NOISE AND VIBRATION IMPACT ANALYSIS

9TH AND TIPPECANOE STREET WAREHOUSE PROJECT

SAN BERNARDINO, CALIFORNIA

LSA

June 2022

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SAN BERNARDINO, CALIFORNIA

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LIST OF ABBREVIATIONS AND ACRONYMS

City	City of San Bernardino
CNEL	Community Noise Equivalent Level
dBA	A-weighted decibel
EPA	United States Environmental Protection Agency
ft	feet
FHWA	Federal Highway Administration
FTA	Federal Transit Administration
HVAC	heating, ventilation, and air conditioning
in/sec	inches per second
SBD	San Bernardino International Airport
L_{dn}	day-night average noise level
L_{eq}	equivalent continuous sound level
L_{max}	maximum instantaneous sound level
PPV	peak particle velocity
project	9th and Tippecanoe Warehouse Project
RMS	root-mean-square
sf	square feet
SPL	sound power level
VdB	vibration velocity decibels

INTRODUCTION

This noise and vibration impact analysis has been prepared to evaluate the potential noise and vibration impacts and reduction measures associated with the 9th and Tippecanoe Warehouse Project (project) in San Bernardino, California. This report is intended to satisfy the City of San Bernardino (City) requirement for a project-specific noise impact analysis by examining the impacts of the project site and evaluating noise reduction measures that the project may require.

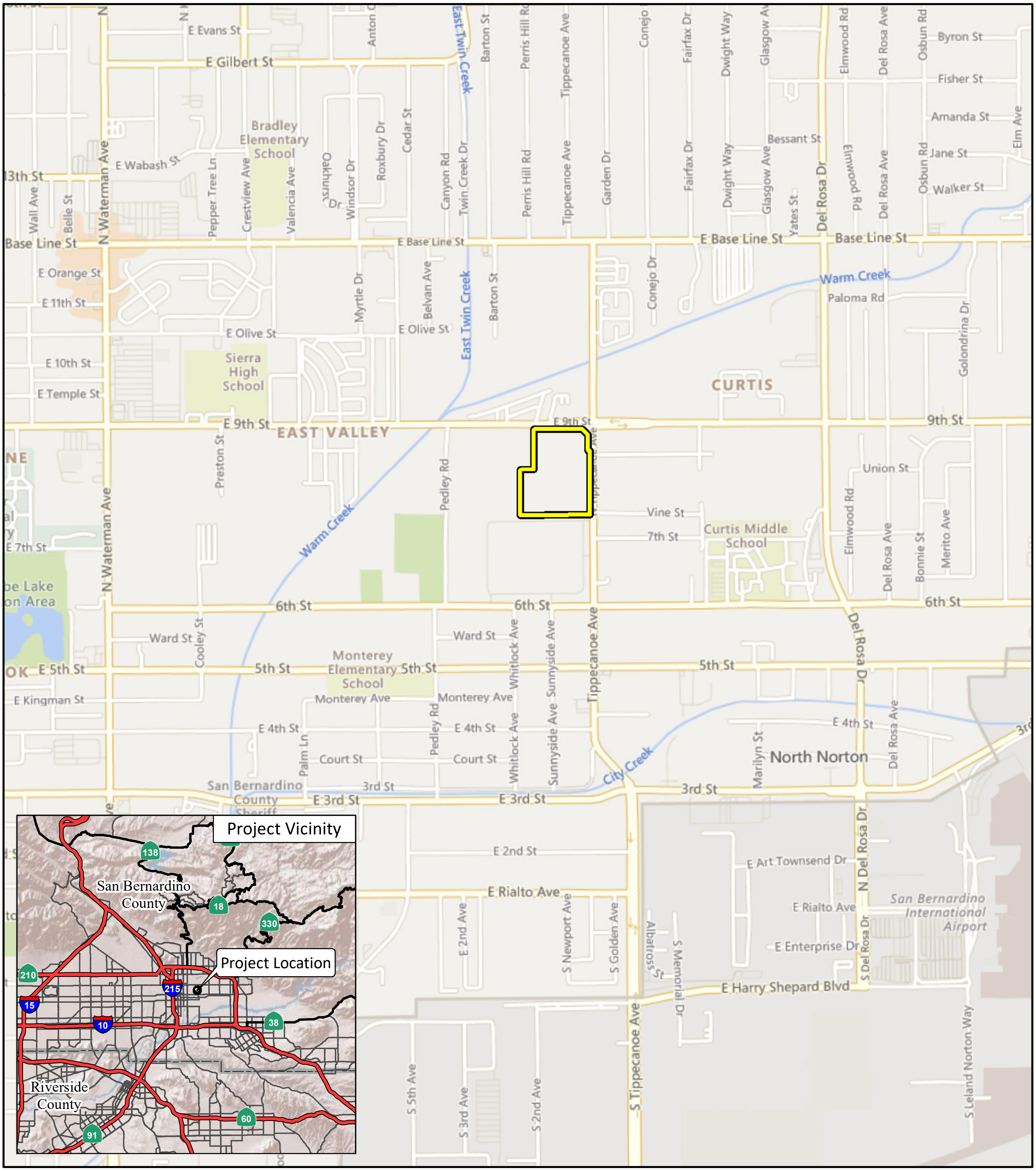
PROJECT LOCATION AND DESCRIPTION

The proposed project is located at the southwest corner of 9th Street and North Tippecanoe Street in the City of San Bernardino, California. Figure 1 illustrates the project site location.

The project site consists of the construction of a new warehouse and parking lot. The new building would consist of a 5,000 sq ft ground office and a 334,600 sq ft warehouse with thirty-five (35) loading docks, totaling to a 339,600 sq ft building structure. The total building area will cover 54.4% of the entire project site. The warehouse would include a parking lot, which would include long and short-term bicycle stalls, clean air / carpool stalls, an electric vehicle charging station, dock doors, grade level doors, and trailer stalls. The proposed project has the potential to operate 24 hours per day, seven (7) days a week.

The project site is accessible from 9th Street and N. Tippecanoe Avenue and would include approximately 294 parking spaces. The speculative warehouse would have a height of approximately 40 ft and would be oriented opposite north of Tippecanoe Street. Figure 2 depicts the proposed project’s site plan.

The project site is located northeast of the East Valley in San Bernardino, which is a mix-use area of the city consisting mainly of industrial, commercial, and residential zones. The project site is bound to N. Tippecanoe Street to the east, 9th Street to the north, and industrial and commercial uses to the south and west. Land uses in the project area include a recreational RV Park, warehouses and commercial uses, existing single-family homes, and apartment complexes. In addition to residential areas, Big Wong Elementary school and Indian Spring High School are located within a mile radius of the project site.



LEGEND

Project Location

FIGURE 1

0 750 1500

FEET

SOURCE: Bing Maps (2022)

9th and Tippecanoe Street Warehouse Project

Regional Project Location

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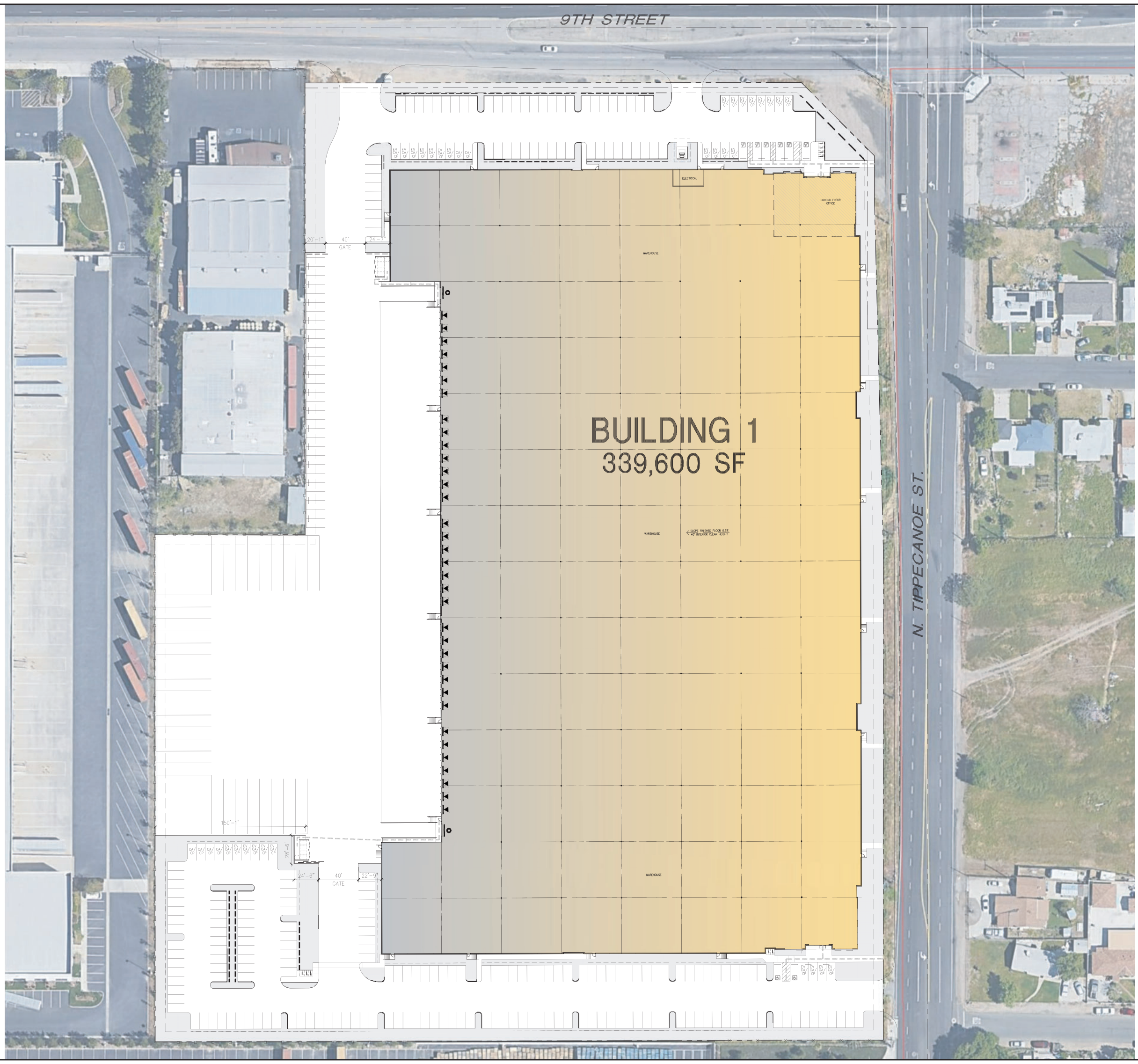

TABULATIONS

SITE AREA		SF	ACRES
Gross		623,832	14.32
Street Dedication		0	0.00
NET SITE AREA		**623,832**	**14.32**
BUILDING AREA			
	Ground Floor Office		5,000
	Warehouse		334,600
Total Building Footprint			339,600
	Mezzanine		0
TOTAL BUILDING AREA			**339,600**
COVERAGE (75% max)			**54.4%**
FAR			**54.4%**
PARKING REQUIRED			
Office			
	0 - 2,999 sf	1/200	0
	2,001 - 7,500 sf	1/250	**20**
Industrial / Warehousing			
	0 - 3,000 sf	1/250	0
	3,001 - 5,000 sf	1/500	0
	5,001 - 10,000 sf	1/750	0
	10,001 - 50,000 sf	1/1000	0
	50,001 sf +	1/1250	**268**
TOTAL PARKING REQUIRED			**288**
PARKING PROVIDED			
Standard Stalls			286
Accessible Stalls			8
TOTAL PARKING PROVIDED			**294**
PARKING RATIO			0.87/1000
	Long Term Bicycle Stalls	5%	**15**
	Short Term Bicycle Stalls	5%	**15**
	Clean Air / Carpool Stalls	12%	**35**
	Electric Vehicle Charging Station	10%	**29**
	Dock Doors		**35**
	Grade Level Doors		**2**
	Trailer Stalls		**32**
LANDSCAPE		%	Area (S.F.)
Paved Surface Area			219,564
Required (15% of paved surface)		15.0%	32,935
Provided		27.4%	60,065

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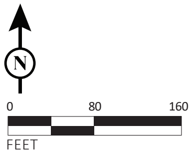
FIGURE 2



SOURCE: G|A|A Architects, February 2022

9th and Tippecanoe Street Warehouse Project
City of San Bernardino, San Bernardino County, California
Site Plan

I:\ESL2201.13\G\Fig 2_Site Plan.ai (6/7/2022)

EXISTING LAND USES IN THE PROJECT AREA

The project site is surrounded primarily by general industrial facilities. The areas adjacent to the project site include the following uses:

- **North:** Existing commercial uses and RV Park opposite 9th Street within the City of San Bernardino;
- **East:** Existing single-family residence opposite Tippecanoe Avenue within the City of Highland;
- **South:** Existing warehouse uses within the County of San Bernardino;
- **West:** Existing warehouse uses within the City of San Bernardino.

The nearest sensitive receptors are:

- **North:** The San Bernardino RV Park approximately 140 ft away from the project boundary line.
- **East:** Single-family residential uses opposite Tippecanoe Avenue approximately 90 ft away from the project boundary line.
- **Northeast:** Bing Wong Elementary School approximately 600 ft away from the project boundary line.

NOISE AND VIBRATION FUNDAMENTALS

CHARACTERISTICS OF SOUND

Noise is usually defined as unwanted sound. Noise consists of any sound that may produce physiological or psychological damage and/or interfere with communication, work, rest, recreation, and sleep.

To the human ear, sound has two significant characteristics: pitch and loudness. Pitch is generally an annoyance, while loudness can affect the ability to hear. Pitch is the number of complete vibrations, or cycles per second, of a sound wave, which results in the tone's range from high to low. Loudness is the strength of a sound, and it describes a noisy or quiet environment; it is measured by the amplitude of the sound wave. Loudness is determined by the intensity of the sound waves combined with the reception characteristics of the human ear. Sound intensity is the average rate of sound energy transmitted through a unit area perpendicular to the direction in which the sound waves are traveling. This characteristic of sound can be precisely measured with instruments. The analysis of a project defines the noise environment of the project area in terms of sound intensity and its effect on adjacent sensitive land uses.

MEASUREMENT OF SOUND

Sound intensity is measured with the A-weighted decibel (dBA) scale to correct for the relative frequency response of the human ear. That is, an A-weighted noise level de-emphasizes low and very high frequencies of sound, similar to the human ear's de-emphasis of these frequencies. Decibels (dB), unlike the linear scale (e.g., inches or pounds), are measured on a logarithmic scale representing points on a sharply rising curve.

For example, 10 dB is 10 times more intense than 0 dB, 20 dB is 100 times more intense than 0 dB, and 30 dB is 1,000 times more intense than 0 dB. Thirty decibels (30 dB) represent 1,000 times as much acoustic energy as 0 dB. The decibel scale increases as the square of the change, representing the sound pressure energy. A sound as soft as human breathing is about 10 times greater than 0 dB. The decibel system of measuring sound gives a rough connection between the physical intensity of sound and its perceived loudness to the human ear. A 10 dB increase in sound level is perceived by the human ear as only a doubling of the sound's loudness. Ambient sounds generally range from 30 dB (very quiet) to 100 dB (very loud).

Sound levels are generated from a source, and their decibel level decreases as the distance from that source increases. Sound levels dissipate exponentially with distance from their noise sources. For a single point source, sound levels decrease approximately 6 dB 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 (e.g., highway traffic or railroad operations), the sound decreases 3 dB for each doubling of distance in a hard site environment. Line source sound levels decrease 4.5 dB for each doubling of distance in a relatively flat environment with absorptive vegetation.

There are many ways to rate noise for various time periods, but an appropriate rating of ambient noise affecting humans also accounts for the annoying effects of sound. The equivalent continuous sound level (L_{eq}) is the total sound energy of time-varying noise over a sample period. However, the predominant rating scales for human communities in the State of California are the L_{eq} and Community Noise Equivalent Level (CNEL) or the day-night average noise level (L_{dn}) based on A-weighted decibels. CNEL is the time-weighted average noise over a 24-hour period, with a 5 dBA weighting factor applied to the hourly L_{eq} for noises occurring from 7:00 p.m. to 10:00 p.m. (defined as relaxation hours) and a 10 dBA weighting factor applied to noises occurring from 10:00 p.m. to 7:00 a.m. (defined as sleeping hours). L_{dn} is similar to the CNEL scale but without the adjustment for events occurring during the relaxation. CNEL and L_{dn} are within 1 dBA of each other and are normally interchangeable. The City uses the CNEL noise scale for long-term traffic noise impact assessment.

Other noise rating scales of importance when assessing the annoyance factor include the maximum instantaneous noise level (L_{max}), which is the highest sound level that occurs during a stated time period. The noise environments discussed in this analysis for short-term noise impacts are specified in terms of maximum levels denoted by L_{max}, which reflects peak operating conditions and addresses the annoying aspects of intermittent noise. It is often used together with another noise scale, or noise standards in terms of percentile noise levels, in noise ordinances for enforcement purposes. For example, the L_{10} noise level represents the noise level exceeded 10 percent of the time during a stated period. The L_{50} noise level represents the median noise level. Half the time the noise level exceeds this level, and half the time it is less than this level. The L_{90} noise level represents the noise level exceeded 90 percent of the time and is considered the background noise level during a monitoring period. For a relatively constant noise source, the L_{eq} and L_{50} are approximately the same.

Noise impacts can be described in three categories. The first category includes audible impacts, which are increases in noise levels noticeable to humans. Audible increases in noise levels generally refer to a change of 3 dB or greater because this level has been found to be barely perceptible in exterior environments. The second category, potentially audible, refers to a change in the noise level between 1 dB and 3 dB. This range of noise levels has been found to be noticeable only in laboratory environments. The last category includes changes in noise levels of less than 1 dB, which are inaudible to the human ear. Only audible changes in existing ambient or background noise levels are considered potentially significant.

Physiological Effects of Noise

Physical damage to human hearing begins at prolonged exposure to sound levels higher than 85 dBA. Exposure to high sound levels affects the entire system, with prolonged sound exposure in excess of 75 dBA increasing body tensions, thereby affecting blood pressure and functions of the heart and the nervous system. In comparison, extended periods of sound exposure above 90 dBA would result in permanent cell damage. When the sound level reaches 120 dBA, a tickling sensation occurs in the human ear, even with short-term exposure. This level of sound is called the threshold of feeling. As the sound reaches 140 dBA, the tickling sensation is replaced by a feeling of pain in the ear (i.e., the threshold of pain). A sound level of 160–165 dBA will result in dizziness or a loss of equilibrium. The ambient or background noise problem is widespread and generally more concentrated in urban areas than in outlying, less developed areas.

Table A lists definitions of acoustical terms, and Table B shows common sound levels and their sources.

Table A: Definitions of Acoustical Terms

Term	Definitions
Decibel, dB	A unit of sound measurement that denotes the ratio between two quantities that are proportional to power; the number of decibels is 10 times the logarithm (to the base 10) of this ratio.
Frequency, Hz	Of a function periodic in time, the number of times that the quantity repeats itself in 1 second (i.e., the number of cycles per second).
A-Weighted Sound Level, dBA	The sound level obtained by use of A-weighting. The A-weighting filter de-emphasizes the very low and very high frequency components of the sound in a manner similar to the frequency response of the human ear and correlates well with subjective reactions to noise. (All sound levels in this report are A-weighted unless reported otherwise.)
L_{01}, L_{10}, L_{50}, L_{90}	The fast A-weighted noise levels that are equaled or exceeded by a fluctuating sound level 1%, 10%, 50%, and 90% of a stated time period, respectively.
Equivalent Continuous Noise Level, L_{eq}	The level of a steady sound that, in a stated time period and at a stated location, has the same A-weighted sound energy as the time-varying sound.
Community Noise Equivalent Level, CNEL	The 24-hour A-weighted average sound level from midnight to midnight, obtained after the addition of 5 dBA to sound levels occurring in the evening from 7:00 p.m. to 10:00 p.m. and after the addition of 10 dBA to sound levels occurring in the night between 10:00 p.m. and 7:00 a.m.
Day/Night Noise Level, L_{dn}	The 24-hour A-weighted average sound level from midnight to midnight, obtained after the addition of 10 dBA to sound levels occurring in the night between 10:00 p.m. and 7:00 a.m.
L_{max}, L_{min}	The maximum and minimum A-weighted sound levels measured on a sound level meter, during a designated time interval, using fast time averaging.
Ambient Noise Level	The all-encompassing noise associated with a given environment at a specified time. Usually a composite of sound from many sources from many directions, near and far; no particular sound is dominant.
Intrusive	The noise that intrudes over and above the existing ambient noise at a given location. The relative intrusiveness of a sound depends upon its amplitude, duration, frequency, time of occurrence, and tonal or informational content, as well as the prevailing ambient noise level.

Source: *Handbook of Acoustical Measurements and Noise Control* (Harris 1991).

Table B: Common Sound Levels and Their Noise Sources

Noise Source	A-Weighted Sound Level in Decibels	Noise Environments	Subjective Evaluations
Near Jet Engine	140	Deafening	128 times as loud
Civil Defense Siren	130	Threshold of Pain	64 times as loud
Hard Rock Band	120	Threshold of Feeling	32 times as loud
Accelerating Motorcycle at a Few Feet Away	110	Very Loud	16 times as loud
Pile Driver; Noisy Urban Street/Heavy City Traffic	100	Very Loud	8 times as loud
Ambulance Siren; Food Blender	95	Very Loud	—
Garbage Disposal	90	Very Loud	4 times as loud
Freight Cars; Living Room Music	85	Loud	—
Pneumatic Drill; Vacuum Cleaner	80	Loud	2 times as loud
Busy Restaurant	75	Moderately Loud	—
Near Freeway Auto Traffic	70	Moderately Loud	Reference level
Average Office	60	Quiet	One-half as loud
Suburban Street	55	Quiet	—
Light Traffic; Soft Radio Music in Apartment	50	Quiet	One-quarter as loud
Large Transformer	45	Quiet	—
Average Residence without Stereo Playing	40	Faint	One-eighth as loud
Soft Whisper	30	Faint	—
Rustling Leaves	20	Very Faint	—
Human Breathing	10	Very Faint	Threshold of Hearing
—	0	Very Faint	—

Source: Compiled by LSA (2022).

FUNDAMENTALS OF VIBRATION

Vibration refers to ground-borne noise and perceptible motion. Ground-borne vibration is almost exclusively a concern inside buildings and is rarely perceived as a problem outdoors, where the motion may be discernible, 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 occupants as the motion of building surfaces, the rattling of items sitting on shelves or hanging on walls, or a low-frequency rumbling noise. The rumbling noise is caused by the vibration of walls, floors, and ceilings that radiate sound waves. Annoyance from vibration often occurs when the vibration exceeds the threshold of perception by 10 dB or less. This is an order of magnitude below the damage threshold for normal buildings.

Typical sources of ground-borne vibration are construction activities (e.g., blasting, pile-driving, and operating heavy-duty earthmoving equipment), steel-wheeled trains, and occasional traffic on rough roads. Problems with both ground-borne vibration and noise from these sources are usually localized to areas within approximately 100 ft from the vibration source, although there are examples of ground-borne vibration causing interference out to distances greater than 200 ft (FTA 2018). 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 ground-borne vibration from street traffic will not exceed the impact criteria; however, construction of the project could result in ground-borne vibration that may be perceptible and annoying.

Ground-borne noise is not likely to be a problem because noise arriving via the normal airborne path will usually be greater than ground-borne noise.

Ground-borne vibration has the potential to disturb people and damage buildings. Although it is very rare for train-induced ground-borne vibration to cause even cosmetic building damage, it is not uncommon for construction processes such as blasting and pile-driving to cause vibration of sufficient amplitudes to damage nearby buildings (FTA 2018). Ground-borne vibration is usually measured in terms of vibration velocity, either the root-mean-square (RMS) velocity or peak particle velocity (PPV). The RMS is best for characterizing human response to building vibration, and PPV is used to characterize the 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 vibration velocity in decibels (VdB), "V" is the RMS velocity amplitude, and "V_{ref}" is the reference velocity amplitude, or 1×10^{-6} inches/second (in/sec) used in the United States.

REGULATORY SETTING

APPLICABLE NOISE STANDARDS

The proposed project site is within the city limits of the City of San Bernardino. Surrounding uses to the east are within the City of Highland limit and uses to the south are within the County of San Bernardino limits. The uses to the south of the project site are similar in nature, also industrial warehouse uses, and therefore are not considered noise sensitive. The applicable noise standards for each jurisdiction containing noise sensitive uses include the criteria in the City of San Bernardino's Noise Element of the General Plan and the City of San Bernardino Municipal Code (SBMC) along with the City of Highland's Noise Element. In order to assess potential noise impacts associated with aircraft operations in the project vicinity, the State of California's Green Building Standards Code (CALGreen) standards are also provided below.

City of San Bernardino

Noise Element of the General Plan

The Noise Element of the General Plan (Chapter 14) provides the City's goals and policies related to noise, including the land use compatibility guidelines for community exterior noise environments. The City has identified the following goals and policies in the Noise Element:

Goal 14.1 *Ensure that residents are protected from excessive noise through careful land planning.*

Policies.

14.1.2 Require that automobile and truck access to commercial properties abutting residential parcels be located at the maximum practical distance from the residential parcel.

14.1.4 Prohibit the development of new or expansion of existing industrial, commercial, or other uses that generate noise impacts on housing, schools, heath care facilities or other sensitive uses above a L_{dn} of 65 dBA.

Goal 14.2 *Encourage the reduction of noise from transportation-related noise sources such as motor vehicles, aircraft operations, and railroad movements.*

Policies.

14.2.3 Require that development that increases the ambient noise level adjacent to noise-sensitive land uses provide appropriate mitigation measures.

14.2.8 Minimize noise attributable to vehicular travel in residential neighborhoods by inhibiting through trips by the use of cul-de-sacs, one-way streets, and other traffic controls

14.2.19 As may be necessary, require acoustical analysis and ensure the provision of effective noise mitigation measures for sensitive land uses, especially residential uses, in areas significantly impacted by noise.

Goal 14.3 *Protect residents from the negative effects of "spill over" or nuisance noise.*

Policies.

14.3.1 Require that construction activities adjacent to residential units be limited as necessary to prevent adverse noise impacts.

14.3.2 Require that construction activities employ feasible and practical techniques that minimize the noise impacts on adjacent uses.

14.3.5 Require that the hours of truck deliveries to commercial properties abutting residential uses be limited unless there is no feasible alternative or there are overriding transportation benefits by scheduling deliveries at another hour.

Figure N-1 of the General Plan, *Land Use Compatibility for Community Noise Exposure*, provides noise criteria to evaluate the land use compatibility of transportation-related noise. The criteria indicate that residential uses are considered "normally acceptable" with noise levels below 60 dBA L_{dn} or CNEL and conditionally acceptable with noise levels of less than 70 dBA L_{dn} or CNEL.

City of San Bernardino Municipal Code

The City of San Bernardino Municipal Code (SBMC) Noise Control Ordinance (Chapter 8.54) includes regulations to control the negative effects of nuisance noise, but it does not identify specific exterior noise level limits. In addition, SBMC Chapter 19.20 contains exterior and interior noise level standards for residential land uses. Section 8.54.060 states when: "such noises are an accompaniment and effect of a lawful business, commercial or industrial enterprise carried on in an area zoned for that purpose…" these activities shall be exempt (Section 8.54.060(B)). However, due to the Project's proximity to residential land uses, Section 19.20.030.15(A) limits the operational stationary-source noise from the proposed Project to an exterior noise level of 65 dBA for residential land uses.

Construction Noise Standards. The City has set restrictions to control noise impacts associated with the construction of the proposed Project. Section 8.54.070, Disturbances from Construction Activity, limits construction activities to within the hours of 7:00 a.m. and 8:00 p.m.

City of Highland

Noise Element of the General Plan

Although exempt from numerical noise standards, the Noise Element provides the exterior noise standards for each land uses. Although the metric indicated for exterior noise standards within Table 7.2 of the General Plan Noise Element is a CNEL, because by definition, CNEL is a 24-hour average and the land use table assigns varying noise thresholds based on time of day, it is likely that an hourly L_{eq} might be more appropriate. For residential uses, the daytime and nighttime hourly noise standards are 60 dBA L_{eq} and 55 dBA L_{eq}, respectively.

State of California Green Building Standards Code

The CALGreen contains mandatory measures for non-residential building construction in Section 5.507 on Environmental Comfort. These noise standards are applied to new construction in California for controlling interior noise levels resulting from exterior noise sources. The regulations specify that acoustical studies must be prepared when non-residential structures are developed in areas where the exterior noise levels exceed 65 dBA CNEL, such as within a noise contour of an airport, freeway, railroad, and other noise source. If the development falls within an airport or freeway 65 dBA CNEL noise contour, buildings shall be construction to provide an interior noise level environment attributable to exterior sources that does not exceed an hourly equivalent level of 50 dBA L_{eq} in occupied areas during any hour of operation.

Federal Transit Administration

Though the City does not have daytime construction noise level limits for activities that occur with the specified hours of Section 8.54.070, to determine potential CEQA noise impacts, construction noise was assessed using criteria from the *Transit Noise and Vibration Impact Assessment Manual* (FTA 2018) (FTA Manual). Table C shows the FTA's General Assessment Construction Noise Criteria based on the composite noise levels per construction phase.

Table C: General Assessment Daytime Construction Noise Criteria

Land Use	Daytime 1-hour L_{eq} (dBA)
Residential	90
Commercial	100
Industrial	100

Source: *Transit Noise and Vibration Impact Assessment Manual* (FTA 2018).
dBA = A-weighted decibels
L_{eq} = equivalent continuous sound level

APPLICABLE VIBRATION STANDARDS

Federal Transit Administration

Vibration standards included in the FTA Manual are used in this analysis for ground-borne vibration impacts on human annoyance. The criteria for environmental impact from ground-borne vibration and noise are based on the maximum levels for a single event. Table D provides the criteria for assessing the potential for interference or annoyance from vibration levels in a building.

Table D: Interpretation of Vibration Criteria for Detailed Analysis

Land Use	Max L_v (VdB)[1]	Description of Use
Workshop	90	Vibration that is distinctly felt. Appropriate for workshops and similar areas not as sensitive to vibration.
Office	84	Vibration that can be felt. Appropriate for offices and similar areas not as sensitive to vibration.
Residential Day	78	Vibration that is barely felt. Adequate for computer equipment and low-power optical microscopes (up to 20×).
Residential Night and Operating Rooms	72	Vibration is not felt, but ground-borne noise may be audible inside quiet rooms. Suitable for medium-power microscopes (100×) and other equipment of low sensitivity.

Source: *Transit Noise and Vibration Impact Assessment Manual* (FTA 2018).
[1] As measured in 1/3-Octave bands of frequency over the frequency range 8 to 80 Hertz.
FTA = Federal Transit Administration
L_V = velocity in decibels
VdB = vibration velocity decibels
Max = maximum

Table E lists the potential vibration building damage criteria associated with construction activities, as suggested in the FTA Manual. FTA guidelines show that a vibration level of up to 0.5 in/sec in PPV is considered safe for buildings consisting of reinforced concrete, steel, or timber (no plaster), and would not result in any construction vibration damage. For non-engineered timber and masonry buildings, the construction building vibration damage criterion is 0.2 in/sec in PPV.

Table E: Construction Vibration Damage Criteria

Building Category	PPV (in/sec)
Reinforced concrete, steel, or timber (no plaster)	0.50
Engineered concrete and masonry (no plaster)	0.30
Non-engineered timber and masonry buildings	0.20
Buildings extremely susceptible to vibration damage	0.12

Source: *Transit Noise and Vibration Impact Assessment Manual* (FTA 2018).
FTA = Federal Transit Administration
PPV = peak particle velocity
in/sec = inch/inches per second

OVERVIEW OF THE EXISTING NOISE ENVIRONMENT

The primary existing noise sources in the project area are industrial uses to the south and west of the project site, traffic noise on 9th street and Tippecanoe Avenue, and aircraft noise.

AMBIENT NOISE MEASUREMENTS

Long-Term Noise Measurements

Long-term (24-hour) noise level measurements were conducted on March 9th and 10th, 2022, using two (2) Larson Davis Spark 706RC Dosimeters. Table F provides a summary of the measured hourly noise levels and calculated CNEL level from the long-term noise level measurements. As shown in Table F, the calculated CNEL levels range from 72.4 dBA CNEL to 72.6 dBA CNEL. Hourly noise levels at surrounding sensitive uses are as low as 58.3 dBA L_{eq} during nighttime hours and 66.7 dBA L_{eq} during daytime hours. Long-term noise monitoring data results are provided in Appendix A. Figure 3 shows the long-term monitoring locations.

Table F: Long-Term 24-Hour Ambient Noise Monitoring Results

Location		Daytime Noise Levels[1] (dBA L_{eq})	Evening Noise Levels[2] (dBA L_{eq})	Nighttime Noise Levels[3] (dBA L_{eq})	Daily Noise Levels (dBA CNEL)
LT-1	1080 9th Street, on second palm tree west of driveway, approximately 60 ft north of the 9th street centerline.	69.0-71.6	66.9-68.8	59.2-68.0	72.6
LT-2	24914 Union Street, on utility pole near the northeast corner of the intersection of Union Street and Tippecanoe Avenue, approximately 50 ft from Tippecanoe Avenue centerline.	66.7-69.0	66.3-70.6	58.3-70.1	72.4

Source: Compiled by LSA (2022).
Note: Noise measurements were conducted from March 9 to March 10, 2022, starting at 10:00 a.m.
1 Daytime Noise Levels = noise levels during the hours from 7:00 a.m. to 7:00 p.m.
2 Evening Noise Levels = noise levels during the hours from 7:00 p.m. to 10:00 p.m.
3 Nighttime Noise Levels = noise levels during the hours from 10:00 p.m. to 7:00 a.m.
dBA = A-weighted decibels
L_{eq} = equivalent continuous sound level
CNEL = Community Noise Equivalent Level

EXISTING AIRCRAFT NOISE

Aircraft flyovers may be audible on the project site due to aircraft activity in the vicinity. The nearest airport to the project is San Bernardino International Airport (SBD), approximately 1.25 miles to the southeast. Noise impacts related to aircraft operations may contribute to the aircraft noise in the project area; however, the project site is located well outside the SBD Airport Influence Area according to the 2017 Existing CNEL Contours and Generalized Land Uses – San Bernardino International Airport (San Bernardino County, 2017). Therefore, the project would not be adversely affected by airport/airfield noise, nor would the project contribute to or result in adverse airport/airfield noise impacts.

LSA

FIGURE 3

LEGEND

- Project Site Boundary
- Short-Term Noise Monitoring Location
- Long-Term Noise Monitoring Location

N

0 400 800
FEET

SOURCE: Google Earth 2021

9th and Tippecanoe Street Warehouse

Noise Monitoring Locations

I:\ESL2201.06\G\Noise_Locs.ai (6/17/22)

PROJECT IMPACTS

SHORT-TERM CONSTRUCTION NOISE IMPACTS

Two types of short-term noise impacts could occur during the construction of the proposed project. First, 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 ft would generate up to 84 dBA L_{max}), the effect on longer-term ambient noise levels would be small when compared to existing daily traffic volumes on 9th Street and Tippecanoe Avenue. Because construction-related vehicle trips would not approach existing daily traffic volumes, traffic noise would not increase by 3 dBA CNEL. A noise level increase of less than 3 dBA would not be perceptible to the human ear in an outdoor environment. Therefore, short-term, construction-related impacts associated with worker commute and equipment transport to the project site would be less than significant.

The second type of short-term noise impact is related to noise generated during construction which includes demolition of the existing structures and other site improvements, site preparation, grading, building construction, paving, and architectural coating 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. Table G lists typical construction equipment noise levels recommended for noise impact assessments, based on a distance of 50 ft between the equipment and a noise receptor, taken from the FHWA *Roadway Construction Noise Model* (FHWA 2006).

In addition to the reference maximum noise level, the usage factor provided in Table G is used to calculate the hourly noise level impact for each piece of equipment based on the following equation:

$$L_{eq}(equip) = E.L. + 10\log(U.F.) - 20\log\left(\frac{D}{50}\right)$$

where: $L_{eq}(equip)$ = L_{eq} at a receiver resulting from the operation of a single piece of equipment over a specified time period.

E.L. = noise emission level of the particular piece of equipment at a reference distance of 50 ft.

U.F. = usage factor that accounts for the fraction of time that the equipment is in use over the specified period of time.

D = distance from the receiver to the piece of equipment.

Table G: Typical Construction Equipment Noise Levels

Equipment Description	Acoustical Usage Factor (%)[1]	Maximum Noise Level (L_{max}) at 50 Feet[2]
Auger Drill Rig	20	84
Backhoes	40	80
Compactor (ground)	20	80
Compressor	40	80
Cranes	16	85
Dozers	40	85
Dump Trucks	40	84
Excavators	40	85
Flat Bed Trucks	40	84
Forklift	20	85
Front-end Loaders	40	80
Graders	40	85
Impact Pile Drivers	20	95
Jackhammers	20	85
Paver	50	77
Pickup Truck	40	55
Pneumatic Tools	50	85
Pumps	50	77
Rock Drills	20	85
Rollers	20	85
Scrapers	40	85
Tractors	40	84
Trencher	50	80
Welder	40	73

Source: FHWA Roadway Construction Noise Model User's Guide, Table 1 (FHWA 2006).
Note: Noise levels reported in this table are rounded to the nearest whole number.
[1] Usage factor is the percentage of time during a construction noise operation that a piece of construction equipment is operating at full power.
[2] Maximum noise levels were developed based on Specification 721.560 from the Central Artery/Tunnel program to be consistent with the City of Boston's Noise Code for the "Big Dig" project.
FHWA = Federal Highway Administration
L_{max} = maximum instantaneous sound level

Each piece of construction equipment operates as an individual point source. Using the following equation, a composite noise level can be calculated when multiple sources of noise operate simultaneously:

$$Leq\ (composite) = 10 * \log_{10}\left(\sum_{1}^{n} 10^{\frac{Ln}{10}}\right)$$

Using the equations from the methodology above, the reference information in Table G, and the construction equipment list provided, the composite noise level of each construction phase was calculated. The project construction composite noise levels at a distance of 50 feet would range from 74 dBA L_{eq} to 88 dBA L_{eq} with the highest noise levels occurring during the grading phase.

Once composite noise levels are calculated, reference noise levels can then be adjusted for distance using the following equation:

$$Leq\ (at\ distance\ X) = Leq\ (at\ 50\ feet) - 20 * \log_{10}\left(\frac{X}{50}\right)$$

In general, this equation shows that doubling the distance would decrease noise levels by 6 dBA while halving the distance would increase noise levels by 6 dBA.

Table H shows the nearest uses to the project site, their distance from the center of construction activities, and composite noise levels expected during construction. These noise level projections do not consider intervening topography or barriers. Construction equipment calculations are provided in Appendix B.

Table H: Potential Construction Noise Impacts at Nearest Receptor

Receptor (Location)	Composite Noise Level (dBA L_{eq}) at 50 feet[1]	Distance (feet)	Composite Noise Level (dBA L_{eq})
Industrial Uses (West)	88	240	75
Residence (East)		480	69
Commercial (North)		590	67
Industrial Uses (South)		650	53
RV Park (North)		650	53
School (Northeast)		1,150	42

Source: Compiled by LSA (2022).

[1] The composite construction noise level represents the grading phase which is expected to result in the greatest noise level as compared to other phases.

dBA L_{eq} = average A-weighted hourly noise level

While construction noise will vary, it is expected that composite noise levels during construction at the nearest off-site industrial uses to the west would reach 75 dBA L_{eq} while construction noise levels would approach 69 dBA L_{eq} at the nearest sensitive residential use to the east during daytime hours. These predicted noise levels would only occur when all construction equipment is operating simultaneously; and therefore, are assumed to be rather conservative in nature. While construction-related short-term noise levels have the potential to be higher than existing ambient noise levels in the project area under existing conditions, the noise impacts would no longer occur once project construction is completed.

As it relates to off-site uses, construction-related noise impacts would remain below the 90 dBA L_{eq} and 100 dBA L_{eq} 1-hour construction noise level criteria for daytime construction noise level criteria as established by the FTA for residential and industrial land uses, respectively, and therefore would be considered less than significant.

As stated above, noise impacts associated with construction activities are regulated by the City's noise ordinance. The proposed project would comply with the construction hours specified in the City's Noise Ordinance, which states that construction activities are allowed between the hours of 7:00 a.m. and 8:00 p.m.

Best construction practices presented at the end of this analysis shall be implemented to minimize noise impacts to surrounding receptors.

SHORT-TERM CONSTRUCTION VIBRATION IMPACTS

This construction vibration impact analysis discusses the level of human annoyance using vibration levels in VdB and assesses the potential for building damages using vibration levels in PPV (in/sec). This is because vibration levels calculated in RMS are best for characterizing human response to building vibration, while vibration level in PPV is best for characterizing potential for damage.

Table I shows the PPV and VdB values at 25 ft from the construction vibration source. As shown in Table I, bulldozers, and other heavy-tracked construction equipment (expected to be used for this project) generate approximately 0.089 PPV in/sec or 87 VdB of ground-borne vibration when measured at 25 ft, based on the FTA Manual. The distance to the nearest buildings for vibration impact analysis is measured between the nearest off-site buildings and the project construction boundary (assuming the construction equipment would be used at or near the project setback line).

Table I: Vibration Source Amplitudes for Construction Equipment

Equipment	Reference PPV/L_V at 25 ft	
	PPV (in/sec)	L_V (VdB)[1]
Pile Driver (Impact), Typical	0.644	104
Pile Driver (Sonic), Typical	0.170	93
Vibratory Roller	0.210	94
Hoe Ram	0.089	87
Large Bulldozer[2]	**0.089**	**87**
Caisson Drilling	0.089	87
Loaded Trucks[2]	**0.076**	**86**
Jackhammer	0.035	79
Small Bulldozer	0.003	58

Source: *Transit Noise and Vibration Impact Assessment Manual* (FTA 2018).
[1] RMS vibration velocity in decibels (VdB) is 1 µin/sec.
[2] Equipment shown in **bold** is expected to be used on site.
µin/sec = microinches per second
ft = foot/feet
FTA = Federal Transit Administration
in/sec = inch/inches per second
L_V = velocity in decibels
PPV = peak particle velocity
RMS = root-mean-square
VdB = vibration velocity decibels

The formulae for vibration transmission are provided below and Tables J and K below provide a summary of off-site construction vibration levels.

$$L_v dB\ (D) = L_v dB\ (25\ ft) - 30\ Log\ (D/25)$$

$$PPV_{equip} = PPV_{ref} \times (25/D)^{1.5}$$

As shown in Table D above, the threshold at which vibration levels would result in annoyance would be 78 VdB for daytime residential uses and 90 VdB for workshop or industrial type uses. As shown in

Table E, the FTA guidelines indicate that for a non-engineered timber and masonry building, the construction vibration damage criterion is 0.2 in/sec in PPV.

Table J: Potential Construction Vibration Annoyance Impacts at Nearest Receptor

Receptor (Location)	Reference Vibration Level (VdB) at 25 feet[1]	Distance (feet) [2]	Vibration Level (VdB)
Industrial Uses (West)	87	240	58
Residence (East)		480	49
Commercial Uses (North)		590	46
Industrial Uses (South)		650	45
Residence – RV Park (North)		650	45
School (Northeast)		1,150	37

Source: Compiled by LSA (2022).

1 The reference vibration level is associated with a large bulldozer which is expected to be representative of the heavy equipment used during construction.

2 The reference distance is associated with the average condition, identified by the distance from the center of construction activities to surrounding uses

ft = foot/feet

VdB = vibration velocity decibels

Table K: Potential Construction Vibration Damage Impacts at Nearest Receptor

Receptor (Location)	Reference Vibration Level (PPV) at 25 feet[1]	Distance (feet) [2]	Vibration Level (PPV)
Industrial Uses (West)	0.089	20	0.124
Residence (East)		95	0.012
Commercial Uses (North)		120	0.008
Industrial Uses (South)		125	0.008
Residence – RV Park (North)		135	0.007
School (Northeast)		720	0.001

Source: Compiled by LSA (2022).

1 The reference vibration level is associated with a large bulldozer which is expected to be representative of the heavy equipment used during construction.

2 The reference distance is associated with the peak condition, identified by the distance from the perimeter of construction activities to surrounding structures

ft = foot/feet

in/sec = inch/inches per second

PPV = peak particle velocity

Based on the information provided in Table J, vibration levels are expected to approach 58 VdB at the closest industrial uses located immediately west of the project site and 49 VdB at the closest residential use to the east which is below the 90 VdB and 78 VdB annoyance threshold for workshop or industrial types uses and for daytime residential uses, respectively. Based on the information provide in Table K, vibration levels are expected to approach 0.124 PPV in/sec at the surrounding structures and would be below the 0.2 PPV in/sec damage threshold.

Because construction activities are regulated by the City's Code of Ordinance which states temporary construction, maintenance, or demolition activities are not allowed between 8:00 p.m.

on one day and 7:00 a.m. of the following day, vibration impacts would not occur during the more sensitive nighttime hours.

Other building structures surrounding the project site are farther away and would experience further reduced vibration. Therefore, no construction vibration impacts would occur. No vibration reduction measures are required.

LONG-TERM OFF-SITE TRAFFIC NOISE IMPACTS

As a result of the implementation of the proposed project, off-site traffic volumes on surrounding roadways have the potential to increase. The proposed project trips generated were obtained from the *Trip Generation Analysis* (EPD Solutions, Inc. 2021). The proposed project would generate 475 daily Passenger Car Equivalent (PCE) trips, 26 PCE trips during the AM peak hour, and 34 PCE trips during the PM peak hour. Based on the ADTs provided in the *City of San Bernardino 24-Hour Traffic County Map*, the ADT along Tippecanoe Avenue exceeds 8,000 while the ADT along 9th Street exceeds 10,800. The following equation was used to determine potential impacts of the project:

$$\text{Change in CNEL} = 10 \log_{10} [V_{e+p}/V_{existing}]$$

Where: $V_{existing}$ = the existing daily volume
V_{e+p} = existing daily volumes plus project
Change in CNEL = the increase in noise level due to the project

The results of the calculations show that an increase of less than 0.3 dBA CNEL is expected along Century Boulevard. A noise level increase of less than 1 dBA would not be perceptible to the human ear; therefore, the traffic noise increase along adjacent roadways resulting from the proposed project would be less than significant. No mitigation is required.

LONG-TERM TRAFFIC-RELATED VIBRATION IMPACTS

The proposed project would not generate vibration levels related to on-site operations. In addition, vibration levels generated from project-related traffic on the adjacent roadways are unusual for on-road vehicles because the rubber tires and suspension systems of on-road vehicles provide vibration isolation. Vibration levels generated from project-related traffic on the adjacent roadways would be less than significant and no mitigation measures are required.

LONG-TERM OFF-SITE STATIONARY NOISE IMPACTS

Adjacent off-site land uses would be potentially exposed to stationary-source noise impacts from the proposed on-site heating, ventilation, and air conditioning (HVAC) equipment, trash enclosure activity, and truck deliveries and loading and unloading activities. The potential noise impacts to off-site sensitive land uses from the proposed operations are discussed below. To provide a conservative analysis, it is assumed that operations would occur equally during all hours of the day and that half of the 35 loading docks would be active at all times. Additionally, it is assumed that within any given hour, 18 heavy trucks would maneuver to park near or back into one of the proposed loading docks. To determine the future noise impacts from project operations to the noise sensitive uses, a 3-D noise model, SoundPLAN, was used to incorporate the site topography as well as the shielding from the proposed building on-site. A graphic representation of the operational noise impacts is presented in Appendix C.

Heating, Ventilation, and Air Conditioning Equipment

The project would have various rooftop mechanical equipment including HVAC units on the proposed building. To be conservative, it is assumed the project could have six (6) rooftop HVAC units and operate 24 hours per day. The HVAC equipment could operate 24 hours per day and would generate sound power levels (SPL) of up to 87 dBA SPL or 72 dBA L_{eq} at 5 feet, based on manufacturer data (Trane).

Truck Deliveries and Truck Loading and Unloading Activities

Noise levels generated by delivery trucks would be similar to noise readings from truck loading and unloading activities, which generate a noise level of 75 dBA L_{eq} at 20 ft based on measurements taken by LSA (*Operational Noise Impact Analysis for Richmond Wholesale Meat Distribution Center* [LSA 2016]). Shorter term noise levels that occur during the docking process taken by LSA were measured to be 76.3 dBA L_8 at 20 ft. Delivery trucks would arrive on site and maneuver their trailers so that trailers would be parked within the loading docks. During this process, noise levels are associated with the truck engine noise, air brakes, and back-up alarms while the truck is backing into the dock. These noise levels would occur for a shorter period of time (less than 5 minutes). After a truck enters the loading dock, the doors would be closed, and the remainder of the truck loading activities would be enclosed and therefore much less perceptible. To present a conservative assessment, it is assumed that truck arrivals activities could occur at 17 parking spaces for a period of less than five (5) minutes each and unloading activities could occur at 17 docks simultaneously for a period of 30 minutes in a given hour.

Trash Enclosure Activities

Noise levels generated by trash enclosures are of short-term duration, less than one minute, and are conservatively assumed to occur at both locations within the same clock hour. Noise levels that occur during the unloading of trash enclosures by large trucks typically generate noise levels of approximately 84 dBA at 50 ft based on measurements presented in *Investigation of Dumpster Noise Controls* (Daly-Standlee & Associates, Inc. 2003).

Cumulative Operations Noise Assessment

Tables L and M below show the combined hourly noise levels generated by HVAC equipment, trash enclosure activities, and truck delivery activities at the closest off-site land uses. The project-related noise level impacts would range from 36.6 dBA L_{eq} to 54.2 dBA L_{eq} at the surrounding sensitive receptors. These levels would be well below the City of San Bernardino's exterior noise standard of 65 dBA L_{eq} and the City of Highlands daytime and nighttime noise standards of 60 dBA L_{eq} and 55 dBA L_{eq}, respectively. Because project noise levels would not generate a noise level by 3 dBA or more or exceed the City's thresholds, the impact would be less than significant, and no noise reduction measures are required.

Table L: Daytime Exterior Noise Level Impacts

Receptor	Direction	Existing Quietest Daytime Noise Level (dBA L_{eq})	Project Generated Noise Levels (dBA L_{eq})	Potential Operational Noise Impact?[1]
Residential (24914 Union Street)	East	66.7	47.3	No
Residential (7769 Vine Street)	East	66.7	37.1	No
Residential (San Bernardino RV Park)	North	69.0	54.2	No
School (Bing Wong Elementary School)	Northeast	69.0	36.6	No

Source: Compiled by LSA (2022).

[1] A potential operational noise impact would occur if (1) the quietest daytime ambient hour is less than the applicable hourly standard and project noise impacts would cause an exceedance of said standard, OR (2) the quietest daytime ambient hour is greater than the applicable hourly standard and project noise impacts are 3 dBA greater than the quietest daytime ambient hour.

dBA = A-weighted decibels

L_{eq} = equivalent noise level

Table M: Nighttime Exterior Noise Level Impacts

Receptor	Direction	Existing Quietest Nighttime Noise Level (dBA L_{eq})	Project Generated Noise Levels (dBA L_{eq})	Potential Operational Noise Impact?[1]
Residential (24914 Union Street)	East	58.3	47.3	No
Residential (7769 Vine Street)	East	58.3	37.1	No
Residential (San Bernardino RV Park)	North	59.2	54.2	No
School (Bing Wong Elementary School)	Northeast	-	-	No[2]

Source: Compiled by LSA (2022).

1 A potential operational noise impact would occur if (1) the quietest nighttime ambient hour is less than the applicable hourly standard and project noise impacts would cause an exceedance of said standard, OR (2) the quietest nighttime ambient hour is greater than the applicable hourly standard and project noise impacts are 3 dBA greater than the quietest nighttime ambient hour.

2 Under typical conditions, the Bing Wong Elementary school is not occupied during nighttime hours.

dBA = A-weighted decibels

L_{eq} = equivalent noise level

BEST CONSTRUCTION PRACTICES

In addition to compliance with the City's Municipal Code allowed hours of construction of 7:00 a.m. to 8:00 p.m., the following best construction practices would further minimize construction noise impacts:

- The project construction contractor shall equip all construction equipment, fixed or mobile, with properly operating and maintained noise mufflers consistent with manufacturer's standards.
- The project construction contractor shall locate staging areas away from off-site sensitive uses during the later phases of project development.
- The project construction contractor shall place all stationary construction equipment so that emitted noise is directed away from sensitive receptors nearest the project site whenever feasible.

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APPENDIX A

NOISE MONITORING DATA

Noise Measurement Survey – 24 HR

Project Number: ESL2206
Project Name: 9th and Tippecanoe

Test Personnel: Corey Knips
Equipment: Spark 906RC (SN:18905)

Site Number: LT-1 Date: 3/9/2022

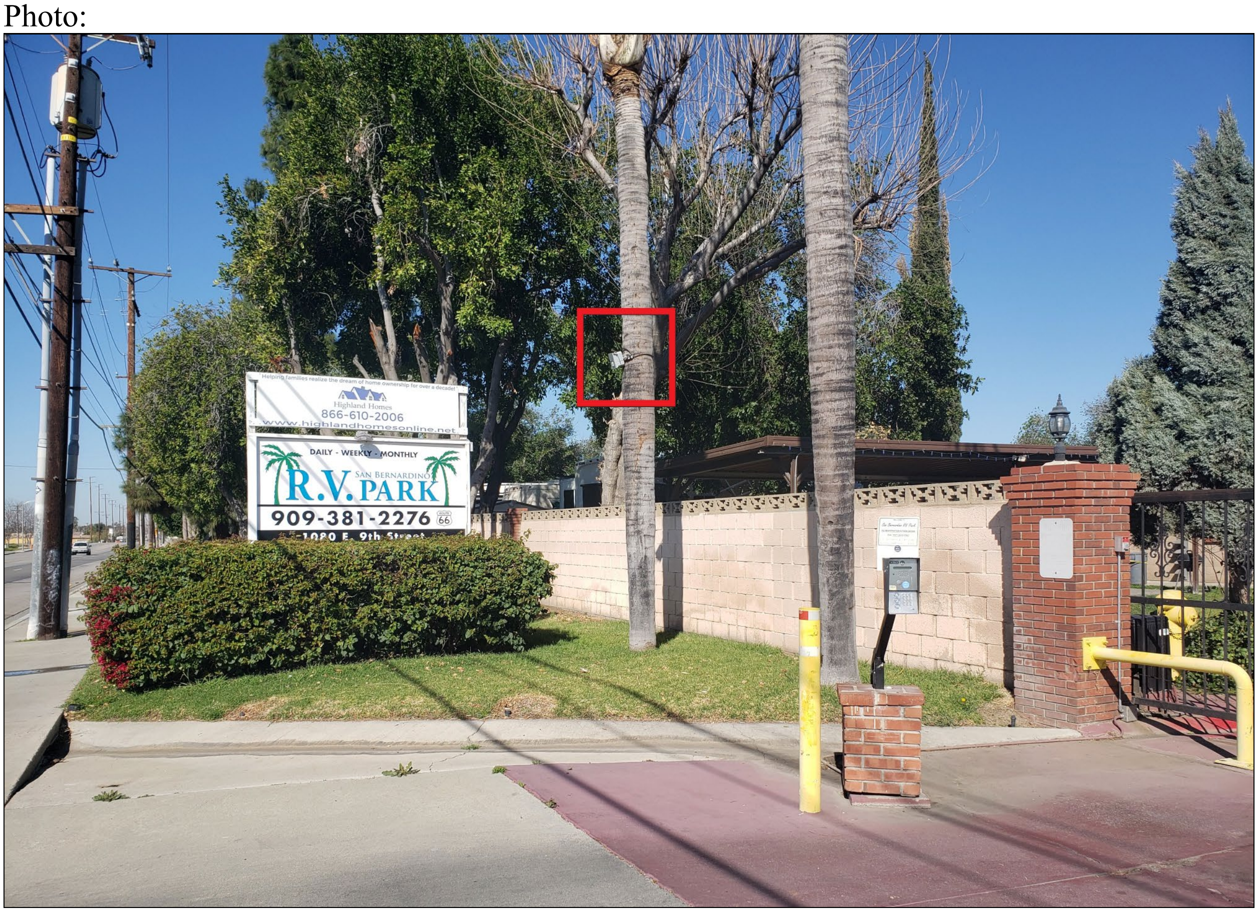
Time: From 10:00 a.m. To 10:00 a.m.

Site Location: 1080 9th Street, San Bernardino. On second palm tree west of driveway, approximately 60 feet north of centerline of 9th Street.

Primary Noise Sources: Traffic on 9th Street, faint traffic on Tippecanoe Avenue, and aircraft.

Comments: Property wall height is 5 foot 4 inches.

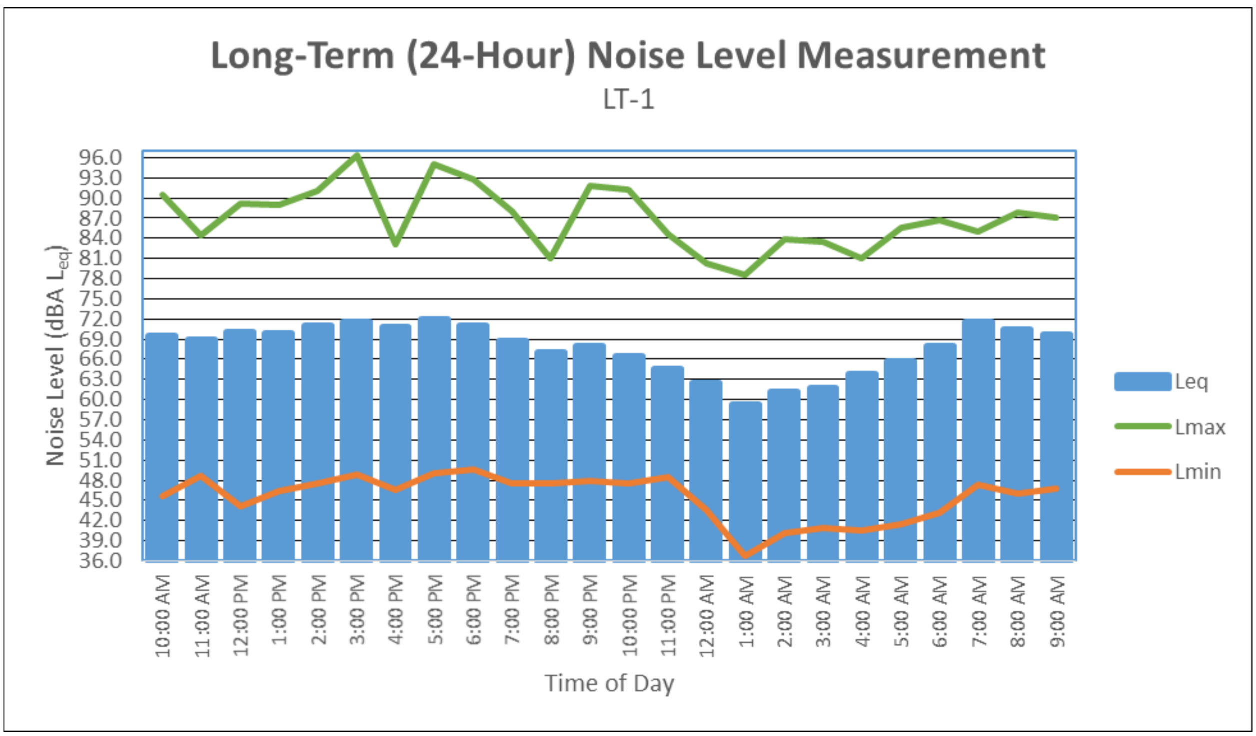
Photo:



Long-Term (24-Hour) Noise Level Measurement Results at LT-1

Start Time	Date	Noise Level (dBA)		
		L_{eq}	L_{max}	L_{min}
10:00 AM	3/9/2022	69.5	90.4	45.7
11:00 AM	3/9/2022	69.0	84.4	48.7
12:00 PM	3/9/2022	70.0	89.1	44.2
1:00 PM	3/9/2022	69.8	89.0	46.4
2:00 PM	3/9/2022	71.0	91.1	47.6
3:00 PM	3/9/2022	71.7	96.3	48.9
4:00 PM	3/9/2022	70.8	83.1	46.5
5:00 PM	3/9/2022	71.9	95.1	49.0
6:00 PM	3/9/2022	71.0	92.7	49.6
7:00 PM	3/9/2022	68.8	88.1	47.5
8:00 PM	3/9/2022	66.9	81.1	47.6
9:00 PM	3/9/2022	68.0	91.8	47.9
10:00 PM	3/9/2022	66.6	91.3	47.6
11:00 PM	3/9/2022	64.5	84.7	48.4
12:00 AM	3/10/2022	62.4	80.2	43.6
1:00 AM	3/10/2022	59.2	78.5	36.7
2:00 AM	3/10/2022	61.1	83.9	40.2
3:00 AM	3/10/2022	61.8	83.4	40.9
4:00 AM	3/10/2022	63.8	81.1	40.5
5:00 AM	3/10/2022	65.7	85.6	41.5
6:00 AM	3/10/2022	68.0	86.8	43.2
7:00 AM	3/10/2022	71.6	85.0	47.3
8:00 AM	3/10/2022	70.4	87.9	46.0
9:00 AM	3/10/2022	69.6	87.0	46.8

Source: Compiled by LSA Associates, Inc. (2022).
dBA = A-weighted decibel
L_{eq} = equivalent continuous sound level
L_{max} = maximum instantaneous noise level
L_{min} = minimum measured sound level



Project Number: ESL2206

Project Name: 9th and Tippecanoe

Test Personnel: Corey Knips

Equipment: Spark 906RC (SN:18906)

Site Number: LT-2 Date: 3/9/2022

Time: From 10:00 a.m. To 10:00 a.m.

Site Location: 24914 Union Street, San Bernardino. On the utility pole near the northeast corner of the intersection of Union Street and Tippecanoe Avenue.

Primary Noise Sources: Traffic on Tippecanoe Avenue and aircraft.

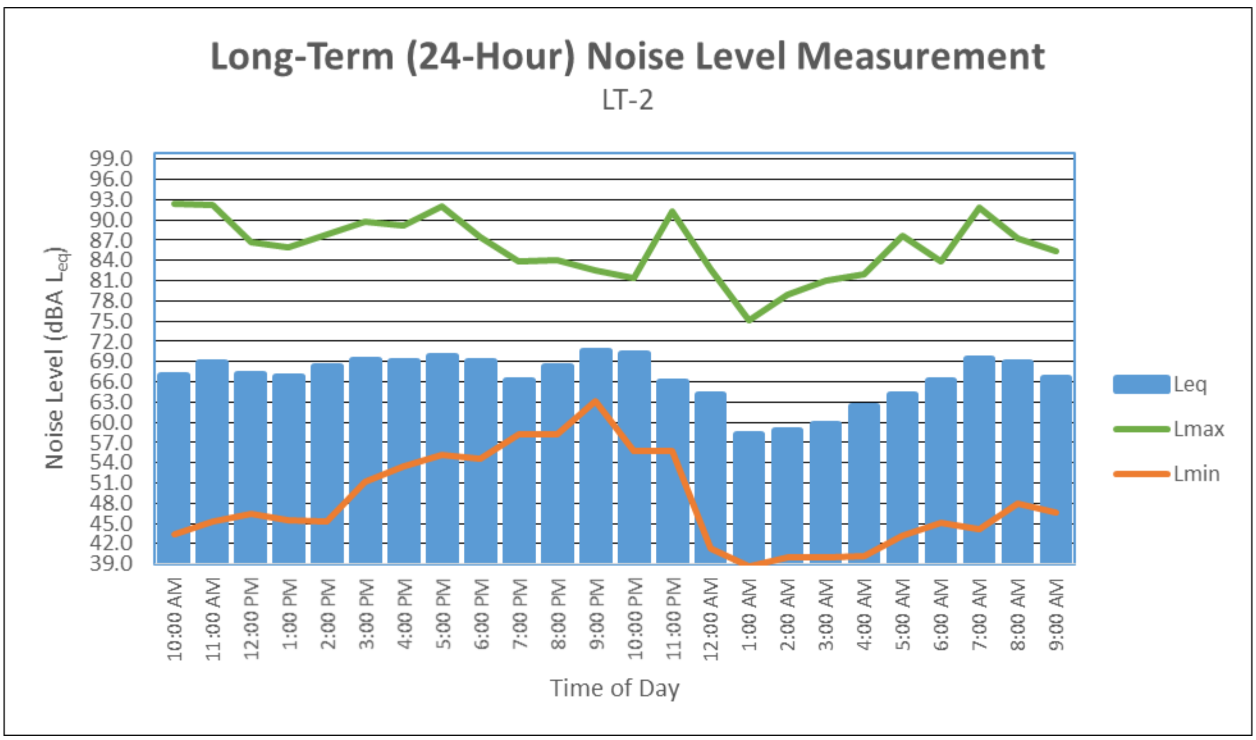
Comments:

Photo:

Long-Term (24-Hour) Noise Level Measurement Results at LT-2

Start Time	Date	Noise Level (dBA)		
		L_{eq}	L_{max}	L_{min}
10:00 AM	3/9/2022	67.0	92.4	43.5
11:00 AM	3/9/2022	68.8	92.3	45.4
12:00 PM	3/9/2022	67.2	86.7	46.5
1:00 PM	3/9/2022	66.8	85.9	45.5
2:00 PM	3/9/2022	68.2	87.9	45.4
3:00 PM	3/9/2022	69.3	89.7	51.2
4:00 PM	3/9/2022	69.1	89.1	53.4
5:00 PM	3/9/2022	69.7	92.1	55.2
6:00 PM	3/9/2022	69.0	87.5	54.7
7:00 PM	3/9/2022	66.3	83.9	58.3
8:00 PM	3/9/2022	68.4	84.1	58.3
9:00 PM	3/9/2022	70.6	82.5	63.1
10:00 PM	3/9/2022	70.1	81.4	55.7
11:00 PM	3/9/2022	66.0	91.2	55.8
12:00 AM	3/10/2022	64.1	82.8	41.3
1:00 AM	3/10/2022	58.3	75.2	38.7
2:00 AM	3/10/2022	58.8	78.9	40.0
3:00 AM	3/10/2022	59.7	81.0	40.0
4:00 AM	3/10/2022	62.4	82.0	40.2
5:00 AM	3/10/2022	64.1	87.7	43.3
6:00 AM	3/10/2022	66.3	83.9	45.1
7:00 AM	3/10/2022	69.5	91.8	44.2
8:00 AM	3/10/2022	68.9	87.3	48.0
9:00 AM	3/10/2022	66.7	85.3	46.7

Source: Compiled by LSA Associates, Inc. (2022).
dBA = A-weighted decibel
L_{eq} = equivalent continuous sound level
L_{max} = maximum instantaneous noise level
L_{min} = minimum measured sound level



APPENDIX B

CONSTRUCTION NOISE LEVEL CALCULATIONS

Construction Calculations

Phase: Site Preparation

Equipment	Quantity	Reference (dBA) 50 ft Lmax	Usage Factor[1]	Distance to Receptor (ft)	Ground Effects	Noise Level (dBA)	
						Lmax	Leq
Dozer	3	82	40	50	0.5	82	83
Tractor	4	84	40	50	0.5	84	86
					Combined at 50 feet	**86**	**88**
					Combined at Receptor 240 feet	**72**	**74**
					Combined at Receptor 480 feet	**66**	**68**
					Combined at Receptor 590 feet	**65**	**66**
					Combined at Receptor 650 feet	**50**	**52**
					Combined at Receptor 1150 feet	**39**	**41**

Phase: Grading

Equipment	Quantity	Reference (dBA) 50 ft Lmax	Usage Factor[1]	Distance to Receptor (ft)	Ground Effects	Noise Level (dBA)	
						Lmax	Leq
Excavator	2	81	40	50	0.5	81	80
Grader	1	85	40	50	0.5	85	81
Dozer	1	82	40	50	0.5	82	78
Scraper	2	84	40	50	0.5	84	83
Tractor	2	84	40	50	0.5	84	83
					Combined at 50 feet	**90**	**88**
					Combined at Receptor 240 feet	**77**	**75**
					Combined at Receptor 480 feet	**71**	**69**
					Combined at Receptor 590 feet	**69**	**67**
					Combined at Receptor 650 feet	**55**	**53**
					Combined at Receptor 1150 feet	**44**	**42**

Phase: Building Construction

Equipment	Quantity	Reference (dBA) 50 ft Lmax	Usage Factor[1]	Distance to Receptor (ft)	Ground Effects	Noise Level (dBA)	
						Lmax	Leq
Crane	1	81	16	50	0.5	81	73
Man Lift	3	75	20	50	0.5	75	73
Generator	1	81	50	50	0.5	81	78
Tractor	3	84	40	50	0.5	84	85
Welder / Torch	1	74	40	50	0.5	74	70
					Combined at 50 feet	**87**	**86**
					Combined at Receptor 240 feet	**74**	**73**

Phase: Paving

Equipment	Quantity	Reference (dBA) 50 ft Lmax	Usage Factor[1]	Distance to Receptor (ft)	Ground Effects	Noise Level (dBA)	
						Lmax	Leq
Paver	2	77	50	50	0.5	77	77
All Other Equipment > 5 HP	2	85	50	50	0.5	85	85
Roller	2	80	20	50	0.5	80	76
					Combined at 50 feet	**87**	**86**
					Combined at Receptor 240 feet	**73**	**72**

Phase: Architectural Coating

Equipment	Quantity	Reference (dBA) 50 ft Lmax	Usage Factor[1]	Distance to Receptor (ft)	Ground Effects	Noise Level (dBA)	
						Lmax	Leq
Compressor (air)	1	78	40	50	0.5	78	74
					Combined at 50 feet	**78**	**74**
					Combined at Receptor 240 feet	**64**	**60**

Sources: RCNM

[1]- Percentage of time that a piece of equipment is operating at full power.
dBA – A-weighted Decibels
Lmax- Maximum Level
Leq- Equivalent Level

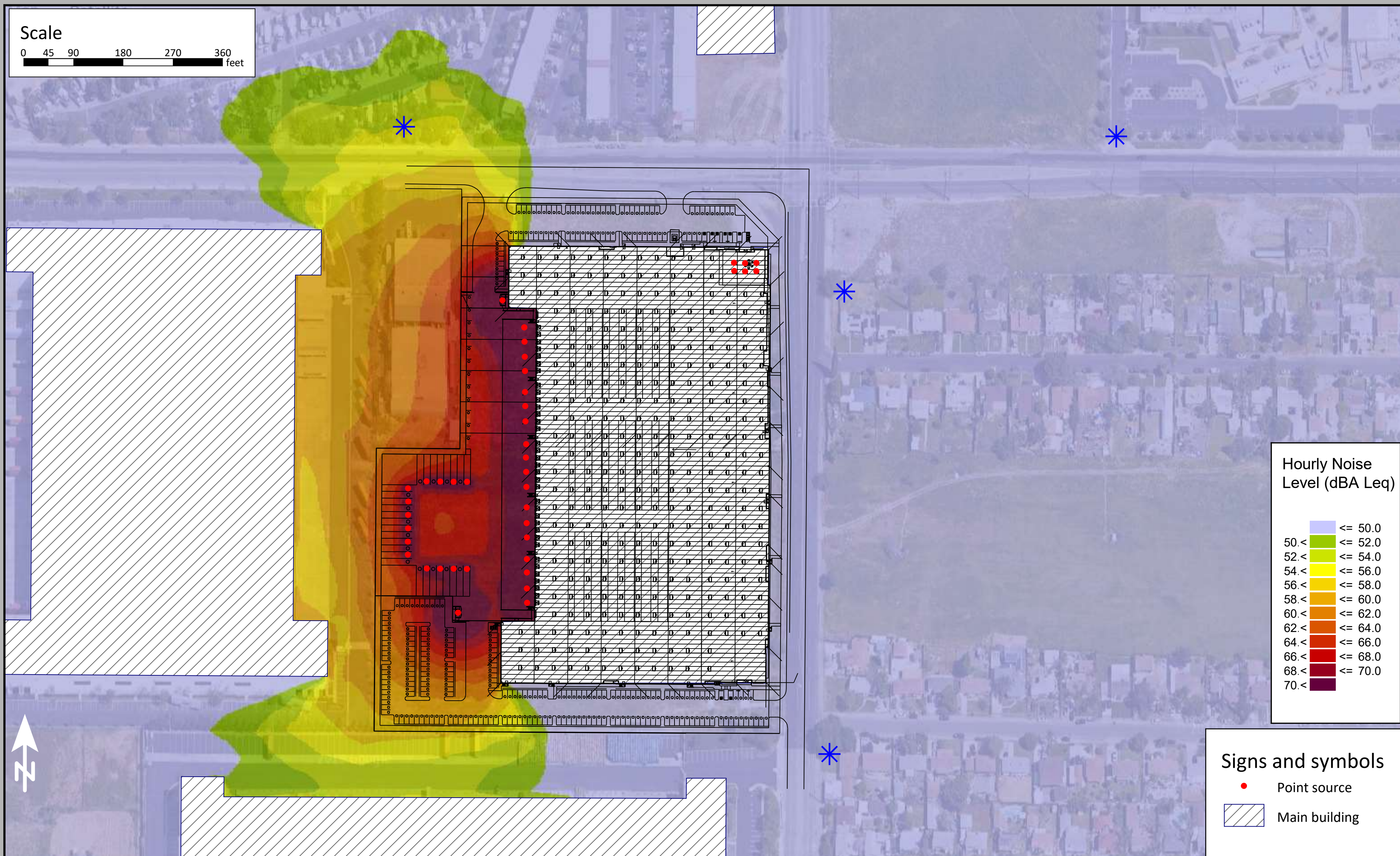
APPENDIX C

SOUNDPLAN NOISE MODEL PRINTOUTS

9th and Tippecanoe Warehouse

Project No. ESL2201.06

Project Operational Noise Levels



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