would use Monroe Street as ingress and egress, would contribute to almost 3 dBA increase, due to the traffic volumes almost double when project-related traffic trips (5,555) are added to the existing traffic trips (5,924). However, under this worst case scenario, total daily traffic trips on Monroe Street (11,479) would still not result in the 65 dBA CNEL/ L_{dn} noise contour to impact residences along the west side of Monroe Street, no significant traffic noise impacts would occur. Other roadway segments that have noise level changes less than the 3 dBA increase normally considered to have potentially significant noise impact would not have any project-related traffic noise impacts. Therefore, no significant traffic noise impact would occur from the implementation of the Project.

Noise Impacts from On-site Land Uses

The proposed 7-11 store and the taco restaurant would have customers coming to the project site, with slow-moving vehicles looking for a parking space. After getting what they need from the 7-11 store or finishing eating at the taco restaurant, people get in to their car and drive off. This pattern of vehicle movement is similar to those vehicles getting fuels at the fueling stations. There

¹⁵ FHWA, *Federal Highway Administration's Traffic Noise Model, Version 1.0 Technical Manual* (February 1998). https://www.fhwa.dot.gov/environment/noise/traffic_noise_model/old_versions/tnm_version_10/tech_manual/index.cfm.

¹⁶ California Department of Transportation, *Technical Noise Supplement to the Traffic Noise Analysis Protocol* (September 2013). http://www.dot.ca.gov/hq/env/noise/pub/TeNS_Sept_2013B.pdf.

will be noise-generating activities, such as loading/unloading, slow-moving vehicles, engine-starting before vehicles driving off, customer conversation in the parking area or at the fueling stations.

Residences to the east are the closest off-site noise-sensitive uses that would be located at 50 feet from the onsite parking activity and slow-moving vehicles. They are also close to the trash enclosure where the trash pickup would occur. However, these residences would be more than 120 feet from the potential store-front loading/unloading area. Residences to the south are approximately 100 feet away from these activities and would receive at least a 6 dBA noise reduction when compared to the noise level experienced at 50 feet. These residences are also more than 150 feet away from the potential store-front loading/unloading area.

Loading/unloading activity generates approximately 75 dBA at a distance of 50 feet. Slow-moving vehicles generate approximately 60 to 65 dBA when passing at a distance of 15 feet. Engine start-up generate approximately 70 to 75 dBA at 15 feet. Customer conversation results in approximately 65 to 70 dBA at a distance of 5 feet. At a distance of 50 feet, the noise level at 15 feet would be attenuated by 10 dBA, and the noise level at 5 feet would be attenuated by 20 dBA. At a distance of 120 feet, the noise level would be reduced by 8 dBA when compared to the noise level at 50 feet. Therefore, slow-moving vehicles would result in noise levels up to 55 dBA at the nearest residences to the east and south. Engine start-up would result in noise levels up to 65 dBA at the nearest residences to the east and south. Customer conversation would result in noise levels up to 60 dBA at the nearest residences to the east and south. Loading/unloading activity noise would be reduced to 67 dBA at 120 feet and 65 dBA at 150 feet. However, loading/unloading activity would occur only during the daytime hours.

The City's Municipal Code states that, for noise-generating events that last a cumulative period of more than one minute (but less than 5 minutes) in any hour, the exterior noise standard of the residential uses would be 55 dBA plus 15 dBA during daytime hours (7 a.m. to 10 p.m.), or 70 dBA, and 45 dBA plus 15 dBA during the nighttime hours (10 p.m. to 7 a.m. next morning), or 60 dBA. Noise associated with engine start-up before vehicles driving off would potentially exceed the noise threshold for nighttime hours. It is therefore recommended that a stand-alone noise barrier with a minimum height of 6 feet be constructed along the project's eastern property line.

Traffic Noise Impacts on On-site Land Uses

The project proposes a 7-11 store with taco restaurant, both commercial uses on the project site that could be exposed to traffic noise from vehicular traffic on Arlington Avenue.

Based on the U.S. EPA Levels Document, standard buildings in warm climate areas would provide a 24 dBA exterior-to-interior noise attenuation with windows and doors closed, and 12 dBA noise attenuation with windows open.

2.7 Noise Mitigation Measures

2.7.1 Project Construction

No mitigation measures would be necessary for the proposed project during construction, with the implementation of the PDF-2.1 and PDF-2.2.

2.7.2 Project Operations

The following mitigation measure would be necessary for project operation:

1. A 6-foot-high stand-alone noise barrier is required along the project's eastern property line adjacent to the residential uses to the east.

3. Vibration Impact Study

3.1 Fundamentals of Vibration

Vibration refers to groundborne noise and perceptible motion. Groundborne vibration is almost exclusively a concern inside buildings and is rarely perceived as a problem outdoors. The motion may be discernible outdoors, but without the effects associated with the shaking of a building, there is less adverse reaction. Vibration energy propagates from a source through intervening soil and rock layers to the foundations of nearby buildings. The vibration then propagates from the foundation throughout the remainder of the structure. Building vibration may be perceived by the occupants as the motion of building surfaces, the rattling of items moving on shelves or hanging on walls, or as a low-frequency rumbling noise. The rumbling noise is caused by the vibrating walls, floors, and ceilings that are radiating sound waves. However, building damage is not a factor for normal transportation projects, except for occasional blasting and pile driving during construction. Annoyance from vibration often occurs when the vibration exceeds the threshold of perception by 10 VdB or less. This is an order of magnitude below the damage threshold for normal buildings.

Typical sources of groundborne vibration are construction activities (e.g., blasting, pile driving, and operating heavy-duty earth-moving equipment), steel-wheeled trains, and occasional traffic on rough roads. Problems with groundborne vibration and noise from these sources are usually localized to areas within approximately 100 feet of the vibration source, although there are examples of groundborne vibration causing interference out to distances greater than 200 feet (FTA 2006). When roadways are smooth, vibration from traffic, even heavy trucks, is rarely perceptible. It is assumed, for most projects, that the roadway surface will be smooth enough that groundborne vibration from street traffic will not exceed the impact criteria; however, construction of the project could result in groundborne vibration that could be perceptible and annoying. Groundborne noise is not likely to be a problem as noise arriving via the normal airborne path usually will be greater than groundborne noise.

Groundborne vibration has the potential to disturb people as well as to damage buildings. Although it is very rare for mobile source-induced groundborne vibration to cause even cosmetic building damage, it is not uncommon for construction processes such as blasting and the pile driving to cause vibration of sufficient amplitudes to damage nearby buildings (FTA 2006). Groundborne vibration is usually measured in terms of vibration velocity, either the root-mean-square (RMS) velocity or peak particle velocity (PPV). RMS is best for characterizing human response to building vibration, and PPV is used to characterize potential for damage. Decibel notation acts to compress the range of numbers required to describe vibration. Vibration velocity level in decibels is defined as:

$$L_v = 20 \log_{10} [V/V_{ref}]$$

where L_v is the VdB, “V” is the RMS velocity amplitude, and “ V_{ref} ” is the reference velocity amplitude, or 1×10^{-6} inches per second (inch/sec) used in the United States. **Table 5** illustrates human response to various vibration levels, as described in the *Transit Noise and Vibration Impact Assessment* (FTA 2006).

TABLE 5
HUMAN RESPONSE TO DIFFERENT LEVELS OF GROUND BORNE NOISE AND VIBRATION

Vibration Velocity Level (VdB)	Noise Level (dBA)		Human Response
	Low Frequency ^a	Mid Frequency ^b	
65	25	40	Approximate threshold of perception for many humans. Low-frequency sound usually inaudible, mid-frequency sound excessive for quiet sleeping areas.
75	35	50	Approximate dividing line between barely perceptible and distinctly perceptible. Many people find transit vibration at this level annoying. Low-frequency noise acceptable for sleeping areas, mid-frequency noise annoying in most quiet occupied areas.
85	45	60	Vibration acceptable only if there are an infrequent number of events per day. Low-frequency noise annoying for sleeping areas, mid-frequency noise annoying even for infrequent events with institutional land uses such as schools and churches.

SOURCE: Federal Transit Administration. Table 7-1, *Transit Noise and Vibration Impact Assessment* (2006).

NOTES:

VdB = vibration velocity decibels; dBA = A-weighted decibels

^a Approximate noise level when vibration spectrum peak is near 30 Hz.

^b Approximate noise level when vibration spectrum peak is near 60 Hz.

Factors that influence groundborne vibration and noise include the following:

- **Vibration Source:** Vehicle/equipment suspension, wheel types and condition, track/roadway surface, track support system, speed, transit structure, and depth of vibration source
- **Vibration Path:** Soil type, rock layers, soil layering, depth to water table, and frost depth
- **Vibration Receiver:** Foundation type, building construction, and acoustical absorption

Among the factors listed above, there are significant differences in the vibration characteristics when the source is underground compared to at the ground surface. In addition, soil conditions are known to have a strong influence on the levels of groundborne vibration. Among the most important factors are the stiffness and internal damping of the soil and the depth to bedrock.

Experience with groundborne vibration shows that vibration propagation is more efficient in stiff clay soils than in loose sandy soils, and shallow rock seems to concentrate the vibration energy close to the surface, resulting in groundborne vibration problems at large distance from the source. Factors such as layering of the soil and depth to water table can have significant effects on the propagation of groundborne vibration. Soft, loose, sandy soils tend to attenuate more vibration energy than hard, rocky materials. Vibration propagation through groundwater is more efficient than through sandy soils.

3.1.1 Thresholds of Significance for Vibration

Federal Transit Administration and California Department of Transportation

The criteria for environmental impact from groundborne vibration are based on the maximum levels for a single event. **Table 6** lists the potential vibration damage criteria associated with construction activities, as suggested in the *Transit Noise and Vibration Impact Assessment* (FTA 2006).

**TABLE 6
CONSTRUCTION VIBRATION DAMAGE CRITERIA**

Building Category	PPV (inch/sec)	Approximate L_v^a
Reinforced-concrete, steel or timber (no plaster)	0.50	102
Engineered concrete and masonry (no plaster)	0.30	98
Non-engineered timber and masonry buildings	0.20	94
Buildings extremely susceptible to vibration damage	0.12	90

SOURCE: Federal Transit Administration. Table 12-3, *Transit Noise and Vibration Impact Assessment* (2006).
NOTES:
PPV = peak particle velocity; L_v = velocity in decibels; inch/sec = inches per second
^a Root-mean-square velocity in decibels (VdB) re 1 microinch per second.

FTA guidelines show that a vibration level of up to 102 VdB (equivalent to 0.5 inch/sec in RMS) (FTA 2006) is considered safe for buildings consisting of reinforced concrete, steel, or timber (no plaster), and would not result in any construction vibration damage. For a non-engineered timber and masonry building, the construction vibration damage criterion is 94 VdB (0.2 inch/sec in RMS). The RMS values for building damage thresholds referenced above are shown in **Table 7**, which is taken from the *Transportation and Construction Vibration Guidance Manual* (Caltrans 2013).

**TABLE 7
GUIDELINE VIBRATION DAMAGE POTENTIAL THRESHOLD CRITERIA**

Structure and Condition	Maximum PPV (inch/sec)	
	Transient Sources^a	Continuous/Frequent Intermittent Sources^b
Extremely fragile historic buildings, ruins, ancient monuments	0.12	0.08
Fragile buildings	0.20	0.10
Historic and some old buildings	0.50	0.25
Older residential structures	0.50	0.30
New residential structures	1.00	0.50
Modern industrial/commercial buildings	2.00	0.50

SOURCE: California Department of Transportation, *Transportation and Construction Vibration Guidance Manual* (2013), Table 19.

NOTES:

PPV = peak particle velocity; inch/sec = inches per second

^a Transient sources create a single, isolated vibration event, such as blasting or drop balls.

^b Continuous/frequent intermittent sources include impact pile drivers, pogo-stick compactors, crack-and-seat equipment, vibratory pile drivers, and vibratory compaction equipment.

Based on Table 8-3 in the FTA's *Transit Noise and Vibration Impact Assessment* (FTA 2006), interpretation of vibration criteria for detailed analysis is 78 VdB for residential uses during daytime hours. During nighttime hours, the vibration criterion is 72 VdB. For office and office buildings, the FTA guidelines suggest that a vibration level of 84 VdB should be used for detailed analysis.

City of Riverside

The City of Riverside has a limit of 78 VdB during the daytime should be used for sensitive receptors such as residences and/or churches.

3.1.2 Construction Vibration Impacts

Because vibration level in RMS is best for characterizing human response to building vibration and vibration level in PPV is best used to characterize potential for damage, this construction vibration impact analysis will discuss the human annoyance using vibration levels in VdB and will assess the potential for building damages using vibration levels in PPV (inch/sec).

Outdoor site preparation for the proposed project is expected to use a bulldozer, loader, a water truck, a concrete truck, and a forklift. It is anticipated that the greatest levels of vibration would occur during the site preparation phase. All other phases are expected to result in lower vibration levels.

Existing noise sensitive uses (residences) in the immediate vicinity include:

- To the west: 100 feet, -18 VdB compared to the vibration level measured at 25 feet
- To the south: 50 feet, -9 VdB compared to the vibration level measured at 25 feet
- To the east: 50 feet, -9 VdB compared to the vibration level measured at 25 feet

Because vibration impacts occur normally within the buildings, the distance to the nearest sensitive uses, for vibration impact analysis purposes, is measured between the nearest off-site sensitive use buildings and the project boundary (assuming the construction equipment would be used at or near the project boundary).

Bulldozers and other heavy-tracked construction equipment generate approximately 87 VdB of groundborne vibration when measured at 25 feet, based on the *Transit Noise and Vibration Impact Assessment* (FTA 2006). This level of groundborne vibration exceeds the threshold of human perception, which is around 65 VdB. Although this range of groundborne vibration levels would result in potential annoyance to residential buildings adjacent to the project site, they would not cause any damage to the buildings. Construction vibration, similar to vibration from other sources, would not have any significant effects on outdoor activities (e.g., those outside the residential buildings in the project vicinity). As shown in Table 6, FTA guidelines show that a vibration level of up to 102 VdB (an equivalent to 0.5 inch/sec in RMS) (FTA 2006) is considered safe for buildings consisting of reinforced concrete, steel, or timber (no plaster), and would not result in any construction vibration damage. For a non-engineered timber and masonry building, the construction vibration damage criterion is 94 VdB (0.2 inch/sec in RMS). The RMS values for building damage thresholds referenced in **Table 8** were taken from the *Transportation and Construction Vibration Guidance Manual* (Caltrans 2013). Table 8 further shows the PPV

values at 25 feet from the construction vibration source as well as vibration levels in terms of VdB at 25 feet from the construction vibration source.

TABLE 8
VIBRATION SOURCE AMPLITUDES FOR CONSTRUCTION EQUIPMENT

Equipment	Reference PPV/L _v at 25 Feet	
	PPV (inch/sec)	L _v (VdB)
Pile Driver (Impact), Typical	0.644	104
Pile Driver (Sonic), Typical	0.170	93
Vibratory Roller	0.210	94
Hoe Ram	0.089	87
Earth Mover	0.011	69
Excavator	0.047	81
Fork Lift	0.047	81
Skid Steer	0.047	81
Wheel Loader	0.076	86
Large Bulldozer	0.089	87
Caisson Drilling	0.089	87
Loaded Trucks	0.076	86
Jackhammer	0.035	79
Small Bulldozer	0.003	58

SOURCE: Federal Transit Administration, *Transit Noise and Vibration Impact Assessment* (2006), Table 12-2.
NOTES:
Equipment and associated source vibration levels that are expected to be used on the project site are shown in **bold**.
PPV = peak particle velocity; L_v = velocity in decibels; inch/sec = inches per second; VdB = vibration velocity decibels

Construction Vibration Structural Damages

Residential buildings adjacent to the project site are approximately 50 feet from the nearest construction area on the project site. Based on Table 6 and Table 7, it would take a vibration PPV level of more than 0.5 inch/sec (or 102 VdB) to potentially result in any building damages. Table 8 shows that none of the construction activities anticipated on the project site would result in a vibration level that would reach 0.5 inch/sec PPV (or 102 VdB) at 25 feet from each of the project construction equipment and/or activities. At 50 feet, these vibration levels would be attenuated by 9 VdB to 93 VdB. Other off-site buildings are farther away from the project site and would be exposed to even lower construction vibration levels. Therefore, no building damages would occur as a result of the project construction.

Construction Vibration Human Annoyance

Vibration levels from standard construction equipment are shown below for various pieces of construction equipment that are expected to be used on the project site:

- **Bulldozer:** 87 VdB at 25 feet
- **Water and pickup trucks:** 69 VdB at 25 feet
- **Concrete pump truck:** 69 VdB at 25 feet
- **Excavators:** 81 VdB at 25 feet
- **Concrete mix truck:** 69 VdB at 25 feet
- **Frontend loader:** 86 VdB at 25 feet
- **Backhoe:** 69 VdB at 25 feet
- **Forklift:** 81 VdB at 25 feet
- **Grader:** 75 VdB at 25 feet
- **Scraper:** 69 VdB at 25 feet
- **Jack hammer:** 79 VdB at 25 feet
- **Compactor:** 81 VdB at 25 feet
- **Truck-mounted crane:** 75 VdB at 25 feet
- **Large crane:** 81 VdB at 25 feet
- **Portable generator:** 73 VdB at 25 feet

$$L_{\text{vdB}}(D) = L_{\text{vdB}}(25 \text{ feet}) - 30 \text{ Log}(D/25)$$

A vibration level at 50 feet is 9 VdB lower than the vibration level at 25 feet. Vibration at 100 feet from the source is 18 VdB lower than the vibration level at 25 feet. Therefore, receptors at 50 feet from the construction activity may be exposed to groundborne vibration up to 78 VdB (or 0.030 inch/sec PPV or lower). Receptors at 100 feet from the source may be exposed to groundborne vibration up to 69 VdB.

Table 9 lists the projected vibration level from various construction equipment expected to be used on the project site to the sensitive uses in the project vicinity. For the project construction activity, the equipment with the highest vibration generation potential is the large bulldozer, which would generate 87 VdB at 25 feet. With the vibration attenuation through distance divergence, the vibration from project construction would be reduced by 9 VdB at the nearest residential buildings adjacent to the project site. The highest construction vibration levels at residential buildings adjacent to the project site would be 78 VdB or lower.

This range of vibration levels from construction equipment or activity would be below the FTA threshold of 94 VdB (or 0.2 inch/sec PPV) for building damage. No significant construction vibration impacts would occur; therefore, no mitigation measures are required.

As shown in Table 9, all construction equipment vibration levels would not exceed the FTA's 78 VdB threshold at the nearest noise-sensitive receiver locations during daytime hours or the FTA's 84 VdB threshold for annoyance of occupants in residential buildings.

TABLE 9
SUMMARY OF CONSTRUCTION EQUIPMENT AND ACTIVITY VIBRATION

Equipment/Activity	Vibration Level (VdB)			
	At 25 Feet	Distance Attenuation	Intervening Canal ^a	Maximum Vibration Level
Residences to the South (50 feet)				
Large dozers, front end loaders, grader, backhoe ^b	87	9	0	78
Loaded trucks	86	9	0	77
Jackhammers, forklift	79	9	0	70
Residences to the West (100 feet)				
Large dozers, front end loaders, grader, backhoe ^b	87	18	0	69
Loaded trucks	86	18	0	68
Jackhammers, forklift	79	18	0	61
Residences to the East (50 feet)				
Large dozers, front end loaders, grader, backhoe ^b	87	9	0	78
Loaded trucks	86	9	0	77
Jackhammers, forklift	79	9	0	70

SOURCE: Compiled by ESA (2020).

NOTES:

The FTA recommended building damage threshold is 0.2 inch/sec or approximately 94 VdB at the receiving property structure or building.

^a No intervening structure that would provide a damping effect on vibration.

^b Large bulldozer represents the construction equipment with the highest vibration potential that would be used on site. Other equipment would result in a lower vibration when compared to that of large bulldozers.

Summary of Construction Vibration Impacts

Table 9 lists the maximum vibration levels that would result from the on-site construction equipment. The projected maximum construction vibration level during project construction at the nearest noise-sensitive receiver locations would not exceed the FTA's vibration standards of 78 VdB for sensitive uses (residences) or the FTA's 84 VdB threshold for commercial/industrial office buildings. No significant construction vibration impacts would occur.

Mitigation Measures for Construction Vibration Impacts

No mitigation measures for vibration impacts are required during project construction.

3.1.3 Operation Vibration Impacts

The project proposes residential uses that would not generate any substantial ground vibration. No operational vibration impacts would occur.

3.2 Vibration Mitigation Measures

3.2.1 Project Construction

With implementation of the Project Design Features (PDF-2.1 and PDF-2.2), no vibration mitigation measures would be necessary for the proposed project during construction.

3.2.2 Project Operations

No vibration mitigation measures would be necessary for project operation.

3.3 Summary of Vibration Impact Analysis Results

Operation of the project would not expose persons to, or generate noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies with the implementation of the project design features. Therefore, operation vibration impacts would be less than significant.

4. References

California Code of Regulations, Title 14, Section 15168(c).

California Department of Transportation, *Technical Noise Supplement (TeNS)*, September 2013.

City of Riverside, Noise Element and Municipal Code.

City of Riverside, 24-Hour Volume Counts, Accessed December 2, 2020.

Federal Highway Administration, *Roadway Construction Noise Model User's Guide*, 2006.

FTA, *Transit Noise and Vibration Impact Assessment*, May 2006.

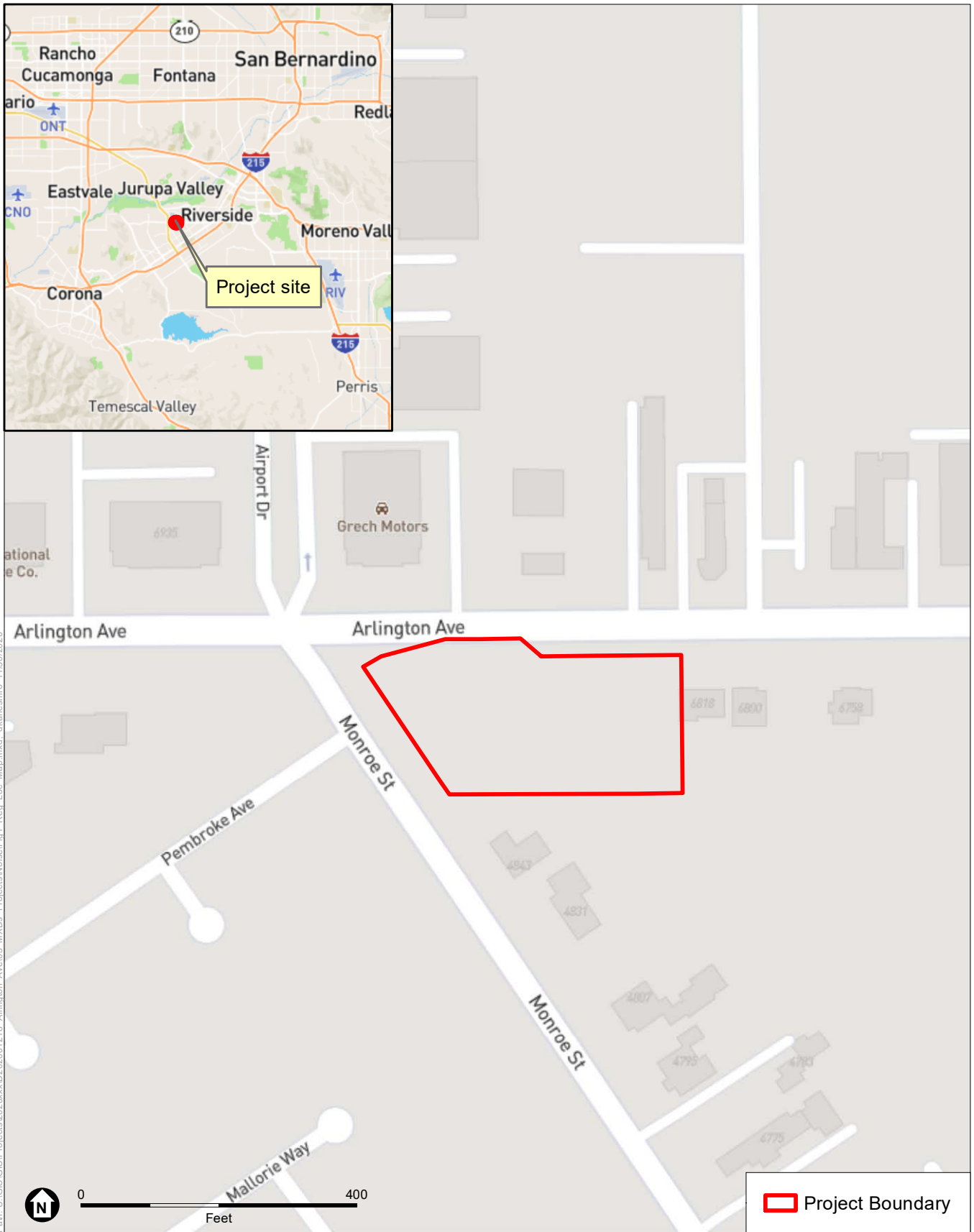
USEPA, *EPA Identifies Noise Levels Affecting Health and Welfare*, April 1974.

USEPA, Protective Noise Levels, Condensed Version of EPA Levels Document (EPA 550/9-79-100, November 1978).

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Appendix A

Project Figures



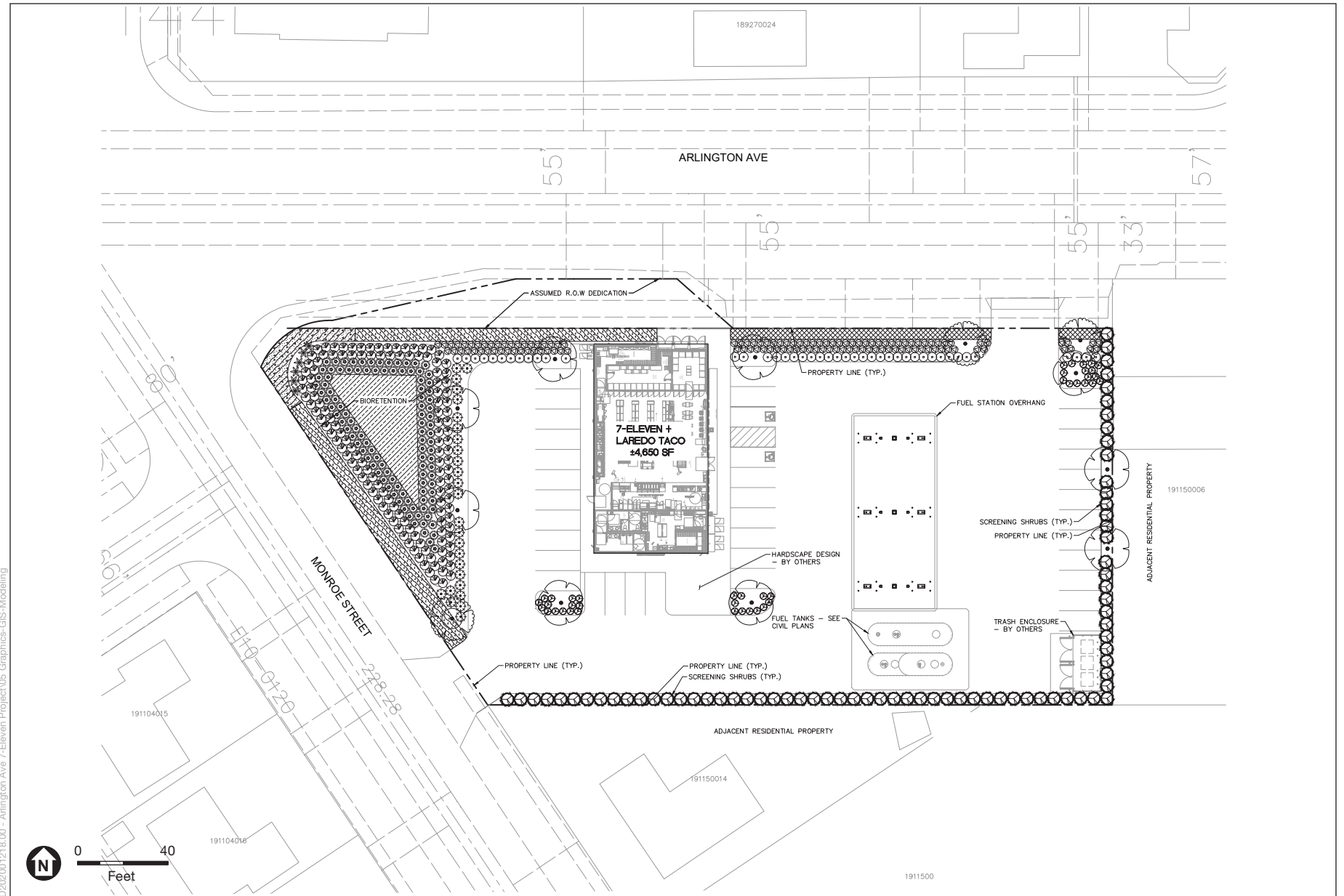
Path: U:\GIS\GIS\Projects\2020\202001218_Arlington_Ave\03_MXD\Projects\Noise\Efig1_Rep_Loc_Map.mxd, dkameshiro, 11/30/2020

SOURCE: OpenStreetMap, 2020

Riverside Arlington Project

Figure 1
Regional Location Map



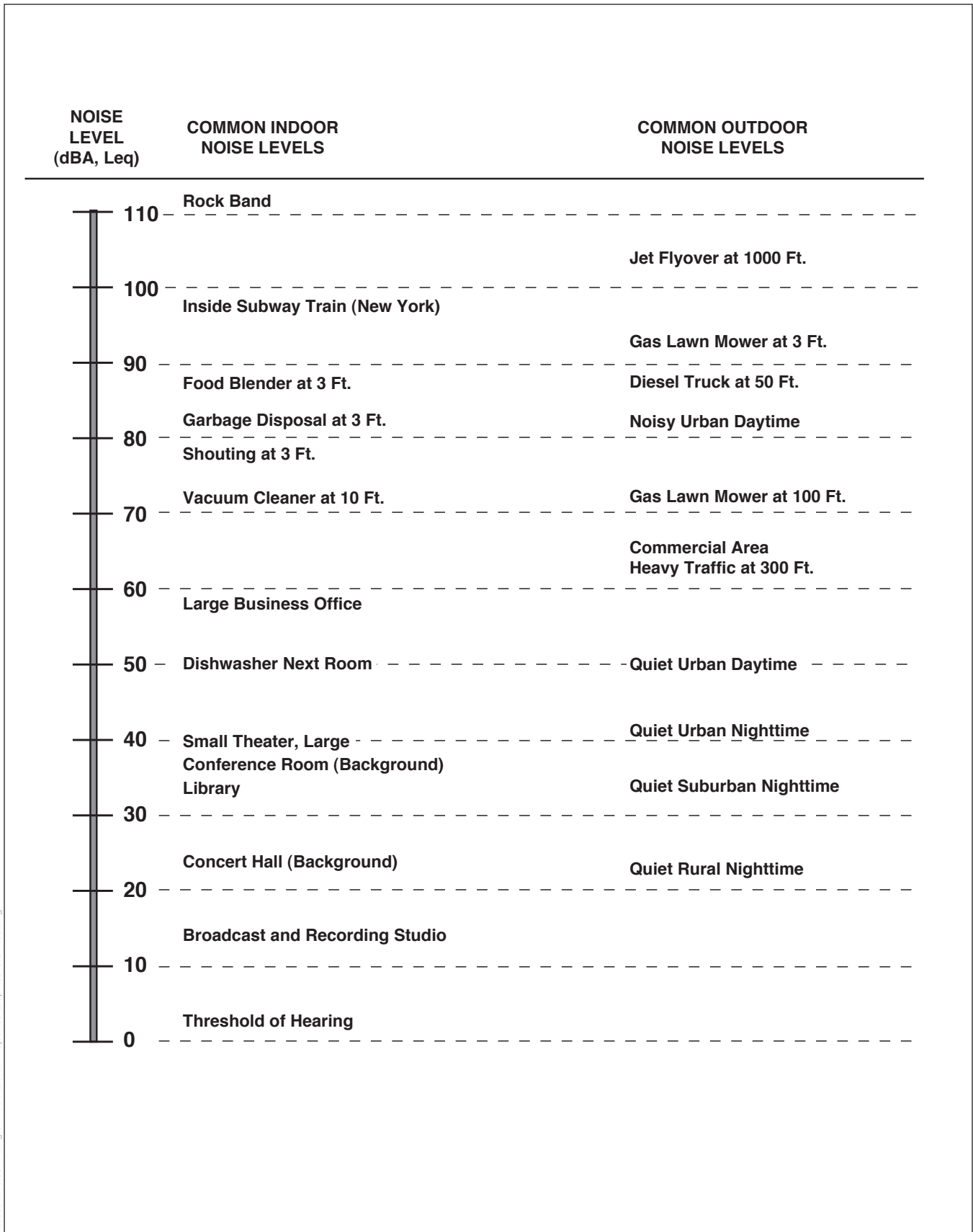


SOURCE: Kimley Horn, 2020

Riverside Arlington Project

Figure 2
Project Site Plan





D:\202001218.00 - Arlington Ave 7-Eleven Project\05_Graphics-GIS-Modeling

SOURCE: State of California, Department of Transportation (Caltrans), Technical Noise Supplement (TeNS). October 1998. Available: [http://www.dot.ca.gov/hq/env/noise/pub/Technical Noise Supplement.pdf](http://www.dot.ca.gov/hq/env/noise/pub/Technical%20Noise%20Supplement.pdf)

Riverside Arlington Project

Figure 3
Decibel Scale and Common Noise Sources

