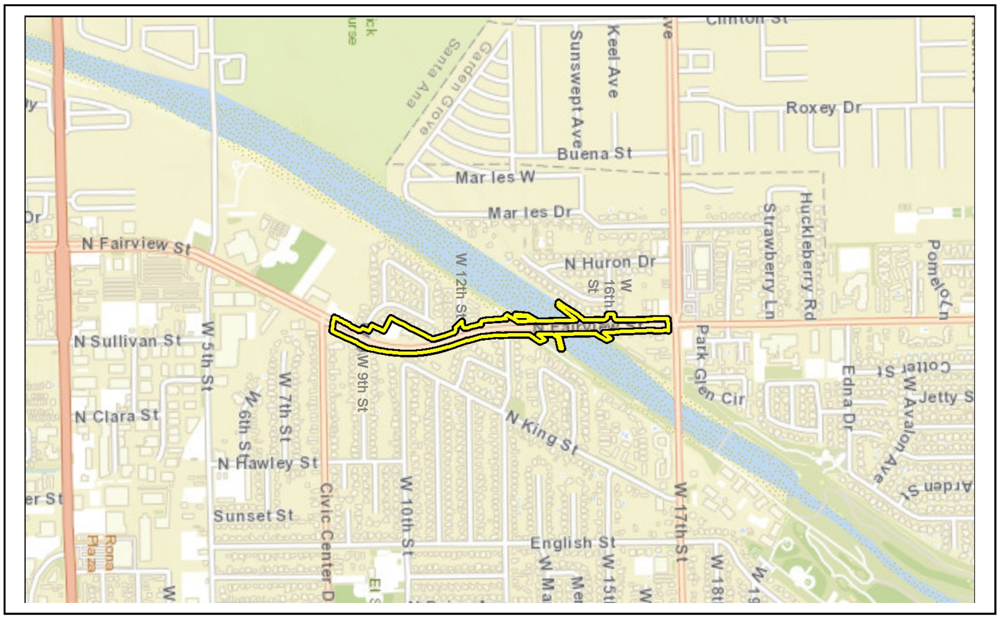

Noise Study Report

Santa Ana, California

Federal Project No. BRLS 5063(184)

January 2019

CALIFORNIA DEPARTMENT OF TRANSPORTATION

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Noise Study Report

Fairview Street Improvements from 9th Street to 16th Street

and Bridge Replacement Project

Santa Ana, California

Federal Project No. BRLS 5063(184)

January 2018

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Summary

The City of Santa Ana (City), in conjunction with the California Department of Transportation (Caltrans), District 12, proposes to widen Fairview Street between 9th Street and 16th Street, including replacing the Fairview Street bridge crossing over the Santa Ana River (proposed Project) in Santa Ana, California. The purpose of the project is to reduce congestion and improve pedestrian and bicyclist safety on Fairview Street between 9th Street and 16th Street, consistent with the Orange County Master Plan of Arterial Highways and the City's General Plan Circulation Element.

South of 9th Street, Fairview Street provides three lanes in each direction, which are reduced to two lanes in each direction north of 9th Street, across the existing four-lane bridge, to 16th Street. The Fairview Street segment between 9th Street and 16th Street is the only constraint for Fairview Street to be built out to its planned width of six lanes. This condition causes a traffic "bottleneck" during peak hours. In addition, there are no sidewalks, bikeways, or lighting on the existing bridge. Pedestrians and bicyclists currently use the roadway shoulder to cross the bridge.

A Type 1 project, as defined by Title 23, Part 772, of the Code of Federal Regulations (23 CFR 772), is any proposed Federal or Federal-aid highway project for the construction of a highway on new location, the physical alteration of an existing highway where there is either substantial horizontal or vertical alignment alteration, or other activities listed as a Type 1 project. The proposed Project is considered a Type 1 project because one additional travel lane in each direction would be added on Fairview Street. A noise analysis is required for all Type 1 projects.

Existing land uses in the project area include single-family and multifamily residences, a medical office, a park (Fairview Triangle Habitat Restoration Park), a multi-use trail, vacant land, and office, commercial, and light industrial uses. The primary source of noise in the project area is traffic on Fairview Street.

The terrain in the project area can be separated into four areas:

- Land uses east of Fairview Street and south of the Santa Ana River include single-family and multifamily residences, vacant land, and commercial uses that range from 3 feet (ft) higher to 7 ft lower in elevation than Fairview Street.

- Land uses west of Fairview Street and south of the Santa Ana River include single-family and multifamily residences, a medical office, a park, a trail, and office uses that range from 2 ft higher to 5 ft lower in elevation than Fairview Street.
- Land uses east of Fairview Street and north of the Santa Ana River include single-family residences and commercial and light industrial uses that range from 2 ft higher in elevation than Fairview Street to approximately the same elevation as Fairview Street.
- Land uses west of Fairview Street and north of the Santa Ana River include single-family residences, vacant land, and commercial and light industrial uses that range from 2 ft higher to 9 ft lower in elevation than Fairview Street.

Fifteen short-term noise level measurements were conducted at representative locations to document the existing noise environment. All short-term noise level measurements were used to calibrate the Federal Highway Administration (FHWA) Traffic Noise Model (TNM) 2.5 (2004) with concurrent traffic counts and observed vehicle speeds to ensure the accuracy of TNM 2.5. A total of 92 representative existing receptors were modeled and evaluated for potential noise impacts resulting from traffic noise. The results of the modeled noise levels for Existing, Future No Build, and Future Build conditions are provided in Table B.1 in Appendix B.

Two long-term (24-hour) noise level measurements were conducted in the project area to characterize the change in hourly noise levels over the course of a 24-hour period in the project area and to identify the peak traffic noise hour.

When traffic noise impacts have been identified, noise abatement measures must be considered. Traffic noise impacts result from one or more of the following occurrences: (1) an increase of 12 A-weighted decibels (dBA) or more over the corresponding existing noise levels, or (2) predicted noise levels approaching or exceeding the Noise Abatement Criteria (NAC).

Implementation of the proposed Project would result in potential short-term noise impacts during construction and long-term operational noise impacts from use of the completed project. Of the 92 modeled receptors, nine receptors would approach or exceed the NAC. No modeled receptors would experience a substantial increase of 12 dBA or more over their corresponding modeled existing noise levels.

Noise abatement measures were evaluated for receptors within the project limits that would be or would continue to be exposed to traffic noise levels approaching or exceeding the NAC. Six noise barriers were evaluated. The results of the noise barrier modeling are shown in Table B.1 in Appendix B. All six noise barriers were capable of reducing noise levels by 5 dBA or more, as required to be considered feasible.

A Noise Abatement Decision Report (NADR) will be prepared for the proposed Project. The NADR is a design responsibility and is prepared to compile information from the Noise Study Report (NSR), other relevant environmental studies, and design considerations into a single, comprehensive document before public review of the proposed Project. The NADR is prepared after completion of the NSR and prior to publication of the draft environmental document. The NADR includes noise abatement construction cost estimates that have been prepared and signed by the project engineer based on site-specific conditions. Construction cost estimates are compared to reasonable allowances in the NADR to identify which noise barrier configurations are reasonable from a cost perspective. The reasonableness determination of the feasible noise barriers shown in Tables 7.1 through 7.6 will be reported in the NADR for the proposed Project.

The design of noise barriers presented in this report is preliminary and has been conducted at a level appropriate for environmental review and not for final design of the proposed Project. If pertinent parameters change substantially during the final project design, preliminary noise barrier designs may be modified or eliminated from the final project. A final decision on the construction of the noise abatement will be made upon completion of the public involvement process during the final project design process.

The closest residences are located approximately 50 ft from the project construction areas. Therefore, the closest residences may be subject to short-term noise reaching 88 dBA maximum instantaneous noise level (L_{max}) or higher generated by construction activities in the project area. Compliance with the Caltrans Standard Specifications, Section 14-8.02, and the City's Municipal Code, Section 18-314, will be required to minimize construction noise impacts on land uses adjacent to the project area. In compliance with these regulations, the contractor shall not perform any construction activities between the hours of 8:00 p.m. and 7:00 a.m. on weekdays and Saturdays, or at any time on Sundays and federal holidays.

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List of Abbreviated Terms

°F	degrees Fahrenheit
μPa	micropascals
23 CFR 772	Title 23, Part 772 of the Code of Federal Regulations
Caltrans	California Department of Transportation
CEQA	California Environmental Quality Act
City	City of Santa Ana
CNEL	Community Noise Equivalent Level
dB	decibel(s)
dBA	A-weighted decibel(s)
dBA L_{eq}	equivalent continuous sound level measured in A-weighted decibels
FHWA	Federal Highway Administration
ft	foot/feet
Hz	Hertz
I.L.	Insertion Loss
kHz	kilohertz
L_{10}	noise level exceeded 10 percent of the time during a stated period
L_{90}	noise level exceeded 90 percent of the time during a stated period
L_{dn}	day-night level
L_{eq}	equivalent continuous sound level
L_{eq}(h)	1-hour A-weighted equivalent continuous sound level
L_{max}	maximum instantaneous sound level
L_{xx}	percentile-exceeded sound level
mph	miles per hour
NAC	Noise Abatement Criteria
NADR	Noise Abatement Decision Report

NB	Noise Barrier
NEPA	National Environmental Policy Act
NSR	Noise Study Report
proposed Project	Fairview Street Improvements from 9th Street to 16th Street and Bridge Replacement Project
Protocol	Traffic Noise Analysis Protocol for New Highway Construction, Reconstruction, and Retrofit Barrier Projects
RCNM	Roadway Construction Noise Model
SPL	sound pressure level
TeNS	Caltrans *Technical Noise Supplement*
TNM	Traffic Noise Model
vplph	vehicles per lane per hour

Chapter 1. Introduction

The City of Santa Ana (City), in conjunction with the California Department of Transportation (Caltrans) District 12, proposes to widen Fairview Street between 9th Street and 16th Street, including replacing the Fairview Street bridge crossing over the Santa Ana River (proposed Project) in Santa Ana, California. The purpose of the project is to reduce congestion and improve pedestrian and bicyclist safety on Fairview Street between 9th Street and 16th Street, consistent with the Orange County Master Plan of Arterial Highways and the City's General Plan Circulation Element.

South of 9th Street, Fairview Street provides three lanes in each direction which are reduced to two lanes in each direction north of 9th Street, across the existing four-lane bridge, to 16th Street. The Fairview Street segment between 9th Street and 16th Street is the only constraint for Fairview Street to be built out to its planned width of six lanes. This condition causes a traffic "bottleneck" during peak hours. In addition, there are no sidewalks, bikeways, or lighting on the existing bridge. Pedestrians and bicyclists currently use the roadway shoulder to cross the bridge.

Within the project limits, Fairview Street is bordered by single-family residences and a few commercial properties.

1.1. Purpose of the Noise Study Report

The purpose of Title 23, Part 772, of the Code of Federal Regulations (23 CFR 772), "Procedures for Abatement of Highway Traffic Noise and Construction Noise," (1982) is to provide procedures to help protect public health and welfare, supply Noise Abatement Criteria (NAC), and establish requirements for information to be given to local officials for use in the planning and design of highways approved pursuant to 23 CFR 772.1. As such, 23 CFR 772 provides procedures for preparing operational and construction noise impact studies and evaluating noise abatement considered for federal and federal-aid highway projects. According to 23 CFR 772.3, all highway projects that are developed in conformance with this regulation are deemed to be in conformance with Federal Highway Administration (FHWA) noise standards.

The Caltrans *Traffic Noise Analysis Protocol for New Highway Construction, Reconstruction, and Retrofit Barrier Projects* (Protocol) (Caltrans 2011) provides Caltrans policy for implementing 23 CFR 772 in California. The Protocol outlines the requirements for preparing Noise Study Reports (NSRs). The purpose of this NSR is to evaluate noise impacts and noise abatement consistent with the requirements of 23 CFR 772.

1.2. Project Purpose and Need

The Project Area has a history of traffic congestion; however, the proposed Project would improve traffic flow and alleviate congestion in this area. The proposed Project would also increase pedestrian safety at Fairview Street bridge by constructing new barrier rails, sidewalks, bicycle lanes, a raised median, and lighting on the proposed bridge structure.

1.2.1. Project Purpose

The purpose of the proposed Project is to improve pedestrian/bicyclist safety and traffic flow on and in the vicinity of Fairview Street bridge. The following goals/ objectives have been identified for the proposed Project:

- Provide for adequate vehicular capacity and greater pedestrian and bike safety on Fairview Street bridge; and
- Make the Fairview Street bridge design and capacity consistent with the Orange County Master Plan of Arterial Highways and the City of Santa Ana General Plan Circulation Element.

1.2.2. Project Need

The existing Fairview Street bridge has insufficient safety barriers and capacity to handle existing and projected traffic levels in the Project Area and is operating with the following deficiencies within the Project limits:

- No sidewalks, bike lanes, center median or barrier, or lighting; and
- Congestion on and around the existing bridge due to high traffic demands and a limited number of lanes relative to areas north and south of the bridge.

Chapter 2. Project Description

The City, in conjunction with Caltrans District 12, proposes to replace the Fairview Street bridge over the Santa Ana River and widen Fairview Street between 9th Street and 16th Street in Santa Ana, California. The City is the lead agency under the California Environmental Quality Act (CEQA). Caltrans is the lead agency under the National Environmental Policy Act (NEPA), as assigned by the FHWA through NEPA Delegation.

This section describes the proposed Project and the alternatives that were developed to meet the identified purpose and need of the proposed Project while avoiding or minimizing environmental impacts. The two alternatives being evaluated are the No Build Alternative and the Build Alternative.

2.1. No Build Alternative

The No Build Alternative assumes that no improvements are made to Fairview Street. The No Build Alternative would maintain the existing conditions and provides a baseline for comparison of the impacts under the Build Alternative. Under the No Build Alternative, the performance of the roadway would continue to deteriorate with the forecasted increase in traffic.

2.2. Build Alternative

The proposed Project includes widening Fairview Street between 9th Street and 16th Street, including replacing the Fairview Street bridge crossing over the Santa Ana River. The proposed Project would widen Fairview Street from two lanes in each direction to three lanes in each direction, as shown in Figures 2-1 and 2-2. Fairview Street bridge would be replaced with a new six-lane bridge (three lanes in each direction), including a complete bridge deck with barrier rails, sidewalks, bicycle lanes, a raised median, and lighting.

The proposed bridge would be expanded from approximately 52 feet (ft) to 100 ft in width, and would have the same roadway profile as the existing bridge. The eight pier walls that support the existing bridge would be removed, and four new pier walls would be constructed to support the new bridge.

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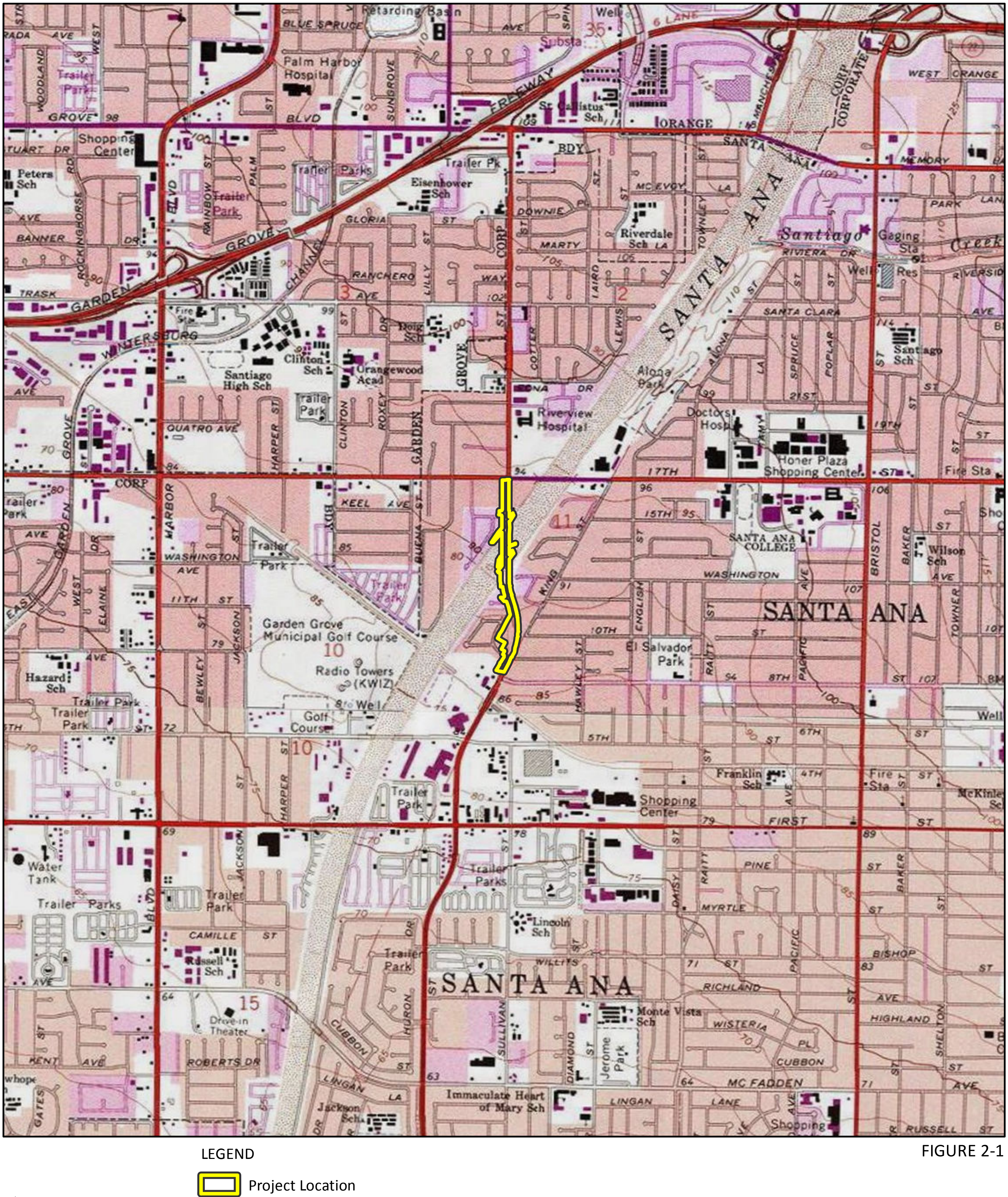

LEGEND

Project Location

FIGURE 2-1

N

0 1000 2000

FEET

Fairview Street Improvements from 9th Street to 16th Street and Bridge Replacement Project

Regional Location and Project Area

Federal Project No.: BRLS 5063(184)

SOURCE: USGS 7.5' Quad - Anaheim (1981) & Newport Beach (1981)

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LEGEND

- Project Area
- Proposed Right of Way
- Proposed Roadway Widening
- Proposed Roadway Modifications
- Proposed Bridge Piers
- Reconstruction of Access Road
- Potential Detour in River
- Grading / Revegetation / BMPS
- Construction Staging Area
- Proposed Construction Access

0 100 200
FEET

SOURCE: WKE (3/2018); Google (2016)

FIGURE 2-2

Fairview Street Improvements from 9th Street to 16th Street and Bridge Replacement Project

Proposed Project

Federal Project No.: BRLS 5063(184)

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The proposed Project would partial acquire right-of-way take from three parcels (two commercial parcels [Assessor's Parcel Numbers (APNs) 405-213-02 and 405-213-01] and one single-family residence [APN 405-213-14]), as shown in Figure 2-2.

An existing 12-inch water line and a bank of 12 phone conduits cross the Santa Ana River, suspended under the deck of the existing bridge. These utilities would need to be temporarily relocated during construction and then permanently relocated to the new bridge.

Water quality best management practices (BMPs) would be included to treat stormwater runoff such as a vegetated swale adjacent to Fairview Street in the Fairview Triangle rest area.

Fairview Street would remain open during the construction period with two southbound lanes and one northbound lane, with lanes shifted to one side of the bridge while the other side is replaced. Therefore, no detours would be required for vehicles traveling along Fairview Street. Access to properties would be maintained.

During construction, pedestrians and bikes would be detoured away from the Fairview Street bridge to the 17th Street Bridge to cross the Santa Ana River by way of the Santa Ana River Trail (SART) between the hours of 9:00 a.m. and 7:00 p.m., when the gates to the SART are open and unlocked. After hours, pedestrians and bicyclists who wish to cross the Santa Ana River would be detoured to adjacent City streets such as King Street.

Construction of the proposed Project would require temporary closure of a portion of the SART for the demolition and placement of the bridge superstructure. The SART includes a Class I bike path on the eastern side and a regional riding and hiking trail on the western side. The portion of the SART affected by project construction would need to be temporarily closed four times for approximately 8 hours each time during two summer periods for the placement of precast concrete girders. During these periods, SART users would be detoured and signage would be provided to display the dates of the closures and to identify the detour routes. Work on the north and south sides of the bridge would be completed during separate periods so that SART users can be detoured to the trail on the opposite side of the Santa Ana River at 5th Street. There are gates and ramps located on both sides of the SART at 5th Street that provide access to bicyclists and pedestrians for these detours. Details regarding the detours are being coordinated with Orange County Parks. Other short-term closures of up to 15 minutes would be allowed with flagmen.

A temporary detour within the river bed may be required as a contingency. This would involve construction of dirt and gravel ramps with asphalt topping to and from the SART and the river bed.

Construction vehicles would access the Santa Ana River from the gate and ramp at the County of Orange access road at the northwest corner of the bridge, and would use the existing concrete access ramp into the river approximately 250 ft west of the Project Area .All access roads to the SART that are utilized by construction vehicles or for detour routes would be reconstructed and restored to pre-construction conditions or better prior to project completion.

Chapter 3. Fundamentals of Traffic Noise

The following is a brief discussion of fundamental traffic noise concepts. For a detailed discussion, refer to the Caltrans *Technical Noise Supplement* (TeNS), a technical supplement to the Protocol that is available on the Caltrans website (Caltrans 2013).

3.1. Sound, Noise, and Acoustics

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) to a hearing organ (e.g., a human ear). Noise is defined as loud, unexpected, or annoying sound.

In the science of acoustics, the fundamental model consists of a sound (or noise) source, a receptor, and the propagation path between the two. The loudness of the noise source and obstructions or atmospheric factors affecting the propagation path to the receptor determine the sound level and characteristics of the noise perceived by the receptor. The field of acoustics deals primarily with the propagation and control of sound.

3.2. Frequency and Hertz

Continuous sound can be described by frequency (pitch) and amplitude (loudness). A low-frequency sound is perceived as low in pitch. Frequency is expressed in terms of cycles per second, or Hertz (Hz) (e.g., a frequency of 250 cycles per second is referred to as 250 Hz). High frequencies are sometimes more conveniently expressed in kilohertz (kHz), or thousands of Hertz. The audible frequency range for humans is generally between 20 Hz and 20,000 Hz.

3.3. Sound Pressure Levels and Decibels

The amplitude of pressure waves generated by a sound source determines the loudness of that source. Sound pressure amplitude is measured in micropascals (μPa). One μPa is approximately one hundred billionths (0.00000000001) of the normal atmospheric pressure. Sound pressure amplitudes for different kinds of noise environments can range from less than 100 to 100,000,000 μPa. Because of this huge range of values, sound is rarely expressed in terms of μPa. Instead, a logarithmic scale is used to describe sound pressure level (SPL) in terms of decibels (dB).

The threshold of hearing for young people is approximately 0 dB, which corresponds to 20 μPa.

3.4. Addition of Decibels

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

3.5. A-Weighted Decibels

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

Human hearing is limited in the range of audible frequencies as well as in the way it perceives the SPL in that range. In general, people are most sensitive to the frequency range of 1,000–8,000 Hz and perceive sounds in that range better than sounds of the same amplitude in higher or lower frequencies. To approximate the response of the human ear, sound levels of individual frequency bands are weighted, depending on the human sensitivity to those frequencies. An “A-weighted” sound level (expressed in units of A-weighted decibels [dBA]) can then be computed based on this information.

The A-weighting network approximates the frequency response of the average young ear when listening to most ordinary sounds. When people make judgments regarding the relative loudness or annoyance of a sound, their judgments correlate well with the A-scale sound levels of those sounds. Other weighting networks have been devised to address high noise levels or other special problems (e.g., B, C, and D scales), but these scales are rarely used in conjunction with highway traffic noise. Noise levels for traffic noise reports are typically reported in terms of dBA. Table 3.1 shows typical A-weighted noise levels.

Table 3.1. Typical Noise Levels

Common Outdoor Activities	Noise Level (dBA)	Common Indoor Activities
	— 110 —	Rock band
Jet flyover at 1,000 ft		
	— 100 —	
Gas lawnmower at 3 ft		
	— 90 —	
Diesel truck at 50 ft at 50 mph		Food blender at 3 ft
	— 80 —	Garbage disposal at 3 ft
Noisy urban area, daytime		
Gas lawnmower, 100 ft	— 70 —	Vacuum cleaner at 10 ft
Commercial area		Normal speech at 3 ft
Heavy traffic at 300 ft	— 60 —	
		Large business office
Quiet urban daytime	— 50 —	Dishwasher in next room
Quiet urban nighttime	— 40 —	Theater, large conference room (background)
Quiet suburban nighttime		
	— 30 —	Library
Quiet rural nighttime		Bedroom at night, concert hall (background)
	— 20 —	
		Broadcast/recording studio
	— 10 —	
Lowest threshold of human hearing	— 0 —	Lowest threshold of human hearing

Source: California Department of Transportation, *Technical Noise Supplement*, Table 2-5 (September 2013).
dBA = A-weighted decibel(s)
ft = foot/feet
mph = miles per hour

3.6. Human Response to Changes in Noise Levels

As discussed previously, doubling sound energy results in a 3 dB increase in sound. However, given a sound level change measured with precise instrumentation, the subjective human perception of a doubling of loudness will usually be different than what is measured.

Under controlled conditions in an acoustical laboratory, the trained, healthy human ear is able to discern 1 dB changes in sound levels when exposed to steady, single-frequency (“pure-tone”) signals in the midfrequency range (1,000–8,000 Hz).
In typical noisy environments, 1–2 dB changes in noise are generally not perceptible. However, it is widely accepted that people are able to begin to detect sound level increases of 3 dB in typical noisy environments. Further, a 5 dB increase is generally perceived as a distinctly noticeable increase, and a 10 dB increase is generally perceived as a doubling of loudness. Therefore, a doubling of sound energy

(e.g., doubling the volume of traffic on a highway) that would result in a 3 dB increase in sound would generally be perceived as barely detectable.

3.7. Noise Descriptors

Noise in the daily environment fluctuates over time. Some fluctuations are minor, but some are substantial. Some noise levels occur in regular patterns, but others are random. Some noise levels fluctuate rapidly, but others fluctuate slowly. Some noise levels vary widely, but others are relatively constant. Various noise descriptors have been developed to describe time-varying noise levels. The following are the noise descriptors most commonly used in traffic noise analysis:

- **Equivalent Continuous Sound Level (L_{eq}):** L_{eq} represents an average of the sound energy occurring over a specified period of time. In effect, L_{eq} is the steady-state sound level containing the same acoustical energy as the time-varying sound that actually occurs during the same period. The 1-hour A-weighted equivalent continuous sound level (L_{eq}[h]) is the energy average of A-weighted sound levels occurring during a 1-hour period and is the basis for the NAC used by Caltrans and the FHWA.
- **Percentile-Exceeded Sound Level (L_{xx}):** L_{xx} represents the sound level exceeded for a given percentage of a specified period of time (e.g., L_{10} is the sound level exceeded 10 percent of the time and L_{90} is the sound level exceeded 90 percent of the time).
- **Maximum Instantaneous Sound Level (L_{max}):** L_{max} is the highest instantaneous sound level measured during a specified period.
- **Day-Night Level (L_{dn}):** L_{dn} is the energy average of A-weighted sound levels occurring over a 24-hour period, with a 10 dB penalty applied to A-weighted sound levels occurring during the nighttime hours between 10:00 p.m. and 7:00 a.m.
- **Community Noise Equivalent Level (CNEL):** Similar to L_{dn}, CNEL is the energy average of the A-weighted sound levels occurring over a 24-hour period, with a 10 dB penalty applied to A-weighted sound levels occurring during the nighttime hours between 10:00 p.m. and 7:00 a.m., and a 5 dB penalty applied to the A-weighted sound levels occurring during the evening hours between 7:00 p.m. and 10:00 p.m.

3.8. Sound Propagation

When sound propagates over a distance, it changes in level and frequency content. The manner in which noise reduces with distance depends on the factors described below.

3.8.1. Geometric Spreading

Sound from a localized source (i.e., a point source) propagates uniformly outward in a spherical pattern. The sound level attenuates (or decreases) at a rate of 6 dB for each doubling of distance from a point source. Highways consist of several localized noise sources on a defined path and hence can be treated as a line source, which approximates the effect of several point sources. Noise from a line source propagates outward in a cylindrical pattern, often referred to as cylindrical spreading. Sound levels attenuate at a rate of 3 dB for each doubling of distance from a line source.

3.8.2. Ground Absorption

The propagation path of noise from a highway to a receptor is usually very close to the ground. Noise attenuation from ground absorption and reflective wave canceling adds to the attenuation associated with geometric spreading. Traditionally, the excess attenuation has also been expressed in terms of attenuation per doubling of distance. This approximation is usually sufficiently accurate for distances of less than 200 ft. For acoustically hard sites (i.e., sites with a reflective surface between the source and the receptor [e.g., a parking lot or body of water]), no excess ground attenuation is assumed. For acoustically absorptive or soft sites (i.e., sites with an absorptive ground surface between the source and the receptor [e.g., soft dirt, grass, or scattered bushes and trees]), an excess ground attenuation value of 1.5 dB per doubling of distance is normally assumed. When added to the cylindrical spreading, the excess ground attenuation results in an overall drop-off rate of 4.5 dB per doubling of distance.

3.8.3. Atmospheric Effects

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

3.8.4. Shielding by Natural or Human-Made Features

A large object or barrier in the path between a noise source and a receptor can substantially attenuate noise levels at the receptor. The amount of attenuation provided by shielding depends on the size of the object and the frequency content of the noise source. Natural terrain features (e.g., hills and dense woods) and human-made features (e.g., buildings and walls) can substantially reduce noise levels. Walls are often constructed between a source and a receptor specifically to reduce noise. A barrier that breaks the line of sight between a source and a receptor will typically result in at least 5 dB of noise reduction. Taller barriers provide increased noise reduction. Vegetation between a highway and a receptor is rarely effective in reducing noise because it does not create a solid barrier.

Chapter 4. Federal, State, and Local Policies and Procedures

This report focuses on the requirements of 23 CFR 772, as discussed in this chapter.

4.1. Federal Regulations

4.1.1. 23 CFR 772

23 CFR 772 provides procedures for preparing operational and construction noise studies and evaluating noise abatement considered for federal and federal-aid highway projects. Under 23 CFR 772.7, projects are categorized as Type 1, Type 2, or Type 3 projects.

The FHWA defines a Type 1 project as a proposed federal or federal-aid highway project for the construction of a highway on a new location or the physical alteration of an existing highway that significantly changes either the horizontal or vertical alignment of the highway. The following projects are also considered Type 1 projects:

- The addition of a through-traffic lane or lanes. This includes the addition of a through-traffic lane that functions as a high-occupancy vehicle lane, high-occupancy toll lane, bus lane, or truck climbing lane.
- The addition of an auxiliary lane, except for when the auxiliary lane is a turn lane.
- The addition or relocation of interchange lanes or ramps added to a quadrant to complete an existing partial interchange.
- Restriping existing pavement for the purpose of adding a through-traffic lane or an auxiliary lane.
- The addition of a new or substantial alteration of an existing weigh station, rest stop, ride-share lot, or toll plaza.

If a project is determined to be a Type 1 project under this definition, the entire project area as defined in the environmental document is a Type 1 project. A Type 2 project is a noise barrier retrofit project that involves no changes to highway capacity or alignment. A Type 3 project is a project that does not meet the classifications of a Type 1 or Type 2 project. Type 3 projects do not require a noise analysis.

Under 23 CFR 772.11, noise abatement must be considered for Type 1 projects if the project is predicted to result in a traffic noise impact. In such cases, 23 CFR 772 requires that the project sponsor "consider" noise abatement before adoption of the final NEPA document. This process involves identification of noise abatement measures that are reasonable, feasible, and likely to be incorporated into the project, and of noise impacts for which no apparent solution is available.

Traffic noise impacts, as defined in 23 CFR 772.5, occur when the predicted noise level in the design year approaches or exceeds the NAC specified in 23 CFR 772, or a predicted noise level substantially exceeds the existing noise level (i.e., a "substantial" noise increase). The terms "substantial increase" or "approach" are not specifically defined in 23 CFR 772; these criteria are defined in the Protocol, as described in the following section.

Table 4.1 summarizes the NAC corresponding to various land use activity categories. Activity categories and related traffic noise impacts are determined based on the actual land use in a given area.

Table 4.1. Activity Categories and Noise Abatement Criteria

Activity Category	Activity Leq(h)1	Evaluation Location	Description of Activities
A	57	Exterior	Lands on which serenity and quiet are of extraordinary significance, that serve an important public need, and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.
B[2]	67	Exterior	Residential.
C[2]	67	Exterior	Active sport areas, amphitheaters, auditoriums, campgrounds, cemeteries, day care centers, hospitals, libraries, medical facilities, parks, picnic areas, places of worship, playgrounds, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, recreation areas, Section 4(f) sites, schools, television studios, trails, and trail crossings.
D	52	Interior	Auditoriums, day care centers, hospitals, libraries, medical facilities, places of worship, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, schools, and television studios.
E	72	Exterior	Hotels, motels, offices, restaurants/bars, and other developed lands, properties, or activities not included in A–D or F.
F	—	—	Agriculture, airports, bus yards, emergency services, industrial uses, logging, maintenance facilities, manufacturing, mining, railyards, retail facilities, shipyards, utilities (water resources, water treatment, electrical), and warehousing.
G	—	—	Undeveloped lands that are not permitted.

Source: California Department of Transportation, *Traffic Noise Analysis Protocol*, Table 1 (May 2011).

[1] The L_{eq}(h) activity criteria values are for impact determination only and are not design standards for noise abatement measures. All values are in dBA.

[2] Includes undeveloped lands permitted for this activity category.

dBA = A-weighted decibel(s)

L_{eq}(h) = equivalent continuous sound level per hour

4.1.2. Traffic Noise Analysis Protocol for New Highway Construction and Reconstruction Projects

The Caltrans Protocol specifies the policies, procedures, and practices to be used by agencies that sponsor new construction or reconstruction of federal or federal-aid highway projects. The NAC specified in the Protocol are the same as those specified in 23 CFR 772. The Protocol defines a noise increase as "substantial" when the predicted noise levels under build conditions exceed existing noise levels by 12 dBA. The Protocol also states that a sound level is considered to approach an NAC level when the sound level is within 1 dB of the NAC identified in 23 CFR 772 (e.g., 66 dBA is considered to approach the NAC of 67 dBA, but 65 dBA is not).

The Caltrans TeNS (September 2013) and the Protocol provide detailed technical guidance for the evaluation of highway traffic noise. This includes field measurement methods, noise modeling methods, and report preparation guidance.

4.2. State Regulations and Policies

4.2.1. California Environmental Quality Act

Noise analysis under CEQA may be required regardless of whether the proposed Project is a Type 1 project. The CEQA noise analysis is completely independent of the 23 CFR 772 analysis done for NEPA. Under CEQA, the baseline noise level is compared to the build noise level. The assessment entails looking at the existing setting and how large or perceptible any noise increase would be in a given area. Key considerations include the uniqueness of the setting, the sensitive nature of the noise receptors, the magnitude of the noise increase, the number of residences affected, and the absolute noise level.

The significance of noise impacts under CEQA are addressed in the environmental document rather than in the NSR. Even though the NSR (or noise technical memorandum) does not specifically evaluate the significance of noise impacts under CEQA, it must contain the technical information that is needed to make that determination in the environmental document.

4.2.2. Section 216 of the California Streets and Highways Code

Section 216 of the California Streets and Highways Code relates to the noise effects of a proposed freeway project on public and private elementary and secondary schools. Under this code, a noise impact occurs if, as a result of a proposed freeway project, noise levels exceed 52 dBA L_{eq}(h) in the interior of public or private elementary or secondary school classrooms, libraries, multipurpose rooms, or spaces.

This requirement does not replace the “approach or exceed” NAC criterion for FHWA Activity Category D for classroom interiors, but it is a requirement that must be addressed in addition to the requirements of 23 CFR 772.

If a project results in a noise impact under this code, noise abatement must be provided to reduce classroom noise to a level that is at or below 52 dBA L_{eq}(h). If the noise levels generated from freeway and nonfreeway sources exceed 52 dBA L_{eq}(h) prior to construction of the proposed freeway project, noise abatement must be provided to reduce noise to the level that existed prior to project construction.

4.3. Local Regulations and Policies

4.3.1. City of Santa Ana

Section 18-314 of the City’s Municipal Code prohibits the construction, repair, remodeling, or grading of any real property except between the hours of 7:00 a.m. and 8:00 p.m. on weekdays and Saturdays. No such work is permitted on Sundays and federal holidays.

Chapter 5. Study Methods and Procedures

5.1. Methods for Identifying Land Uses and Selecting Noise Measurement and Modeling Receptor Locations

A field investigation was conducted to identify land uses that could be subject to traffic and construction noise impacts from the proposed Project. Land uses in the project area were categorized by land use type, activity category (as defined in Table 4.1), and frequency of human use. An area of frequent human use is an area where people are exposed to traffic noise for an extended period of time on a regular basis. One practical test for determining frequent human use is the presence of existing facilities that invite human use such as benches, barbeque facilities, covered group picnic areas, and uncovered picnic tables. As stated in the Protocol, noise abatement is only considered for areas of frequent human use that would benefit from a lowered noise level. Accordingly, this noise impact analysis focuses on locations with defined outdoor activity areas (e.g., residential backyards, parks, and sitting areas).

The topographical features of the project area relative to nearby existing and planned land uses, such as hills and changes in terrain, were also identified.

Fifteen short-term measurement locations were selected to represent noise-sensitive land uses in the project area. Two long-term measurement sites were selected to capture the diurnal traffic noise level pattern in the project area. Short-term measurement locations were selected to serve as representative modeling locations. Also, other nonmeasurement locations were selected as modeling locations. A total of 92 receptor locations were modeled to represent land uses in the project area. These monitoring and modeled receptor locations are shown on Figure 5-1.

5.2. Field Measurement Procedures

A field noise study was conducted in accordance with the recommended procedures in the Caltrans TeNS (2013). The following is a summary of the procedures used to collect short-term and long-term sound level data.

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LEGEND

- ▲ Short-Term Monitoring Locations
- ■ Long-Term Monitoring Locations
- ● Modeled Receptors
- Proposed Right of Way Acquisition
- Proposed Improvements
- Existing Right of Way
- Existing Walls

0 75 150
FEET

SOURCE: Google Aerial (12/2017); WKE (2017)

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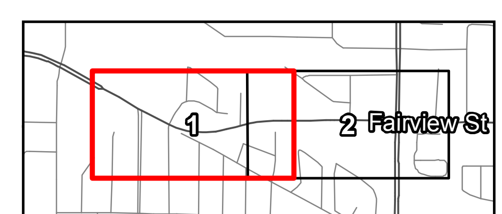

FIGURE 5-1
Sheet 1 of 2

Fairview Street Improvements
from 9th Street to 16th Street and Bridge Replacement Project
Monitoring and Modeled Receptor Locations

Federal Project No.: BRLS 5063(184)

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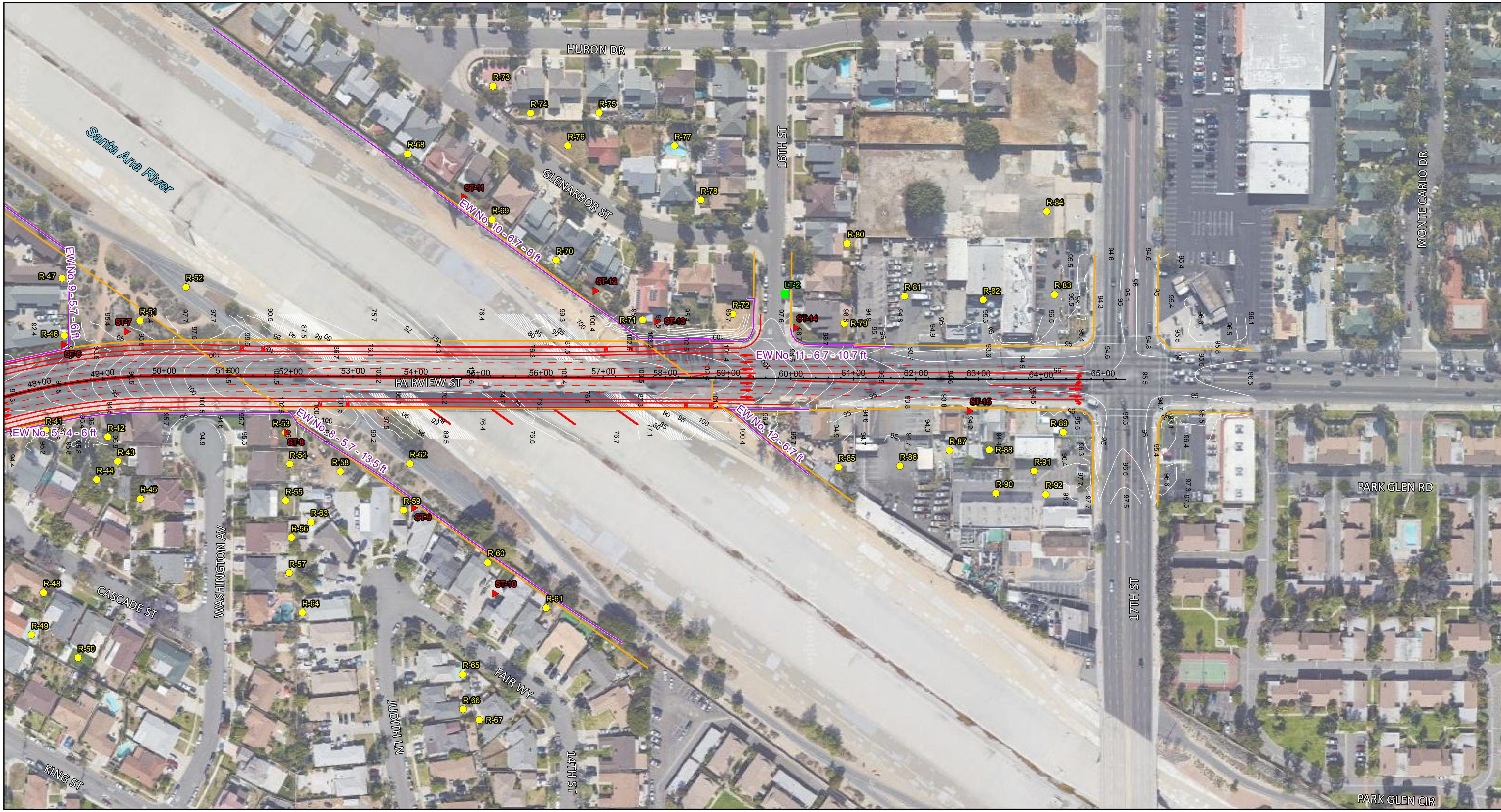

LEGEND

- ▲ Short-Term Monitoring Locations
- ■ Long-Term Monitoring Locations
- ● Modeled Receptors
- Proposed Right of Way Acquisition
- Proposed Improvements
- Existing Right of Way
- Existing Walls

0 75 150
FEET

1
2 Fairview St

FIGURE 5-1
Sheet 2 of 2

Fairview Street Improvements
from 9th Street to 16th Street and Bridge Replacement Project
Monitoring and Modeled Receptor Locations
Federal Project No.: BRLS 5063(184)

SOURCE: Google Aerial (12/2017); WKE (2017)
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5.2.1. Short-Term Measurements

Short-term noise level measurements in the project vicinity were sampled during off-peak traffic hours when traffic was flowing freely. Short-term noise level measurements were made using Larson Davis Model 831, 824, and 820 Type 1 sound level meters.

The following measurement procedures were used:

- Calibrate the sound level meter.
- Set up the sound level meter at a height of 5 ft.
- Commence noise monitoring.
- Collect site-specific data (e.g., date, time, direction of traffic, vehicle speed, and location of the sound level meter relative to any existing feature).
- Count passing vehicles for a period of 20 minutes during noise level measurement. Vehicles are split into three categories: automobiles, medium trucks, and heavy trucks.
- Stop measurement after 20 minutes.
- Calibrate the sound level meter.
- Proceed to the next monitoring site and repeat.

The traffic counts were expanded to hourly volumes (multiplied by three to normalize the results to hourly values) and entered into the FHWA Traffic Noise Model (TNM) 2.5 (2004) for each monitoring site. The monitoring results were used to calibrate the model outputs.

5.2.2. Long-Term Measurements

Two long-term noise level measurements were conducted using one dosimeter in the study area. The purpose of the long-term measurements was to identify variations in sound levels throughout the day.

5.3. Traffic Noise Level Prediction Methods

Traffic noise levels were predicted using the FHWA's TNM 2.5 (FHWA 2004). TNM 2.5 is a computer model based on two FHWA reports: FHWA-PD-96-009 and FHWA PD-96-010 (FHWA 1998a, 1998b). Key inputs to TNM 2.5 were the locations of roadways, traffic mix, vehicle speeds, shielding features (e.g., topography and buildings), noise barriers, ground type, and receptors.

The existing and future 2040 traffic (design year) noise levels at all 92 receptor locations were modeled using either the worst-case traffic operations (prior to speed degradation) or peak-hour traffic volumes, whichever were lower. The worst-case traffic condition is assumed to be level of service C and is generally loudest when vehicles on a given roadway travel at free-flowing traffic conditions. Accordingly, the worst-case traffic volume assumptions are based on the maximum number of vehicles that can typically travel in a given lane while still resulting in free-flowing traffic conditions. The worst-case traffic condition is assumed to be 750 vehicles per lane per hour (vplph) on Fairview Street and other local roadways. The a.m. peak-hour traffic volume was selected over the p.m. peak-hour traffic volume because the worst-hour noise levels based on the long-term (24-hour) noise level measurements occur during the a.m. hour. The a.m. and p.m. peak-hour traffic volumes were obtained from the *Traffic Impact Analysis* (LSA 2018). A summary of traffic data inputs for existing and future conditions is provided in Appendix A.

TNM 2.5 is sensitive to the volume of trucks on the roadway because trucks contribute disproportionally to traffic noise. Vehicle distributions on Fairview Street were obtained from traffic counts collected during ambient noise level measurement. Vehicle distribution on other local roadways in the project area was assumed to be similar to Fairview Street. Table 5.1 shows the vehicle distribution and vehicle speeds for each vehicle category in the project area used to calculate existing and future traffic noise levels.

Table 5.1. Vehicle Distribution

Roadway	Vehicle Distribution (%)			Vehicle Speed (mph)		
	Autos	Medium Trucks	Heavy Trucks	Autos	Medium Trucks	Heavy Trucks
Fairview Street and all other local roadways	95	4	1	45	45	45

Source: Compiled by LSA (May 2018).
mph = miles per hour

5.4. Methods for Identifying Traffic Noise Impacts and Consideration of Abatement

Traffic noise impacts are considered to occur at receptor locations where predicted design-year noise levels are at least 12 dBA greater than existing noise levels, or where predicted design-year noise levels approach or exceed the NAC for the applicable activity category. Where traffic noise impacts are identified, noise abatement must be considered for reasonableness and feasibility as required by 23 CFR 772 and the Protocol.

According to the Protocol, an abatement measure is considered acoustically feasible if a minimum noise reduction of 5 dBA at impacted receptor locations is predicted with implementation of the abatement measure. In addition, barriers should be designed to intercept the line of sight from the exhaust stack of a truck to the first tier of receptors as required by the Caltrans *Highway Design Manual* (2015), Chapter 1100. Other factors that affect feasibility include topography, access requirements for driveways and ramps, presence of local cross-streets, utility conflicts, other noise sources in the area, and safety considerations. The overall reasonableness of noise abatement is determined by considering factors such as the construction cost of the barrier, the noise reduction design goal (a noise level reduction of 7 dBA or more at one or more benefited receptors), and the viewpoints of benefited receptors (including property owners and residents of the benefited receptors).

The Protocol defines the procedure for assessing the reasonableness of noise barriers from a cost perspective. A cost allowance per residence is assigned to each benefited residence (i.e., residences that receive at least 5 dBA of noise reduction from a noise barrier). The 2018 allowance is $95,000 per benefited residence. Total allowances are calculated by multiplying the cost allowance per residence by the number of benefited residences.

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Chapter 6. Existing Noise Environment

6.1. Existing Land Uses

Developed and undeveloped land uses in the project vicinity were identified through land use maps, aerial photography, and site inspection. Receptors were identified in each land use category. Existing land uses in the project area include single-family and multifamily residences, a medical office, a park (Fairview Triangle Habitat Restoration Park), a multi-use trail, vacant land, and commercial and light industrial uses. Existing land uses in the project area and surrounding vicinity are described in further detail as follows:

- **East of Fairview Street and South of the Santa Ana River (Receptors R-2 through R-7, R-11, R-12, R-13, R-17, R-18, R-24 through R-30, R-37 through R-45, R-48 through R-50, and R-53 through R-67):** Land uses in this area include single-family and multifamily residences, commercial uses, and vacant land. Land uses in this area range from 3 ft higher in elevation than Fairview Street to 7 ft lower in elevation than Fairview Street. Currently, 4 ft to 13.5 ft high existing walls along the private property lines shield the single-family residences. The single-family residences were evaluated under Activity Category B, which has an exterior NAC of 67 dBA L_{eq}. The commercial uses and vacant land were evaluated under Activity Categories E and F, respectively, for reporting purposes.
- **West of Fairview Street and South of the Santa Ana River (Receptors R-1, R-8 through R-10, R-14, R-15, R-16, R-19 through R-23, R-31 through R-36, R-46, R-47, R-51, and R-52):** Land uses in this area include single-family and multifamily residences, a medical office, a park, a multi-use trail, and office uses. Land uses in this area range from 2 ft higher in elevation than Fairview Street to 5 ft lower in elevation than Fairview Street. Currently, 2.7 ft to 9.3 ft high existing walls along the private property lines shield the single-family and multifamily residences. The single-family and multifamily residences were evaluated under Activity Category B, which has an exterior NAC of 67 dBA L_{eq}. The park at the southwest corner of Fairview Street and the Santa Ana River was evaluated under Activity Category C, which has an exterior NAC of 67 dBA L_{eq}. The multi-use trail has no outdoor frequent human use areas and was classified under Activity Category C for reporting purposes. The office uses with no outdoor frequent human use areas were classified under Activity Category E for reporting purposes.

- **East of Fairview Street and North of the Santa Ana River (Receptors R-85 through R-92):** Land uses in this area include single-family residences and commercial and light industrial uses. Land uses in this area range from 2 ft higher in elevation than Fairview Street to approximately the same in elevation as Fairview Street. Currently, a 6.7 ft high existing wall along the private property line shields the commercial use. The single-family residences were evaluated under Activity Category B, which has an exterior NAC of 67 dBA L_{eq}. The commercial and light industrial uses were classified under Activity Categories E and F, respectively, for reporting purposes.
- **West of Fairview Street and North of the Santa Ana River (Receptors R-68 through R-84):** Land uses in this area include single-family residences, vacant land, and commercial and light industrial uses. Land uses in this area range from 2 ft higher in elevation than Fairview Street to 9 ft lower in elevation than Fairview Street. Currently, 6.7 ft to 10.7 ft high existing walls along the private property lines shield the single-family residences. The single-family residences were evaluated under Activity Category B, which has an exterior NAC of 67 dBA L_{eq}. The commercial uses with no outdoor frequent human use areas were evaluated under Activity Category E for reporting purposes. The vacant land and light industrial uses were classified under Activity Category F for reporting purposes.

6.2. Noise Measurement Results

The existing noise environment in the project area is based on short-term (20-minute) and long-term (24-hour) noise level measurements.

6.2.1. Short-Term Monitoring

The primary source of noise in the project area is vehicular traffic on Fairview Street. Short-term (20-minute) noise measurements were conducted to document existing noise levels at 15 representative receptor locations in the project area. Short-term noise level measurements were conducted using Larson Davis Models 831, 824, and 820 Type 1 sound level meters. Table 6.1 contains the results of the short-term noise level measurements along with a description of the physical location of each monitoring site. These short-term noise measurements were used to calibrate the noise model and to predict the noise levels at all 92 modeled receptors in the project area. The short-term monitoring locations are shown on Figure 5-1. The concurrent traffic counts and observed vehicle speeds are provided in Appendix A. The noise monitoring results for each monitoring site are included in Appendix C.

Table 6.1. Short-Term Ambient Noise Monitoring Results

Monitor No.	Date	Start Time	Duration	dBA L_{eq}	Traffic Counts			Observed Speed (mph)	Location Description	Noise Sources	Comments
					Automobiles[1]	Medium Trucks	Heavy Trucks				
ST-1	4/17/2018	9:23 a.m.	20 minutes	63.4	280/340	10/19	6/5	45/45	2234 West 9th Street. In the residence backyard.	Traffic on Fairview Street, birds, and rooster crowing.	Residence wall is about 4.7 ft high.
ST-2	4/17/2018	9:23 a.m.	20 minutes	63.8	280/340	10/19	6/5	45/45	2507 9th Street. In the residence backyard.	Traffic on Fairview Street.	Back wall is about 5.3 ft high. Side wall is about 5 ft high.
ST-3	4/17/2018	9:23 a.m.	20 minutes	64.9	280/340	10/19	6/5	45/45	1908 King Street. In the residence backyard.	Traffic on Fairview Street and birds.	Northern neighbor wall is about 4 ft high.
ST-4	4/17/2018	10:28 a.m.	20 minutes	67.3	305/313	11/12	4/6	45/45	1007 Marengo Place. In the residence backyard.	Traffic on Fairview Street and birds.	Wood slat fence is about 6 ft high.
ST-5	4/17/2018	10:28 a.m.	20 minutes	65.6	305/313	11/12	4/6	45/45	2332 West 12th Street. In the residence backyard.	Traffic on Fairview Street.	Residence wall is about 5.5 ft high.
ST-6	4/17/2018	11:36 a.m.	20 minutes	64.7	313307	5/8	6/3	45/45	2503 West 12th Street. In the residence backyard.	Traffic on Fairview Street.	Side wall is about 6 ft high. Back wall is about 5.7 ft high.
ST-7	5/10/2018	11:10 a.m.	20 minutes	66.7	473/361	14/14	4/3	45/45	In Fairview Triangle Habitat Restoration Park.	Traffic on Fairview Street, birds, and wind.	None.
ST-8	4/17/2018	10:28 a.m.	20 minutes	56.7	305/313	11/12	4/6	45/45	2413 West Washington Avenue. In the residence backyard.	Traffic on Fairview Street.	North wall is about 5.7 ft high. West wall is about 8.7 ft high.
ST-9	4/17/2018	1:53 p.m.	20 minutes	55.7	359/326	17/9	3/3	45/45	1322 Fair Way. In the residence backyard.	Traffic on Fairview Street.	Back wall is about 5.7 ft high. South wall is about 5.7 ft high.
ST-10	4/17/2018	1:54 p.m.	20 minutes	53.3	359/326	17/9	3/3	45/45	1334 Fair Way. In the residence backyard.	Traffic on Fairview Street.	Outer wall is about 5.3 ft high. Inner wall is about 6 ft high.
ST-11	4/17/2018	12:19 p.m.	20 minutes	50.0	377/378 272/260	33/15 8/3	6/2 4/3	45/45 45/45	1321 North Glenarbor Street. In the residence backyard.	Traffic on Fairview Street.	Back wall is about 6.7 ft high. Northern wall is about 5.7 ft high.
ST-12	4/17/2018	12:19 p.m.	20 minutes	54.5	377/378 272/260	33/15 8/3	6/2 4/3	45/45 45/45	1413 North Glenarbor Street. In the residence backyard.	Traffic on Fairview Street.	Eastern wall is about 7.2 ft high. Northern wall is about 6 ft high. Southern wall is about 6.7 ft high.
ST-13	4/17/2018	1:12 p.m.	20 minutes	55.7	300/280 280/310	8/7 2/4	2/10 3/4	45/45 45/45	1417 North Glenarbor Street. In the residence backyard.	Traffic on Fairview Street.	Back wall is about 7 ft high. Northern wall is about 5.3 ft high. Southern wall is about 4.7 ft high.
ST-14	5/10/2018	12:10 p.m.	20 minutes	63.0	270/320	11/6	3/7	45/45	2501 16th Street. In the residence front yard.	Traffic on Fairview Street and light traffic on 16th Street.	Residence wall is about 6.4 ft high.
ST-15	4/17/2018	1:12 p.m.	20 minutes	74.0	300/280 280/310	8/7 2/4	2/10 3/4	45/45 45/45	South of 1609 Fairview Street. In the residence front yard.	Traffic on Fairview Street.	None.

Source: Compiled by LSA (May 2018).
[1] Traffic volumes and observed speeds are for Fairview Street northbound/southbound. For ST-11, ST-12, ST-13, and ST-15, traffic volumes and observed speeds on 17th Street eastbound/westbound are shown below the Fairview Street traffic volumes and observed speeds.
dBA L_{eq} = equivalent continuous sound level measured in A-weighted decibels
ft = foot/feet
mph = miles per hour
ST = short-term

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Table 6.2. Meteorological Conditions During Noise Monitoring

Date	Temperature (°F)	Average Wind Speed (mph)	Relative Humidity (%)
4/17/2018	58.0–78.8	2.4–6.4	23.1–77.5
5/10/2018	71.0	3.0	60.0

Source: Compiled by LSA (May 2018).
°F = degrees Fahrenheit
mph = miles per hour

6.2.2. Long-Term Monitoring

Long-term traffic noise level measurements were conducted to document the peak traffic noise hour. Long-term ambient noise monitoring was conducted using one dosimeter at two representative locations in the project area. The long-term noise level measurement at LT-1 was performed from 9:00 a.m. on Tuesday, April 17, 2018, to 9:00 a.m. on Wednesday, April 18, 2018, at a single-family residence at 1008 North King Street. Table 6.3 shows that traffic noise peaks during the 6:00 a.m., 7:00 a.m., and 8:00 a.m. hours at LT-1. The long-term noise level measurement at LT-2 was performed from 2:00 p.m. on Wednesday, April 18, 2018, to 2:00 p.m. on Thursday, April 19, 2018, at a single-family residence at 2505 West 16th Street. Table 6.4 shows that traffic noise peaks during the 8:00 a.m. hour at LT-2. The long-term noise monitoring locations are shown on Figure 5-1. The long-term noise level measurement results are shown in Tables 6.3 and 6.4.

6.3. Noise Model Calibration

Eight separate model runs for the 15 monitoring locations were conducted using the traffic counts and observed vehicle speeds collected during the ambient noise monitoring. The results of these model runs were compared to the measured ambient noise levels to ensure the accuracy of TNM 2.5. Correction factors known as K-factors were applied to each of the modeled receptor locations so that the monitored and modeled noise levels were the same. Table 6.5 shows the measured ambient noise level, the modeled noise levels using traffic counts and measured vehicle speeds during noise monitoring, and the K-factor at each of the 15 monitored locations.

As shown in Table 6.5, some of the monitoring locations have K-factors greater than 3 dBA but less than 5 dBA. Based on Section 4.4.1.6 of the TeNS, K-factors between 3 and 4 can be calibrated unless the validity of the noise measurement conducted is in serious doubt.

Table 6.3. Long-Term (24-Hour) Noise Level Measurement Results at 1008 North King Street, Santa Ana, California (LT-1)

	Start Time	Date	Noise Level (dBA L_{eq})
1	9:00 AM	4/17/2018	72
2	10:00 AM	4/17/2018	71
3	11:00 AM	4/17/2018	71
4	12:00 PM	4/17/2018	72
5	1:00 PM	4/17/2018	72
6	2:00 PM	4/17/2018	72
7	3:00 PM	4/17/2018	71
8	4:00 PM	4/17/2018	68
9	5:00 PM	4/17/2018	66
10	6:00 PM	4/17/2018	67
11	7:00 PM	4/17/2018	72
12	8:00 PM	4/17/2018	71
13	9:00 PM	4/17/2018	70
14	10:00 PM	4/17/2018	69
15	11:00 PM	4/17/2018	68
16	12:00 AM	4/18/2018	65
17	1:00 AM	4/18/2018	63
18	2:00 AM	4/18/2018	62
19	3:00 AM	4/18/2018	64
20	4:00 AM	4/18/2018	69
21	5:00 AM	4/18/2018	72
22	6:00 AM	4/18/2018	**73**[1]
23	7:00 AM	4/18/2018	**73**
24	8:00 AM	4/18/2018	**73**

Source: Compiled by LSA (May 2018).
[1] **Bold** numbers represent the peak traffic noise hour.
dBA L_{eq} = equivalent continuous sound level measured in A-weighted decibels

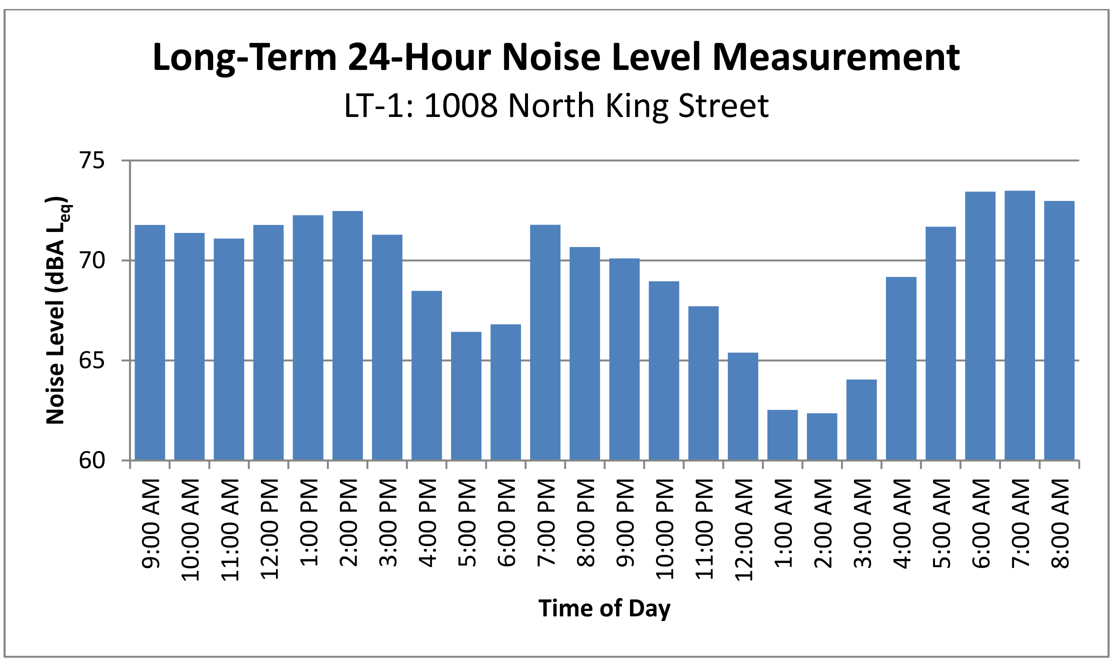

Table 6.4. Long-Term (24-Hour) Noise Level Measurement Results at 2505 West 16th Street, Santa Ana, California (LT-2)

	Start Time	Date	Noise Level (dBA L_{eq})
1	2:00 PM	4/18/2018	64
2	3:00 PM	4/18/2018	64
3	4:00 PM	4/18/2018	64
4	5:00 PM	4/18/2018	64
5	6:00 PM	4/18/2018	64
6	7:00 PM	4/18/2018	64
7	8:00 PM	4/18/2018	63
8	9:00 PM	4/18/2018	63
9	10:00 PM	4/18/2018	62
10	11:00 PM	4/18/2018	59
11	12:00 AM	4/19/2018	57
12	1:00 AM	4/19/2018	54
13	2:00 AM	4/19/2018	55
14	3:00 AM	4/19/2018	56
15	4:00 AM	4/19/2018	60
16	5:00 AM	4/19/2018	63
17	6:00 AM	4/19/2018	66
18	7:00 AM	4/19/2018	66
19	8:00 AM	4/19/2018	**67**[1]
20	9:00 AM	4/19/2018	66
21	10:00 AM	4/19/2018	65
22	11:00 AM	4/19/2018	65
23	12:00 PM	4/19/2018	66
24	1:00 PM	4/19/2018	64

Source: Compiled by LSA (May 2018).
[1] **Bold** numbers represent the peak traffic noise hour.
dBA L_{eq} = equivalent continuous sound level measured in A-weighted decibels

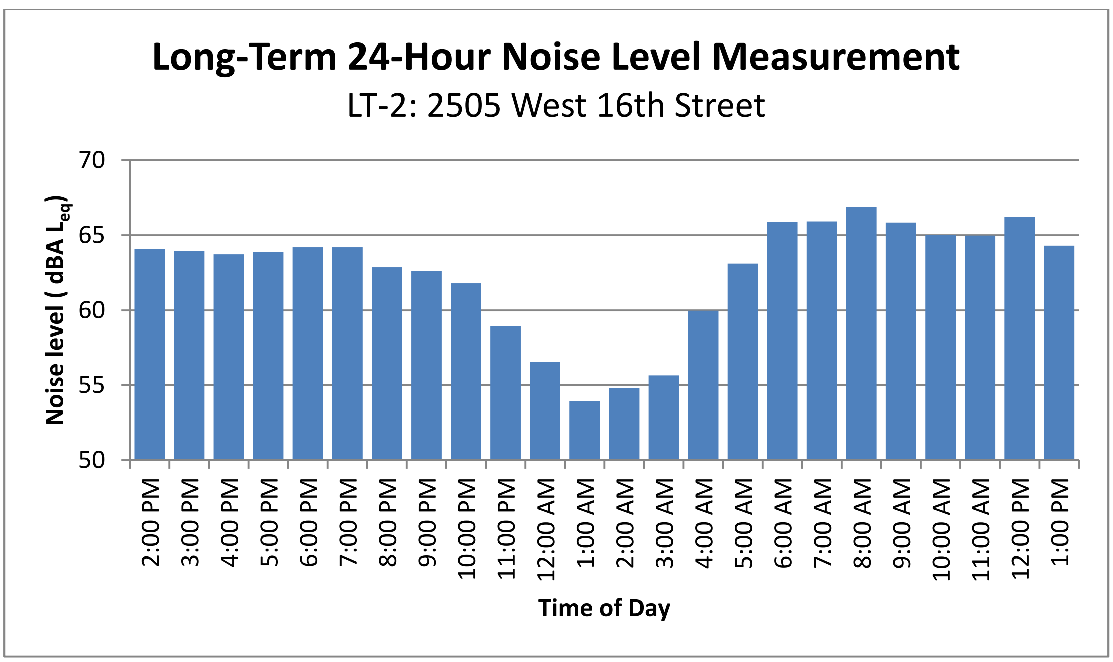

Table 6.5. Model Calibration

Monitor No.	Measured Noise Level (dBA L_{eq})	Modeled Noise Level (dBA L_{eq})	K-Factor (dBA)
ST-1	63.4	65.6	-2.2
ST-2	63.8	65.5	-1.7
ST-3	64.9	67.9	-3.0
ST-4	67.3	70.5	-3.2
ST-5	65.6	62.8	2.8
ST-6	64.7	62.6	2.1
ST-7	66.7	68.6	-1.9
ST-8	56.7	59.1	-2.4
ST-9	55.7	57.2	-1.5
ST-10	53.3	54.7	-1.4
ST-11	50.0	53.8	-3.8
ST-12	54.5	57.1	-2.6
ST-13	55.7	57.6	-1.9
ST-14	63.0	62.0	1.0
ST-15	74.0	73.0	1.0

Source: Compiled by LSA (May 2018).
dBA = A-weighted decibel(s)
dBA L_{eq} = equivalent continuous sound level measured in A-weighted decibels
ST = Short-Term

All of the monitoring locations were rechecked and noise level measurements and field surveys of existing features and the TNM 2.5 modeled input data were re-examined and determined to be accurate. Therefore, the K-factors shown in Table 6.5 were used to calibrate the noise model.

6.4. Existing Noise Levels

The existing a.m. peak-hour traffic volumes obtained from the *Traffic Impact Analysis* (LSA 2018) or the worst-case traffic operations (prior to speed degradation), whichever were lower, were coded into TNM 2.5 with existing roadway conditions. The a.m. peak-hour traffic volumes were selected over the p.m. peak-hour traffic volumes because the long-term (24-hour) noise level measurements indicate that the peak noise hour occurs during this period. Table B.1 in Appendix B provides the results of the existing traffic noise modeling. Figure 5-1 shows the locations of the modeled receptors.

Chapter 7. Future Noise Environment, Impacts, and Considered Abatement

7.1. Future Noise Environment and Impacts

This NSR was prepared to determine the future traffic noise impacts at receptors along Fairview Street. Potential long-term noise impacts under the Future Build condition are solely from traffic noise. Traffic noise was evaluated for the worst-case traffic condition. Using coordinates obtained from the topographic maps, 92 receptor locations were evaluated in the model.

Future traffic noise levels at all 92 receptor locations were determined using either the worst-case traffic operations (prior to speed degradation) or the 2040 a.m. peak-hour traffic volumes obtained from the *Traffic Impact Analysis* (LSA 2018), whichever were lower, as described in Section 5.3. Table B.1 in Appendix B summarizes the TNM results for the Existing, Future No Build, and Future Build conditions. The modeled future noise levels with the proposed Project were compared to the modeled existing noise levels (after calibration) from TNM 2.5 to determine whether a substantial noise increase would occur. The modeled future noise levels were also compared to the NAC to determine whether a traffic noise impact would occur.

Traffic noise impacts occur when either of the following occurs: (1) the traffic noise level at a receptor location is predicted to "approach or exceed" its corresponding NAC or (2) the predicted traffic noise level is 12 dBA or more over the corresponding modeled existing noise level at the receptor locations analyzed. When traffic noise impacts occur, noise abatement measures must be considered. Of the 92 modeled receptors, 9 receptors under the Future Build condition would approach or exceed the NAC. No receptor would experience a substantial noise increase of 12 dBA or more over its corresponding modeled existing noise level under any scenario. The receptor locations listed below would be or would continue to be exposed to noise levels that either approach or exceed the NAC under Future Build conditions.

- **Receptor R-5:** This receptor location represents an existing single-family residence on the northbound side of Fairview Street between Civic Center Drive and West 9th Street. Currently, a 4.7 ft high existing wall shields the residence.

One noise barrier (Noise Barrier [NB] No. 1) was modeled along the private property line on the northbound side of Fairview Street to shield this residence.

- **Receptor R-8:** This receptor location represents an existing single-family residence on the southbound side of Fairview Street between Civic Center Drive and West 9th Street. Currently, a 2.7 ft to 6 ft high existing wall shields this residence. One noise barrier (NB No. 2) was modeled along the private property line on the southbound side of Fairview Street to shield this residence.
- **Receptor R-14:** This receptor location represents an existing single-family residence on the southbound side of Fairview Street between West 9th Street and West 12th Street. Currently, a 5.3 ft high existing wall shields this residence. One noise barrier (NB No. 3) was modeled along the private property line on the southbound side of Fairview Street to shield this residence.
- **Receptor R-23:** This receptor location represents existing multifamily residences on the southbound side of Fairview Street between West 9th Street and West 12th Street. Existing wood fences along the private property line would not provide effective noise attenuation at these residences. One noise barrier (NB No. 4) was modeled along the private property line on the southbound side of Fairview Street to shield these residences.
- **Receptors R-24, R-25, and R-40:** These receptor locations represent existing single-family residences on the northbound side of Fairview Street between West 9th Street and West 12th Street. Currently, a 4 ft to 6 ft high wall shields these residences. One noise barrier (NB No. 5) was modeled along the private property line on the northbound side of Fairview Street to shield these residences.
- **Receptor R-46:** This receptor location represents an existing single-family residence on the southbound side of Fairview Street between West 12th Street and the Santa Ana River. Currently, a 5.7 ft high existing wall shields this residence. One noise barrier (NB No. 6) was modeled along the private property line on the southbound side of Fairview Street to shield this residence.
- **Receptor R-51:** This receptor location represents a park on the southbound side of Fairview Street between West 12th Street and the Santa Ana River. Currently, no wall shields the park. Because there is driveway and pedestrian access onto Fairview Street, it is not feasible to abate traffic noise from Fairview Street with noise barriers.

7.2. Preliminary Noise Abatement Analysis

Noise abatement is considered where noise impacts are predicted in areas of frequent human use that would benefit from a lowered noise level. According to 23 CFR

772(13)(c) and 772(15)(c), federal funding may be used for the following abatement measures:

- Construction of noise barriers, including acquisition of property rights, either within or outside the highway right-of-way.
- Traffic management measures including, but not limited to, traffic control devices and signing for prohibition of certain vehicle types, time-use restrictions for certain vehicle types, modified speed limits, and exclusive lane designations.
- Alteration of horizontal and vertical alignments.
- Acquisition of real property or interests therein (predominantly unimproved property) to serve as a buffer zone to preempt development that would be adversely impacted by traffic noise.

Noise barriers are the only form of noise abatement considered for this project. Each noise barrier has been evaluated for feasibility based on achievable noise reduction. For each noise barrier found to be acoustically feasible, reasonable cost allowances were calculated by multiplying the number of benefited receptors by $95,000. Table B.1 in Appendix B summarizes the results at receptor locations for the noise barriers evaluated in detail for this project. Table B.1 shows predicted noise levels, insertion loss, and the number of benefited receptors at analyzed barrier heights for the Future Build condition.

For any noise barrier to be considered reasonable from a cost perspective, the estimated cost of the noise barrier should be equal to or less than the total cost allowance calculated for the barrier. The cost calculations of the noise barrier must include all items appropriate and necessary for its construction (e.g., traffic control, drainage modification, retaining walls, landscaping for graffiti abatement, and right-of-way costs). Construction cost estimates are not provided in this NSR but will be presented in the Noise Abatement Decision Report (NADR). The NADR is a design responsibility and is prepared to compile information from the NSR, other relevant environmental studies, and design considerations into a single comprehensive document before public review of the project. The NADR is prepared by the project engineer after completion of the NSR and prior to publication of the draft environmental document. The NADR includes noise abatement construction cost estimates that have been prepared and signed by the project engineer based on site-specific conditions. Construction cost estimates are compared to reasonableness allowances in the NADR to identify which wall configurations are reasonable from a cost perspective.

The design of noise barriers presented in this report is preliminary and has been conducted at a level appropriate for environmental review and not for final design of the project. Preliminary information on the physical location, length, and height of noise barriers is provided in this report. If pertinent parameters change substantially during the final project design, preliminary noise barrier designs may be modified or eliminated from the final project. A final decision on the construction of the noise abatement will be made upon completion of the project design.

7.2.1. Future Build

The following is a discussion of the noise abatement measures considered for the Future Build condition where traffic noise impacts are predicted.

7.2.1.1. Noise Barrier No. 1

A 169 ft long barrier (STA 36+55 to STA 37+31) along the private property line on the northbound side of Fairview Street between Civic Center Drive and 9th Street was analyzed to shield Receptor R-5. Table B.1 in Appendix B shows the results of the analysis. NB No. 1 was evaluated from 6 ft to 16 ft high in 2 ft increments. Figure 7-1 shows the location of NB No. 1. Table 7.1 lists the highest noise barrier reduction, the number of benefited residences, the reasonable allowance per benefited residence, and the total reasonable allowance for each barrier height. The minimum feasible barrier height is 8 ft.

Table 7.1. Summary of Reasonableness Allowances for Noise Barrier No. 1

Build Alternative with Barrier[1]	6 ft Barrier	8 ft Barrier	10 ft Barrier	12 ft Barrier	14 ft Barrier	16 ft Barrier
Highest Noise Barrier Reduction (dB)	3	5	7	8	9	10
Number of Benefited Receptors/Units	0	1	1	1	1	1
Reasonable Allowance per Benefited Receptor/Unit[2]	$0	$95,000	$95,000	$95,000	$95,000	$95,000
Total Reasonable Allowance	$0	$95,000	$95,000	$95,000	$95,000	$95,000

Source: Compiled by LSA (2018).

1 A NADR will be prepared to identify the noise barrier construction cost information and the noise barriers that are reasonable from a cost perspective.

2 The cost consideration in the reasonableness determination of noise abatement is based on a 2018 allowance per benefited receptor/unit of $95,000.

dB = decibels

ft = foot/feet

NADR = Noise Abatement Decision Report

LEGEND

- Modeled Receptors
- Proposed Right of Way Acquisition
- Proposed Improvements
- Existing Right of Way
- Existing Walls
- Modeled Noise Barriers

0 75 150
FEET

SOURCE: Google Aerial (12/2017); WKE (2017)

I:\WKE1702\GIS\NSR_ModeledNoiseBarriers.mxd (1/14/2019)

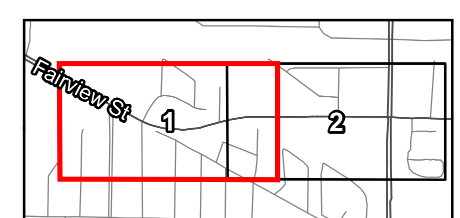

FIGURE 7-1
Sheet 1 of 2

Fairview Street Improvements
from 9th Street to 16th Street and Bridge Replacement Project

Modeled Noise Barrier and Receptor Locations

Federal Project No.: BRLS 5063(184)

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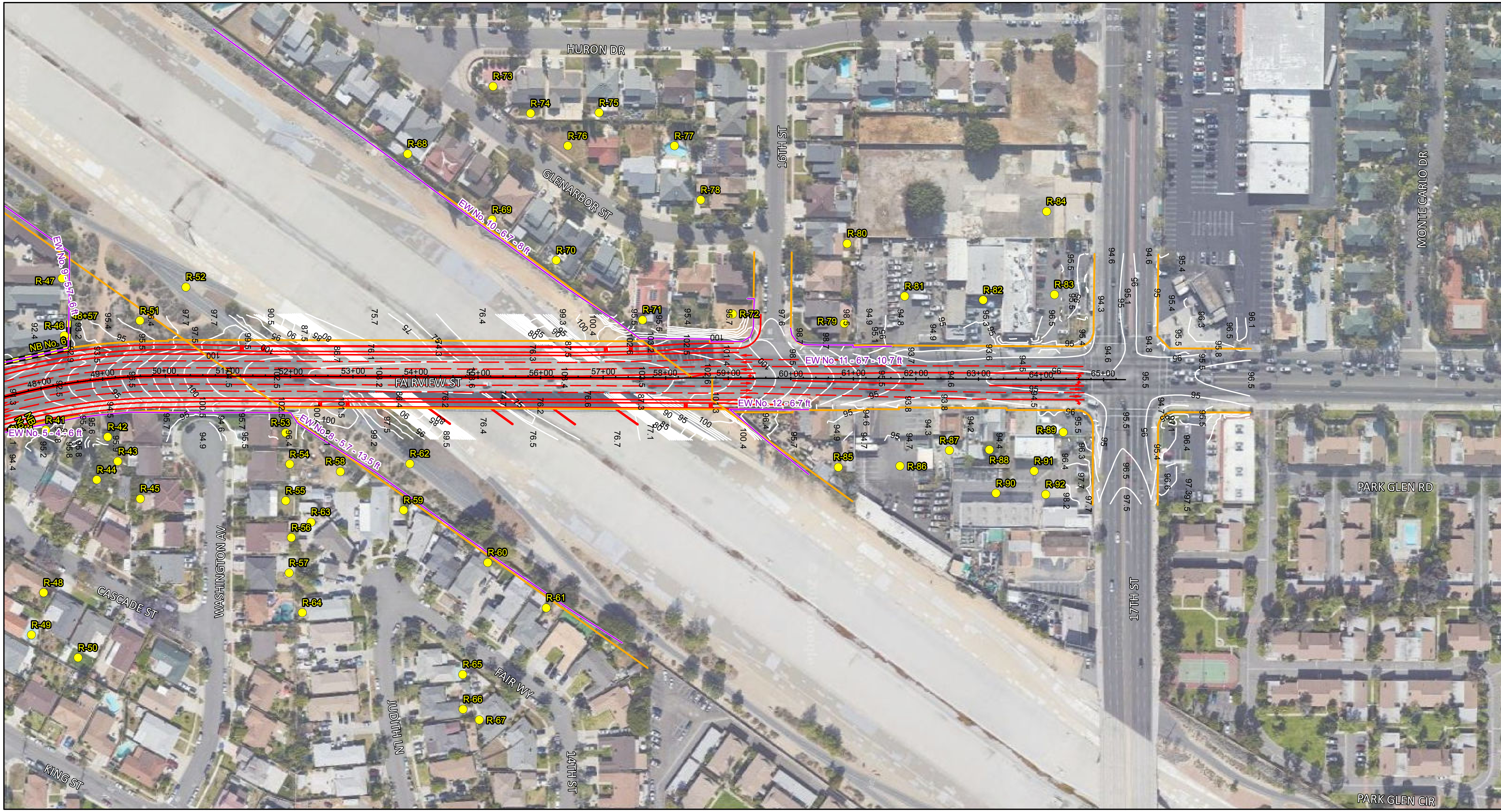

LEGEND

- Modeled Receptors
- Proposed Right of Way Acquisition
- Proposed Improvements
- Existing Right of Way
- Existing Walls
- Modeled Noise Barriers

0 75 150
FEET

SOURCE: Google Aerial (12/2017); WKE (2017)

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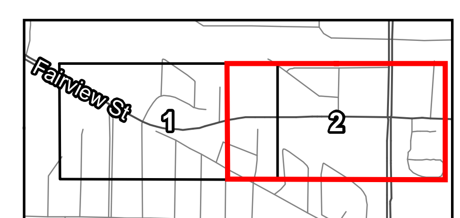

FIGURE 7-1
Sheet 2 of 2

Fairview Street Improvements
from 9th Street to 16th Street and Bridge Replacement Project

Modeled Noise Barrier and Receptor Locations

Federal Project No.: BRLS 5063(184)

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7.2.1.2. Noise Barrier No. 2

A 129 ft long barrier (STA 36+30 to STA 37+07) along the private property line on the southbound side of Fairview Street between Civic Center Drive and 9th Street was analyzed to shield Receptor R-8. Table B.1 in Appendix B shows the results of the analysis. NB No. 2 was evaluated from 6 ft to 16 ft high in 2 ft increments. Figure 7-1 shows the location of NB No. 2. Table 7.2 lists the highest noise barrier reduction, the number of benefited residences, the reasonable allowance per benefited residence, and the total reasonable allowance for each barrier height. The minimum feasible barrier height is 8 ft.

Table 7.2. Summary of Reasonableness Allowances for Noise Barrier No. 2

Build Alternative with Barrier[1]	6 ft Barrier	8 ft Barrier	10 ft Barrier	12 ft Barrier	14 ft Barrier	16 ft Barrier
Highest Noise Barrier Reduction (dB)	4	6	8	9	10	11
Number of Benefited Receptors/Units	0	1	1	1	1	1
Reasonable Allowance Per Benefited Receptor/Unit[2]	$0	$95,000	$95,000	$95,000	$95,000	$95,000
Total Reasonable Allowance	$0	$95,000	$95,000	$95,000	$95,000	$95,000

Source: Compiled by LSA (2018).
1 A NADR will be prepared to identify the noise barrier construction cost information and the noise barriers that are reasonable from a cost perspective.
2 The cost consideration in the reasonableness determination of noise abatement is based on a 2018 allowance per benefited receptor/unit of $95,000.
dB = decibels
ft = foot/feet
NADR = Noise Abatement Decision Report

7.2.1.3. Noise Barrier No. 3

A 113 ft long barrier (STA 38+70 to STA 39+22) along the private property line on the southbound side of Fairview Street between West 9th Street and West 12th Street was analyzed to shield Receptor R-14. Table B.1 in Appendix B shows the results of the analysis. NB No. 3 was evaluated from 6 ft to 16 ft high in 2 ft increments. Figure 7-1 shows the location of NB No. 3. Table 7.3 lists the highest noise barrier reduction, the number of benefited residences, the reasonable allowance per benefited residence, and the total reasonable allowance for each barrier height. The minimum feasible barrier height is 8 ft.

Table 7.3. Summary of Reasonableness Allowances for Noise Barrier No. 3

Build Alternative with Barrier[1]	6 ft Barrier	8 ft Barrier	10 ft Barrier	12 ft Barrier	14 ft Barrier	16 ft Barrier
Highest Noise Barrier Reduction (dB)	4	6	7	7	8	8
Number of Benefited Receptors/Units	0	1	1	1	1	1
Reasonable Allowance per Benefited Receptor/Unit[2]	$0	$95,000	$95,000	$95,000	$95,000	$95,000
Total Reasonable Allowance	$0	$95,000	$95,000	$95,000	$95,000	$95,000

Source: Compiled by LSA (2018).
[1] A NADR will be prepared to identify the noise barrier construction cost information and the noise barriers that are reasonable from a cost perspective.
[2] The cost consideration in the reasonableness determination of noise abatement is based on a 2018 allowance per benefited receptor/unit of $95,000.
dB = decibels
ft = foot/feet
NADR = Noise Abatement Decision Report

7.2.1.4. Noise Barrier No. 4

A 171 ft long barrier (STA 43+45 to STA 45+15) along the private property line on the southbound side of Fairview Street between West 9th Street and West 12th Street was analyzed to shield Receptor R-23. Table B.1 in Appendix B shows the results of the analysis. NB No. 4 was evaluated from 6 ft to 16 ft high in 2 ft increments. Figure 7-1 shows the location of NB No. 4. Table 7.4 lists the highest noise barrier reduction, the number of benefited residences, the reasonable allowance per benefited residence, and the total reasonable allowance for each barrier height. The minimum feasible barrier height is 6 ft.

Table 7.4. Summary of Reasonableness Allowances for Noise Barrier No. 4

Build Alternative with Barrier[1]	6 ft Barrier	8 ft Barrier	10 ft Barrier	12 ft Barrier	14 ft Barrier	16 ft Barrier
Highest Noise Barrier Reduction (dB)	7	10	12	14	15	16
Number of Benefited Receptors/Units	2	2	2	2	2	2
Reasonable Allowance Per Benefited Receptor/Unit[2]	$95,000	$95,000	$95,000	$95,000	$95,000	$95,000
Total Reasonable Allowance	$190,000	$190,000	$190,000	$190,000	$190,000	$190,000

Source: Compiled by LSA (2018).
[1] A NADR will be prepared to identify the noise barrier construction cost information and the noise barriers that are reasonable from a cost perspective.
[2] The cost consideration in the reasonableness determination of noise abatement is based on a 2018 allowance per benefited receptor/unit of $95,000.
dB = decibels
ft = foot/feet
NADR = Noise Abatement Decision Report

7.2.1.5. Noise Barrier No. 5

A 705 ft long barrier (STA 40+45 to STA 42+14) along the private property line on the northbound side of Fairview Street between Civic Center Drive and the Santa Ana River was analyzed to shield Receptors R-24, R-25, and R-40. Table B.1 in Appendix B shows the results of the analysis. NB No. 5 was evaluated from 6 ft to 16 ft high in 2 ft increments. Figure 7-1 shows the location of NB No. 5. Table 7.5 lists the highest noise barrier reduction, the number of benefited residences, the reasonable allowance per benefited residence, and the total reasonable allowance for each barrier height. The minimum feasible barrier height is 6 ft.

Table 7.5. Summary of Reasonableness Allowances for Noise Barrier No. 5

Build Alternative with Barrier[1]	6 ft Barrier	8 ft Barrier	10 ft Barrier	12 ft Barrier	14 ft Barrier	16 ft Barrier
Highest Noise Barrier Reduction (dB)	6	9	11	13	14	16
Number of Benefited Receptors/Units	2	3	3	5	7	7
Reasonable Allowance Per Benefited Receptor/Unit[2]	$95,000	$95,000	$95,000	$95,000	$95,000	$95,000
Total Reasonable Allowance	$190,000	$285,000	$285,000	$475,000	$665,000	$665,000

Source: Compiled by LSA (2018).

1 A NADR will be prepared to identify the noise barrier construction cost information and the noise barriers that are reasonable from a cost perspective.

2 The cost consideration in the reasonableness determination of noise abatement is based on a 2018 allowance per benefited receptor/unit of $95,000.

dB = decibels

ft = foot/feet

NADR = Noise Abatement Decision Report

7.2.1.6. Noise Barrier No. 6

A 184 ft long barrier (STA 47+16 to STA 48+57) along the private property line on the southbound side of Fairview Street between West 12th Street and the Santa Ana River was analyzed to shield Receptor R-46. Table B.1 in Appendix B shows the results of the analysis. NB No. 6 was evaluated from 6 ft to 16 ft high in 2 ft increments. Figure 7-1 shows the location of NB No. 6. Table 7.6 lists the highest noise barrier reduction, the number of benefited residences, the reasonable allowance per benefited residence, and the total reasonable allowance for each barrier height. The minimum feasible barrier height is 10 ft.

Table 7.6. Summary of Reasonableness Allowances for Noise Barrier No. 6

Build Alternative with Barrier[1]	6 ft Barrier	8 ft Barrier	10 ft Barrier	12 ft Barrier	14 ft Barrier	16 ft Barrier
Highest Noise Barrier Reduction (dB)	0	4	7	8	9	10
Number of Benefited Receptors/Units	0	0	1	1	1	1
Reasonable Allowance Per Benefited Receptor/Unit[2]	$0	$0	$95,000	$95,000	$95,000	$95,000
Total Reasonable Allowance	$0	$0	$95,000	$95,000	$95,000	$95,000

Source: Compiled by LSA (2018).

1 A NADR will be prepared to identify the noise barrier construction cost information and the noise barriers that are reasonable from a cost perspective.

2 The cost consideration in the reasonableness determination of noise abatement is based on a 2018 allowance per benefited receptor/unit of $95,000.

dB = decibels

ft = foot/feet

NADR = Noise Abatement Decision Report

Chapter 8. Construction Noise

Two types of short-term noise impacts would occur during construction of the proposed Project. The first type would be from construction crew commutes and the transport of construction equipment and materials to the project site that would incrementally raise noise levels on access roads leading to the site. The pieces of heavy equipment for grading and construction activities will be moved on site, will remain for the duration of each construction phase, and will not add to the daily traffic volumes in the project vicinity. A high single-event noise exposure potential at a maximum level of 84 dBA L_{max} from trucks passing at 50 ft will exist. However, the projected construction traffic volume will be minimal when compared to existing traffic volumes on Fairview Street and other adjacent roadways, and the associated long-term noise level change will not be perceptible. Therefore, short-term construction-related worker commutes and equipment transport noise impacts would be less than substantial.

The second type of short-term noise impact is related to noise generated during roadway construction. Construction is performed 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 and the noise levels in the project area 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 8.1 lists typical construction equipment noise levels (L_{max}) recommended for noise impact assessments based on a distance of 50 ft between the equipment and a noise receptor.

Typical noise levels at 50 ft from an active construction area range up to 88 dBA L_{max} during the noisiest construction phases. The site preparation phase, which includes grading and paving, tends to generate the highest noise levels because the noisiest construction equipment is earthmoving equipment. Earthmoving equipment includes excavating machinery (e.g., backfillers, bulldozers, and front loaders). Earthmoving and compacting equipment includes 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.

Table 8.1. RCNM Default Noise Emission Reference Levels and Usage Factors

Equipment Description	Spec 721.560[1] dBA L_{max} at 50 ft	Actual Measured[2] dBA L_{max} at 50 ft
Backhoe	80	78
Compactor (ground)	80	83
Crane	85	81
Dozer	85	82
Dump Truck	84	76
Excavator	85	81
Flat Bed Truck	84	74
Front-End Loader	80	79
Grader	85	N/A[3]
Jackhammer	85	89
Pickup Truck	55	75
Pneumatic Tools	85	85
Pumps	77	81
Rock Drill	85	81
Roller	85	80
Scraper	85	84
Tractor	84	N/A
Vibratory Pile Driver	95	101

Source: Federal Highway Administration, *Roadway Construction Noise Model,* Table 9.1 (January 2006).
Note: Noise levels reported in this table are rounded to the nearest whole number.
[1] Maximum noise levels were developed based on Spec 721.560 from the CA/T program to be consistent with the City of Boston's Noise Code for the "Big Dig" project.
[2] The maximum noise level was developed based on the average noise level measured for each piece of equipment during the CA/T program in Boston, Massachusetts.
[3] Because the maximum noise level based on the average noise level measured for this piece of equipment was not available, the maximum noise level developed based on Spec 721.560 was used.
CA/T = Central Artery/Tunnel
dBA = decibel(s)
ft = foot/feet
L_{max} = maximum instantaneous sound level
N/A = not applicable
RCNM = Roadway Construction Noise Model

Construction of the proposed Project is expected to require the use of graders, bulldozers, and water trucks/pickup trucks. Noise associated with the use of construction equipment is estimated to be between 55 and 85 dBA L_{max} at a distance of 50 ft from the active construction area for the grading phase. As seen in Table 8.1, the maximum noise level generated by each grader is assumed to be approximately 85 dBA L_{max} at 50 ft from the grader in operation. Each bulldozer would generate approximately 85 dBA L_{max} at 50 ft. The maximum noise level generated by water trucks/pickup trucks is estimated to be approximately 55 dBA L_{max} at 50 ft from these vehicles. Each doubling of the sound source with equal strength increases the noise level by 3 dBA. Each piece of construction equipment operates as an individual point source. The worst-case composite noise level at the nearest residence during this phase of construction would be 88 dBA L_{max} at a distance of 50 ft from an active construction area. Based on a usage factor of 40 percent, the worst-case combined noise level during this phase of construction would be 84 dBA L_{eq} at a distance of 50 ft from the active construction area.

The closest residences are located approximately 50 ft from the project construction areas. Therefore, the closest residences may be subject to short-term noise reaching 88 dBA L_{max} generated by construction activities in the project area. Compliance with Section 14-8.02 of the Caltrans Standard Specifications and Section 18-314 of the City's Municipal Code will be required to minimize construction noise impacts on land uses adjacent to the project site. In compliance with these regulations, the contractor shall not perform any construction activities between the hours of 8:00 p.m. and 7:00 a.m. on weekdays and Saturdays, or at any time on Sundays and federal holidays.

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Chapter 9. References

California Department of Transportation (Caltrans). 2015. *Highway Design Manual*. December.

———. 2013. *Technical Noise Supplement*, September. Website: http://www.dot.ca.gov/hq/env/noise/pub/TeNS_Sept_2013B.pdf (accessed September 2017).

———. 2011. *Traffic Noise Analysis Protocol for New Highway Construction, Reconstruction, and Retrofit Barrier Projects*. May.

———. 2010. Standard Specifications, Section 14-8.02.

Federal Highway Administration (FHWA). 2006. *Roadway Construction Noise Model*. January.

———. 2004. *Traffic Noise Model* (TNM) Version 2.5. April.

———. 1998a. *Traffic Noise Model* (TNM) Version 1.0 User's Guide. January. FHWA-PD-96-009. Washington, D.C.

———. 1998b. *Traffic Noise Model* (TNM) Version 1.0. February. FHWA-PD-96-010. Washington, D.C.

LSA Associates, Inc. (LSA). 2018. *Fairview Street Improvements from 9th Street to 16th Street and Bridge Replacement Project Traffic Impact Analysis.* May.

United States Department of Transportation. 1982. *Federal Highway Administration Procedures for Abatement of Highway Traffic Noise*, CFR 23 Part 772, as amended July 8, 1982.

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Appendix A. Traffic Counts and Traffic Data

This appendix contains tables presenting the traffic counts with observed vehicle speeds during ambient noise level measurements and traffic data for Existing, Future No Build, and Future Build conditions.

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Table A-1. Existing Traffic Counts and Posted Speed Limit During Short-Term Noise Measurement

	Existing Traffic Counts (20 min)			Distribution (%)			Traffic Volume (Hourly)			Lane 1-2			Lane 3			Posted Speed Limit (mph)		
	Auto	Medium	Heavy	Auto	Medium	Heavy	Auto	Medium	Heavy	Auto	Medium	Heavy	Auto	Medium	Heavy	Auto	Medium	Heavy
SET 1 (ST-1, ST-2, ST-3)																		
Fairview Street NB	280	10	6	0.95	0.03	0.02	840	30	18	560	20	12	280	10	6	45	45	45
Fairview Street SB	340	19	5	0.93	0.05	0.01	1020	57	15	680	38	10	340	19	5	45	45	45
SET 2 (ST-4, ST-5, ST-8)																		
Fairview Street NB	305	11	4	0.95	0.03	0.01	915	33	12	610	22	8	305	11	4	45	45	45
Fairview Street SB	313	12	6	0.95	0.04	0.02	939	36	18	626	24	12	313	12	6	45	45	45
SET 3 (ST-6)																		
Fairview Street NB	313	5	6	0.97	0.02	0.02	939	15	18	626	10	12	313	5	6	45	45	45
Fairview Street SB	307	8	3	0.97	0.03	0.01	921	24	9							45	45	45
SET 4 (ST-7)																		
Fairview Street NB	473	14	4	0.96	0.03	0.01	1419	42	12							45	45	45
Fairview Street SB	361	14	3	0.96	0.04	0.01	1083	42	9							45	45	45
SET 5 (ST-9, ST-10)																		
Fairview Street NB	359	17	3	0.95	0.04	0.01	1077	51	9							45	45	45
Fairview Street SB	326	9	3	0.96	0.03	0.01	978	27	9							45	45	45
SET 6 (ST-11, ST-12)																		
Fairview Street NB	377	33	6	0.91	0.08	0.01	1131	99	18							45	45	45
Fairview Street SB	378	15	2	0.96	0.04	0.01	1134	45	6							45	45	45
17th St EB	272	8	4	0.96	0.03	0.01	816	24	12	544	16	8	272	8	4	45	45	45
17th St WB	260	3	3	0.98	0.01	0.01	780	9	9	520	6	6	260	3	3	45	45	45
SET 7 (ST-13, ST-15)																		
Fairview Street NB	300	8	2	0.97	0.03	0.01	900	24	6							45	45	45
Fairview Street SB	280	7	10	0.94	0.02	0.03	840	21	30							45	45	45
17th St EB	280	2	3	0.98	0.01	0.01	840	6	9	560	4	6	280	2	3	45	45	45
17th St WB	310	4	4	0.97	0.01	0.01	930	12	12	620	8	8	310	4	4	45	45	45
SET 8 (ST-14)																		
Fairview Street NB	270	11	3	0.95	0.04	0.01	810	33	9							45	45	45
Fairview Street SB	320	6	7	0.96	0.02	0.02	960	18	21							45	45	45

Table A-2. Existing Traffic Volumes (2017)

Roadway Segments	No. of Lanes	AM Peak Hour	PM Peak Hour	Worst-Case Traffic Volume	Selected Volume	Vehicle Distribution (%)			Modeled Volumes			Lanes 1 & 2			Lane 3			Posted Speed Limit (mph)		
						Auto	Medium	Heavy	Auto	Medium	Heavy	Auto	Medium	Heavy	Auto	Medium	Heavy	Auto	Medium	Heavy
N Fairview St NB - North of 17th St	2	1,313	1,686	1,500	1,313	0.95	0.04	0.01	1,247	53	13							45	45	45
N Fairview St NB - Between 17th St and W 16th St	2	1,343	1,517	1,500	1,343	0.95	0.04	0.01	1,276	54	13							45	45	45
N Fairview St NB - Between W 16th St and W 12th St	2	1,355	1,521	1,500	1,355	0.95	0.04	0.01	1,287	54	14							45	45	45
N Fairview St NB - Between W 12th St and W 9th St	2	1,365	1,488	1,500	1,365	0.95	0.04	0.01	1,296	55	14	864	37	9	432	18	5	45	45	45
N Fairview St NB - Between W 9th St and W Civic Center Dr	3	1,406	1,559	2,250	1,406	0.95	0.04	0.01	1,336	56	14	891	37	9	445	19	5	45	45	45
N Fairview St NB - South of W Civic Center Dr	3	1,668	1,809	2,250	1,668	0.95	0.04	0.01	1,584	67	17	1,056	45	11	528	22	6	45	45	45
N Fairview St SB - North of 17th St	2	1,753	1,461	1,500	1,500	0.95	0.04	0.01	1,425	60	15							45	45	45
N Fairview St SB - Between 17th St and W 16th St	2	1,616	1,548	1,500	1,500	0.95	0.04	0.01	1,425	60	15							45	45	45
N Fairview St SB - Between W 16th St and W 12th St	2	1,718	1,558	1,500	1,500	0.95	0.04	0.01	1,425	60	15							45	45	45
N Fairview St SB - Between W 12th St and W 9th St	2	1,708	1,456	1,500	1,500	0.95	0.04	0.01	1,425	60	15							45	45	45
N Fairview St SB - Between W 9th St and W Civic Center Dr	3	1,703	1,446	2,250	1,703	0.95	0.04	0.01	1,618	68	17	1,079	45	11	539	23	6	45	45	45
N Fairview St SB - South of W Civic Center Dr	3	1,721	1,747	2,250	1,721	0.95	0.04	0.01	1,635	69	17	1,090	46	11	545	23	6	45	45	45
17th St EB - West of N Fairview St	3	1,557	1,290	2,250	1,557	0.95	0.04	0.01	1,479	62	16	986	41	11	493	21	5	40	40	40
17th St EB - East of N Fairview St	3	1,872	1,283	2,250	1,872	0.95	0.04	0.01	1,778	75	19	1,185	50	13	593	25	6	40	40	40
17th St WB - West of N Fairview St	3	736	1,462	2,250	736	0.95	0.04	0.01	700	29	7	467	19	5	233	10	2	40	40	40
17th St WB - East of N Fairview St	3	882	1,627	2,250	882	0.95	0.04	0.01	838	35	9	559	23	6	279	12	3	40	40	40
W 16th St - West of N Fairview St	2	114	46	1,500	114	0.95	0.04	0.01	108	5	1							25	25	25
W 12th St - West of N Fairview St	2	26	31	1,500	26	0.95	0.04	0.01	25	1	0							25	25	25
W 9th St - West of N Fairview St	2	103	114	1,500	103	0.95	0.04	0.01	98	4	1							25	25	25
W 9th St - East of N Fairview St	2	122	106	1,500	122	0.95	0.04	0.01	116	5	1							25	25	25
W Civic Center Dr EB - East of N Fairview St	2	682	590	1,500	682	0.95	0.04	0.01	648	27	7							35	35	35
W Civic Center Dr WB - East of N Fairview St	2	434	639	1,500	434	0.95	0.04	0.01	413	17	4							35	35	35

Table A-3. Future No Build Traffic Volumes (2040)

Roadway Segments	No. of Lanes	AM Peak Hour	PM Peak Hour	Worst-Case Traffic Volume	Selected Volume	Vehicle Distribution (%)			Modeled Volumes			Lanes 1 & 2			Lane 3			Posted Speed Limit (mph)		
						Auto	Medium	Heavy	Auto	Medium	Heavy	Auto	Medium	Heavy	Auto	Medium	Heavy	Auto	Medium	Heavy
N Fairview St NB - North of 17th St	2	1,881	2,436	1,500	1,500	0.95	0.04	0.01	1,425	60	15							45	45	45
N Fairview St NB - Between 17th St and W 16th St	2	1,572	1,802	1,500	1,500	0.95	0.04	0.01	1,425	60	15							45	45	45
N Fairview St NB - Between W 16th St and W 12th St	2	1,584	1,806	1,500	1,500	0.95	0.04	0.01	1,425	60	15							45	45	45
N Fairview St NB - Between W 12th St and W 9th St	2	1,594	1,773	1,500	1,500	0.95	0.04	0.01	1,425	60	15	950	40	10	475	20	5	45	45	45
N Fairview St NB - Between W 9th St and W Civic Center Dr	3	1,646	1,844	2,250	1,646	0.95	0.04	0.01	1,564	66	16	1,043	44	11	521	22	5	45	45	45
N Fairview St NB - South of W Civic Center Dr	3	1,840	1,952	2,250	1,840	0.95	0.04	0.01	1,748	74	18	1,165	49	12	583	25	6	45	45	45
N Fairview St SB - North of 17th St	2	2,467	2,068	1,500	1,500	0.95	0.04	0.01	1,425	60	15							45	45	45
N Fairview St SB - Between 17th St and W 16th St	2	1,867	1,808	1,500	1,500	0.95	0.04	0.01	1,425	60	15							45	45	45
N Fairview St SB - Between W 16th St and W 12th St	2	1,969	1,818	1,500	1,500	0.95	0.04	0.01	1,425	60	15							45	45	45
N Fairview St SB - Between W 12th St and W 9th St	2	1,959	1,716	1,500	1,500	0.95	0.04	0.01	1,425	60	15							45	45	45
N Fairview St SB - Between W 9th St and W Civic Center Dr	3	1,942	1,705	2,250	1,942	0.95	0.04	0.01	1,845	78	19	1,230	52	13	615	26	6	45	45	45
N Fairview St SB - South of W Civic Center Dr	3	1,777	2,082	2,250	1,777	0.95	0.04	0.01	1,688	71	18	1,125	47	12	563	24	6	45	45	45
17th St EB - West of N Fairview St	3	1,500	1,339	2,250	1,500	0.95	0.04	0.01	1,425	60	15	950	40	10	475	20	5	40	40	40
17th St EB - East of N Fairview St	3	1,910	1,284	2,250	1,910	0.95	0.04	0.01	1,815	76	19	1,210	51	13	605	25	6	40	40	40
17th St WB - West of N Fairview St	3	736	1,462	2,250	736	0.95	0.04	0.01	700	29	7	467	19	5	233	10	2	40	40	40
17th St WB - East of N Fairview St	3	853	1,697	2,250	853	0.95	0.04	0.01	810	34	9	540	23	6	270	11	3	40	40	40
W 16th St - West of N Fairview St	2	114	46	1,500	114	0.95	0.04	0.01	108	5	1							25	25	25
W 12th St - West of N Fairview St	2	26	31	1,500	26	0.95	0.04	0.01	25	1	0							25	25	25
W 9th St - West of N Fairview St	2	103	114	1,500	103	0.95	0.04	0.01	98	4	1							25	25	25
W 9th St - East of N Fairview St	2	122	106	1,500	122	0.95	0.04	0.01	116	5	1							25	25	25
W Civic Center Dr EB - East of N Fairview St	2	758	590	1,500	758	0.95	0.04	0.01	720	30	8							35	35	35
W Civic Center Dr WB - East of N Fairview St	2	427	780	1,500	427	0.95	0.04	0.01	406	17	4							35	35	35

Table A-4. Future Build Traffic Volumes (Year 2040)

Roadway Segments	No. of Lanes	AM Peak Hour	PM Peak Hour	Worst-Case Traffic Volume	Selected Volume	Vehicle Distribution (%)			Modeled Volumes			Lanes 1 & 2			Lane 3			Posted Speed Limit (mph)		
						Auto	Medium	Heavy	Auto	Medium	Heavy	Auto	Medium	Heavy	Auto	Medium	Heavy	Auto	Medium	Heavy
N Fairview St NB - North of 17th St	2	1,931	2,453	1,500	1,500	0.95	0.04	0.01	1,425	60	15							45	45	45
N Fairview St NB - Between 17th St and W 16th St	2	1,784	2,086	1,500	1,500	0.95	0.04	0.01	1,425	60	15							45	45	45
N Fairview St NB - Between W 16th St and W 12th St	3	1,802	2,102	2,250	1,802	0.95	0.04	0.01	1,712	72	18	1,141	48	12	571	24	6	45	45	45
N Fairview St NB - Between W 12th St and W 9th St	3	1,810	2,059	2,250	1,810	0.95	0.04	0.01	1,720	72	18	1,147	48	12	573	24	6	45	45	45
N Fairview St NB - Between W 9th St and W Civic Center Dr	3	1,848	2,211	2,250	1,848	0.95	0.04	0.01	1,756	74	18	1,171	49	12	585	25	6	45	45	45
N Fairview St NB - South of W Civic Center Dr	3	1,928	2,170	2,250	1,928	0.95	0.04	0.01	1,832	77	19	1,221	51	13	611	26	6	45	45	45
N Fairview St SB - North of 17th St	2	2,546	2,077	1,500	1,500	0.95	0.04	0.01	1,425	60	15							45	45	45
N Fairview St SB - Between 17th St and W 16th St	2	2,170	1,979	1,500	1,500	0.95	0.04	0.01	1,425	60	15							45	45	45
N Fairview St SB - Between W 16th St and W 12th St	3	2,272	1,989	2,250	2,250	0.95	0.04	0.01	2,137	90	23	1,425	60	15	712	30	8	45	45	45
N Fairview St SB - Between W 12th St and W 9th St	3	2,266	1,889	2,250	2,250	0.95	0.04	0.01	2,137	90	23	1,425	60	15	712	30	8	45	45	45
N Fairview St SB - Between W 9th St and W Civic Center Dr	3	2,249	1,878	2,250	2,249	0.95	0.04	0.01	2,137	90	22	1,425	60	15	712	30	7	45	45	45
N Fairview St SB - South of W Civic Center Dr	3	1,865	2,105	2,250	1,865	0.95	0.04	0.01	1,771	75	19	1,181	50	13	590	25	6	45	45	45
17th St EB - West of N Fairview St	3	1,516	1,294	2,250	1,516	0.95	0.04	0.01	1,440	61	15	960	41	10	480	20	5	40	40	40
17th St EB - East of N Fairview St	3	1,872	1,283	2,250	1,872	0.95	0.04	0.01	1,778	75	19	1,185	50	13	593	25	6	40	40	40
17th St WB - West of N Fairview St	3	735	1,462	2,250	735	0.95	0.04	0.01	699	29	7	466	19	5	233	10	2	40	40	40
17th St WB - East of N Fairview St	3	860	1,636	2,250	860	0.95	0.04	0.01	817	34	9	545	23	6	272	11	3	40	40	40
W 16th St - West of N Fairview St	2	120	58	1,500	120	0.95	0.04	0.01	114	5	1							25	25	25
W 12th St - West of N Fairview St	2	26	31	1,500	26	0.95	0.04	0.01	25	1	0							25	25	25
W 9th St - West of N Fairview St	2	103	114	1,500	103	0.95	0.04	0.01	98	4	1							25	25	25
W 9th St - East of N Fairview St	2	122	106	1,500	122	0.95	0.04	0.01	116	5	1							25	25	25
W Civic Center Dr EB - East of N Fairview St	2	840	592	1,500	840	0.95	0.04	0.01	798	34	8							35	35	35
W Civic Center Dr WB - East of N Fairview St	2	417	877	1,500	417	0.95	0.04	0.01	396	17	4							35	35	35

Appendix B. Predicted Future Noise Levels

This appendix contains a table that summarizes the traffic noise modeling results and noise barrier analysis results for Existing, Future No Build, and Future Build conditions.

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Table B.1 – Predicted Future Noise and Noise Barrier Analysis

Receptor No.	Existing Wall No.	NB No.	Noise Barrier Location	Land Use	No. of Receptors /Units	Existing Noise Level, dBA $L_{eq}(h)$	Future Noise Levels, dBA $L_{eq}(h)$						Noise Prediction with Barrier, Barrier I.L., and NBR																	
							2040 Noise Level				Activity Category (NAC)	Impact Type	6 ft			8 ft			10 ft			12 ft			14 ft			16 ft		
							Without Project, dBA L_{eq}	With Project, dBA L_{eq}	With Project Minus Without Project Conditions	With Project Minus Existing Conditions			$L_{eq}(h)$	I.L.[1]	NBR	$L_{eq}(h)$	I.L.	NBR	$L_{eq}(h)$	I.L.	NBR	$L_{eq}(h)$	I.L.	NBR	$L_{eq}(h)$	I.L.	NBR	$L_{eq}(h)$	I.L.	NBR
R-1				Office	1	62	62	63	1	1	E[2]	None	--[3]	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-2	EW No. 1			Commercial	1	68	69	69	0	1	E[2]	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-3	EW No. 1	1	ROW/PL	Residential	1	56	56	57	1	1	B(67)	None	57	0	0	57	0	0	56	1	0	56	1	0	56	1	0	56	1	0
R-4	EW No. 1	1	ROW/PL	Residential	1	56	57	57	0	1	B(67)	None	57	0	0	57	0	0	57	0	0	57	0	0	57	0	0	56	1	0
R-5	EW No. 1	1	ROW/PL	Residential	1	65	65	**66**[4]	1	1	B(67)	A/E	63	3	0	61	5[5]	1	59	7	1	58	8	1	57	9	1	56	10	1
R-6	EW No. 1	1	ROW/PL	Residential	1	57	58	58	0	1	B(67)	None	58	0	0	58	0	0	58	0	0	57	1	0	57	1	0	57	1	0
R-7	EW No. 1	1	ROW/PL	Residential	1	56	56	57	1	1	B(67)	None	56	1	0	56	1	0	56	1	0	56	1	0	56	1	0	56	1	0
R-8	EW No. 2	2	PL	Residential	1	**67**	**67**	**68**	1	1	B(67)	A/E	64	4	0	62	6	1	60	8	1	59	9	1	58	10	1	57	11	1
R-9	EW No. 2	2	PL	Residential	1	64	65	65	0	1	B(67)	None	65	0	0	64	1	0	64	1	0	64	1	0	64	1	0	64	1	0
R-10	EW No. 2			Residential	1	62	62	62	0	0	B(67)	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-11	EW No. 3			Residential	1	61	61	62	1	1	B(67)	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-12	EW No. 3			Residential	1	58	59	60	1	2	B(67)	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-13	EW No. 3			Residential	1	56	57	58	1	2	B(67)	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-14	EW No. 4	3	ROW	Residential	1	65	65	**67**	2	2	B(67)	A/E	63	4	0	61	6	1	60	7	1	60	7	1	59	8	1	59	8	1
R-15	EW No. 4	3	ROW	Residential	1	60	60	61	1	1	B(67)	None	60	1	0	60	1	0	59	2	0	59	2	0	59	2	0	59	2	0
R-16	EW No. 4	3	ROW	Residential	1	57	58	59	1	2	B(67)	None	58	1	0	58	1	0	58	1	0	57	2	0	57	2	0	57	2	0
R-17	EW No. 3			Residential	1	57	57	58	1	1	B(67)	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-18	EW No. 3			Residential	1	54	55	56	1	2	B(67)	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-19				Medical Office	1	66	66	67	1	1	E[2]	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-20	EW No. 4			Residential	1	57	57	58	1	1	B(67)	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-21	EW No. 4			Residential	2	53	53	54	1	1	B(67)	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-22	EW No. 4			Residential	3	49	49	50	1	1	B(67)	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-23	EW No. 4	4	ROW/PL	Residential	2	**66**	**67**	**68**	1	2	B(67)	A/E	61	7	2	58	10	2	56	12	2	54	14	2	53	15	2	52	16	2
R-24	EW No. 5	5	ROW	Residential	2	**66**	**66**	**67**	1	1	B(67)	A/E	61	6	2	58	9	2	56	11	2	54	13	2	53	14	2	51	16	2
R-25	EW No. 5	5	ROW	Residential	1	65	65	**66**	1	1	B(67)	A/E	62	4	0	59	7	1	57	9	1	55	11	1	54	12	1	53	13	1
R-26	EW No. 5	5	ROW	Vacant Land	1	63	63	65	2	2	F[2]	None	64	1	0	63	2	0	61	4	0	60	5	1	59	6	1	58	7	1
R-27	EW No. 6	5	ROW	Residential	1	52	52	53	1	1	B(67)	None	53	0	0	52	1	0	52	1	0	52	1	0	51	2	0	51	2	0
R-28	EW No. 6	5	ROW	Residential	1	51	51	52	1	1	B(67)	None	52	0	0	51	1	0	52	0	0	51	1	0	51	1	0	50	2	0
R-29	EW No. 5	5	ROW	Residential	1	49	50	50	0	1	B(67)	None	50	0	0	50	0	0	50	0	0	50	0	0	50	0	0	50	0	0
R-30	EW No. 5	5	ROW	Residential	1	48	49	50	1	2	B(67)	None	50	0	0	49	1	0	49	1	0	49	1	0	48	2	0	48	2	0
R-31	EW No. 4			Residential	2	44	44	45	1	1	B(67)	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-32	EW No. 7	4	ROW/PL	Residential	1	50	51	52	1	2	B(67)	None	50	2	0	50	2	0	50	2	0	49	3	0	49	3	0	49	3	0
R-33	EW No. 7	4	ROW/PL	Residential	1	50	51	52	1	2	B(67)	None	51	1	0	51	1	0	51	1	0	51	1	0	50	2	0	50	2	0
R-34	EW No. 7			Residential	1	59	59	61	2	2	B(67)	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-35	EW No. 7			Residential	1	58	59	60	1	2	B(67)	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-36	EW No. 7			Residential	1	55	55	56	1	1	B(67)	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-37	EW No. 5	5	ROW	Residential	2	56	56	57	1	1	B(67)	None	57	0	0	56	1	0	55	2	0	54	3	0	53	4	0	53	4	0
R-38	EW No. 5	5	ROW	Residential	1	61	62	63	1	2	B(67)	None	63	0	0	62	1	0	60	3	0	59	4	0	58	5	1	57	6	1
R-39	EW No. 5	5	ROW	Residential	1	64	64	65	1	1	B(67)	None	65	0	0	64	1	0	62	3	0	61	4	0	60	5	1	59	6	1
R-40	EW No. 5	5	ROW	Residential	1	65	**66**	**67**	1	2	B(67)	A/E	67	0	0	64	3	0	63	4	0	62	5	1	61	6	1	60	7	1
R-41	EW No. 8			Residential	2	62	62	63	1	1	B(67)	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-42	EW No. 8			Residential	1	60	60	61	1	1	B(67)	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-43	EW No. 8			Residential	1	61	61	62	1	1	B(67)	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Table B.1 – Predicted Future Noise and Noise Barrier Analysis

Receptor No.	Existing Wall No.	NB No.	Noise Barrier Location	Land Use	No. of Receptors /Units	Existing Noise Level, dBA L_{eq}(h)	Future Noise Levels, dBA L_{eq}(h)																								
							2040 Noise Level				Activity Category (NAC)	Impact Type	Noise Prediction with Barrier, Barrier I.L., and NBR																	
													6 ft			8 ft			10 ft			12 ft			14 ft			16 ft		
							Without Project, dBA L_{eq}	With Project, dBA L_{eq}	With Project Minus Without Project Conditions	With Project Minus Existing Conditions			L_{eq}(h)	I.L.[1]	NBR	L_{eq}(h)	I.L.	NBR	L_{eq}(h)	I.L.	NBR	L_{eq}(h)	I.L.	NBR	L_{eq}(h)	I.L.	NBR	L_{eq}(h)	I.L.	NBR
R-44	EW No. 8			Residential	2	60	60	61	1	1	B(67)	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-45	EW No. 8			Residential	1	58	58	59	1	1	B(67)	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-46	EW No. 9	6	ROW/PL	Residential	1	**66**	**66**	**68**	2	2	B(67)	A/E	68	0	0	64	4	0	61	7	1	60	8	1	59	9	1	58	10	1
R-47	EW No. 9	6	ROW/PL	Residential	2	59	59	60	1	1	B(67)	None	60	0	0	60	0	0	60	0	0	60	0	0	60	0	0	60	0	0
R-48	EW No. 8			Residential	1	55	55	57	2	2	B(67)	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-49	EW No. 8			Residential	1	54	54	55	1	1	B(67)	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-50	EW No. 8			Residential	3	53	53	54	1	1	B(67)	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-51				Park	1	**67**	**68**	**69**	1	2	C(67)	A/E	NF[6]	--	--	NF	--	--	NF	--	--	NF	--	--	NF	--	--	NF	--	--
R-52				Trail	1	63	63	65	2	2	C[2]	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-53	EW No. 8			Residential	1	57	58	59	1	2	B(67)	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-54	EW No. 8			Residential	1	57	58	59	1	2	B(67)	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-55	EW No. 8			Residential	1	56	56	57	1	1	B(67)	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-56	EW No. 8			Residential	1	55	55	56	1	1	B(67)	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-57	EW No. 8			Residential	1	53	53	54	1	1	B(67)	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-58	EW No. 8			Residential	1	59	60	61	1	2	B(67)	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-59	EW No. 8			Residential	2	57	57	58	1	1	B(67)	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-60	EW No. 8			Residential	4	55	55	56	1	1	B(67)	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-61	EW No. 8			Residential	4	53	54	55	1	2	B(67)	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-62				Trail	1	65	65	67	2	2	C[2]	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-63	EW No. 8			Residential	1	56	56	57	1	1	B(67)	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-64	EW No. 8			Residential	4	51	52	52	0	1	B(67)	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-65	EW No. 8			Residential	2	51	51	52	1	1	B(67)	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-66	EW No. 8			Residential	2	51	51	52	1	1	B(67)	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-67	EW No. 8			Residential	2	51	51	52	1	1	B(67)	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-68	EW No. 10			Residential	2	50	50	51	1	1	B(67)	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-69	EW No. 10			Residential	3	54	54	55	1	1	B(67)	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-70	EW No. 10			Residential	2	55	55	57	2	2	B(67)	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-71	EW No. 10			Residential	1	56	56	58	2	2	B(67)	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-72	EW No. 10			Residential	2	56	56	58	2	2	B(67)	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-73	EW No. 10			Residential	1	50	50	51	1	1	B(67)	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-74	EW No. 10			Residential	2	51	51	52	1	1	B(67)	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-75	EW No. 10			Residential	2	51	51	52	1	1	B(67)	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-76	EW No. 10			Residential	2	51	52	53	1	2	B(67)	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-77	EW No. 10			Residential	1	51	51	52	1	1	B(67)	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-78	EW No. 10			Residential	1	53	53	54	1	1	B(67)	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-79	EW No. 11			Residential	2	65	65	65	0	0	B(67)	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-80	EW No. 11			Residential	2	61	61	62	1	1	B(67)	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-81	EW No. 11			Light Industrial	1	67	67	67	0	0	F[2]	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-82				Light Industrial	1	67	67	67	0	0	F[2]	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-83				Commercial	1	72	72	72	0	0	E[2]	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-84				Vacant Land	1	68	68	68	0	0	F[2]	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-85	EW No. 12			Commercial	1	64	64	65	1	1	E[2]	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-86				Commercial	1	65	65	65	0	0	E[2]	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Table B.1 – Predicted Future Noise and Noise Barrier Analysis

Receptor No.	Existing Wall No.	NB No.	Noise Barrier Location	Land Use	No. of Receptors /Units	Existing Noise Level, dBA $L_{eq}(h)$	Future Noise Levels, dBA $L_{eq}(h)$																								
							2040 Noise Level				Activity Category (NAC)	Impact Type	Noise Prediction with Barrier, Barrier I.L., and NBR																	
													6 ft			8 ft			10 ft			12 ft			14 ft			16 ft		
							Without Project, dBA L_{eq}	With Project, dBA L_{eq}	With Project Minus Without Project Conditions	With Project Minus Existing Conditions			$L_{eq}(h)$	I.L.[1]	NBR	$L_{eq}(h)$	I.L.	NBR	$L_{eq}(h)$	I.L.	NBR	$L_{eq}(h)$	I.L.	NBR	$L_{eq}(h)$	I.L.	NBR	$L_{eq}(h)$	I.L.	NBR
R-87				Residential	1	63	63	63	0	0	B(67)	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-88				Residential	1	62	62	62	0	0	B(67)	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-89				Light Industrial	1	75	75	75	0	0	F[2]	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-90				Light Industrial	1	64	64	64	0	0	F[2]	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-91				Light Industrial	1	66	66	66	0	0	F[2]	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
R-92				Light Industrial	1	69	70	70	0	1	F[2]	None	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Source: Compiled by LSA (2018).
[1] I.L.: Insertion Loss.
[2] Activity categories without outdoor frequent human use areas were not evaluated against the NAC.
[3] No barrier was analyzed at this location because the modeled receptor would not approach or exceed the NAC.
[4] Numbers in **bold** represent noise levels that approach or exceed the NAC.
[5] Underlined noise levels have been attenuated by at least 5 dBA (i.e., feasible barrier height).
[6] NF = Not Feasible.

A/E = Approach/Exceed
dB = decibel(s)
dBA = A-weighted decibel(s)
EW = Existing Wall
ft = foot/feet
$L_{eq}(h)$ = 1-hour A-weighted equivalent continuous sound level
NAC = Noise Abatement Criteria
NB = Noise Barrier
NBR = Number of Benefited Receptors
PL = property line
ROW = right-of-way

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Appendix C. Supplemental Data

This appendix contains the noise monitoring results and sound level calibration certifications.

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LONG-TERM NOISE LEVEL MEASUREMENTS

Noise Measurement Survey – 24 HR

Project Number: WKE1702
Project Name: Fairview Street Improvements

Test Personnel: Jason Lui
Equipment: Dosimeter

Site Number: LT-1 Date: 4/17-18/2018

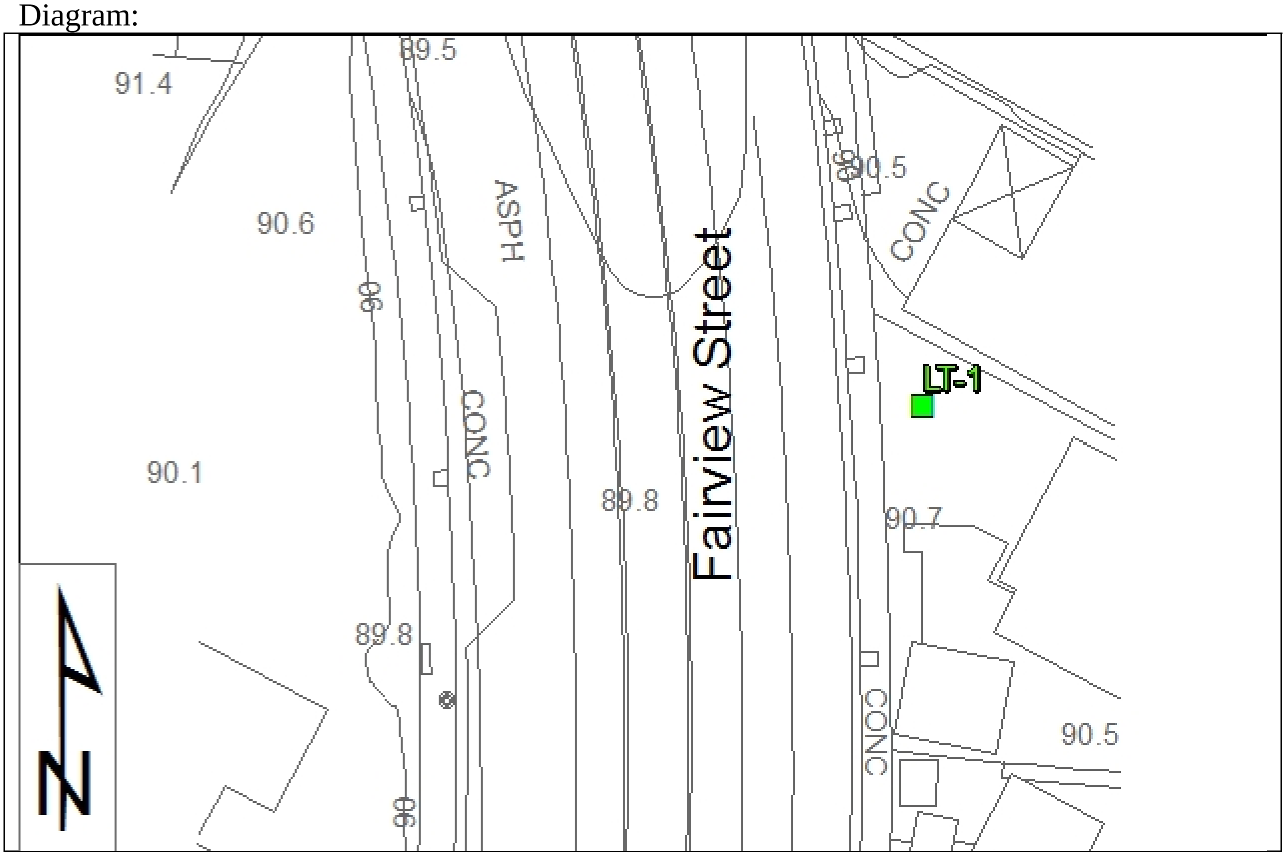
Time: From 9:00 a.m. To 9:00 a.m.

Site Location: 1008 King Street. In the backyard.

Primary Noise Sources: Traffic on Fairview Street.

Comments: Residence has dog, but was temporarily relocated to side yard. Children did not play in the backyard. Activities in the backyard were minimized.

Diagram:



Location Photo:

Noise Measurement Survey – 24 HR

Project Number: WKE1702

Test Personnel: Daniel Kaufman

Project Name: Fairview Street Improvements

Equipment: Dosimeter

Site Number: LT-2 Date: 4/18-19/2018

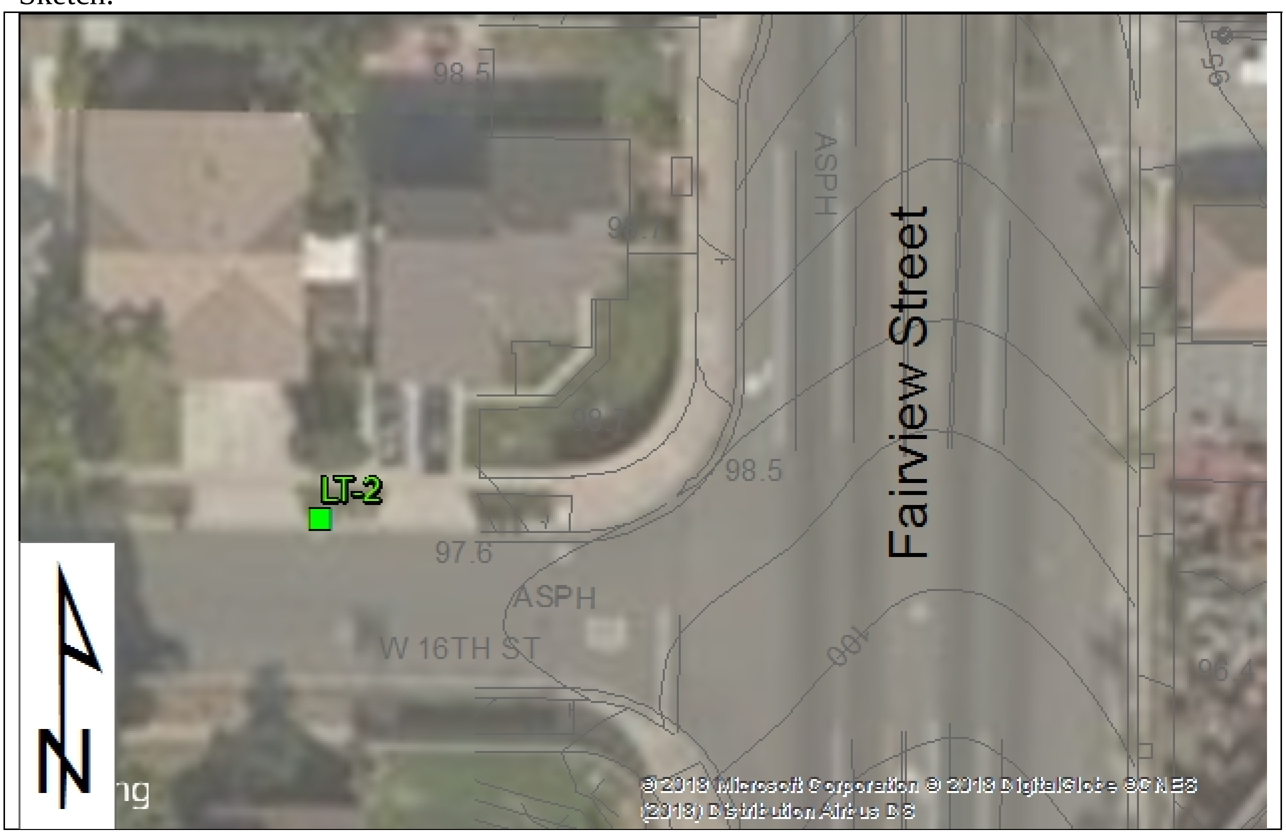
Time: From 9:00 a.m. To 9:00 a.m.

Site Location: 2505 West 16th Street. In front of the house, on a light post southeast of the home.

Primary Noise Sources: Traffic on Fairview Street.

Comments:

Sketch:



Location Photo:

SHORT-TERM NOISE LEVEL MEASUREMENTS

Noise Measurement Survey

Project Number: WKE1702
Test Personnel: Logan Freeberg
Project Name: Fairview Street Improvements
Equipment: Larson Davis 820

Site Number: ST-1 Date: 4/17/2018
Time: From 9:23AM To 9:43AM

Site Location: 2234 West 9th Street in the residence backyard.

Primary Noise Sources: Traffic on Fairview Street, birds and rooster crowing.

Measurement Results	
	dBA
L_{eq}	63.4
L_{max}	76.1
L_{min}	50.2
L_{peak}	90.4
L_2	68.7
L_8	66.8
L_{25}	64.7
L_{50}	61.8

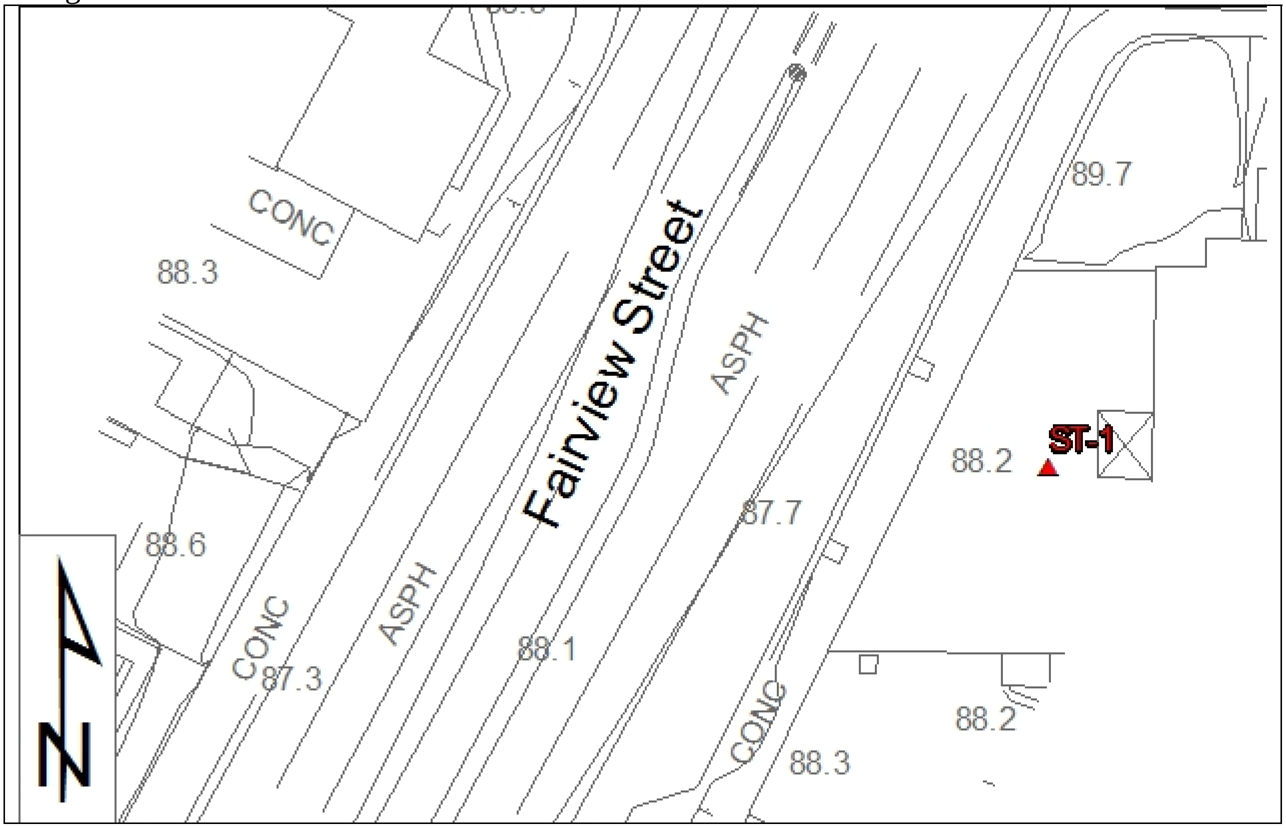
Atmospheric Conditions	
Average Wind Velocity (mph)	3.1
Maximum Wind Velocity (mph)	1.6
Temperature (F)	58.0
Relative Humidity (%)	35.9

Comments: Residence wall = 6 blocks @ 8 inches each with 1 topper @ 8 inches each.

Traffic Description:

Roadway	# Lanes	Speeds	NB/EB Counts			SB/WB Counts		
			Auto	MT	HT	Auto	MT	HT
Fairview St	2/2	45 mph	280	10	6	340	19	5

Diagram:



Location Photo:

Noise Measurement Survey

Project Number: WKE1702
Test Personnel: Jason Lui
Project Name: Fairview Street Improvements
Equipment: Larson Davis 824

Site Number: ST-2 Date: 4/17/2018
Time: From 9:23AM To 9:43AM

Site Location: 2507 9th Street in residence backyard.

Primary Noise Sources: Traffic on Fairview Street.

Measurement Results	
	dBA
L_{eq}	63.8
L_{max}	71.3
L_{min}	47.6
L_{peak}	83.4
L_2	67.6
L_8	66.6
L_{25}	65.2
L_{50}	63.4

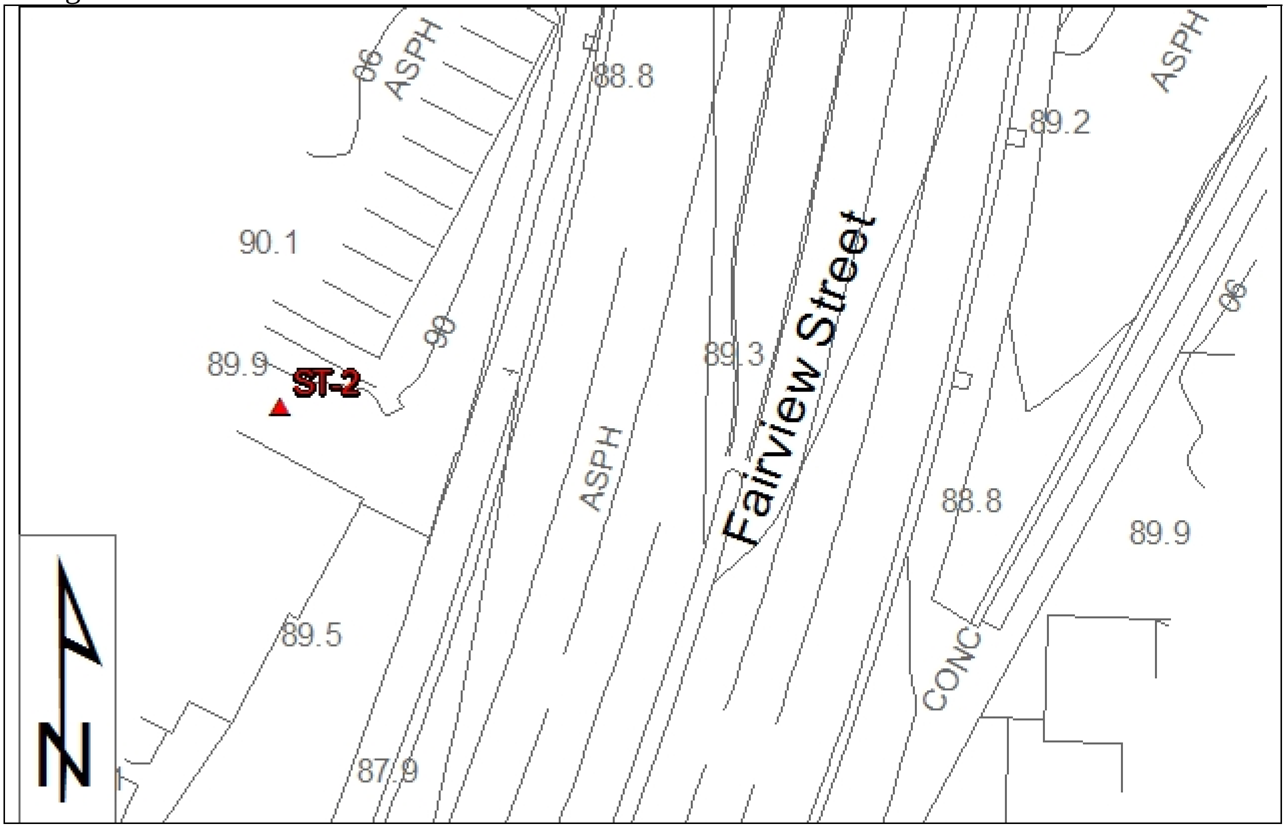
Atmospheric Conditions	
Average Wind Velocity (mph)	3.3
Maximum Wind Velocity (mph)	0.9
Temperature (F)	59.0
Relative Humidity (%)	36.5

Comments: Back wall = 8 blocks @ 8 inches each. Side wall = 7.5 blocks @ 8 inches each.

Traffic Description:

Roadway	# Lanes	Speeds	NB/EB Counts			SB/WB Counts		
			Auto	MT	HT	Auto	MT	HT
Fairview St	2/2	45 mph	280	10	6	340	19	5

Diagram:



Location Photo:

Noise Measurement Survey

Project Number: WKE1702
Project Name: Fairview Street Improvements

Test Personnel: Daniel Kaufman
Equipment: Larson Davis 831

Site Number: ST-3 Date: 4/17/2018

Time: From 9:23AM To 9:43AM

Site Location: 1908 King Street in residence back yard.

Primary Noise Sources: Traffic on Fairview Street and birds.

Measurement Results	
	dBA
L_{eq}	64.9
L_{max}	74.5
L_{min}	47.3
L_{peak}	85.0
L_2	69.9
L_8	68.3
L_{25}	66.2
L_{50}	64.2

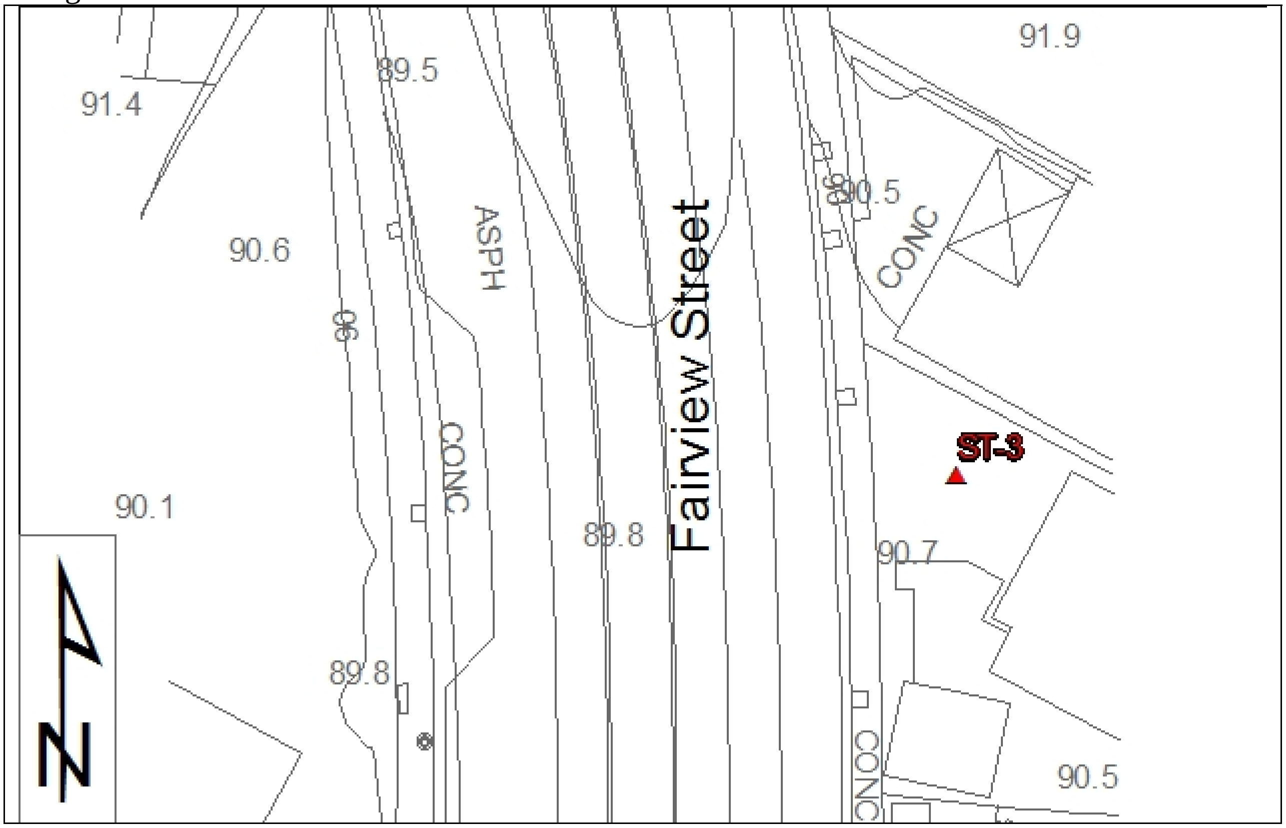
Atmospheric Conditions	
Average Wind Velocity (mph)	2.5
Maximum Wind Velocity (mph)	0.6
Temperature (F)	67.4
Relative Humidity (%)	26.4

Comments: Northern neighbor wall = 6 blocks @ 8 inches each.

Traffic Description:

Roadway	# Lanes	Speeds	NB/EB Counts			SB/WB Counts		
			Auto	MT	HT	Auto	MT	HT
Fairview St	2/2	45 mph	280	10	6	340	19	5

Diagram:



Location Photo:

Noise Measurement Survey

Project Number: WKE1702
Test Personnel: Logan Freeberg
Project Name: Fairview Street Improvements
Equipment: Larson Davis 820

Site Number: ST-4 Date: 4/17/2018
Time: From 10:28AM To 10:48AM

Site Location: 1007 Marengo Place in residence back yard.

Primary Noise Sources: Traffic on Fairview Street and birds.

Measurement Results	
	dBA
L_{eq}	67.3
L_{max}	81.3
L_{min}	46.4
L_{peak}	94.4
L_2	73.0
L_8	70.6
L_{25}	68.6
L_{50}	66.3

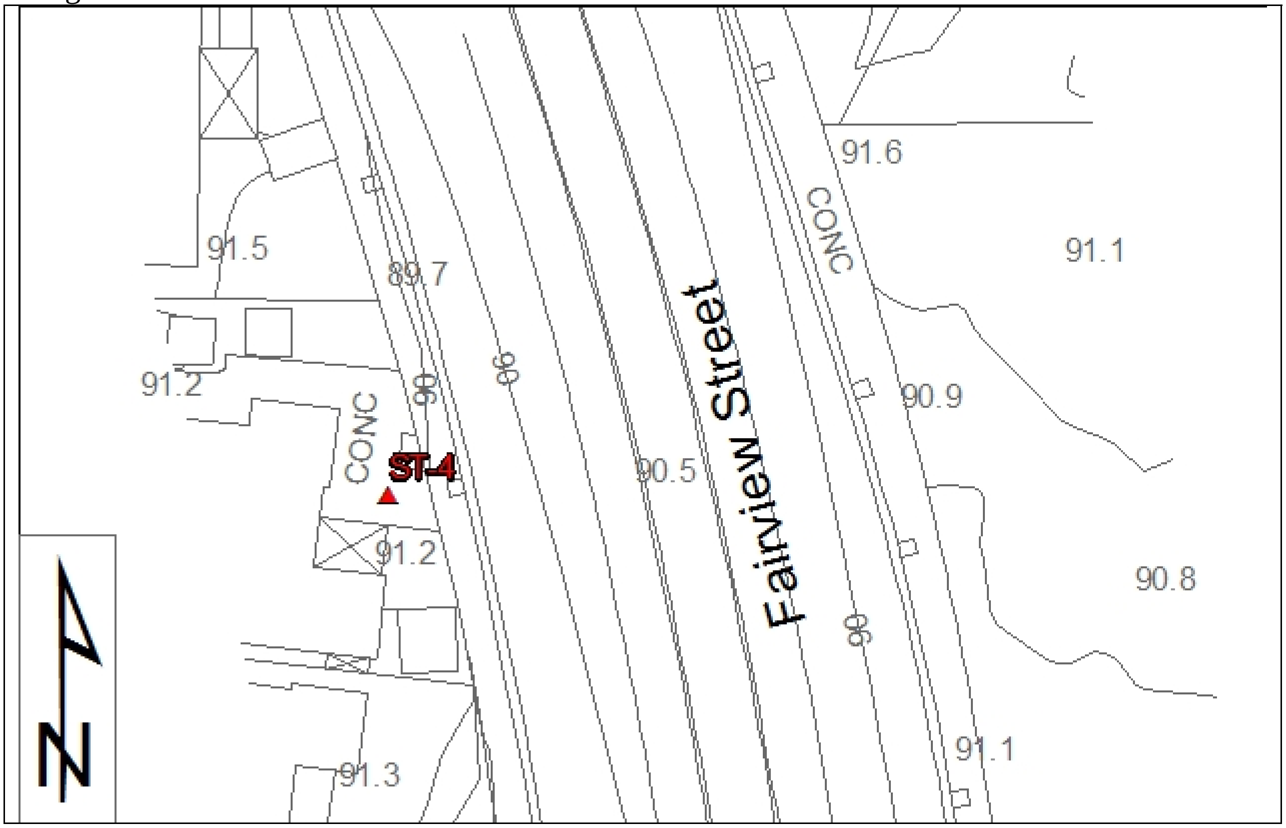
Atmospheric Conditions	
Average Wind Velocity (mph)	2.5
Maximum Wind Velocity (mph)	1.2
Temperature (F)	68.5
Relative Humidity (%)	28.4

Comments: Wood slat fence about 6 feet high. The gaps have been covered with other pieces of fencing. Large Cypress trees along fenceline bordering Fairview St.

Traffic Description:

Roadway	# Lanes	Speeds	NB/EB Counts			SB/WB Counts		
			Auto	MT	HT	Auto	MT	HT
Fairview St.	2/2	45 mph	305	11	4	313	12	6

Diagram:



Location Photo:

Noise Measurement Survey

Project Number: WKE1702
Test Personnel: Jason Lui
Project Name: Fairview Street Improvements
Equipment: Larson Davis 824

Site Number: ST-5 Date: 4/17/2018
Time: From 10:28AM To 10:48AM

Site Location: 2332 West 12th Street in residence backyard.

Primary Noise Sources: Traffic on Fairview Street.

Measurement Results	
	dBA
L_{eq}	65.6
L_{max}	74.7
L_{min}	45.3
L_{peak}	85.7
L_{2}	70.5
L_{8}	69.0
L_{25}	67.2
L_{50}	64.8

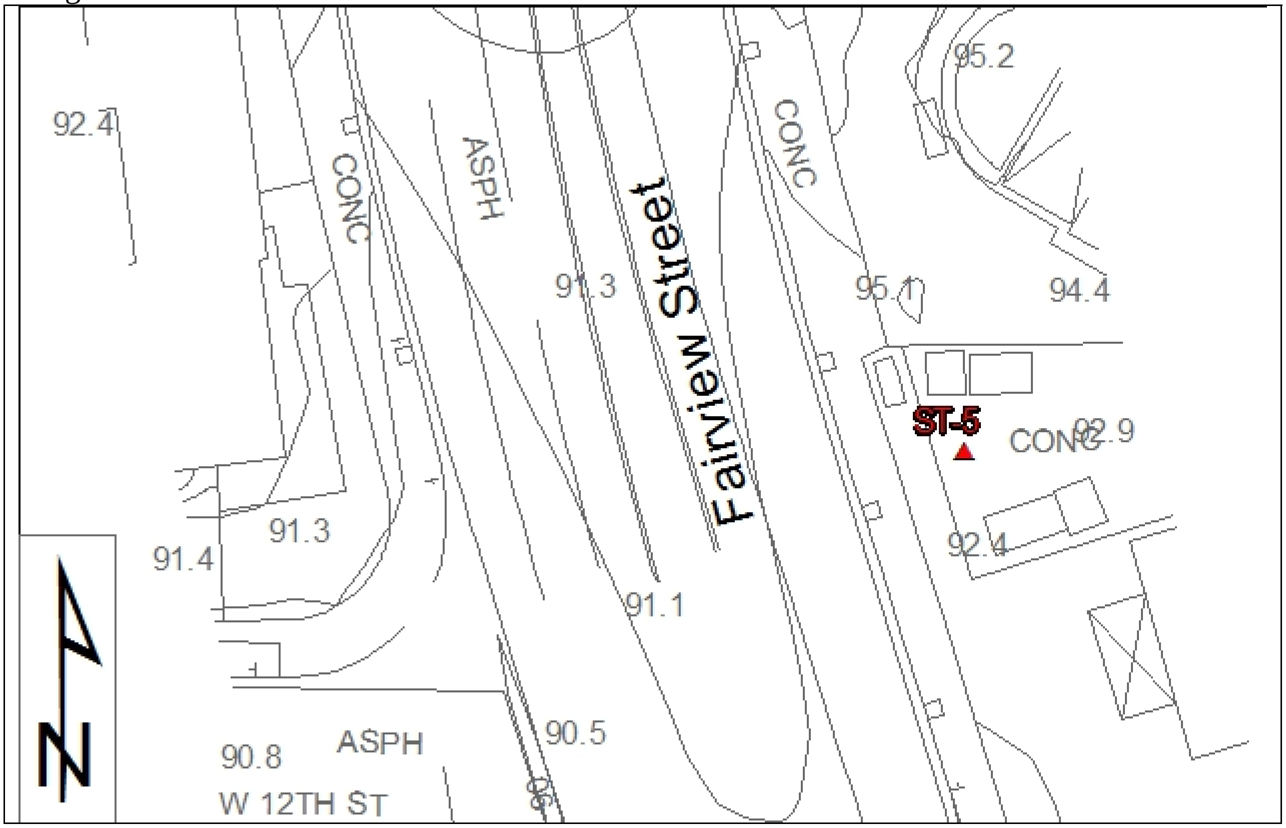
Atmospheric Conditions	
Average Wind Velocity (mph)	2.4
Maximum Wind Velocity (mph)	0.9
Temperature (F)	70.4
Relative Humidity (%)	26.4

Comments: Vacant land wall = 12 blocks @ 6 inches each. Residential wall = 11 blocks @ 6 inches each.

Traffic Description:

Roadway	# Lanes	Speeds	NB/EB Counts			SB/WB Counts		
			Auto	MT	HT	Auto	MT	HT
Fairview St.	2/2	45 mph	305	11	4	313	12	6

Diagram:



Location Photo:

Noise Measurement Survey

Project Number: WKE1702
Test Personnel: Jason Lui
Project Name: Fairview Street Improvements
Equipment: Larson Davis 824

Site Number: ST-6 Date: 4/17/2018
Time: From 11:36AM To 11:56AM

Site Location: 2503 West 12th Street in residence backyard.

Primary Noise Sources: Traffic on Fairview Street.

Measurement Results	
	dBA
L_{eq}	64.7
L_{max}	79.5
L_{min}	41.7
L_{peak}	92.7
L_2	70.0
L_8	68.0
L_{25}	66.0
L_{50}	63.5

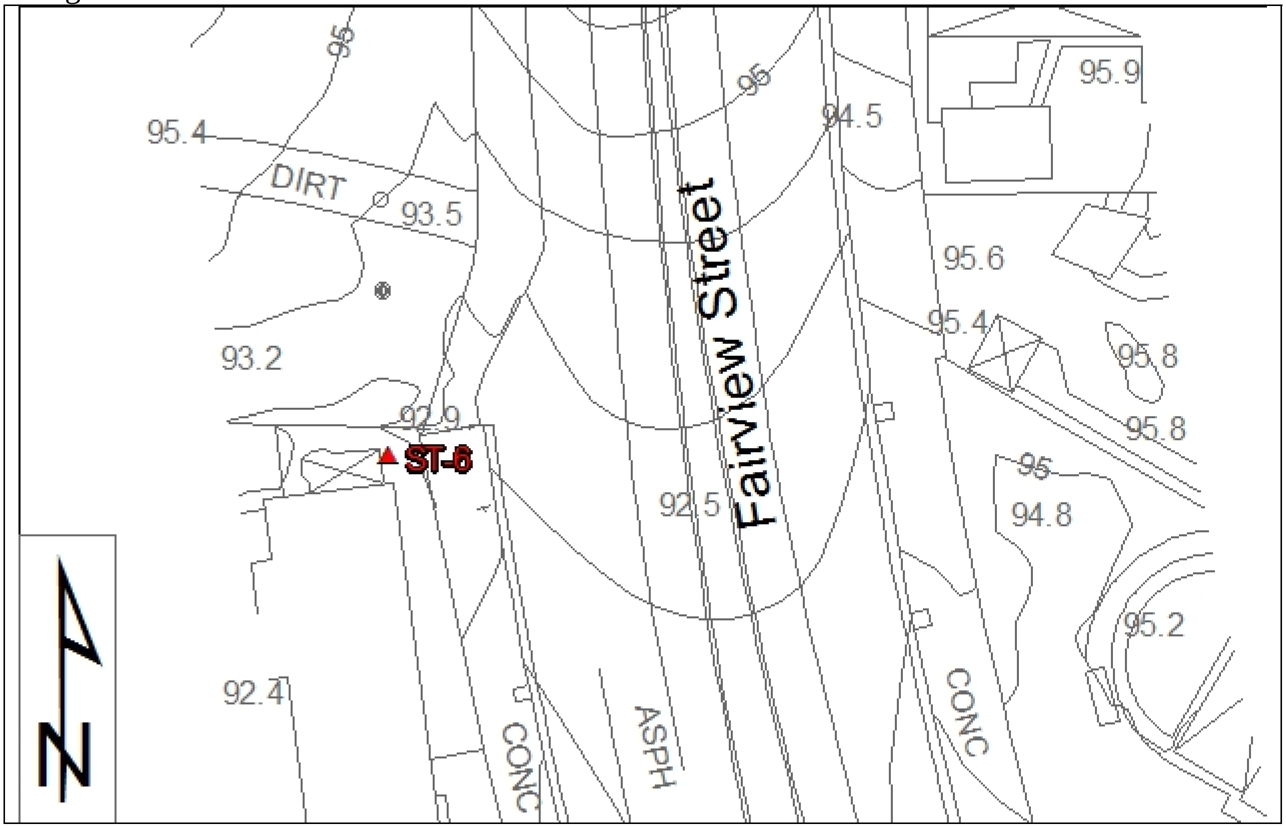
Atmospheric Conditions	
Average Wind Velocity (mph)	4.3
Maximum Wind Velocity (mph)	1.0
Temperature (F)	77.3
Relative Humidity (%)	70.2

Comments: Side wall = 12 blocks @ 6 inches each. Back wall = 8.5 blocks @ 8 inches each.

Traffic Description:

Roadway	# Lanes	Speeds	NB/EB Counts			SB/WB Counts		
			Auto	MT	HT	Auto	MT	HT
Fairview St.	2/2	45 mph	313	5	6	307	8	3

Diagram:



Location Photo:

Noise Measurement Survey

Project Number: WKE1702
Test Personnel: Akshay Newgi
Project Name: Fairview Street Improvements
Equipment: Larson Davis 820

Site Number: ST-7 Date: 5/10/2018
Time: From 11:10AM To 11:30AM

Site Location: In Fairview Triangle Habitat Restoration park.

Primary Noise Sources: Traffic on Fairview Street. Birds and wind.

Measurement Results	
	dBA
L_{eq}	66.7
L_{max}	81.1
L_{min}	41.6
L_{peak}	92.4
L_2	71.7
L_8	70.4
L_{25}	68.2
L_{50}	65.2

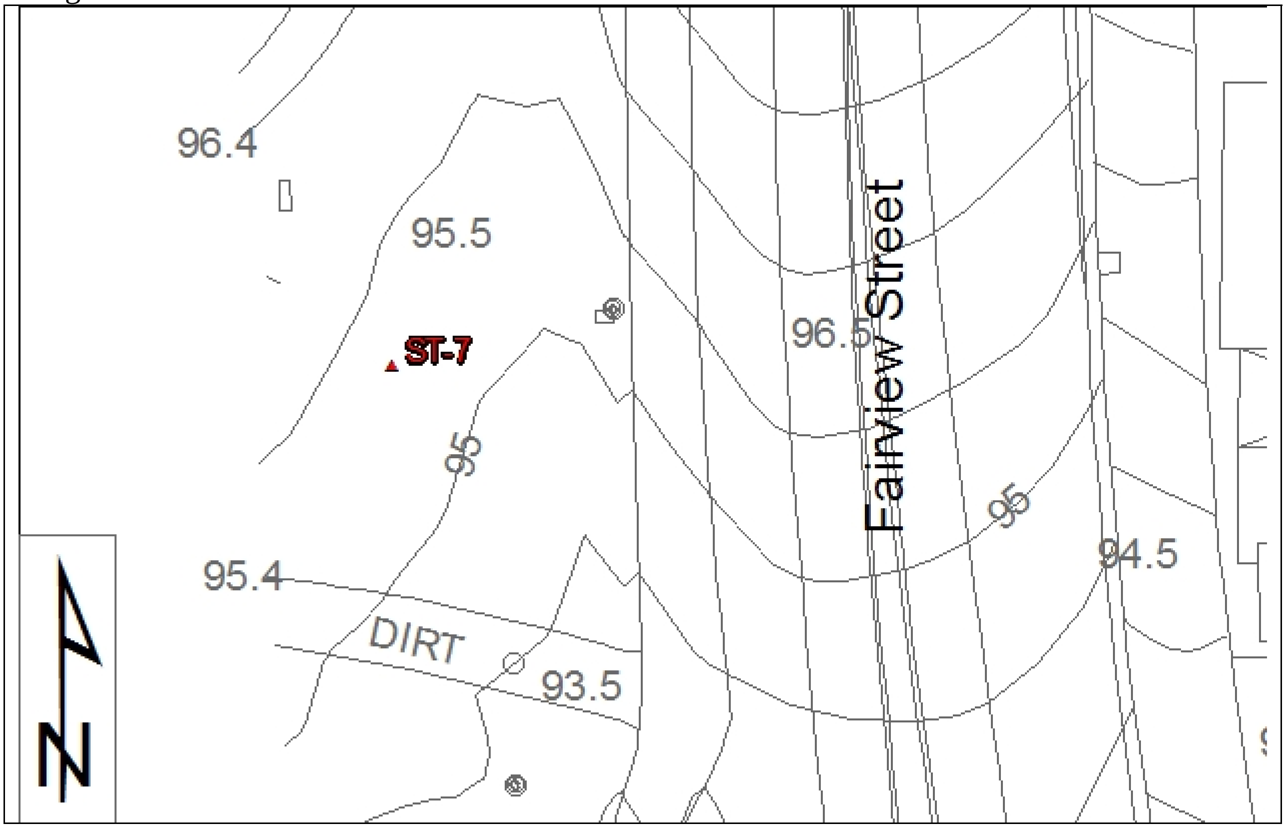
Atmospheric Conditions	
Average Wind Velocity (mph)	3
Maximum Wind Velocity (mph)	6
Temperature (F)	71
Relative Humidity (%)	60

Comments:

Traffic Description:

Roadway	# Lanes	Speeds	NB/EB Counts			SB/WB Counts		
			Auto	MT	HT	Auto	MT	HT
Fairview St.	2/2	45 mph	270	11	3	320	6	7

Diagram:



Location Photo:

Noise Measurement Survey

Project Number: WKE1702
Test Personnel: Daniel Kaufman
Project Name: Fairview Street Improvements
Equipment: Larson Davis 831

Site Number: ST-8 Date: 4/17/2018
Time: From 10:28AM To 10:48AM

Site Location: 2413 West Washington Avenue in residence back yard.

Primary Noise Sources: Traffic on Fairview Street.

Measurement Results	
	dBA
L_{eq}	56.7
L_{max}	67.6
L_{min}	36.1
L_{peak}	79.3
L_2	62.3
L_8	60.3
L_{25}	58.1
L_{50}	55.4

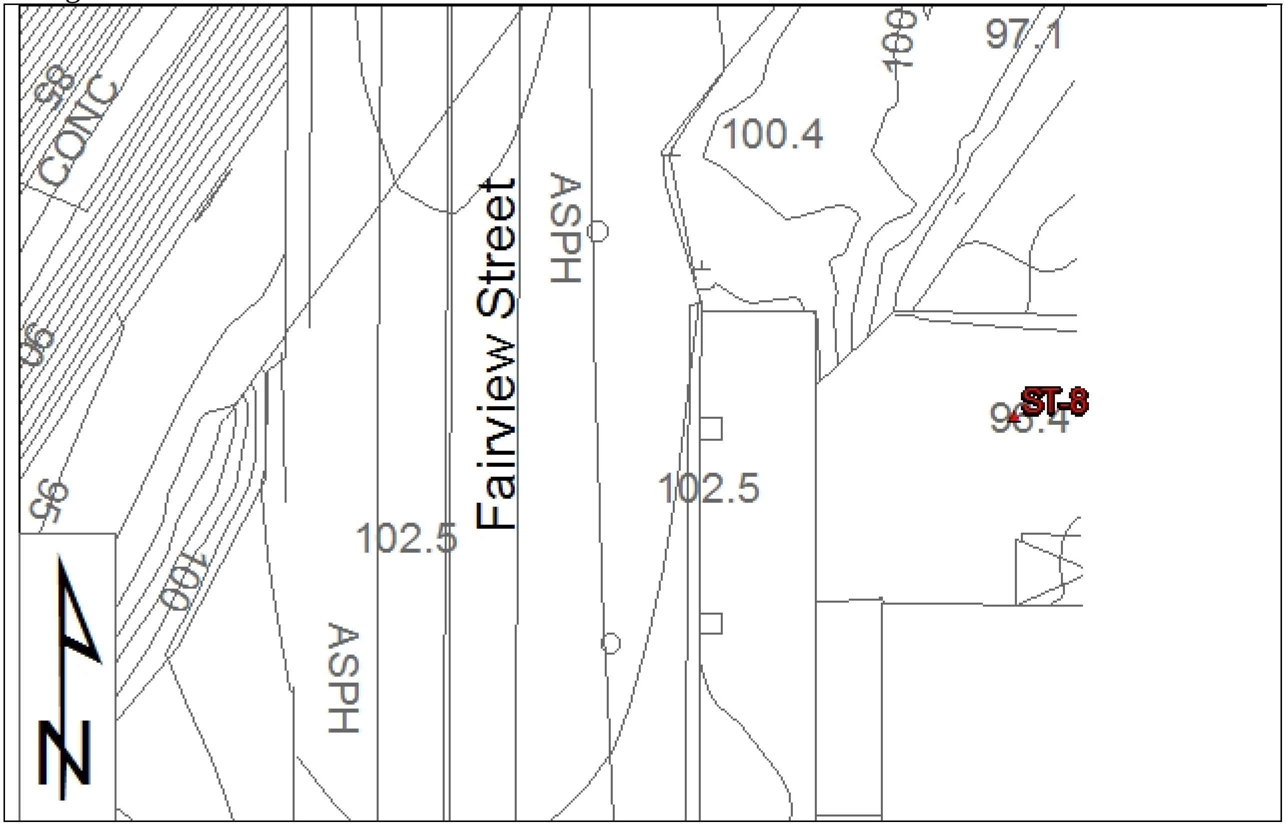
Atmospheric Conditions	
Average Wind Velocity (mph)	2.8
Maximum Wind Velocity (mph)	1.0
Temperature (F)	72.5
Relative Humidity (%)	23.1

Comments:

Traffic Description:

Roadway	# Lanes	Speeds	NB/EB Counts			SB/WB Counts		
			Auto	MT	HT	Auto	MT	HT
Fairview St.	2/2	45 mph	305	11	4	313	12	6

Diagram:



Location Photo:

Noise Measurement Survey

Project Number: WKE1702
Test Personnel: Jason Lui
Project Name: Fairview Street Improvements
Equipment: Larson Davis 824

Site Number: ST-9 Date: 4/17/2018
Time: From 1:53PM To 2:14PM

Site Location: 1322 Fair Way in residence back yard.

Primary Noise Sources: Traffic on Fairview Street.

Measurement Results	
	dBA
L_{eq}	55.7
L_{max}	66.5
L_{min}	40.3
L_{peak}	81.4
L_2	60.3
L_8	58.9
L_{25}	57.1
L_{50}	54.9

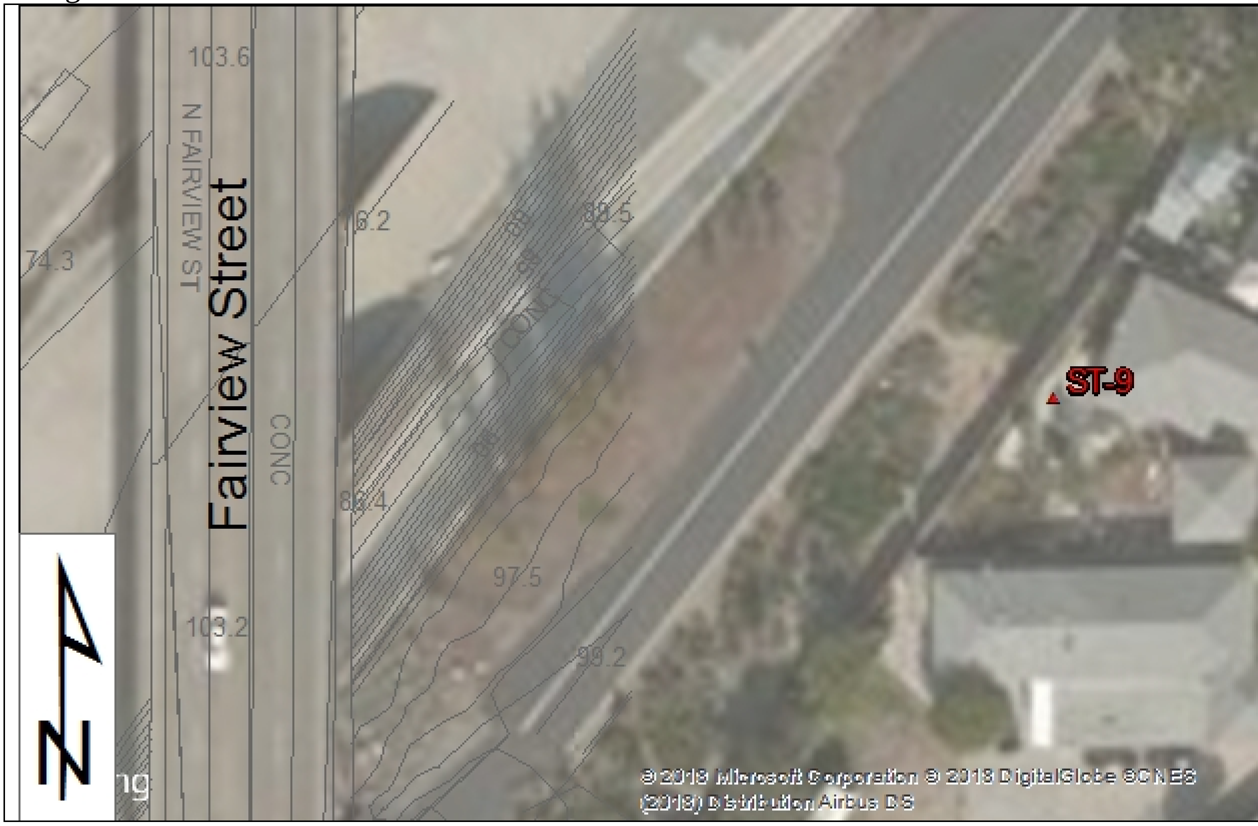
Atmospheric Conditions	
Average Wind Velocity (mph)	2.5
Maximum Wind Velocity (mph)	0.8
Temperature (F)	78.8
Relative Humidity (%)	77.5

Comments: Back wall = 8.5 blocks @ 8 inches each. South wall = 8.5 blocks @ 8 inches each.

Traffic Description:

Roadway	# Lanes	Speeds	NB/EB Counts			SB/WB Counts		
			Auto	MT	HT	Auto	MT	HT
Fairview St.	2/2	45 mph	473	14	4	361	14	3

Diagram:



Location Photo:

Noise Measurement Survey

Project Number: WKE1702
Project Name: Fairview Street Improvements

Test Personnel: Daniel Kaufman
Equipment: Larson Davis 831

Site Number: ST-10 Date: 4/17/2018

Time: From 1:54PM To 2:14PM

Site Location: 1334 Fair Way in front of residence back yard.

Primary Noise Sources: Traffic on Fairview Street.

Measurement Results	
	dBA
L_{eq}	53.3
L_{max}	71.2
L_{min}	41.5
L_{peak}	95.8
L_2	58.6
L_8	56.5
L_{25}	54.3
L_{50}	52.2

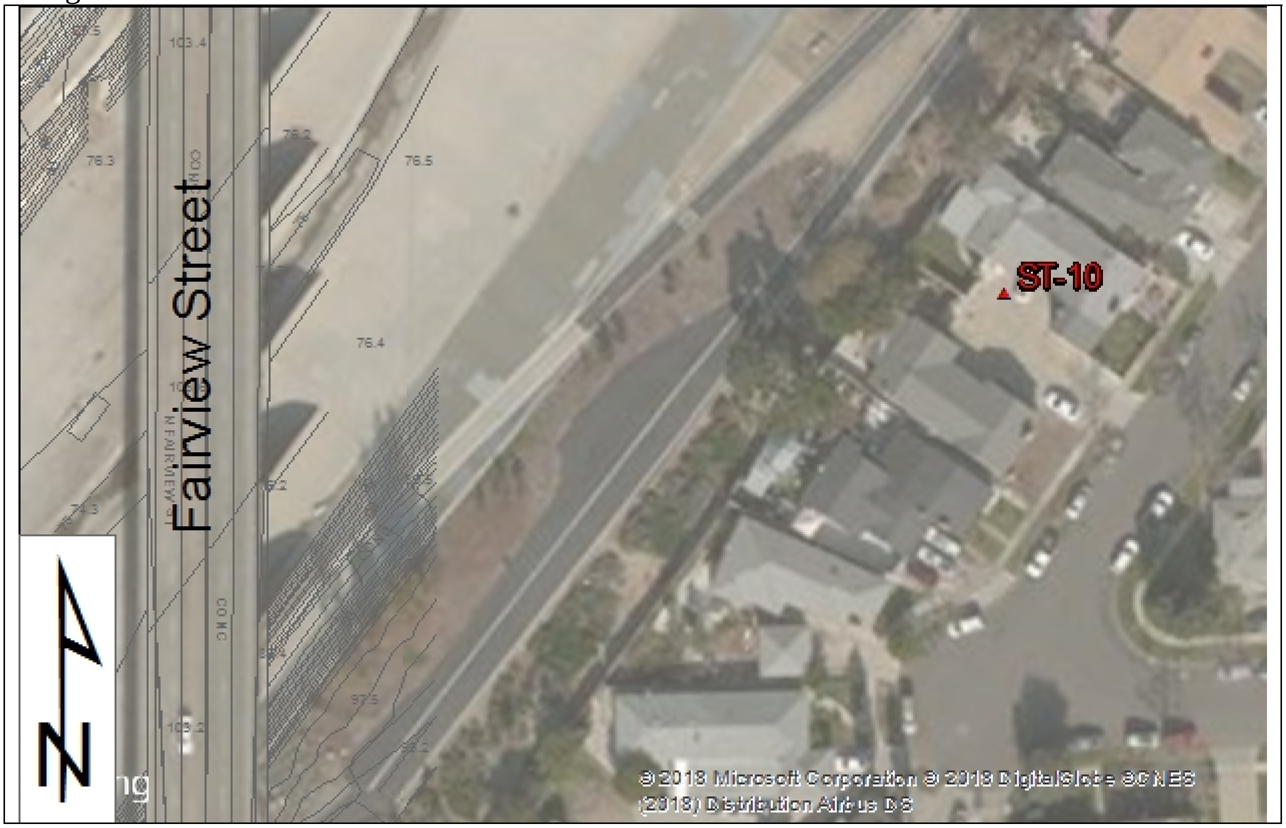
Atmospheric Conditions	
Average Wind Velocity (mph)	6.4
Maximum Wind Velocity (mph)	2.3
Temperature (F)	75.0
Relative Humidity (%)	27.4

Comments: Outer wall = Eight 8 inch blocks with topper. Inner wall = Nine 8 inch blocks with topper.

Traffic Description:

Roadway	# Lanes	Speeds	NB/EB Counts			SB/WB Counts		
			Auto	MT	HT	Auto	MT	HT
Fairview St.	2/2	45 mph	473	14	4	361	14	3

Diagram:



Location Photo:

Noise Measurement Survey

Project Number: WKE1702
Test Personnel: Jason Lui
Project Name: Fairview Street Improvements
Equipment: Larson Davis 824

Site Number: ST-11 Date: 4/17/2018
Time: From 12:19PM To 12:39PM

Site Location: 1321 Glenarbor Street in residence back yard.

Primary Noise Sources: Traffic on Fairview Street.

Measurement Results	
	dBA
L_{eq}	50.0
L_{max}	75.0
L_{min}	37.2
L_{peak}	91.5
L_2	55.8
L_8	52.3
L_{25}	50.0
L_{50}	47.7

Atmospheric Conditions	
Average Wind Velocity (mph)	4.9
Maximum Wind Velocity (mph)	0.9
Temperature (F)	73.6
Relative Humidity (%)	77.0

Comments: Back wall = 10 blocks @ 8 inches each. North wall = 7 blocks @ 8 inches each + planter = 1.5 block @ 8 inches each.

Traffic Description:

Roadway	# Lanes	Speeds	NB/EB Counts			SB/WB Counts		
			Auto	MT	HT	Auto	MT	HT
Fairview St.	2/2	45 mph	359	17	3	326	9	3

Diagram:

Location Photo:

Noise Measurement Survey

Project Number: WKE1702
Project Name: Fairview Street Improvements
Test Personnel: Daniel Kaufman
Equipment: Larson Davis 831

Site Number: ST-12 Date: 4/17/2018
Time: From 12:19PM To 12:39PM

Site Location: 1413 North Glenarbor Street in residence back yard.

Primary Noise Sources: Traffic on Fairview Street.

Measurement Results	
	dBA
L_{eq}	54.5
L_{max}	67.5
L_{min}	37.8
L_{peak}	96.0
L_2	60.1
L_8	58.3
L_{25}	55.7
L_{50}	52.7

Atmospheric Conditions	
Average Wind Velocity (mph)	5.1
Maximum Wind Velocity (mph)	1.4
Temperature (F)	75.5
Relative Humidity (%)	26.0

Comments: Eastern wall = 10 blocks @ 8 inches each + 6 inch topper. Northern wall = 9 blocks @ 8 inches each. Southern wall = 10 blocks @ 8 inches each.

Traffic Description:

Roadway	# Lanes	Speeds	NB/EB Counts			SB/WB Counts		
			Auto	MT	HT	Auto	MT	HT
Fairview St.	2/2	45 mph	359	17	3	326	9	3

Diagram:

Location Photo:

Noise Measurement Survey

Project Number: WKE1702
Test Personnel: Jason Lui
Project Name: Fairview Street Improvements
Equipment: Larson Davis 824

Site Number: ST-13 Date: 4/17/2018
Time: From 1:12PM To 1:32PM

Site Location: 1417 Glenarbor Street in residence backyard.

Primary Noise Sources: Traffic on Fairview Street.

Measurement Results	
	dBA
L_{eq}	55.7
L_{max}	67.9
L_{min}	39.8
L_{peak}	84.3
L_{2}	61.5
L_{8}	58.9
L_{25}	57.0
L_{50}	54.7

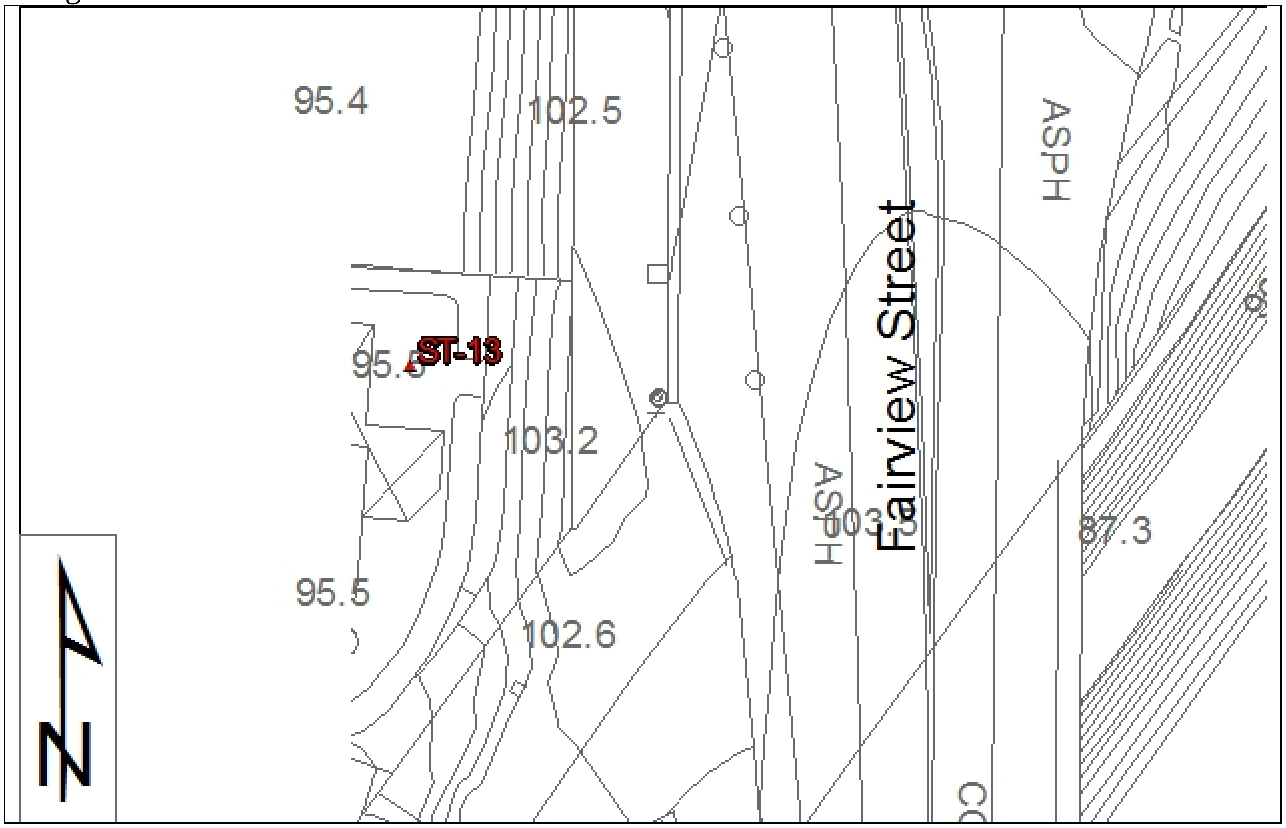
Atmospheric Conditions	
Average Wind Velocity (mph)	6.3
Maximum Wind Velocity (mph)	1.7
Temperature (F)	75.4
Relative Humidity (%)	76.5

Comments: Back wall = 10.5 blocks @ 8 inches each. North wall = 8 blocks @ 8 inches each + 5 planter blocks. South wall = 7 blocks @ 8 inches each + 5 planter blocks. Approximately 8-10 feet down.

Traffic Description:

Roadway	# Lanes	Speeds	NB/EB Counts			SB/WB Counts		
			Auto	MT	HT	Auto	MT	HT
Fairview St.	2/2	45 mph	377	33	6	378	15	2
17th St.	3/3	45 mph	272	8	4	260	3	3

Diagram:



Location Photo:

Noise Measurement Survey

Project Number: WKE1702
Test Personnel: Akshay Newgi
Project Name: Fairview Street Improvements
Equipment: Larson Davis 820

Site Number: ST-14 Date: 5/10/2018
Time: From 12:10 PM To 12:30 PM

Site Location: 2501 16th Street in residence front yard.

Primary Noise Sources: Traffic on Fairview Street and light traffic on 16th Street.

Measurement Results	
	dBA
L_{eq}	63.0
L_{max}	75.2
L_{min}	48.0
L_{peak}	87.2
L_2	69.4
L_8	66.5
L_{25}	64.1
L_{50}	61.5

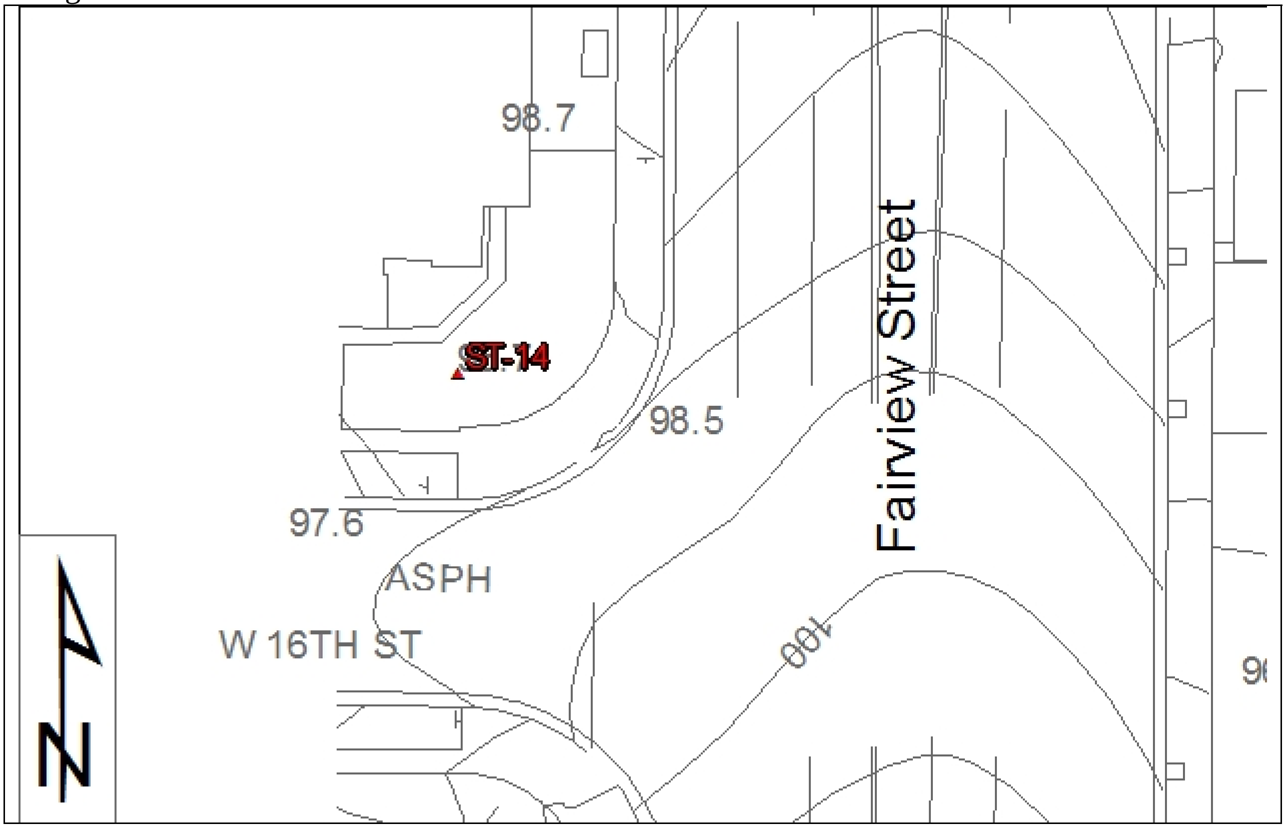
Atmospheric Conditions	
Average Wind Velocity (mph)	3
Maximum Wind Velocity (mph)	6
Temperature (F)	71
Relative Humidity (%)	60

Comments: Residence wall = 11 blocks @7 inches each.

Traffic Description:

Roadway	# Lanes	Speeds	NB/EB Counts			SB/WB Counts		
			Auto	MT	HT	Auto	MT	HT
Fairview St.	2/2	45 mph	300	8	2	280	7	10
17th St.	3/3	45 mph	280	2	3	310	4	4

Diagram:



Location Photo:

Noise Measurement Survey

Project Number: WKE1702
Test Personnel: Daniel Kaufman
Project Name: Fairview Street Improvements
Equipment: Larson Davis 831

Site Number: ST-15 Date: 4/17/2018
Time: From 1:12PM To 1:32PM

Site Location: South of 1609 Fairview Street in front yard.

Primary Noise Sources: Traffic on Fairview Street.

Measurement Results	
	dBA
L_{eq}	74.0
L_{max}	92.5
L_{min}	53.5
L_{peak}	103.9
L_2	82.0
L_8	77.9
L_{25}	73.7
L_{50}	70.1

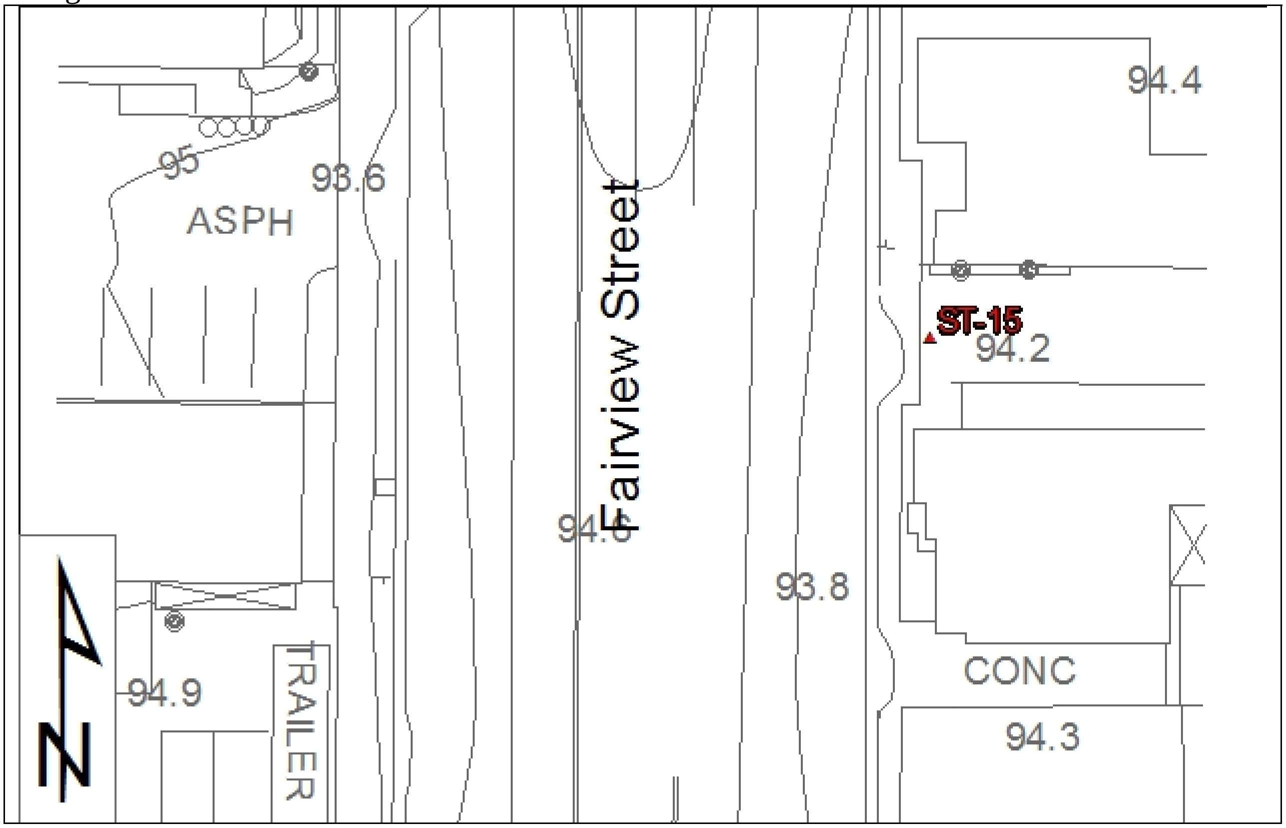
Atmospheric Conditions	
Average Wind Velocity (mph)	4.4
Maximum Wind Velocity (mph)	1.3
Temperature (F)	70.9
Relative Humidity (%)	25.4

Comments:

Traffic Description:

Roadway	# Lanes	Speeds	NB/EB Counts			SB/WB Counts		
			Auto	MT	HT	Auto	MT	HT
Fairview St.	2/2	45 mph	377	33	6	378	15	2
17th St.	3/3	45 mph	272	8	4	260	3	3

Diagram:



Location Photo:

CALIBRATION CERTIFICATE FOR LARSON DAVIS 820

PCB PIEZOTRONICS
A PCB GROUP COMPANY

Certificate of Calibration and Conformance

Certificate Number 2017-205567

Instrument Model 820, Serial Number 1584, was calibrated on 28 Aug 2017. The instrument meets factory specifications per Procedure D0001.8160, ANSI S1.4 1983, IEC 651-Type 1 1979, and IEC 804-Type 1 1985.

Instrument found to be in calibration as received: YES
Date Calibrated: 28 Aug 2017
Calibration due: 28 Aug 2018

Calibration Standards Used

MANUFACTURER	MODEL	SERIAL NUMBER	INTERVAL	CAL. DUE	TRACEABILITY NO.
Larson Davis	LDSigGn/2209	0617 / 0104	12 Months	19 Dec 2017	2016-204448

Reference Standards are traceable to the National Institute of Standards and Technology (NIST)

Calibration Environmental Conditions

Temperature: 24 ° Centigrade

Relative Humidity: 31 %

Affirmations

This Certificate attests that this instrument has been calibrated under the stated conditions with Measurement and Test Equipment (M&TE) Standards traceable to the U.S. National Institute of Standards and Technology (NIST). All of the Measurement Standards have been calibrated to their manufacturers' specified accuracy / uncertainty. Evidence of traceability and accuracy is on file at Provo Engineering & Manufacturing Center. An acceptable accuracy ratio between the Standard(s) and the item calibrated has been maintained. This instrument meets or exceeds the manufacturer's published specification unless noted.

The collective uncertainty of the Measurement Standard used does not exceed 25% of the applicable tolerance for each characteristic calibrated unless otherwise noted.

The results documented in this certificate relate only to the item(s) calibrated or tested. A one year calibration is recommended, however calibration interval assignment and adjustment are the responsibility of the end user. This certificate may not be reproduced, except in full, without the written approval of the issuer.

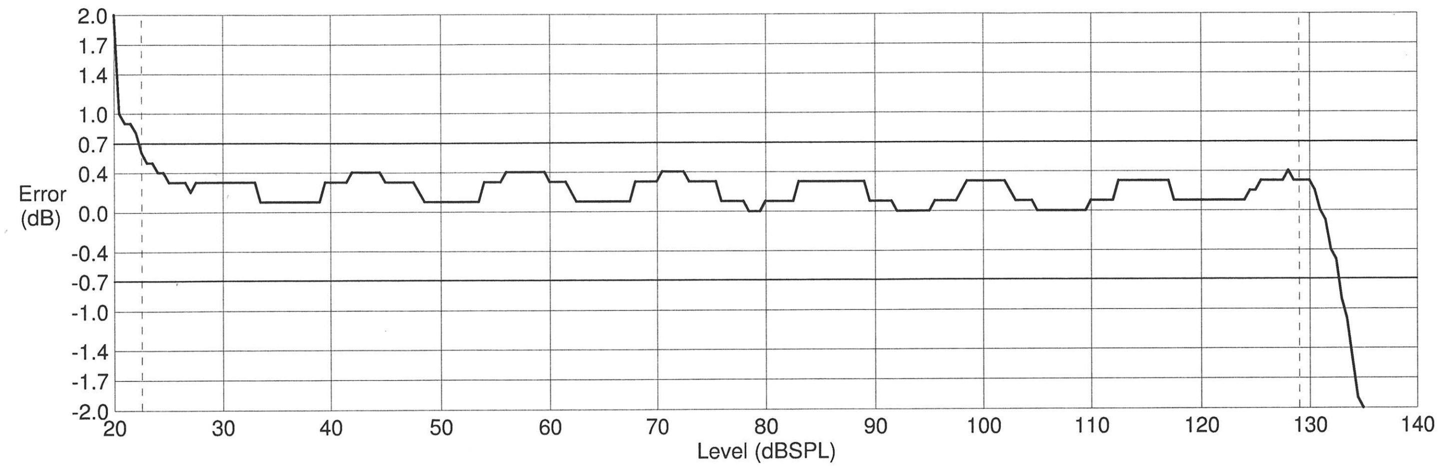
"As received" data is the same as shipped data.
Tested with PRM828 S/N 2484

Signed: ____________
Technician: Sean Childs

Provo Engineering and Manufacturing Center, 1681 West 820 North, Provo, Utah 84601
Toll Free: 888.258.3222 Telephone: 716.926.8243 Fax: 716.926.8215
ISO 9001-2008 Certified

Sound Level Meter Model: 820A Serial Number: A1584
Log Linearity, Differential Linearity and Range Data

This Type 1 Sound Level Meter (including attached PRM828 preamplifier and ADP005 18 pF input adapter) was calibrated with a reference 1kHz sine wave at a level of 114.0 dBSPL. The instrument's Log Linearity A-weighted slow response was then electrically tested using a 1kHz sine wave from 18.0 dBSPL to 138.0 dBSPL in 0.5 dB increments.



Levl dBSPL	Meas dBSPL	Err dB	Levl dBSPL	Meas dBSPL	Err dB	Levl dBSPL	Meas dBSPL	Err dB	Levl dBSPL	Meas dBSPL	Err dB	Levl dBSPL	Meas dBSPL	Err dB	Levl dBSPL	Meas dBSPL	Err dB
18.0	20.1	2.1	38.5	38.6	0.1	59.0	59.4	0.4	79.5	79.5	0.0	100.0	100.3	0.3	120.5	120.6	0.1
18.5	20.4	1.9	39.0	39.1	0.1	59.5	59.9	0.4	80.0	80.1	0.1	100.5	100.8	0.3	121.0	121.1	0.1
19.0	20.6	1.6	39.5	39.8	0.3	60.0	60.3	0.3	80.5	80.6	0.1	101.0	101.3	0.3	121.5	121.6	0.1
19.5	20.9	1.4	40.0	40.3	0.3	60.5	60.8	0.3	81.0	81.1	0.1	101.5	101.8	0.3	122.0	122.1	0.1
20.0	21.2	1.2	40.5	40.8	0.3	61.0	61.3	0.3	81.5	81.6	0.1	102.0	102.3	0.3	122.5	122.6	0.1
20.5	21.5	1.0	41.0	41.3	0.3	61.5	61.8	0.3	82.0	82.1	0.1	102.5	102.7	0.2	123.0	123.1	0.1
21.0	21.9	0.9	41.5	41.8	0.3	62.0	62.2	0.2	82.5	82.6	0.1	103.0	103.1	0.1	123.5	123.6	0.1
21.5	22.4	0.9	42.0	42.4	0.4	62.5	62.6	0.1	83.0	83.3	0.3	103.5	103.6	0.1	124.0	124.1	0.1
22.0	22.8	0.8	42.5	42.9	0.4	63.0	63.1	0.1	83.5	83.8	0.3	104.0	104.1	0.1	124.5	124.7	0.2
22.5	23.1	0.6	43.0	43.4	0.4	63.5	63.6	0.1	84.0	84.3	0.3	104.5	104.6	0.1	125.0	125.2	0.2
23.0	23.5	0.5	43.5	43.9	0.4	64.0	64.1	0.1	84.5	84.8	0.3	105.0	105.0	0.0	125.5	125.8	0.3
23.5	24.0	0.5	44.0	44.4	0.4	64.5	64.6	0.1	85.0	85.3	0.3	105.5	105.5	0.0	126.0	126.3	0.3
24.0	24.4	0.4	44.5	44.9	0.4	65.0	65.1	0.1	85.5	85.8	0.3	106.0	106.0	0.0	126.5	126.8	0.3
24.5	24.9	0.4	45.0	45.3	0.3	65.5	65.6	0.1	86.0	86.3	0.3	106.5	106.5	0.0	127.0	127.3	0.3
25.0	25.3	0.3	45.5	45.8	0.3	66.0	66.1	0.1	86.5	86.8	0.3	107.0	107.0	0.0	127.5	127.8	0.3
25.5	25.8	0.3	46.0	46.3	0.3	66.5	66.6	0.1	87.0	87.3	0.3	107.5	107.5	0.0	128.0	128.4	0.4
26.0	26.3	0.3	46.5	46.8	0.3	67.0	67.1	0.1	87.5	87.8	0.3	108.0	108.0	0.0	128.5	128.8	0.3
26.5	26.8	0.3	47.0	47.3	0.3	67.5	67.6	0.1	88.0	88.3	0.3	108.5	108.5	0.0	129.0	129.3	0.3
27.0	27.2	0.2	47.5	47.8	0.3	68.0	68.3	0.3	88.5	88.8	0.3	109.0	109.0	0.0	129.5	129.8	0.3
27.5	27.8	0.3	48.0	48.2	0.2	68.5	68.8	0.3	89.0	89.3	0.3	109.5	109.5	0.0	130.0	130.3	0.3
28.0	28.3	0.3	48.5	48.6	0.1	69.0	69.3	0.3	89.5	89.6	0.1	110.0	110.1	0.1	130.5	130.7	0.2
28.5	28.8	0.3	49.0	49.1	0.1	69.5	69.8	0.3	90.0	90.1	0.1	110.5	110.6	0.1	131.0	131.0	0.0
29.0	29.3	0.3	49.5	49.6	0.1	70.0	70.3	0.3	90.5	90.6	0.1	111.0	111.1	0.1	131.5	131.4	-0.1
29.5	29.8	0.3	50.0	50.1	0.1	70.5	70.9	0.4	91.0	91.1	0.1	111.5	111.6	0.1	132.0	131.6	-0.4
30.0	30.3	0.3	50.5	50.6	0.1	71.0	71.4	0.4	91.5	91.6	0.1	112.0	112.1	0.1	132.5	132.0	-0.5
30.5	30.8	0.3	51.0	51.1	0.1	71.5	71.9	0.4	92.0	92.0	0.0	112.5	112.8	0.3	133.0	132.1	-0.9
31.0	31.3	0.3	51.5	51.6	0.1	72.0	72.4	0.4	92.5	92.5	0.0	113.0	113.3	0.3	133.5	132.4	-1.1
31.5	31.8	0.3	52.0	52.1	0.1	72.5	72.9	0.4	93.0	93.0	0.0	113.5	113.8	0.3	134.0	132.5	-1.5
32.0	32.3	0.3	52.5	52.6	0.1	73.0	73.3	0.3	93.5	93.5	0.0	114.0	114.3	0.3	134.5	132.6	-1.9
32.5	32.8	0.3	53.0	53.1	0.1	73.5	73.8	0.3	94.0	94.0	0.0	114.5	114.8	0.3	135.0	132.6	-2.4
33.0	33.3	0.3	53.5	53.6	0.1	74.0	74.3	0.3	94.5	94.5	0.0	115.0	115.3	0.3	135.5	132.6	-2.9
33.5	33.6	0.1	54.0	54.3	0.3	74.5	74.8	0.3	95.0	95.0	0.0	115.5	115.8	0.3	136.0	132.6	-3.4
34.0	34.1	0.1	54.5	54.8	0.3	75.0	75.3	0.3	95.5	95.6	0.1	116.0	116.3	0.3	136.5	132.5	-4.0
34.5	34.6	0.1	55.0	55.3	0.3	75.5	75.8	0.3	96.0	96.1	0.1	116.5	116.8	0.3	137.0	132.5	-4.5
35.0	35.1	0.1	55.5	55.8	0.3	76.0	76.1	0.1	96.5	96.6	0.1	117.0	117.3	0.3	137.5	132.6	-4.9
35.5	35.6	0.1	56.0	56.4	0.4	76.5	76.6	0.1	97.0	97.1	0.1	117.5	117.6	0.1	138.0	132.6	-5.4
36.0	36.1	0.1	56.5	56.9	0.4	77.0	77.1	0.1	97.5	97.6	0.1	118.0	118.1	0.1			
36.5	36.6	0.1	57.0	57.4	0.4	77.5	77.6	0.1	98.0	98.2	0.2	118.5	118.6	0.1			
37.0	37.1	0.1	57.5	57.9	0.4	78.0	78.1	0.1	98.5	98.8	0.3	119.0	119.1	0.1			
37.5	37.6	0.1	58.0	58.4	0.4	78.5	78.5	0.0	99.0	99.3	0.3	119.5	119.6	0.1			
38.0	38.1	0.1	58.5	58.9	0.4	79.0	79.0	0.0	99.5	99.8	0.3	120.0	120.1	0.1			

Plotted per typical sensitivity of a 2541 microphone; 44.5 mV/Pa & 17.1 pF.

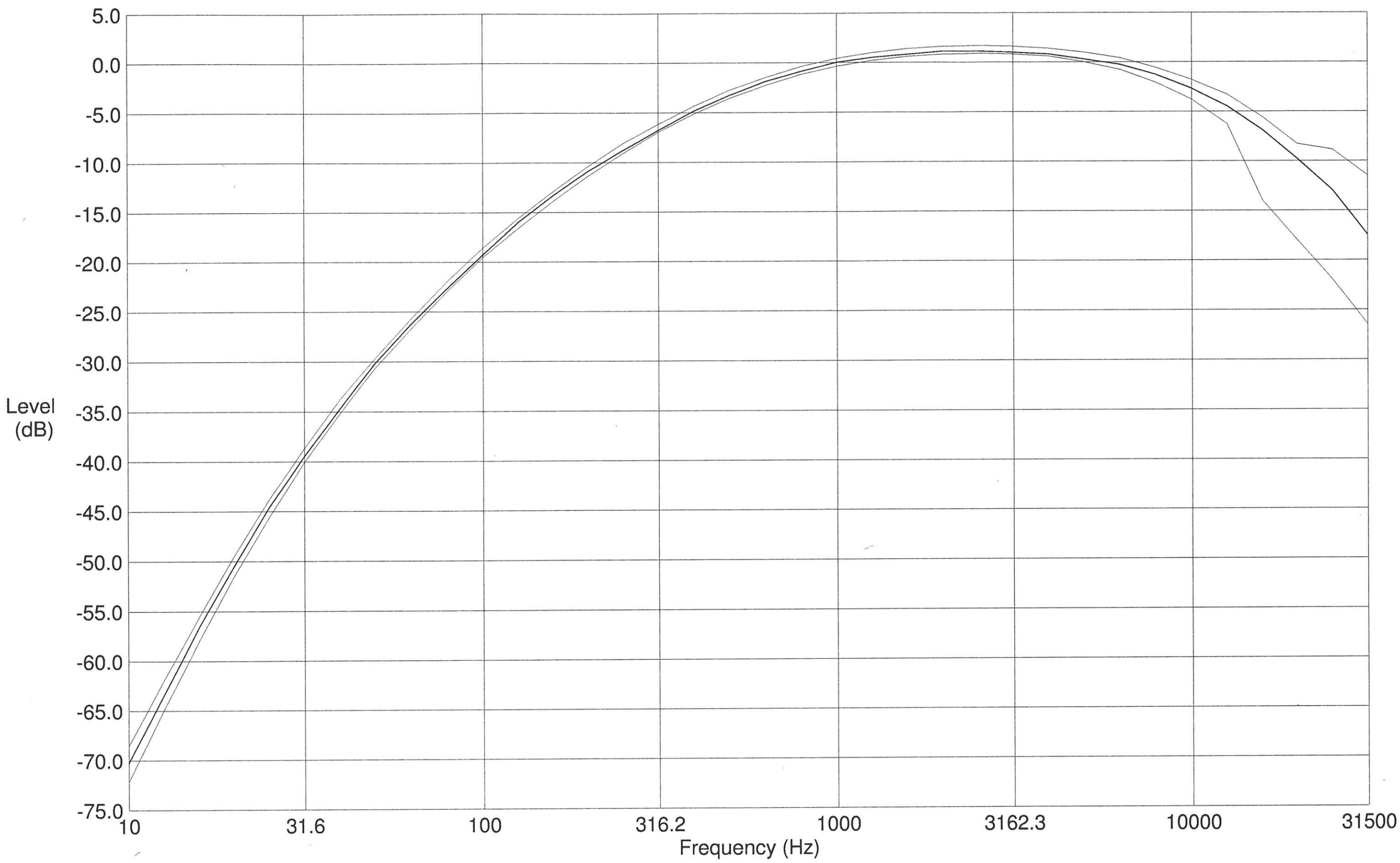
Overload occurs at 129.1 dBSPL.
Primary indicator range: 106.5 dB (lower limit: 22.5 dBSPL to upper limit: 129.0 dBSPL).
Dynamic range: 112.1 dB (noise floor: 16.9 dBSPL to upper limit: 129.0 dBSPL).

This instrument is in compliance with IEC 60651 (2001-10) 7.9 and 7.10, ANSI S1.4-1983 3.2 and IEC 60804 (2001-10) 9.2.1 for Type 1 sound level meters when used with a Larson Davis Type 1 microphone.

Technician: Sean Childs   Test Date: 28AUG2017

Sound Level Meter Model: 820A Serial Number: A1584
Certificate of A-Weight Electrical Conformance

This Type 1 Sound Level Meter (including attached PRM828 preamplifier and ADP005 18 pF input adapter) was calibrated with a reference 1kHz sine wave at a level of 114.0 dBSPL. The instrument's A-weighted response was then electrically tested using a 1.8 Vrms sinewave at exact frequencies as specified in IEC 60651 (2001-10) and ANSI S1.4-1983.



Freq (Hz)	Theor	Measured	Error	Tolerance
10.00	-70.4	-70.30	0.10	+1.8, -1.8
12.59	-63.4	-63.40	0.00	+1.5, -1.5
15.85	-56.7	-56.50	0.20	+1.2, -1.2
19.95	-50.5	-50.50	0.00	+1.0, -1.0
25.12	-44.7	-44.60	0.10	+0.9, -0.9
31.62	-39.4	-39.50	-0.10	+0.7, -0.7
39.81	-34.6	-34.80	-0.20	+0.7, -0.7
50.12	-30.2	-30.20	0.00	+0.5, -0.5
63.10	-26.2	-26.20	0.00	+0.5, -0.5
79.43	-22.5	-22.70	-0.20	+0.5, -0.5
100.00	-19.1	-19.30	-0.20	+0.5, -0.5
125.89	-16.1	-16.00	0.10	+0.5, -0.5
158.49	-13.4	-13.30	0.10	+0.5, -0.5
199.53	-10.9	-10.90	0.00	+0.5, -0.5
251.19	-8.6	-8.80	-0.20	+0.5, -0.5
316.23	-6.6	-6.80	-0.20	+0.4, -0.4
398.11	-4.8	-4.90	-0.10	+0.4, -0.4
501.19	-3.2	-3.30	-0.10	+0.4, -0.4

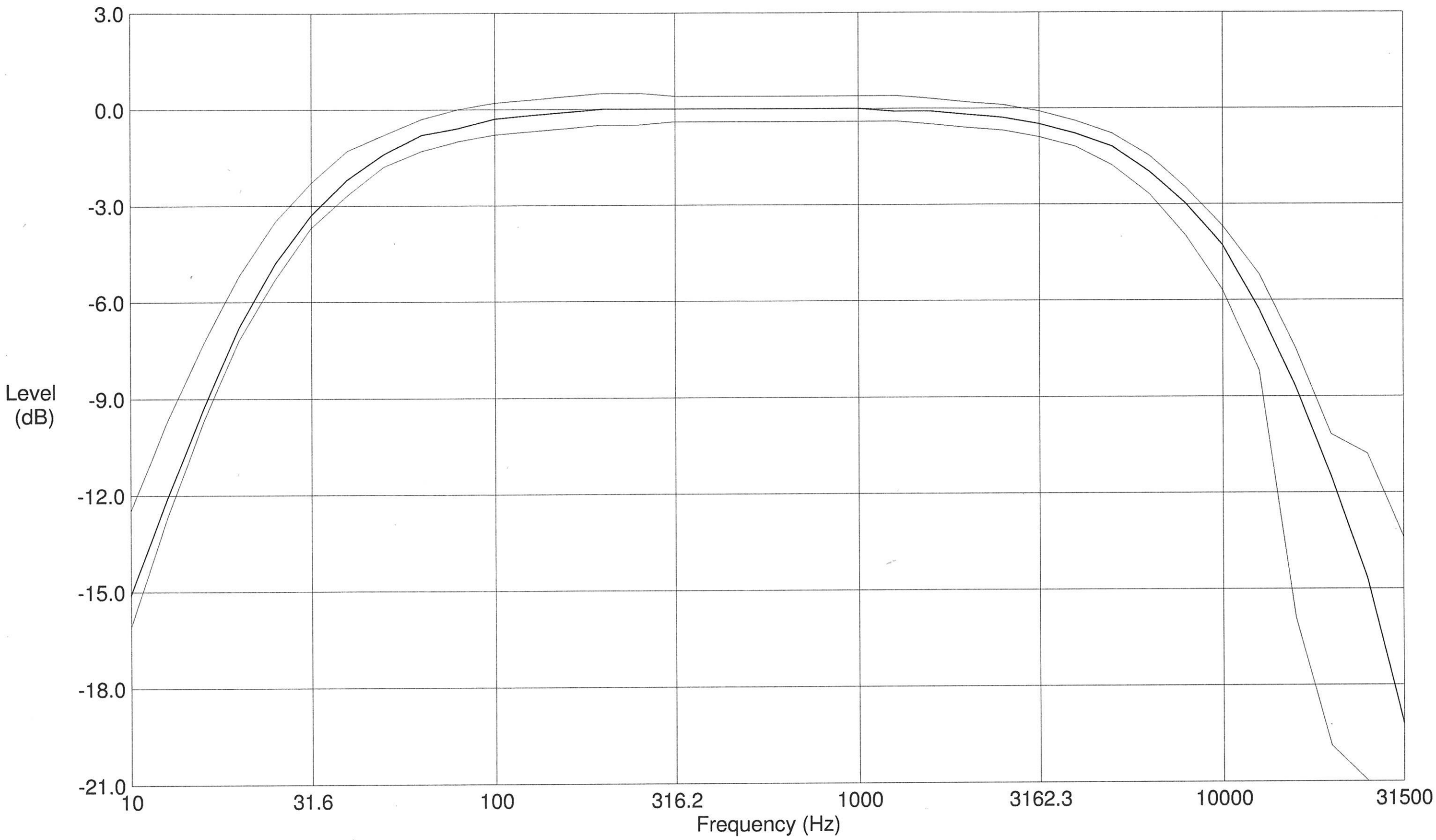
Freq (Hz)	Theor	Measured	Error	Tolerance
630.96	-1.9	-1.90	0.00	+0.4, -0.4
794.33	-0.8	-0.90	-0.10	+0.4, -0.4
1000.00	0.0	0.00	0.00	+0.4, -0.4
1258.90	0.6	0.50	-0.10	+0.4, -0.4
1584.90	1.0	0.80	-0.20	+0.4, -0.4
1995.30	1.2	1.10	-0.10	+0.4, -0.4
2511.90	1.3	1.10	-0.20	+0.4, -0.4
3162.30	1.2	1.00	-0.20	+0.4, -0.4
3981.10	1.0	0.80	-0.20	+0.4, -0.4
5011.90	0.5	0.30	-0.20	+0.5, -0.5
6309.60	-0.1	-0.30	-0.20	+0.5, -0.7
7943.30	-1.1	-1.30	-0.20	+0.5, -1.0
10000.00	-2.5	-2.70	-0.20	+0.7, -1.3
12589.00	-4.3	-4.50	-0.20	+1.0, -2.0
15849.00	-6.6	-6.90	-0.30	+1.0, -7.4
19953.00	-9.3	-9.80	-0.50	+1.0, -8.7
25119.00	-12.4	-13.00	-0.60	+3.5, -9.6
31623.00	-15.8	-17.50	-1.70	+4.3, -10.7

This instrument is in compliance with IEC 60651 (2001-10) 6.1 and 9.2.2, ANSI S1.4-1983 5.1 and 8.2.1, and IEC 60804 (2001-10) 5.1 for Type 1 sound level meters when used with a Larson Davis Type 1 microphone.

Technician: Sean Childs Test Date: 28AUG2017

Sound Level Meter Model: 820A Serial Number: A1584
Certificate of C-Weight Electrical Conformance

This Type 1 Sound Level Meter (including attached PRM828 preamplifier and ADP005 18 pF input adapter) was calibrated with a reference 1kHz sine wave at a level of 114.0 dBSPL. The instrument's C-weighted response was then electrically tested using a 1.8 Vrms sinewave at exact frequencies as specified in IEC 60651 (2001-10) and ANSI S1.4-1983.



Freq (Hz)	Theor	Measured	Error	Tolerance
10.00	-14.3	-15.10	-0.80	+1.8, -1.8
12.59	-11.2	-12.10	-0.90	+1.5, -1.5
15.85	-8.5	-9.30	-0.80	+1.2, -1.2
19.95	-6.2	-6.80	-0.60	+1.0, -1.0
25.12	-4.4	-4.80	-0.40	+0.9, -0.9
31.62	-3.0	-3.30	-0.30	+0.7, -0.7
39.81	-2.0	-2.20	-0.20	+0.7, -0.7
50.12	-1.3	-1.40	-0.10	+0.5, -0.5
63.10	-0.8	-0.80	0.00	+0.5, -0.5
79.43	-0.5	-0.60	-0.10	+0.5, -0.5
100.00	-0.3	-0.30	0.00	+0.5, -0.5
125.89	-0.2	-0.20	0.00	+0.5, -0.5
158.49	-0.1	-0.10	0.00	+0.5, -0.5
199.53	0.0	0.00	0.00	+0.5, -0.5
251.19	0.0	0.00	0.00	+0.5, -0.5
316.23	0.0	0.00	0.00	+0.4, -0.4
398.11	0.0	0.00	0.00	+0.4, -0.4
501.19	0.0	0.00	0.00	+0.4, -0.4
630.96	0.0	0.00	0.00	+0.4, -0.4
794.33	0.0	0.00	0.00	+0.4, -0.4
1000.00	0.0	0.00	0.00	+0.4, -0.4
1258.90	0.0	-0.10	-0.10	+0.4, -0.4
1584.90	-0.1	-0.10	0.00	+0.4, -0.4
1995.30	-0.2	-0.20	0.00	+0.4, -0.4
2511.90	-0.3	-0.30	0.00	+0.4, -0.4
3162.30	-0.5	-0.50	0.00	+0.4, -0.4
3981.10	-0.8	-0.80	0.00	+0.4, -0.4
5011.90	-1.3	-1.20	0.10	+0.5, -0.5
6309.60	-2.0	-2.00	0.00	+0.5, -0.7
7943.30	-3.0	-3.00	0.00	+0.5, -1.0
10000.00	-4.4	-4.30	0.10	+0.7, -1.3
12589.00	-6.2	-6.30	-0.10	+1.0, -2.0
15849.00	-8.5	-8.70	-0.20	+1.0, -7.4
19953.00	-11.2	-11.50	-0.30	+1.0, -8.7
25119.00	-14.3	-14.70	-0.40	+3.5, -9.6
31623.00	-17.7	-19.20	-1.50	+4.3, -10.7

This instrument is in compliance with IEC 60651 (2001-10) 6.1 and 9.2.2, ANSI S1.4-1983 5.1 and 8.2.1, and IEC 60804 (2001-10) 5.1 for Type 1 sound level meters when used with a Larson Davis Type 1 microphone.

Technician: Sean Childs Test Date: 28AUG2017

PCB PIEZOTRONICS
A PCB GROUP COMPANY

Certificate of Calibration and Conformance

Certificate Number 2017-205566

Instrument Model PRM828, Serial Number 2484, was calibrated on 28 Aug 2017. The instrument meets factory specifications per Procedure D0001.8135.

Instrument found to be in calibration as received: YES
Date Calibrated: 28 Aug 2017
Calibration due: 28 Aug 2018

Calibration Standards Used

MANUFACTURER	MODEL	SERIAL NUMBER	INTERVAL	CAL. DUE	TRACEABILITY NO.
Larson Davis	LDSigGn/2209	0617 / 0104	12 Months	19 Dec 2017	2016-204448
Agilent Technologies	34401A	MY41038589	12 Months	6 Jan 2018	2017000125

Reference Standards are traceable to the National Institute of Standards and Technology (NIST)

Calibration Environmental Conditions

Temperature: 24 ° Centigrade

Relative Humidity: 31 %

Affirmations

This Certificate attests that this instrument has been calibrated under the stated conditions with Measurement and Test Equipment (M&TE) Standards traceable to the U.S. National Institute of Standards and Technology (NIST). All of the Measurement Standards have been calibrated to their manufacturers' specified accuracy / uncertainty. Evidence of traceability and accuracy is on file at Provo Engineering & Manufacturing Center. An acceptable accuracy ratio between the Standard(s) and the item calibrated has been maintained. This instrument meets or exceeds the manufacturer's published specification unless noted.

The collective uncertainty of the Measurement Standard used does not exceed 25% of the applicable tolerance for each characteristic calibrated unless otherwise noted.

The results documented in this certificate relate only to the item(s) calibrated or tested. A one year calibration is recommended, however calibration interval assignment and adjustment are the responsibility of the end user. This certificate may not be reproduced, except in full, without the written approval of the issuer.

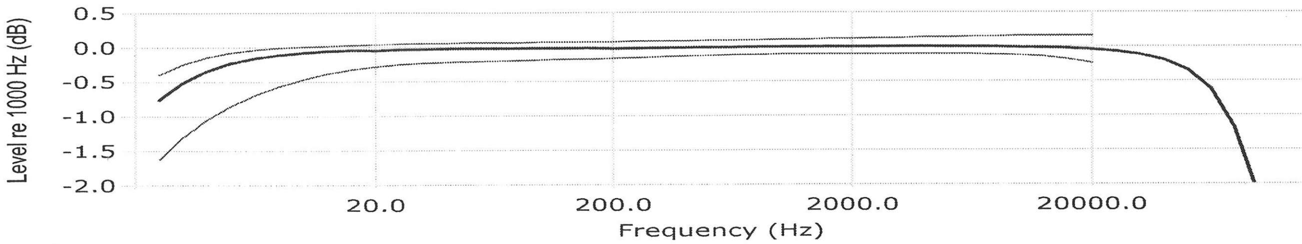
"As received" data is the same as shipped data.

Signed: [signature]
Technician: Sean Childs

Provo Engineering and Manufacturing Center, 1681 West 820 North, Provo, Utah 84601
Toll Free: 888.258.3222 Telephone: 716.926.8243 Fax: 716.926.8215
ISO 9001-2008 Certified

Preamplifier Model: PRM828 Serial Number: 2484
Frequency Response Test Report

Frequency response electrically tested at 120.0 dBμV using a 18 pF capacitor to simulate microphone capacitance.



Frequency (Hz)	Relative Level (dB)	Uncertainty (dB)	Limits (dB)	Frequency (Hz)	Relative Level (dB)	Uncertainty (dB)	Limits (dB)
2.5	-0.76	0.08	-0.39,-1.62	631.0	-0.00	0.02	0.10,-0.11
3.2	-0.51	0.06	-0.24,-1.30	794.3	-0.00	0.02	0.10,-0.11
4.0	-0.34	0.06	-0.14,-1.05	1000.0	0.00	0.02	0.11,-0.10
5.0	-0.23	0.04	-0.07,-0.85	1258.9	0.00	0.02	0.11,-0.10
6.3	-0.15	0.04	-0.03,-0.69	1584.9	0.00	0.02	0.12,-0.10
7.9	-0.10	0.04	0.00,-0.56	1995.3	0.00	0.02	0.12,-0.10
10.0	-0.07	0.02	0.01,-0.46	2511.9	0.00	0.02	0.13,-0.10
12.6	-0.05	0.02	0.02,-0.38	3162.3	0.01	0.02	0.13,-0.10
15.8	-0.04	0.02	0.03,-0.32	3981.1	0.01	0.02	0.14,-0.10
20.0	-0.04	0.02	0.04,-0.28	5011.9	0.00	0.02	0.14,-0.10
25.1	-0.03	0.02	0.05,-0.25	6309.6	0.00	0.02	0.15,-0.10
31.6	-0.03	0.02	0.06,-0.23	7943.3	-0.00	0.02	0.15,-0.11
39.8	-0.02	0.02	0.06,-0.22	10000.0	-0.01	0.02	0.16,-0.12
50.1	-0.02	0.02	0.07,-0.21	12589.3	-0.01	0.02	0.16,-0.14
63.1	-0.01	0.02	0.07,-0.20	15848.9	-0.02	0.02	0.16,-0.18
79.4	-0.01	0.02	0.07,-0.19	19952.6	-0.04	0.02	0.16,-0.24
100.0	-0.01	0.02	0.08,-0.18	25118.9	-0.07	0.02	inf ,-inf
125.9	-0.01	0.02	0.08,-0.17	31622.8	-0.11	0.02	inf ,-inf
158.5	-0.01	0.02	0.08,-0.17	39810.7	-0.19	0.02	inf ,-inf
199.5	-0.02	0.02	0.08,-0.16	50118.7	-0.34	0.02	inf ,-inf
251.2	-0.01	0.02	0.09,-0.15	63095.7	-0.61	0.05	inf ,-inf
316.2	-0.01	0.02	0.09,-0.14	79432.8	-1.18	0.05	inf ,-inf
398.1	-0.01	0.02	0.09,-0.13	100000.0	-2.15	0.05	inf ,-inf
501.2	-0.00	0.02	0.10,-0.12	125892.5	-3.44	0.06	inf ,-inf

1000 Hz measured level: 118.995 dBμV, -1.005 dB re input (0.033 dB uncertainty; -1.533 dB to -0.367 dB limit)
1 kHz (1/3 Octave) Noise Floor : 0.34 μV, -9.40 dBμV (0.47 dB uncertainty; -3.00 dB limit)
Flat (20 Hz - 20 kHz) Noise Floor : 6.28 μV, 15.96 dBμV (0.47 dB uncertainty; 17.00 dB limit)
A-weight Noise Floor : 1.82 μV, 5.21 dBμV (0.46 dB uncertainty; 13.00 dB limit)
Environmental conditions: 23.6 °C, 31.4 %RH (0.3 °C, 3 %RH uncertainty)
Uncertainties are given as expanded uncertainty at ~95 percent confidence level (k = 2).
Test Procedure: D0001.8135 with PRM828.xml
This frequency response is in compliance with manufacturers specification for the item tested.

Technician: Sean Childs   Test Date: 28 Aug 2017 11:43:09

Test Location: Larson Davis, a division of PCB Piezotronics, Inc.
1681 West 820 North, Provo, Utah 84601
Tel: 716 684-0001   www.LarsonDavis.com

Calibration Certificate

Certificate Number 2017009356

Customer:
LSA Associates Inc
20 Executive Park
Irvine, CA 92614, United States

Model Number	377A60	**Procedure Number**	D0001.8387		
Serial Number	101355	**Technician**	Abraham Ortega		
Test Results	**Pass**	**Calibration Date**	29 Aug 2017		
Initial Condition	AS RECEIVED same as shipped	**Calibration Due**	29 Aug 2018		
Description	1/2 inch Microphone - RI - 200V	**Temperature**	23.5	°C	± 0.01 °C
		Humidity	31.6	%RH	± 0.5 %RH
		Static Pressure	101.27	kPa	± 0.03 kPa

Evaluation Method Tested electrically using an electrostatic actuator.

Compliance Standards Compliant to Manufacturer Specifications.

Issuing lab certifies that the instrument described above meets or exceeds all specifications as stated in the referenced procedure (unless otherwise noted). It has been calibrated using measurement standards traceable to the SI through the National Institute of Standards and Technology (NIST), or other national measurement institutes, and meets the requirements of ISO/IEC 17025:2005. **Test points marked with a ‡ do not fall within this laboratory's scope of accreditation.**

The quality system is registered to ISO 9001:2008.

This calibration is a direct comparison of the unit under test to the listed reference standards and did not involve any sampling plans to complete. No allowance has been made for the instability of the test device due to use, time, etc. Such allowances would be made by the customer as needed.

The uncertainties were computed in accordance with the ISO Guide to the Expression of Uncertainty in Measurement (GUM). A coverage factor of approximately 2 sigma (k=2) has been applied to the standard uncertainty to express the expanded uncertainty at approximately 95% confidence level.

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Standards Used

Description	Cal Date	Cal Due	Cal Standard
Larson Davis Model 2900 Real Time Analyzer	07/17/2017	07/17/2018	001230
Microphone Calibration System	08/30/2017	08/30/2018	001233
1/2" Preamplifier	12/15/2016	12/15/2017	001274
Agilent 34401A DMM	12/06/2016	12/06/2017	001329
Larson Davis CAL250 Acoustic Calibrator	01/04/2017	01/04/2018	003030
1/2" Preamplifier	04/12/2017	04/12/2018	006506
Larson Davis 1/2" Preamplifier 7-pin LEMO	09/12/2016	09/11/2017	006507
1/2 inch Microphone - RI - 200V	10/03/2016	10/03/2017	006511
1/2 inch Microphone - RI - 200V	08/09/2017	08/09/2018	006519
Larson Davis 1/2" Preamplifier 7-pin LEMO	09/12/2016	09/12/2017	006530
Larson Davis 1/2" Preamplifier 7-pin LEMO	08/11/2017	08/11/2018	006531

Larson Davis, a division of PCB Piezotronics, Inc
1681 West 820 North
Provo, UT 84601, United States
716-684-0001

ACCREDITED Cert. #3622.01

LARSON DAVIS
A PCB PIEZOTRONICS DIV.

Certificate Number 2017009356

Sensitivity

Measurement	Test Result [mV/Pa]	Lower limit [mV/Pa]	Upper limit [mV/Pa]	Expanded Uncertainty [mV/Pa]	Result
Open Circuit Sensitivity	48.18	39.00	59.43	1.00	Pass

-- End of measurement results--

Capacitance

Measurement	Test Result [pF]	
Capacitance	19.00	‡

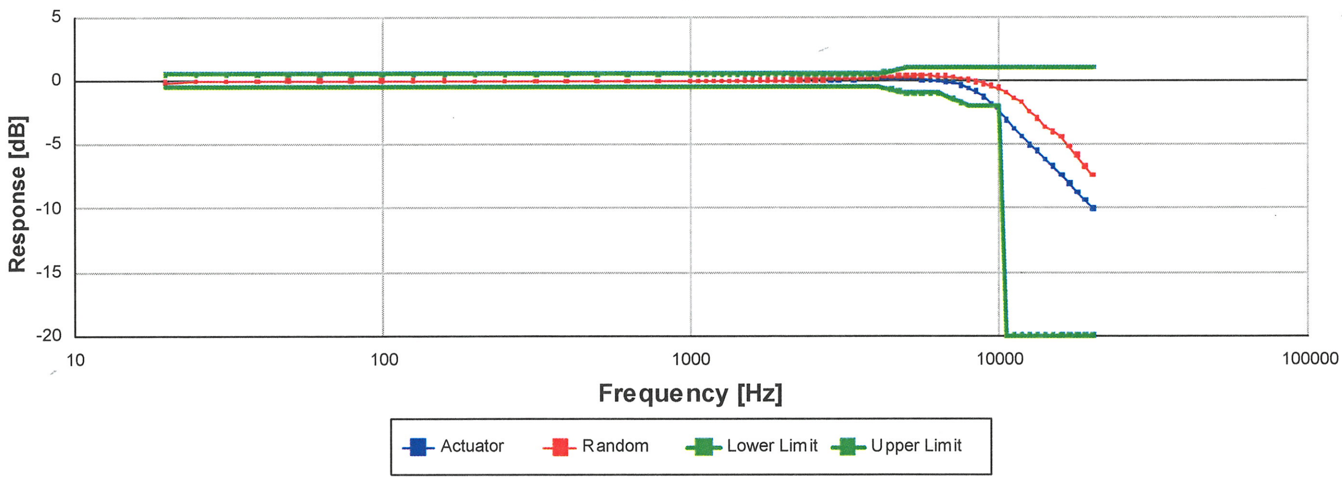
-- End of measurement results--

Lower Limiting Frequency

Measurement	Test Result [Hz]	Lower limit [Hz]	Upper limit [Hz]	Result
-3 dB Frequency	1.19	1.00	2.00	Pass ‡

-- End of measurement results--

Frequency Response



Data is normalized for 0 dB @ 251.19 Hz.

Frequency [Hz]	Actuator [dB]	Random [dB]	Lower limit [dB]	Upper limit [dB]	Result
19.95	-0.11	-0.11	-0.50	0.50	Pass ‡
25.12	-0.05	-0.05	-0.50	0.50	Pass ‡
31.62	-0.02	-0.02	-0.50	0.50	Pass ‡
39.81	0.00	0.00	-0.50	0.50	Pass ‡
50.12	0.01	0.01	-0.50	0.50	Pass ‡
63.10	0.01	0.01	-0.50	0.50	Pass ‡
79.43	0.01	0.01	-0.50	0.50	Pass ‡
100.00	0.01	0.01	-0.50	0.50	Pass ‡
125.89	0.01	0.01	-0.50	0.50	Pass ‡
158.49	0.01	0.01	-0.50	0.50	Pass ‡
199.53	0.00	0.00	-0.50	0.50	Pass ‡

Frequency [Hz]	Actuator [dB]	Random [dB]	Lower limit [dB]	Upper limit [dB]	Result
251.19	0.00	0.00	-0.50	0.50	Pass ‡
316.23	0.00	0.00	-0.50	0.50	Pass ‡
398.11	-0.01	-0.01	-0.50	0.50	Pass ‡
501.19	-0.01	-0.01	-0.50	0.50	Pass ‡
630.96	-0.01	-0.01	-0.50	0.50	Pass ‡
794.33	-0.01	-0.01	-0.50	0.50	Pass ‡
1,000.00	-0.01	-0.01	-0.50	0.50	Pass ‡
1,059.25	-0.01	-0.01	-0.50	0.50	Pass ‡
1,122.02	0.00	0.00	-0.50	0.50	Pass ‡
1,188.50	0.00	0.00	-0.50	0.50	Pass ‡
1,258.93	0.00	0.00	-0.50	0.50	Pass ‡
1,333.52	0.00	0.00	-0.50	0.50	Pass ‡
1,412.54	0.00	0.00	-0.50	0.50	Pass ‡
1,496.24	0.01	0.01	-0.50	0.50	Pass ‡
1,584.89	0.01	0.01	-0.50	0.50	Pass ‡
1,678.80	0.01	0.01	-0.50	0.50	Pass ‡
1,778.28	0.02	0.02	-0.50	0.50	Pass ‡
1,883.65	0.02	0.02	-0.50	0.50	Pass ‡
1,995.26	0.02	0.02	-0.50	0.50	Pass ‡
2,113.49	0.03	0.03	-0.50	0.50	Pass ‡
2,238.72	0.04	0.04	-0.50	0.50	Pass ‡
2,371.37	0.05	0.06	-0.50	0.50	Pass ‡
2,511.89	0.06	0.07	-0.50	0.50	Pass ‡
2,660.73	0.06	0.07	-0.50	0.50	Pass ‡
2,818.38	0.07	0.09	-0.50	0.50	Pass ‡
2,985.38	0.08	0.11	-0.50	0.50	Pass ‡
3,162.28	0.10	0.14	-0.50	0.50	Pass ‡
3,349.65	0.08	0.14	-0.50	0.50	Pass ‡
3,548.13	0.09	0.17	-0.50	0.50	Pass ‡
3,758.37	0.10	0.20	-0.50	0.50	Pass ‡
3,981.07	0.11	0.23	-0.50	0.50	Pass ‡
4,216.97	0.12	0.26	-0.63	0.63	Pass ‡
4,466.84	0.12	0.29	-0.75	0.75	Pass ‡
4,731.51	0.12	0.32	-0.88	0.88	Pass ‡
5,011.87	0.11	0.34	-1.00	1.00	Pass ‡
5,308.84	0.10	0.35	-1.00	1.00	Pass ‡
5,623.41	0.07	0.36	-1.00	1.00	Pass ‡
5,956.62	0.04	0.37	-1.00	1.00	Pass ‡
6,309.57	-0.03	0.34	-1.00	1.00	Pass ‡
6,683.44	-0.11	0.31	-1.25	1.00	Pass ‡
7,079.46	-0.22	0.24	-1.50	1.00	Pass ‡
7,498.94	-0.39	0.15	-1.75	1.00	Pass ‡
7,943.28	-0.61	0.07	-2.00	1.00	Pass ‡
8,413.95	-0.89	-0.09	-2.00	1.00	Pass ‡
8,912.51	-1.29	-0.23	-2.00	1.00	Pass ‡
9,440.61	-1.83	-0.43	-2.00	1.00	Pass ‡
10,000.00	-2.39	-0.59	-2.00	1.00	Pass ‡
10,592.54	-3.09	-0.97		1.00	Pass ‡
11,220.19	-3.82	-1.37		1.00	Pass ‡
11,885.02	-4.39	-1.70		1.00	Pass ‡
12,589.25	-5.04	-2.42		1.00	Pass ‡
13,335.21	-5.54	-2.96		1.00	Pass ‡
14,125.38	-6.18	-3.64		1.00	Pass ‡

Frequency [Hz]	Actuator [dB]	Random [dB]	Lower limit [dB]	Upper limit [dB]	Result
14,962.36	-6.73	-4.01		1.00	Pass ‡
15,848.93	-7.39	-4.39		1.00	Pass ‡
16,788.04	-8.07	-5.12		1.00	Pass ‡
17,782.80	-8.74	-5.85		1.00	Pass ‡
18,836.49	-9.37	-6.69		1.00	Pass ‡
19,952.62	-10.00	-7.38		1.00	Pass ‡

-- End of measurement results--

Signatory: *Abraham Ortega*

Larson Davis, a division of PCB Piezotronics, Inc
1681 West 820 North
Provo, UT 84601, United States
716-684-0001

ACCREDITED Cert. #3622.01

LARSON DAVIS A PCB PIEZOTRONICS DIV.

CALIBRATION CERTIFICATE FOR LARSON DAVIS 824

PCB PIEZOTRONICS
A PCB GROUP COMPANY

Certificate of Calibration and Conformance

Certificate Number 2017-206012

Instrument Model 824, Serial Number A1612, was calibrated on 28 Nov 2017. The instrument meets factory specifications per Procedure D0001.8046, IEC 61672-1:2002 Class 1; IEC 60651-2001, 60804-2000 and ANSI S1.4-1983 Type 1 1/3, 1/1 Oct. Filters; S1.11-1986 Type 1C; IEC61260-am1-2001 Class 1 .

Instrument found to be in calibration as received: YES
Date Calibrated: 28 Nov 2017
Calibration due: 28 Nov 2018

Calibration Standards Used

MANUFACTURER	MODEL	SERIAL NUMBER	INTERVAL	CAL. DUE	TRACEABILITY NO.
Larson Davis	LDSigGn/2209	0662/0114	12 Months	8 Dec 2017	2016-204417

Reference Standards are traceable to the National Institute of Standards and Technology (NIST)

Calibration Environmental Conditions

Temperature: 23 ° Centigrade

Relative Humidity: 26 %

Affirmations

This Certificate attests that this instrument has been calibrated under the stated conditions with Measurement and Test Equipment (M&TE) Standards traceable to the U.S. National Institute of Standards and Technology (NIST). All of the Measurement Standards have been calibrated to their manufacturers' specified accuracy / uncertainty. Evidence of traceability and accuracy is on file at Provo Engineering & Manufacturing Center. An acceptable accuracy ratio between the Standard(s) and the item calibrated has been maintained. This instrument meets or exceeds the manufacturer's published specification unless noted.

The collective uncertainty of the Measurement Standard used does not exceed 25% of the applicable tolerance for each characteristic calibrated unless otherwise noted.

The results documented in this certificate relate only to the item(s) calibrated or tested. A one year calibration is recommended, however calibration interval assignment and adjustment are the responsibility of the end user. This certificate may not be reproduced, except in full, without the written approval of the issuer.

"As received" data is the same as shipped data.
Tested with PRM902 S/N 2104

Signed:

Technician: Sean Childs

Provo Engineering and Manufacturing Center, 1681 West 820 North, Provo, Utah 84601
Toll Free: 888.258.3222 Telephone: 716.926.8243 Fax: 716.926.8215
ISO 9001-2008 Certified

PCB PIEZOTRONICS
A PCB GROUP COMPANY

Certificate of Calibration and Conformance

Certificate Number 2017-206010

Instrument Model PRM902, Serial Number 2104, was calibrated on 28 Nov 2017. The instrument meets factory specifications per Procedure D0001.8126.

Instrument found to be in calibration as received: YES
Date Calibrated: 28 Nov 2017
Calibration due: 28 Nov 2018

Calibration Standards Used

MANUFACTURER	MODEL	SERIAL NUMBER	INTERVAL	CAL. DUE	TRACEABILITY NO.
Larson Davis	LDSigGn/2209	0617 / 0104	12 Months	19 Dec 2017	2016-204448
Agilent Technologies	34401A	MY41038589	12 Months	6 Jan 2018	2017000125

Reference Standards are traceable to the National Institute of Standards and Technology (NIST)

Calibration Environmental Conditions

Temperature: 23 ° Centigrade

Relative Humidity: 26 %

Affirmations

This Certificate attests that this instrument has been calibrated under the stated conditions with Measurement and Test Equipment (M&TE) Standards traceable to the U.S. National Institute of Standards and Technology (NIST). All of the Measurement Standards have been calibrated to their manufacturers' specified accuracy / uncertainty. Evidence of traceability and accuracy is on file at Provo Engineering & Manufacturing Center. An acceptable accuracy ratio between the Standard(s) and the item calibrated has been maintained. This instrument meets or exceeds the manufacturer's published specification unless noted.

The collective uncertainty of the Measurement Standard used does not exceed 25% of the applicable tolerance for each characteristic calibrated unless otherwise noted.

The results documented in this certificate relate only to the item(s) calibrated or tested. A one year calibration is recommended, however calibration interval assignment and adjustment are the responsibility of the end user. This certificate may not be reproduced, except in full, without the written approval of the issuer.

"As received" data is the same as shipped data.

Signed:

Technician: Sean Childs

Provo Engineering and Manufacturing Center, 1681 West 820 North, Provo, Utah 84601
Toll Free: 888.258.3222 Telephone: 716.926.8243 Fax: 716.926.8215
ISO 9001-2008 Certified

Calibration Certificate

Certificate Number 2017012481

Customer:
LSA Associates Inc
20 Executive Park
Irvine, CA 92614, United States

Model Number	2541	***Procedure Number***	D0001.8387		
Serial Number	7977	***Technician***	Abraham Ortega		
Test Results	**Pass**	***Calibration Date***	29 Nov 2017		
Initial Condition	AS RECEIVED same as shipped	***Calibration Due***	29 Nov 2018		
Description	1/2 inch Microphone - FF - 200V	***Temperature***	23.5	°C	± 0.01 °C
		Humidity	27.9	%RH	± 0.5 %RH
		Static Pressure	101.49	kPa	± 0.03 kPa

Evaluation Method Tested electrically using an electrostatic actuator.

Compliance Standards Compliant to Manufacturer Specifications.

Issuing lab certifies that the instrument described above meets or exceeds all specifications as stated in the referenced procedure (unless otherwise noted). It has been calibrated using measurement standards traceable to the SI through the National Institute of Standards and Technology (NIST), or other national measurement institutes, and meets the requirements of ISO/IEC 17025:2005.
Test points marked with a ‡ do not fall within this laboratory's scope of accreditation.

The quality system is registered to ISO 9001:2008.

This calibration is a direct comparison of the unit under test to the listed reference standards and did not involve any sampling plans to complete. No allowance has been made for the instability of the test device due to use, time, etc. Such allowances would be made by the customer as needed.

The uncertainties were computed in accordance with the ISO Guide to the Expression of Uncertainty in Measurement (GUM). A coverage factor of approximately 2 sigma (k=2) has been applied to the standard uncertainty to express the expanded uncertainty at approximately 95% confidence level.

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Standards Used

Description	Cal Date	Cal Due	Cal Standard
Larson Davis Model 2900 Real Time Analyzer	07/17/2017	07/17/2018	001230
Microphone Calibration System	08/30/2017	08/30/2018	001233
1/2" Preamplifier	12/15/2016	12/15/2017	001274
Agilent 34401A DMM	12/06/2016	12/06/2017	001329
Larson Davis CAL250 Acoustic Calibrator	01/04/2017	01/04/2018	003030
1/2" Preamplifier	04/12/2017	04/12/2018	006506
Larson Davis 1/2" Preamplifier 7-pin LEMO	09/12/2017	09/12/2018	006507
1/2 inch Microphone - RI - 200V	04/24/2017	04/24/2018	006510
1/2 inch Microphone - RI - 200V	08/09/2017	08/09/2018	006519
Larson Davis 1/2" Preamplifier 7-pin LEMO	09/12/2017	09/12/2018	006530
Larson Davis 1/2" Preamplifier 7-pin LEMO	08/11/2017	08/11/2018	006531

Larson Davis, a division of PCB Piezotronics, Inc
1681 West 820 North
Provo, UT 84601, United States
716-684-0001

ilac-MRA ACCREDITED Cert. #3622.01

LARSON DAVIS
A PCB PIEZOTRONICS DIV.

Calibration Certificate

Certificate Number 2017012136

Customer:

LSA Associates Inc
20 Executive Park
Irvine, CA 92614, United States

Model Number	CAL200
Serial Number	3228
Test Results	**Pass**
Initial Condition	AS RECEIVED same as shipped
Description	Larson Davis CAL200 Acoustic Calibrator

Procedure Number	D0001.8386		
Technician	Scott Montgomery		
Calibration Date	17 Nov 2017		
Calibration Due	17 Nov 2018		
Temperature	25	°C	± 0.3 °C
Humidity	33	%RH	± 3 %RH
Static Pressure	101.5	kPa	± 1 kPa

Evaluation Method The data is aquired by the insert voltage calibration method using the reference microphone's open circuit sensitivity. Data reported in dB re 20 μPa.

Compliance Standards Compliant to Manufacturer Specifications per D0001.8190 and the following standards:
IEC 60942:2003 ANSI S1.40-2006

Issuing lab certifies that the instrument described above meets or exceeds all specifications as stated in the referenced procedure (unless otherwise noted). It has been calibrated using measurement standards traceable to the SI through the National Institute of Standards and Technology (NIST), or other national measurement institutes, and meets the requirements of ISO/IEC 17025:2005.
Test points marked with a ‡ in the uncertainties column do not fall within this laboratory's scope of accreditation.

The quality system is registered to ISO 9001:2008.

This calibration is a direct comparison of the unit under test to the listed reference standards and did not involve any sampling plans to complete. No allowance has been made for the instability of the test device due to use, time, etc. Such allowances would be made by the customer as needed.

The uncertainties were computed in accordance with the ISO Guide to the Expression of Uncertainty in Measurement (GUM). A coverage factor of approximately 2 sigma (k=2) has been applied to the standard uncertainty to express the expanded uncertainty at approximately 95% confidence level.

This report may not be reproduced, except in full, unless permission for the publication of an approved abstract is obtained in writing from the organization issuing this report.

Standards Used

Description	Cal Date	Cal Due	Cal Standard
Agilent 34401A DMM	09/06/2017	09/06/2018	001021
Larson Davis Model 2900 Real Time Analyzer	04/10/2017	04/10/2018	001051
Microphone Calibration System	08/08/2017	08/08/2018	005446
1/2" Preamplifier	10/05/2017	10/05/2018	006506
Larson Davis 1/2" Preamplifier 7-pin LEMO	08/08/2017	08/08/2018	006507
1/2 inch Microphone - RI - 200V	04/24/2017	04/24/2018	006510
Pressure Transducer	06/01/2017	06/01/2018	007310

CALIBRATION CERTIFICATE FOR LARSON DAVIS 831

Calibration Certificate

Certificate Number 2017004790

Customer:

LSA Associates Inc
20 Executive Park
Irvine, CA 92614, United States

Model Number	831
Serial Number	0002441
Test Results	**Pass**
Initial Condition	AS RECEIVED same as shipped
Description	Larson Davis Model 831 Class 1 Sound Level Meter Firmware Revision: 2.311

Procedure Number	D0001.8378		
Technician	Ron Harris		
Calibration Date	9 May 2017		
Calibration Due	9 May 2018		
Temperature	23.54	°C	± 0.25 °C
Humidity	49.4	%RH	± 2.0 %RH
Static Pressure	85.93	kPa	± 0.13 kPa

Evaluation Method Tested electrically using Larson Davis PRM831 S/N 017139 and a 12.0 pF capacitor to simulate microphone capacitance. Data reported in dB re 20 μPa assuming a microphone sensitivity of 50.0 mV/Pa.

Compliance Standards Compliant to Manufacturer Specifications and the following standards when combined with Calibration Certificate from procedure D0001.8384:

IEC 60651:2001 Type 1	ANSI S1.4-2014 Class 1
IEC 60804:2000 Type 1	ANSI S1.4 (R2006) Type 1
IEC 61252:2002	ANSI S1.11 (R2009) Class 1
IEC 61260:2001 Class 1	ANSI S1.25 (R2007)
IEC 61672:2013 Class 1	ANSI S1.43 (R2007) Type 1

Issuing lab certifies that the instrument described above meets or exceeds all specifications as stated in the referenced procedure (unless otherwise noted). It has been calibrated using measurement standards traceable to the International System of Units (SI) through the National Institute of Standards and Technology (NIST), or other national measurement institutes, and meets the requirements of ISO/IEC 17025:2005. **Test points marked with a ‡ in the uncertainties column do not fall within this laboratory's scope of accreditation.**

The quality system is registered to ISO 9001:2008.

This calibration is a direct comparison of the unit under test to the listed reference standards and did not involve any sampling plans to complete. No allowance has been made for the instability of the test device due to use, time, etc. Such allowances would be made by the customer as needed.

The uncertainties were computed in accordance with the ISO Guide to the Expression of Uncertainty in Measurement (GUM). A coverage factor of approximately 2 sigma (k=2) has been applied to the standard uncertainty to express the expanded uncertainty at approximately 95% confidence level.

Correction data from Larson Davis Model 831 Sound Level Meter Manual, I831.01 Rev O, 2016-09-19

Calibration Check Frequency: 1000 Hz; Reference Sound Pressure Level: 114 dB re 20 μPa; Reference Range: 0 dB gain

Periodic tests were performed in accordance with precedures from IEC 61672-3:2013 / ANSI/ASA S1.4-2014/Part3.

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1681 West 820 North
Provo, UT 84601, United States
716-684-0001

ACCREDITED Cert. #3622.01

LARSON DAVIS
A PCB PIEZOTRONICS DIV.

Pattern approval for IEC 61672-1:2013 / ANSI/ASA S1.4-2014/Part 1 successfully completed by Physikalisch-Technische Bundesanstalt (PTB) on 2016-02-24 certificate number DE-15-M-PTB-0056.

The sound level meter submitted for testing successfully completed the periodic tests of IEC 61672-3:2013 / ANSI/ASA S1.4-2014/Part 3, for the environmental conditions under which the tests were performed. As evidence was publicly available, from an independent testing organization responsible for approving the results of pattern-evaluation tests performed in accordance with IEC 61672-2:2013 / ANSI/ASA S1.4-2014/Part 2, to demonstrate that the model of sound level meter fully conformed to the class 1 specifications in IEC 61672-1:2013 / ANSI/ASA S1.4-2014/Part 1; the sound level meter submitted for testing conforms to the class 1specifications in IEC 61672-1:2013 / ANSI/ASA S1.4-2014/Part 1.

Standards Used

Description	Cal Date	Cal Due	Cal Standard
SRS DS360 Ultra Low Distortion Generator	2017-01-19	2018-01-19	006239
Hart Scientific 2626-S Humidity/Temperature Sensor	2016-06-17	2017-06-17	006946

Calibration Certificate

Certificate Number 2017004807

Customer:

LSA Associates Inc
20 Executive Park
Irvine, CA 92614, United States

Model Number	831	***Procedure Number***	D0001.8384		
Serial Number	0002441	***Technician***	Ron Harris		
Test Results	**Pass**	***Calibration Date***	9 May 2017		
Initial Condition	AS RECEIVED same as shipped	***Calibration Due***	9 May 2018		
Description	Larson Davis Model 831 Class 1 Sound Level Meter Firmware Revision: 2.311	***Temperature***	23.89	°C	± 0.25 °C
		Humidity	50.7	%RH	± 2.0 %RH
		Static Pressure	85.85	kPa	± 0.13 kPa

Evaluation Method ***Tested with:***

Larson Davis PRM831. S/N 017139
PCB 377B02. S/N 120629
Larson Davis CAL200. S/N 9079
Larson Davis CAL291. S/N 0203

Data reported in dB re 20 μPa.

Compliance Standards Compliant to Manufacturer Specifications and the following standards when combined with Calibration Certificate from procedure D0001.8378:

IEC 60651:2001 Type 1	ANSI S1.4-2014 Class 1
IEC 60804:2000 Type 1	ANSI S1.4 (R2006) Type 1
IEC 61252:2002	ANSI S1.11 (R2009) Class 1
IEC 61260:2001 Class 1	ANSI S1.25 (R2007)
IEC 61672:2013 Class 1	ANSI S1.43 (R2007) Type 1

Issuing lab certifies that the instrument described above meets or exceeds all specifications as stated in the referenced procedure (unless otherwise noted). It has been calibrated using measurement standards traceable to the International System of Units (SI) through the National Institute of Standards and Technology (NIST), or other national measurement institutes, and meets the requirements of ISO/IEC 17025:2005.
Test points marked with a ‡ in the uncertainties column do not fall within this laboratory's scope of accreditation.

The quality system is registered to ISO 9001:2008.

This calibration is a direct comparison of the unit under test to the listed reference standards and did not involve any sampling plans to complete. No allowance has been made for the instability of the test device due to use, time, etc. Such allowances would be made by the customer as needed.

The uncertainties were computed in accordance with the ISO Guide to the Expression of Uncertainty in Measurement (GUM). A coverage factor of approximately 2 sigma (k=2) has been applied to the standard uncertainty to express the expanded uncertainty at approximately 95% confidence level.

Correction data from Larson Davis Model 831 Sound Level Meter Manual, I831.01 Rev O, 2016-09-19

For 1/4" microphones, the Larson Davis ADP024 1/4" to 1/2" adaptor is used with the calibrators and the Larson Davis ADP043 1/4" to

1/2" adaptor is used with the preamplifier.

Calibration Check Frequency: 1000 Hz; Reference Sound Pressure Level: 114 dB re 20 µPa; Reference Range: 0 dB gain

Periodic tests were performed in accordance with precedures from IEC 61672-3:2013 / ANSI/ASA S1.4-2014/Part3.

Pattern approval for IEC 61672-1:2013 / ANSI/ASA S1.4-2014/Part 1 successfully completed by Physikalisch-Technische Bundesanstalt (PTB) on 2016-02-24 certificate number DE-15-M-PTB-0056.

The sound level meter submitted for testing successfully completed the periodic tests of IEC 61672-3:2013 / ANSI/ASA S1.4-2014/Part 3, for the environmental conditions under which the tests were performed. As evidence was publicly available, from an independent testing organization responsible for approving the results of pattern-evaluation tests performed in accordance with IEC 61672-2:2013 / ANSI/ASA S1.4-2014/Part 2, to demonstrate that the model of sound level meter fully conformed to the class 1 specifications in IEC 61672-1:2013 / ANSI/ASA S1.4-2014/Part 1; the sound level meter submitted for testing conforms to the class 1specifications in IEC 61672-1:2013 / ANSI/ASA S1.4-2014/Part 1.

Standards Used

Description	Cal Date	Cal Due	Cal Standard
SRS DS360 Ultra Low Distortion Generator	2016-06-21	2017-06-21	006311
Hart Scientific 2626-S Humidity/Temperature Sensor	2016-06-17	2017-06-17	006946
Larson Davis CAL200 Acoustic Calibrator	2016-07-26	2017-07-26	007027
Larson Davis Model 831	2017-03-01	2018-03-01	007182
PCB 377A13 1/2 inch Prepolarized Pressure Microphone	2017-03-08	2018-03-08	007185
Larson Davis CAL291 Residual Intensity Calibrator	2016-09-22	2017-09-22	007287

Acoustic Calibration

Measured according to IEC 61672-3:2013 10 and ANSI S1.4-2014 Part 3: 10

Measurement	Test Result [dB]	Lower Limit [dB]	Upper Limit [dB]	Expanded Uncertainty [dB]	Result
1000 Hz	114.01	113.80	114.20	0.14	Pass

As Received Level: 114.13
Adjusted Level: 114.01

-- End of measurement results--

Acoustic Signal Tests, C-weighting

Measured according to IEC 61672-3:2013 12 and ANSI S1.4-2014 Part 3: 12 using a comparison coupler with Unit Under Test (UUT) and reference SLM using slow time-weighted sound level for compliance to IEC 61672-1:2013 5.5; ANSI S1.4-2014 Part 1: 5.5

Frequency [Hz]	Test Result [dB]	Expected [dB]	Lower Limit [dB]	Upper Limit [dB]	Expanded Uncertainty [dB]	Result
125	0.02	-0.20	-1.20	0.80	0.23	Pass
1000	0.08	0.00	-0.70	0.70	0.23	Pass
8000	-4.90	-3.00	-5.50	-1.50	0.32	Pass

-- End of measurement results--

Larson Davis, a division of PCB Piezotronics, Inc
1681 West 820 North
Provo, UT 84601, United States
716-684-0001

Calibration Certificate

Certificate Number 2017004789

Customer:
LSA Associates Inc
20 Executive Park
Irvine, CA 92614, United States

Model Number	PRM831	**Procedure Number**	D0001.8383		
Serial Number	017139	**Technician**	Ron Harris		
Test Results	**Pass**	**Calibration Date**	9 May 2017		
Initial Condition	AS RECEIVED same as shipped	**Calibration Due**	9 May 2018		
		Temperature	23.4	°C	± 0.01 °C
Description	Larson Davis 1/2" Preamplifier for Model 831 Type 1	**Humidity**	50.5	%RH	± 0.5 %RH
		Static Pressure	85.94	kPa	± 0.03 kPa

Evaluation Method Tested electrically using a 12.0 pF capacitor to simulate microphone capacitance. Data reported in dB re 20 μPa assuming a microphone sensitivity of 50.0 mV/Pa.

Compliance Standards Compliant to Manufacturer Specifications

Issuing lab certifies that the instrument described above meets or exceeds all specifications as stated in the referenced procedure (unless otherwise noted). It has been calibrated using measurement standards traceable to the SI through the National Institute of Standards and Technology (NIST), or other national measurement institutes, and meets the requirements of ISO/IEC 17025:2005. **Test points marked with a ‡ in the uncertainties column do not fall within this laboratory's scope of accreditation.**

The quality system is registered to ISO 9001:2008.

This calibration is a direct comparison of the unit under test to the listed reference standards and did not involve any sampling plans to complete. No allowance has been made for the instability of the test device due to use, time, etc. Such allowances would be made by the customer as needed.

The uncertainties were computed in accordance with the ISO Guide to the Expression of Uncertainty in Measurement (GUM). A coverage factor of approximately 2 sigma (k=2) has been applied to the standard uncertainty to express the expanded uncertainty at approximately 95% confidence level.

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Standards Used

Description	Cal Date	Cal Due	Cal Standard
Sound Level Meter / Real Time Analyzer	03/08/2017	03/08/2018	003003
Hart Scientific 2626-S Humidity/Temperature Sensor	06/17/2016	06/17/2017	006946
Agilent 34401A DMM	06/07/2016	06/07/2017	007165
SRS DS360 Ultra Low Distortion Generator	10/14/2016	10/14/2017	007167

Larson Davis, a division of PCB Piezotronics, Inc
1681 West 820 North
Provo, UT 84601, United States
716-684-0001

ilac-MRA ACCREDITED Cert. #3622.01

LARSON DAVIS A PCB PIEZOTRONICS DIV.

CALIBRATION CERTIFICATE FOR QUEST NOISE PRO

INSTRUCTIONS CALIBRATION REPORT

Advanced Labs, Inc.

Pine Environmental Services, Inc

Instrument ID	R7360
Description	Quest NoisePro DLX Dosimeter
Calibrated	5/2/2017

Manufacturer	Quest	**Classification**	
Model Number	NoisePro DLX Dosimeter	**Status**	pass
Serial Number	NXE120104	**Frequency**	Yearly EOM
Location	New Jersey	**Department**	Lab
Temp	77	**Humidity**	35

Calibration Specifications

Group # 1

Group Name Acoustic Tests Performed

Test Performed: Yes **As Found Result: Fail** **As Left Result: Pass**

Test Instruments Used During the Calibration

Test Instrument ID	Description	Manufacturer	Serial Number	Last Cal Date (As Of Cal Entry Date)	Next Cal Date
B&K 4226	Brüel & Kjær 4226	Brüel & Kjær	2590968	4/24/2017	4/24/2018
B&K 4228	Brüel & Kjær 4228	Brüel & Kjær	2667476	4/5/2017	4/5/2018
FLUKE 114	Fluke 114 NIST Traceable Multimeter	Fluke	15310288	5/6/2016	5/6/2017

Notes about this calibration

Calibration Result Calibration Successful

Who Calibrated Kevin Cole

Advanced Labs, Inc. hereby certifies that this instrument is calibrated and functions to meet the manufacture's specifications using NIST traceable standards, or is derived from accepted values of physical constants.

INSTRUMENT CALIBRATION REPORT

Pine Environmental Services LLC

1340 Reynolds Avenue, Suite 108
Irvine, CA 92614
Toll-free: 888-620-7463

Pine Environmental Services, Inc.

Instrument ID R7360
Description Quest NoisePro DLX
Calibrated 4/16/2018 6:05:19PM

Manufacturer Quest
Model Number Noisepro DLX
Serial Number/ Lot Number NXE120104
Location California
Department

State Certified
Status Pass
Temp °C 24
Humidity % 48

Calibration Specifications

Group # 1
Group Name Calibrated to 114db w/ Quest Sound Source
Test Performed: Yes **As Found Result:** Pass **As Left Result:** Pass

Test Instruments Used During the Calibration **(As Of Cal Entry Date)**

Test Standard ID	Description	Manufacturer	Model Number	Serial Number / Lot Number	Last Cal Date/ Opened Date	Next Cal Date / Expiration Date

Notes about this calibration

Calibration Result Calibration Successful
Who Calibrated Angela Reiter

All instruments are calibrated by Pine Environmental Services LLC according to the manufacturer's specifications, but it is the customer's responsibility to calibrate and maintain this unit in accordance with the manufacturer's specifications and/or the customer's own specific needs.

Notify Pine Environmental Services LLC of any defect within 24 hours of receipt of equipment
Please call 800-301-9663 for Technical Assistance

INSTRUMENT CALIBRATION REPORT

Advanced Labs, Inc.

Pine Environmental Services, Inc

Instrument ID 11571
Description Quest NoisePro DLX Dosimeter
Calibrated 5/23/2017

Manufacturer	Quest	**Classification**	
Model Number	NoisePro DLX Dosimeter	**Status**	pass
Serial Number	NXG070063	**Frequency**	Yearly EOM
Location	New Jersey	**Department**	Lab
Temp	76	**Humidity**	40

Calibration Specifications

Group # 1
Group Name Acoustic Tests Performed
Test Performed: Yes **As Found Result: Fail** **As Left Result: Pass**

Test Instruments Used During the Calibration

Test Instrument ID	Description	Manufacturer	Serial Number	Last Cal Date (As Of Cal Entry Date)	Next Cal Date
B&K 4226	Brüel & Kjær 4226	Brüel & Kjær	2590968	4/24/2017	4/24/2018
B&K 4228	Brüel & Kjær 4228	Brüel & Kjær	2667476	4/5/2017	4/5/2018

Notes about this calibration

Calibration Result Calibration Successful
Who Calibrated Kevin Cole

Advanced Labs, Inc. hereby certifies that this instrument is calibrated and functions to meet the manufacture's specifications using NIST traceable standards, or is derived from accepted values of physical constants.

INSTRUMENT CALIBRATION REPORT

Pine Environmental Services LLC

1340 Reynolds Avenue, Suite 108
Irvine, CA 92614
Toll-free: 888-620-7463

Pine Environmental Services, Inc.

Instrument ID 11571
Description Quest NoisePro DLX
Calibrated 4/16/2018 6:04:25PM

Manufacturer	Quest	**State Certified**	
Model Number	Noisepro DLX	**Status**	Pass
Serial Number/ Lot Number	NXG070063	**Temp °C**	24
Location	California	**Humidity %**	48
Department			

Calibration Specifications

Group # 1
Group Name
Test Performed: Yes **As Found Result: Pass** **As Left Result: Pass**

Test Instruments Used During the Calibration **(As Of Cal Entry Date)**

Test Standard ID	Description	Manufacturer	Model Number	Serial Number / Lot Number	Last Cal Date/ Opened Date	Next Cal Date / Expiration Date

Notes about this calibration

Calibration Result Calibration Successful
Who Calibrated Angela Reiter

All instruments are calibrated by Pine Environmental Services LLC according to the manufacturer's specifications, but it is the customer's responsibility to calibrate and maintain this unit in accordance with the manufacturer's specifications and/or the customer's own specific needs.

Notify Pine Environmental Services LLC of any defect within 24 hours of receipt of equipment
Please call 800-301-9663 for Technical Assistance

INSTRUMENT CALIBRATION REPORT

Advanced Labs, Inc.

Pine Environmental Services, Inc

Instrument ID 1432
Description Quest QC-10 Acoustic Calibrator
Calibrated 8/22/2017

Manufacturer	Quest	**Classification**	
Model Number	QC-10	**Status**	pass
Serial Number	QI0080143	**Frequency**	Yearly EOM
Location	New Jersey	**Department**	Lab
Temp	76	**Humidity**	36

Calibration Specifications

Group # 1
Group Name Acoustic Tests Performed
Test Performed: Yes **As Found Result:** Fail **As Left Result:** Pass

Test Instruments Used During the Calibration

Test Instrument ID	Description	Manufacturer	Serial Number	Last Cal Date (As Of Cal Entry Date)	Next Cal Date (As Of Cal Entry Date)
B&K 4226	Brüel & Kjær 4226	Brüel & Kjær	2590968	4/24/2017	4/24/2018
B&K 4228	Brüel & Kjær 4228	Brüel & Kjær	2667476	4/5/2017	4/5/2018
SOUNDPRO DL-1-1/3	3M SoundPro DL-1-1/3	Quest Technologies	BLL070002	4/17/2017	4/17/2018

Notes about this calibration

Calibration Result Calibration Successful
Who Calibrated Kevin Cole

Advanced Labs, Inc. hereby certifies that this instrument is calibrated and functions to meet the manufacture's specifications using NIST traceable standards, or is derived from accepted values of physical constants.