45dB Acoustics

45dB Acoustics, LLC
www.45dB.com
(805) 250-1566

PO Box 1717
Buellton, CA 93427

September 20, 2023
45dB Project 23051

Project & Address:	**Architect:**
Roseville Starbucks 111 S. Harding Blvd. Roseville, CA 95678	Valerio, Inc. Attn: Elizabeth Valerio evalerio@valerioinc.com 323.954.8996 x 101

Summary

45dB Acoustics LLC ("**45dB**") has conducted an acoustical analysis of the proposed drive-through coffee shop at the above address in the City of Roseville, CA. This analysis utilizes published traffic counts input into a noise propagation model (SoundPLAN®) along with sound levels for the proposed drive-through system based upon our experience, previous measurements, and speaker manufacturer data. The potential impact of noise from the project at nearby receiving land uses was evaluated in comparison to the existing noise environment.

Existing noise levels were modeled for the site—including traffic from Interstate 80 and Douglas Boulevard. The principal noise sources associated with the proposed drive-through were added and compared to the City's Municipal Code exterior noise level limits. Based on our analysis, there is expected to be a 0 dB impact (i.e., at most 0.5 dB) on noise levels at the nearest residential land uses.

No mitigation is required for this project, and it is expected that this coffee shop with drive-through service will comply with the City's Municipal Code noise limits.

Please contact me with any questions.

for 45dB Acoustics, LLC:

Sarah Taubitz, Mem.INCE, ASA

Erin Dugan, INCE Bd. Cert.

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1 Introduction

This sound level assessment is intended to determine the potential noise impacts associated with the proposed Starbucks Coffee drive-through project to be located at 111 S. Harding Blvd. in Roseville, California. The following topics are presented in this report in response to the City of Roseville requirements for stationary noise, as identified by the Municipal Code. The following factors are considered:

- The topographical relationship of potential noise sources and the nearby potential sensitive receptors
- Identification of noise sources and their characteristics, including predicted sound levels at the property lines of nearby residential homes, considering present and future land usage and terrain
- Basis for the sound level prediction (i.e., acoustically modeled from published data), noise attenuation measures to be applied, and an analysis of the noise propagation considering the physical layout of the built environment
- Noise attenuation measures (mitigation) to be applied, if needed
- Information on fundamentals of noise and vibration to aid in interpreting the report (see Appendix, Section 10)

The proposed Project is to be located at the southwest corner of Interstate 80. and W. Douglas Blvd. in Roseville, CA as a reuse of a previous Burger King drive-through restaurant. The Project's location is shown in Figure 1, highlighted in yellow. The site has residential land uses located to the south of the site and commercial land uses located to the east and west (see Figure 2)[1].

The site plan, provided by the Client, is shown in Figure 3. The proposed Project will consist of a drive-through coffee shop with a menu ordering system located south of the building and a pick-up window located on the east side of the building. We understand that the coffee shop intends to operate between 5:00 am and 11:00 pm or 12:00 am, depending on the season.

2 Regulatory Setting

Noise regulations are addressed by federal, state, and local government agencies, as discussed below. In general, local policies are adaptations of federal and state guidelines, adjusted to prevailing local conditions.

2.1 Local Regulation

The City of Roseville Municipal Code[2] provides regulations and guidelines regarding non-transportation noise sources. Section 9.24.100 (Figure 7) states that exterior noise levels at the

[1] City of Roseville Parcel Map. https://roseville.maps.arcgis.com/apps/webappviewer/index.html?id=2a67e5a4e1cc4f489868b6563589bf19
[2] City of Roseville, Municipal Code, Chapter 9.24, *Noise Regulation.* https://library.qcode.us/lib/roseville_ca/pub/municipal_code/item/title_9-chapter_9_24-9_24_100

property lines of sensitive receptors, such as residential properties, cannot exceed an hourly noise level (“L_{eq}”) of 50 dBA daytime (between 7:00am to 10:00pm) and 45 dBA nighttime (between 10:00pm and 7:00am). Maximum levels (“L_{max}”) cannot exceed 70 dBA during daytime and 65 dBA at nighttime.

For noise sources consisting of music or voice, such as at a drive-thru speaker, all the above levels are reduced by 5 dB. For locations where the ambient noise level exceeds the published limits, the allowable levels are adjusted to 3 dB over the ambient level.

3 Existing Ambient Noise Level Measurements

Sound levels (L_{eq}, L_{max}, L_{min}, etc.) have been measured by **45dB** at two locations near the project site, shown in Figure 4, for a 24-hour period on Monday September 11 to Tuesday Septtember 12, 2023. Two SoftdB Piccolo Type/Class 2 calibrated sound level meters and a Larson Davis CAL200 Type/Class 1 calibrator were utilized. Calculation of the L_d (daytime) and the L_n (nighttime) sound levels are based on 1-sec Leq measurement data.

Time series of the measured 24-hour sound levels for both locations are shown in Figure 5, collated into one representative midnight-to-midnight day The west location had daytime and nighttime hourly levels of 57 dBA and the east location had daytime hourly levels of 60 dBA and nighttime levels of 57 dBA.

Weather (Figure 6) at the Sacramento International Airport[3] was clear without precipitation, with temperatures ranging from 61 to 94 degrees Fahrenheit. Wind speeds were fairly low throughout the measurement period, ranging up to 12 mph.

4 Noise Propagation Model

SoundPLAN® is a state-of-the-art sound propagation modeling software package that calculates sound levels while taking into account the air and ground attenuation, terrain variation and the built environment, road pavement types, and other relevant factors. SoundPLAN incorporates the relevant noise propagation calculation standards—for road traffic, this model utilizes the Federal Highway Administration’s Traffic Noise Model, and for other sources such as the drive-through speaker, ISO 9613-2 is utilized in order to accurately calculate noise propagation accurately. Traffic counts for local roads are input to the model to establish an ambient existing noise environment for comparison with the calculated noise levels due to the Project’s proposed noise-generating sources. See the Appendix for more information on this software and its calculation methods. All sound levels in this report are presented in units of A-weighted decibels, dBA.

[3] Weather Underground, Sacramento CA Weather History, September 11-12, 2023. https://www.wunderground.com/history/daily/us/ca/sacramento/KSMF/date/2023-9-12

4.1 Traffic Noise

The noise propagation software, SoundPLAN, utilizes traffic counts to accurately model/predict the noise levels from roads. Traffic counts are input into SoundPLAN which, by default, apportions the count into vehicle types including automobiles and medium trucks. Traffic counts for S. Douglas Blvd. and Harding Blvd. were obtained from the City of Roseville Department of Public Works[4] and counts for I-80 were obtained from the California Department of Transportation (CalTrans)[5]. Bus counts were also included for Douglas Blvd, based on the Roseville Transit[6] (route L) bus schedule. The counts (see Table 1) were adjusted to the current year, assuming a 1% per year increase in traffic. SoundPLAN apportions the counts into daytime and nighttime hours, and appropriate vehicle speeds are input in order to predict the outdoor noise levels using the Traffic Noise Model.

Table 1: Traffic Count Data and 2023 Projections

Road	Published AADT	Year	Years to Project	2023 AADT Projection with 1% Annual Growth
I-80 (N of Douglas)	159,000	2021	2	162,196
I-80 (S of Douglas)	174,000	2021	2	177,497
Ramp from EB Douglas to WB I-80	5600	2016	7	6004
Ramp from WB I-80 to Douglas	17,901	2016	7	19,192
Douglas (W of Harding)	20,393	2023	0	20,393
Douglas (E of Harding)	31,745	2023	0	31,745
Harding (N of Douglas)	15,827	2023	0	15,827
Harding (S of Douglas)	1551	2023	0	1551

The FHWA's Traffic Noise Model utilizes an average hourly traffic count (AADT) that is the same for all daytime hours—on any given day or hour, traffic counts may vary from this annualized average. Field measurements conducted by **45dB**, as discussed in Section 3, are expected to be generally representative of the expected sound levels at this location, although could be somewhat lower than average, because Mondays tend to have lower traffic activity than midweek days. The modeled traffic on I-80 was reduced slightly so that the existing ambient daytime and nighttime levels at these locations agreed within 3 dB of the measured levels. Minor differences can be attributed to slight variations in daily traffic.

[4] Roseville Department of Public Works. *Traffic Volumes*. http://traffic.roseville.ca.us/webreports/DxReportViewer.aspx?rpt=VolumePerMultiDayGraph
[5] California Department of Transportation, Traffic Census Program. https://dot.ca.gov/programs/traffic-operations/census
[6] Roseville Transit, Bus schedules. (Accessed Sept 2023) https://www.roseville.ca.us/cms/One.aspx?portalId=7964922&pageId=8756381

Table 2: Comparison of September 11-12, 2023, Measured Levels with Predicted/Modeled Daytime and Nighttime Hourly Levels at Project Site

	Measured		Predicted/Modeled	
Receiver	Daytime Leq (dBA)	Nighttime Leq (dBA)	Daytime Leq (dBA)	Nighttime Leq (dBA)
SN205	57	57	60	57
SN207	60	57	61	59

4.2 Drive Through Speaker Noise

All project-related sources that would potentially add significant increase in resulting noise levels for the area are also included in the model. Those are, namely:

- **Drive-through speaker** incorporating an AVC (Adjustable Volume Control) loudspeaker, which adjusts volume according to the ambient levels and does not allow the levels to exceed 15 dB above the background noise. Documentation on this system is also included at the end of this report.

- **3 people speaking loudly: driver placing their order, driver at pick-up window, and worker at pick-up window** – all of whom were simply modeled as point sources representing louder speaking voices with sound power level of 80 dBA, which is considered a conservatively high level.

Both sources (drive-through speaker and driver) at the drive-through menu ordering location were conservatively modeled with a 50% duty cycle, meaning the sources were active for 30 minutes per hour that the store was operating (4:00 am – 12:00 am). Both sources at the pick-up window (the driver and worker) were each modeled with a 25% duty cycle, i.e., speaking 15 minutes per hour.

Although idling cars associated with the drive-through do emit incremental noise and were included in the model, it is not a significant additional contributor to the above noise sources.

4.3 Parking Lot Noise

The traffic study[7] provided by the Client indicated the expected number of daytime and nighttime peak hour vehicle trips into the proposed project's parking lot. The study estimated 44 peak hour trips and 15 peak hour trips into the parking lot. While the number of these vehicles that used the drive-through was not explicitly defined, we conservatively modeled the project's parking lot with the highest number of hourly vehicles (i.e., 44 cars enter and leave the parking lot each hour) throughout the day while the store is expected to be operating (4:00 am – 12:00 am).

[7] *Memorandum, Re:Traffic Evaluation*, Kimley-Horn, June 2, 2023.

5 Modeled Existing Ambient Noise Environment

Figure 8 and Figure 9 show the daytime hourly "$L_{eq,d}$" and nighttime hourly "$L_{eq,n}$" noise contours respectively, for the area (at a 5-ft height), due to existing road traffic.

In general, the existing ambient sound levels are anticipated to be 56-61 dBA during daytime hours and 54 – 60 dBA during nighttime hours at receiving land uses along the south residential property lines. Table 3summarizes these levels.

6 Expected Noise Levels with Project

Figure 10 shows a 3D view of the acoustic model's geometry with the project in place. Terrain/elevation data is imported from Google Maps.

The resulting daytime and nighttime hourly noise contours are shown in Figure 11 and Figure 12, respectively. These represent the hourly sound levels with the coffee shop operating between the hours of 4:00 am and 12:00 am with the drive-thru speaker in use and people speaking at the order pick-up window.

Daytime and nighttime maximum noise levels due to the coffee shop operations are shown in Figure 13 and Figure 14.

7 Project Compliance Evaluation

The existing ambient and expected daytime and nighttime hourly levels with the project in place are provided below in Table 3 for selected receiver locations along the property lines (as shown in Figure 11 and Figure 12). Receivers were placed 5 feet from the existing CMU wall along the property line to minimize reflections and shadowing from the wall. Traffic noise from I-80 is the dominant noise source throughout the surrounding area.

For residential locations along the southern property line, levels are expected to increase by up to 0.5 dB, which is imperceptible to the human ear (see Section 10.1, Table 5) and within the Code's limit. This is considered a negligible increase and would have no impact on the residential land use to the south.

Table 3: Daytime and Nighttime Hourly Levels at Selected Receiver Locations along Residential Property Line

	Existing Ambient		Municipal Code Limit*		With Project		Change with Project	
Receiver Location	Daytime Leq,d (dBA)	Nighttime Leq,n (dBA)	Daytime Leq,d (dBA)	Nighttime Leq,n (dBA)	Daytime Leq,d (dBA)	Nighttime Leq,n (dBA)	Daytime Leq,d (dBA)	Nighttime Leq,n (dBA)
PL-1	58	55	61	58	59	55	0.4	0.5
PL-2	56	54	59	57	56	54	0.3	0.2
PL-3	61	60	64	63	61	60	0.1	0.1
PL-4	61	60	64	63	61	60	0.2	0.1
PL-5	61	60	64	63	61	60	0.1	0.1

** Daytime hourly 45 dBA and nighttime hourly 40 dBA, or Ambient + 3 dB, whichever is greater*

The expected maximum daytime and nighttime levels due to the project are provided below in Table 4. Maximum levels are expected to be well below the Code limits.

Table 4: Daytime and Nighttime Maximum Levels at Selected Receiver Locations along Residential Property Line

	Code Limit*		With Project	
Receiver Location	Daytime Lmax (dBA)	Nighttime Lmax (dBA)	Daytime Lmax (dBA)	Nighttime Lmax (dBA)
PL-1	70	65	27	27
PL-2	70	65	24	24
PL-3	70	65	26	26
PL-4	70	65	24	24
PL-5	70	65	22	20

8 Conclusion

Based on the above analysis, no mitigation is required for this project, and it is expected that this coffee shop with drive-through service will comply with the City's Municipal Code noise limits.

The conclusions and recommendations of this acoustical analysis are based upon the information known to 45dB Acoustics, LLC ("**45dB**") at the time the analysis was prepared, including but not limited to: proposed site plans; traffic volumes; proposed equipment and hours of operation; and reference noise level data. Any significant changes to these factors will require a reevaluation of the findings of this report. Additionally, any significant future changes in equipment, noise regulations or other factors beyond **45dB**'s control may result in long-term noise results different from those described by this analysis.

9 Figures

Figure 1: Site View (Google Maps)

Figure 2: Zoning Map

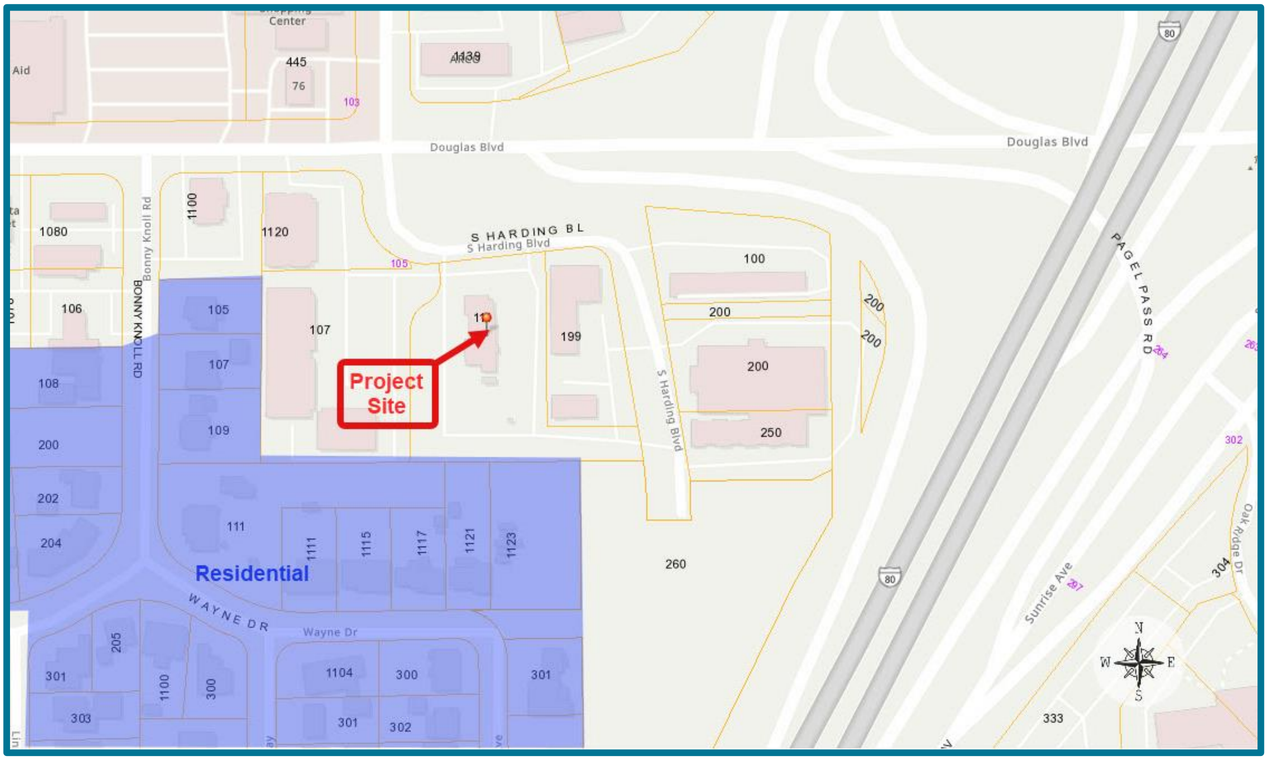

Figure 3: Project Site Plan (reprinted from client drawings)

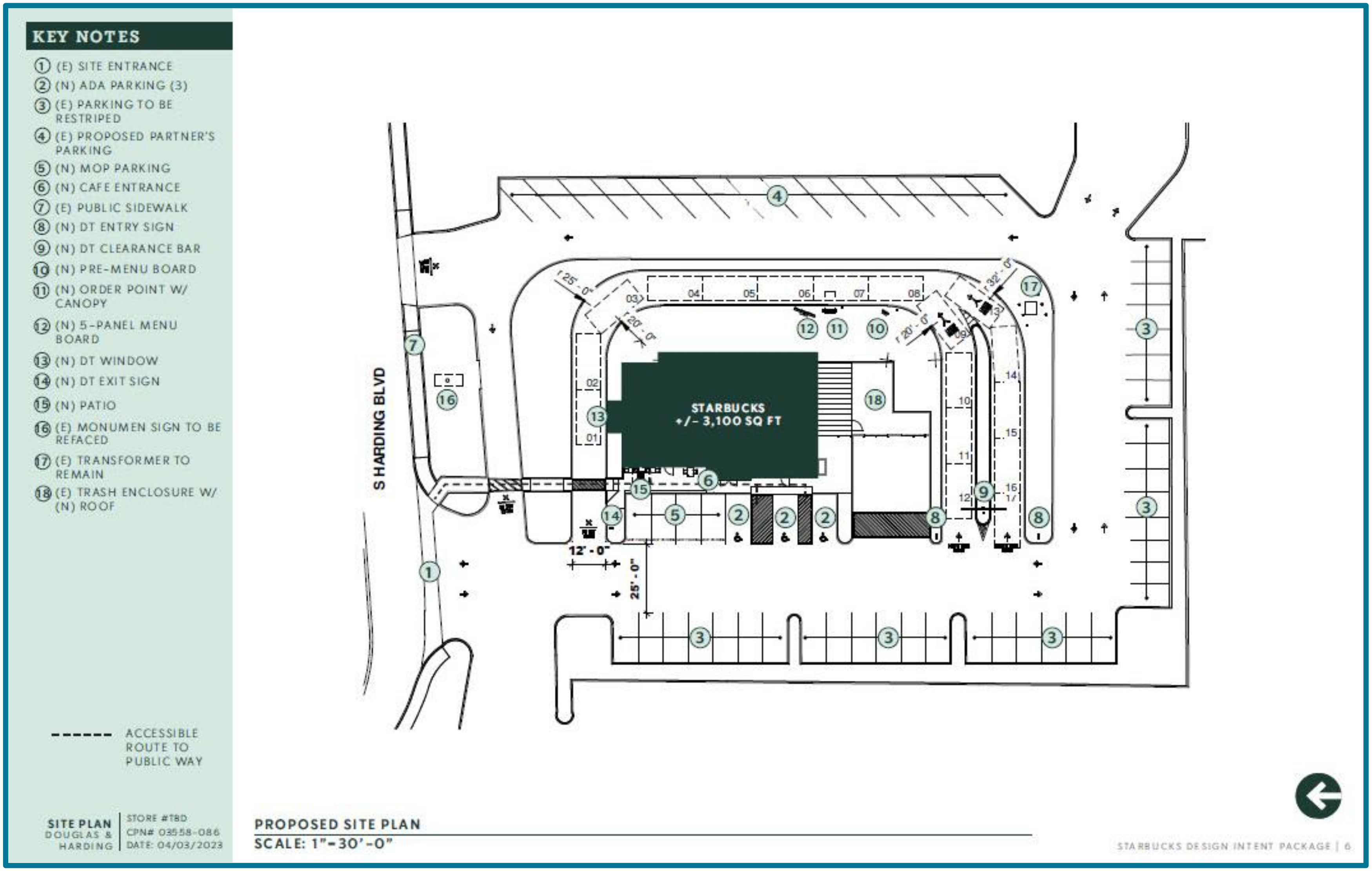

Figure 4: Existing Sound Level Measurement Locations

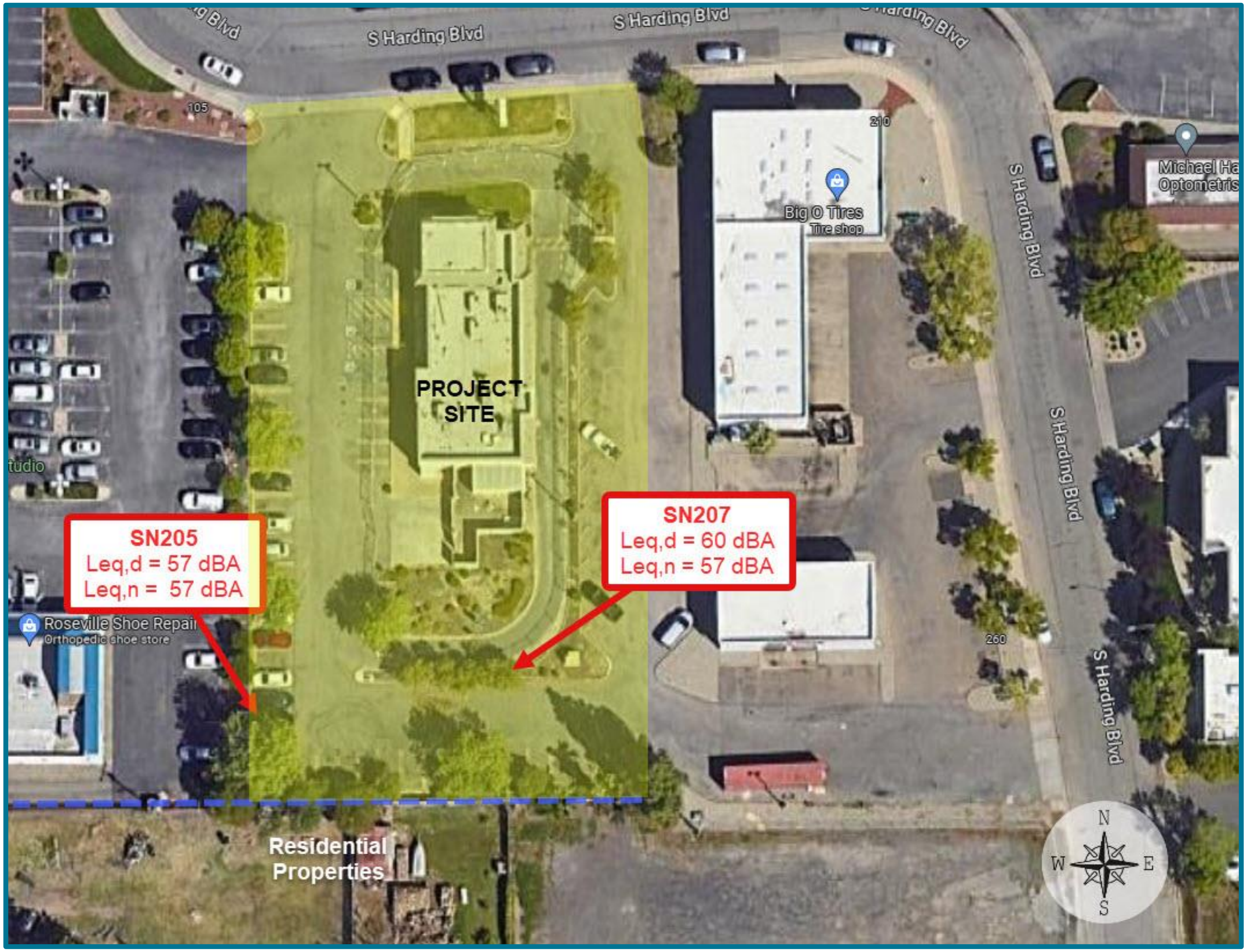

Figure 5: 24-Hour Measured Sound Levels

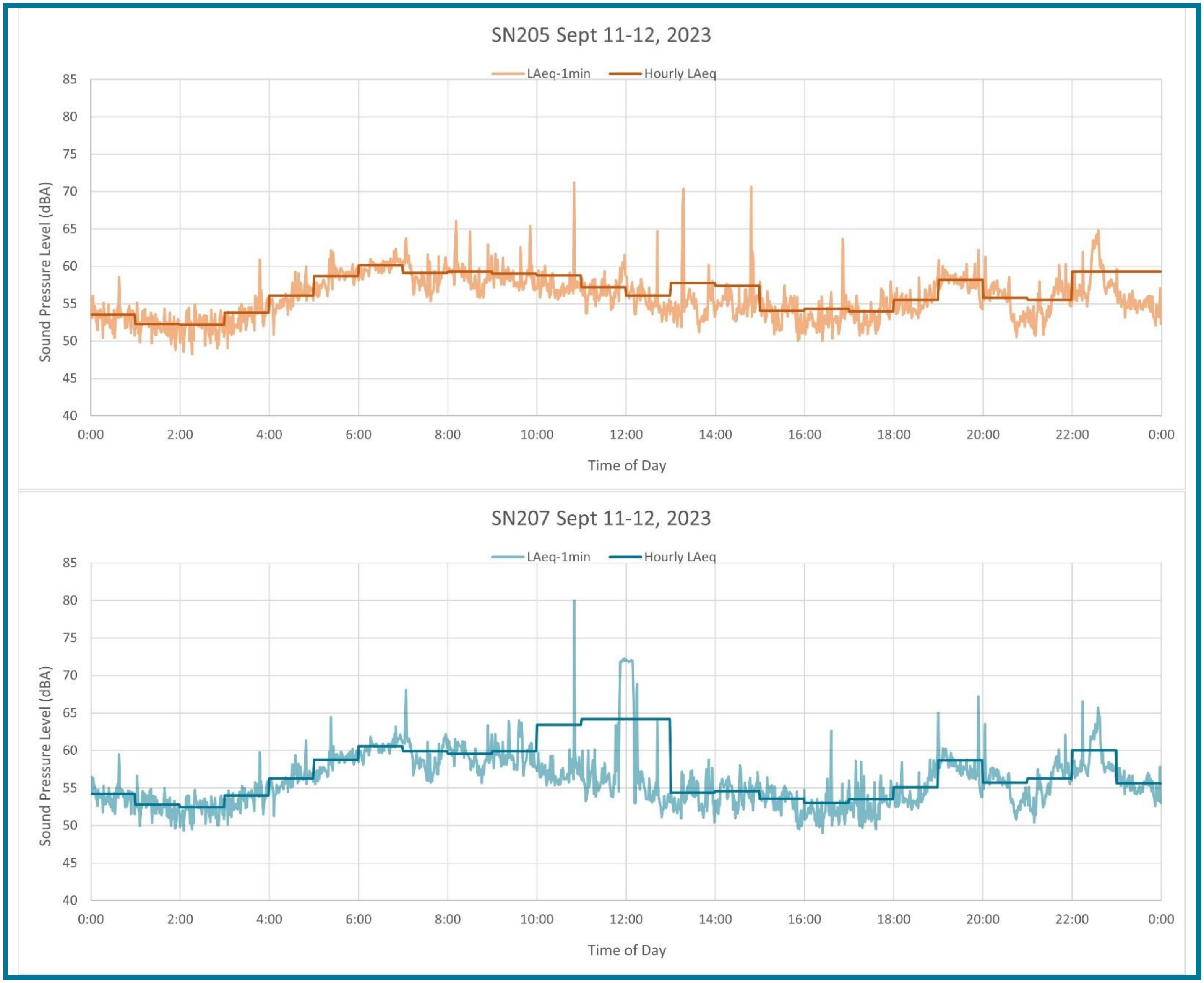

Figure 6: Local Weather Data, September 11-12, 2023 (as recorded at Sacramento International Airport)

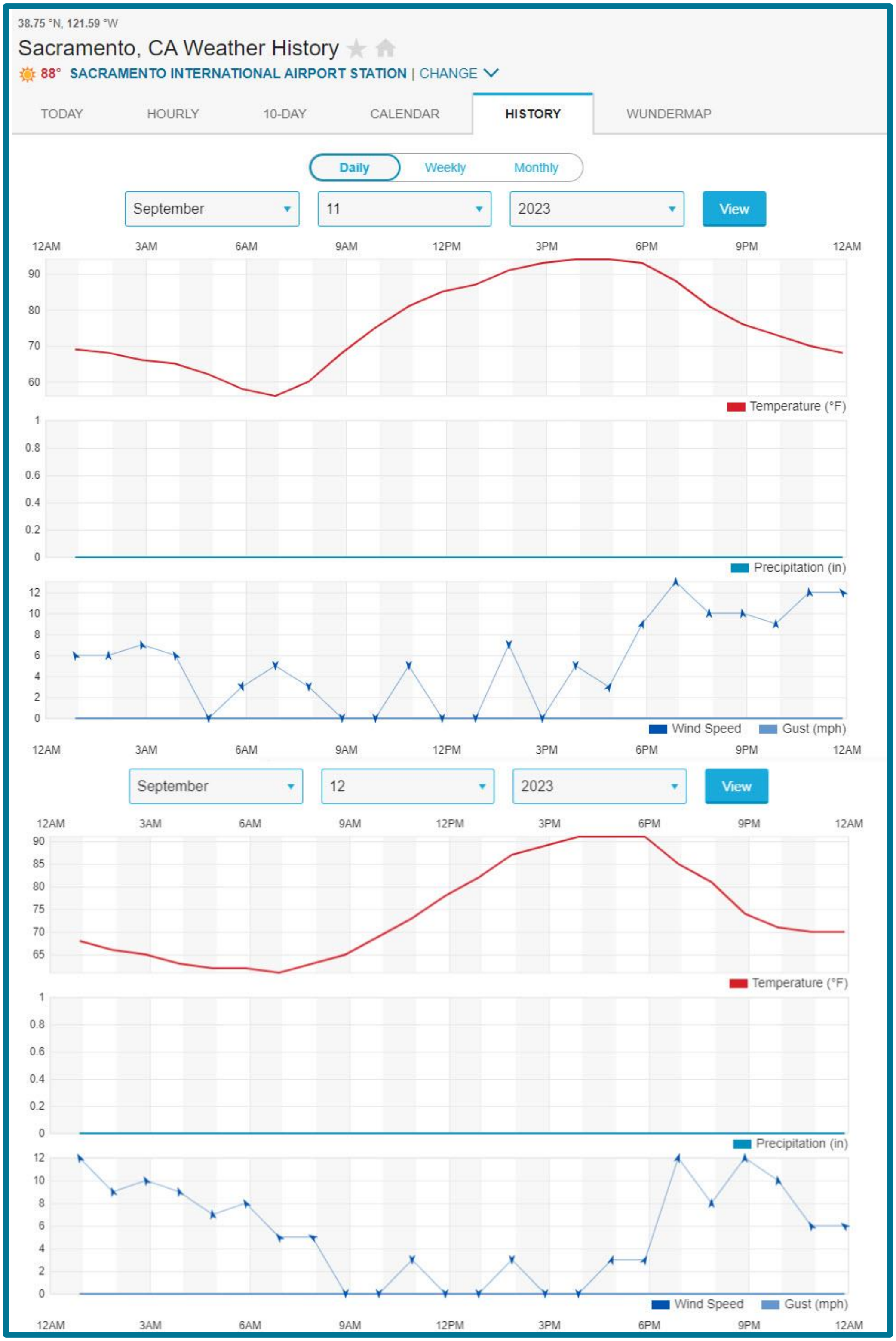

Figure 7: Sections 9.24.100 of the Roseville Municipal Code

Roseville, California Municipal Code

Title 9 HEALTH AND SAFETY

Chapter 9.24 NOISE REGULATION

Show All

9.24.100 Sound limits for sensitive receptors.

It is unlawful for any person at any location to create any sound, or to allow the creation of any sound, on property owned, leased, occupied or otherwise controlled by such person, which causes the exterior sound level when measured at the property line of any affected sensitive receptor to exceed the ambient sound level by three dBA or exceed the sound level standards as set forth in Table 1, by three dBA, whichever is greater.

Table 1
SOUND LEVEL STANDARDS
(for non-transportation or fixed sound sources)

Sound Level Descriptor	Daytime (7:00 a.m. to 10:00 p.m.)	Nighttime (10:00 p.m. to 7:00 a.m.)
Hourly l_{eq}, dB	50	45
Maximum level, dB	70	65

A. Each of the sound level standards specified in Table 1 shall be reduced by five dB for simple tone noises, consisting of speech and music. However, in no case shall the sound level standard be lower than the ambient sound level plus three dB.

B. If the intruding sound source is continuous and cannot reasonably be discontinued or stopped for a time period whereby the ambient sound level can be measured, the sound level measured while the source is in operation shall be compared directly to the sound level standards of Table 1. (Ord. 3638 § 1, 2001.)

Figure 8: Existing Ambient Daytime Hourly ($L_{eq,d}$) Sound Level Contours, Plan View

Figure 9: Existing Ambient Nighttime Hourly ($L_{eq,n}$) Sound Level Contours, Plan View

Figure 10: 3D Perspective of Acoustic Model Geometry

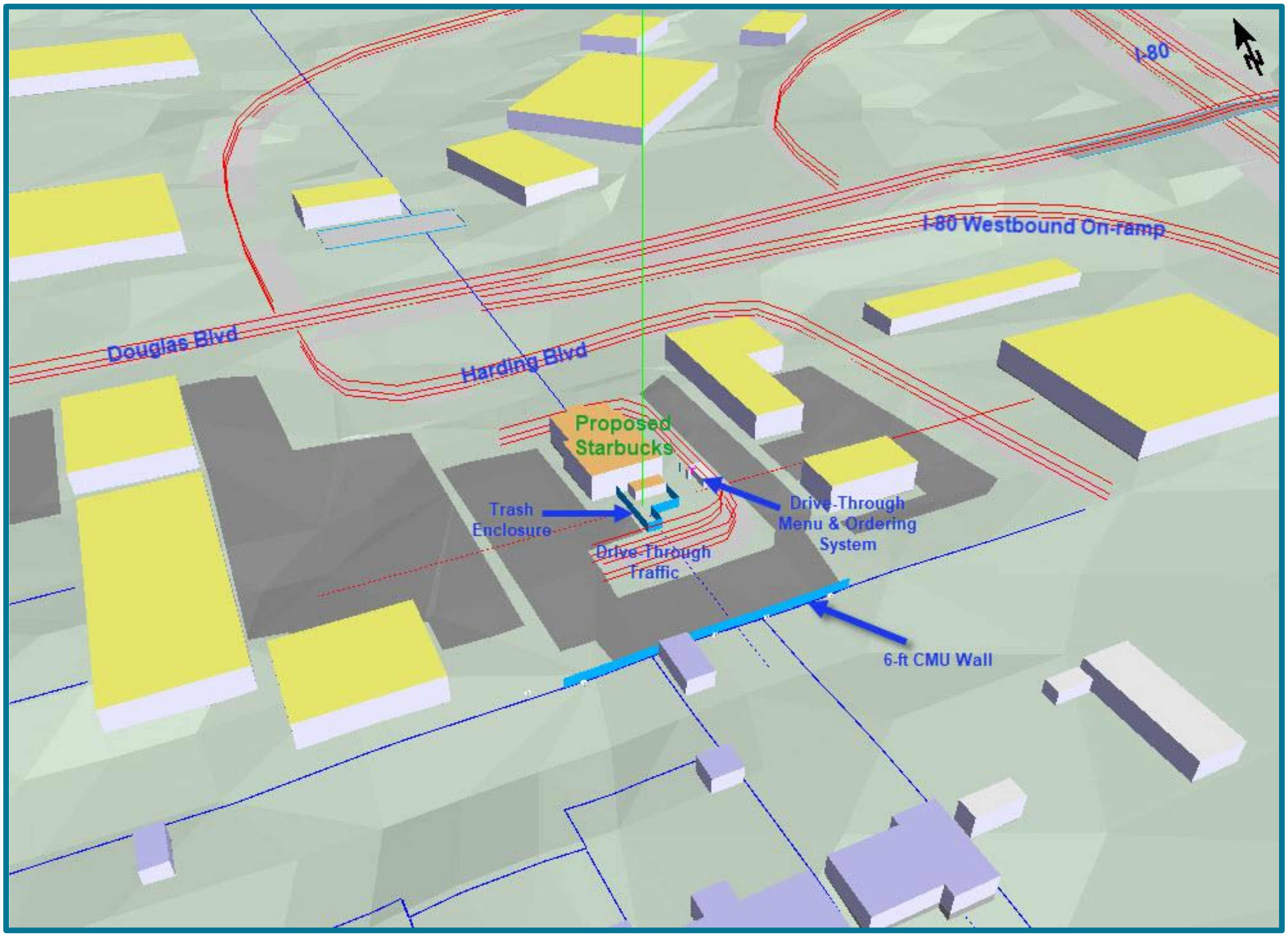

Figure 11: Project Daytime Hourly ($L_{eq,d}$) Sound Level Contours, Plan View

Figure 12: Project Nighttime Hourly ($L_{eq,n}$) Sound Level Contours, Plan View

Figure 13: Project Daytime Maximum (L_{max}) Sound Level Contours, Plan View

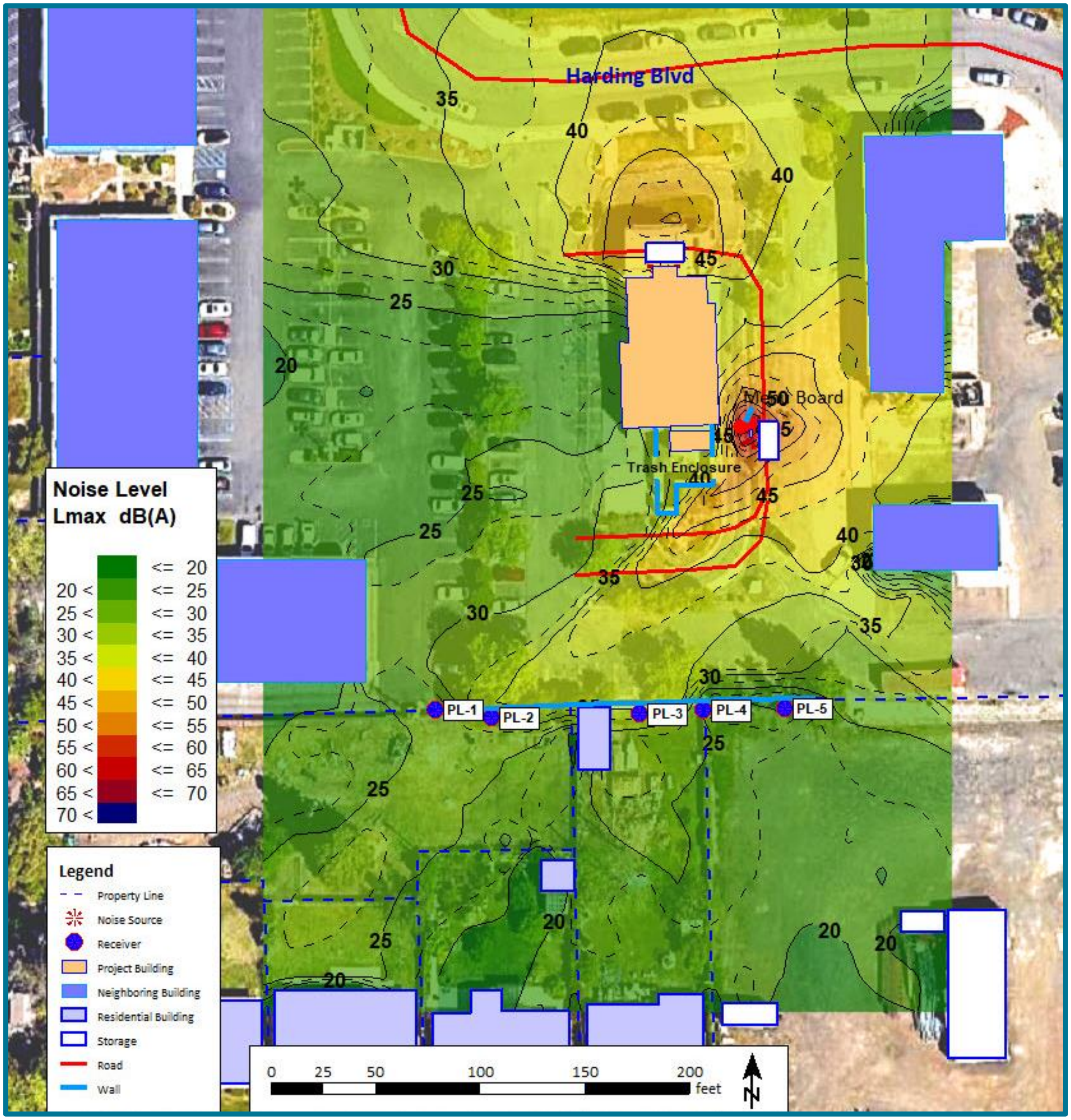

Figure 14: Project Nighttime Maximum (L_{max}) Sound Level Contours, Plan View

10 Appendix

10.1 Characteristics of Sound

When an object vibrates, it radiates part of its energy as acoustical pressure in the form of a sound wave. Sound can be described in terms of amplitude (loudness), frequency (pitch), or duration (time). The human hearing system is not equally sensitive to sound at all frequencies. Therefore, to approximate this human, frequency-dependent response, the A-weighted filter system is used to adjust measured sound levels. The normal range of human hearing extends from approximately 0 to 140 dBA. Unlike linear units such as inches or pounds, decibels are measured on a logarithmic scale, representing points on a sharply rising curve. Because of the physical characteristics of noise transmission and of noise perception, the relative loudness of sound does not closely match the actual amounts of sound energy. Table 5 below presents the subjective effect of changes in sound pressure levels.

Table 5: Sound Level Change Relative Loudness/Acoustic Energy Loss[8]

Change in Level	Relative Loudness	Acoustic Energy Loss
0 dB	Reference	0%
- 3 dB	Just Perceptible Change	50%
- 5 dB	Readily Perceptible Change	67%
- 10 dB	Half as Loud	90%
- 20 dB	1/4 as Loud	99%
- 30 dB	1/8 as Loud	99.9%

Sound levels are generated from a source and their decibel level decreases as the distance from that source increases. Sound dissipates exponentially with distance from the noise source. This phenomenon is known as spreading loss. Generally, sound levels from a point source will decrease by 6 dBA for each doubling of distance. Sound levels for a highway line source vary differently with distance because sound pressure waves propagate along the line and overlap at the point of measurement. A closely spaced, continuous line of vehicles along a roadway becomes a line source and produces a 3 dBA decrease in sound level for each doubling of distance. However, experimental evidence has shown that where sound from a highway propagates close to “soft” ground (e.g., plowed farmland, grass, crops, etc.), a more suitable drop-off rate to use is not 3.0 dBA but rather 4.5 dBA per distance doubling (FHWA 2010).

When sound is measured for distinct time intervals, the statistical distribution of the overall sound level during that period can be obtained. The L_{eq} is the most common parameter associated with such measurements. The L_{eq} metric is a single-number noise descriptor that represents the average sound level over a given period of time. For example, the L50 noise level is the level that is exceeded 50 percent of the time. This level is also the level that is exceeded 30 minutes in an hour. Similarly, the L02, L08 and L25 values are the noise levels that are exceeded 2, 8, and 25 percent of the time or 1, 5, and 15 minutes per hour. Other values typically noted during a

[8] Highway Traffic Noise Analysis and Abatement Policy and Guidance, U.S. Department of Transportation, Federal Highway Administration, Office of Environment and Planning, Noise and Air Quality Branch, June 1995.

noise survey are the L_{min} and L_{max}. These values represent the minimum and maximum root-mean-square noise levels obtained over the measurement period.

Because community receptors are more sensitive to unwanted noise intrusion during the evening and at night, State law requires that, for planning purposes, an artificial dB increment be added to quiet-time noise levels in a 24-hour noise descriptor called the CNEL or L_{dn}. This increment is incorporated in the calculation of CNEL or L_{dn}, described earlier.

10.2 Terminology/Glossary

A-Weighted Sound Level (dBA)
The sound pressure level in decibels as measured on a sound level meter using the internationally standardized A-weighting filter or as computed from sound spectral data to which A-weighting adjustments have been made. A-weighting de-emphasizes the low and very high frequency components of the sound in a manner similar to the response of the average human ear. A-weighted sound levels correlate well with subjective reactions of people to noise and are universally used for community noise evaluations.

Air-borne Sound
Sound that travels through the air, differentiated from structure-borne sound.

Ambient Sound Level
The prevailing general sound level existing at a location or in a space, which usually consists of a composite of sounds from many sources near and far. The ambient level is typically defined by the L_{eq} level.

Background Sound Level
The underlying, ever-present lower-level noise that remains in the absence of intrusive or intermittent sounds. Distant sources, such as Traffic, typically make up the background. The background level is generally defined by the L90 percentile noise level.

Community Noise Equivalent Level (CNEL)
The L_{eq} of the A-weighted noise level over a 24-hour period with a 5-dB penalty applied to noise levels between 7 p.m. and 10 p.m. and a 10-dB penalty applied to noise levels between 10 p.m. and 7 a.m. CNEL is similar to L_{dn}.

Day-Night Sound Level (DNL or L_{dn})
The L_{eq} of the A-weighted noise level over a 24-hour period with a 10-dB penalty applied to noise levels between 10 p.m. and 7 a.m. L_{dn} is similar to CNEL.

Decibel (dB)
The decibel is a measure on a logarithmic scale of the magnitude of a particular quantity (such as sound pressure, sound power, sound intensity) with respect to a reference quantity.

DBA or dB(A)
A-weighted sound level. The ear does not respond equally to all frequencies, and is less sensitive at low and high frequencies than it is at medium or speech range frequencies. Thus, to obtain a single number representing the sound level of a noise containing a wide range of frequencies in a manner representative of the ear's response, it is necessary to reduce the effects of the low and

high frequencies with respect to the medium frequencies. The resultant sound level is said to be A-weighted, and the units are dBA. The A-weighted sound level is also called the noise level.

Energy Equivalent Level (L_{eq})
Because sound levels can vary markedly in intensity over a short period of time, some method for describing either the average character of the sound or the statistical behavior of the variations must be utilized. Most commonly, one describes ambient sounds in terms of an average level that has the same acoustical energy as the summation of all the time-varying events. This energy-equivalent sound/noise descriptor is called L_{eq} . In this report, an hourly period is used.

Field Sound Transmission Class (FSTC)
A single number rating similar to STC, except that the transmission loss values used to derive the FSTC are measured in the field. All sound transmitted from the source room to the receiving room is assumed to be through the separating wall or floor-ceiling assembly.

Noise Reduction (NR)
Noise reduction is the difference between outdoor sound level and indoor sound level. It is not identical to Sound Transmission Class.

Outdoor-Indoor Transmission Class (OITC)
A single number classification, specified by the American Society for Testing and Materials (ASTM E 1332 issued 1994), that establishes the A-weighted sound level reduction provided by building facade components (walls, doors, windows, and combinations thereof), based upon a reference sound spectrum that is an average of typical air, road, and rail transportation sources. The OITC is the preferred rating when exterior façade components are exposed to a noise environment dominated by transportation sources. Once built, as much as a 5-point reduction in Apparent Outside-Inside Transmission Class (OITC) from the original, as-designed OITC may be expected.

Percentile Sound Level, Ln
The noise level exceeded during *n* percent of the measurement period, where *n* is a number between 0 and 100 (e.g., L10 or L90)

Sound Transmission Class (STC)
STC is a single number rating, specified by the American Society for Testing and Materials, which can be used to measure the sound insulation properties for comparing the sound transmission capability, in decibels, of interior building partitions for noise sources such as speech, radio, and television. It is used extensively for rating sound insulation characteristics of building materials and products.

Structure-Borne Sound
Sound propagating through building structure. Rapidly fluctuating elastic waves in gypsum board, joists, studs, etc.

Sound Exposure Level (SEL)
SEL is the sound exposure level, defined as a single number rating indicating the total energy of a discrete noise-generating event (e.g., an aircraft flyover) compressed into a 1-second time duration. This level is handy as a consistent rating method that may be combined with other SEL and L_{eq} readings to provide a complete noise scenario for measurements and predictions.

However, care must be taken in the use of these values since they may be misleading because their numeric value is higher than any sound level which existed during the measurement period.

Subjective Loudness Level
In addition to precision measurement of sound level changes, there is a subjective characteristic which describes how most people respond to sound:

- A change in sound level of 3 dBA is *barely perceptible* by most listeners.
- A change in level of 6 dBA is *clearly perceptible*.
- A change of 10 dBA is perceived by most people as being *twice* (or *half*) as loud.

10.3 SoundPLAN® Acoustics Software

SoundPLAN®, the software used for this acoustic analysis, is an acoustic ray-tracing program dedicated to the prediction of noise in the environment. Noise emitted by various sources propagates and disperses over a given terrain in accordance with the laws of physics. The software calculates sound attenuation of environmental noise, even over complex terrain, uneven ground conditions, and with complex obstacles. Up to three reflections for each noise source are taken into account to closely and accurately predict real-world acoustics. Worldwide, governments and engineering associations have created algorithms to calculate acoustical phenomena to standardize the assessment of physical scenarios. Accuracy has been validated in published studies to be + / - 2.7 dBA with an 85% confidence level, for a wide variety of large-scale models and situations.

10.4 ISO 9613-2

For industrial and other noise sources besides road traffic, SoundPLAN calculates the sound field in accordance with ISO 9613-2 "Acoustics - Attenuation of sound during propagation outdoors, Part 2: General Method of Calculation." The standard states that "this part of ISO 9613 specifies an engineering method for calculating the attenuation of sound during propagation outdoors, in order to predict the levels of environmental noise at a distance from a variety of sources. The method predicts the equivalent continuous A-weighted sound pressure level under meteorological conditions favorable to propagation from sources of known sound emissions. These conditions are for downwind propagation under a well-developed moderate ground-based temperature inversion, such as commonly occurs at night." The uncertainty of calculations with this method are +/-1 dB for sources less than 10m in height and within 1000m of the receiver.

10.5 Traffic Noise Model (TNM)

The Federal Highway Administration Traffic Noise Model (TNM), implemented into the SoundPLAN® software, was used for the road traffic sound level modeling in this study. TNM contains the following components:

1. Modeling of five standard vehicle types, including automobiles, medium trucks, heavy trucks, buses, and motorcycles, as well as user-defined vehicles.
2. Modeling both constant- and interrupted-flow traffic using a field-measured database.
3. Modeling effects of different pavement types, as well as the effects of graded roadways.
4. Sound level computations based on a one-third octave-band data base and algorithms.

5. Graphically-interactive noise barrier design and optimization.
6. Attenuation over/through rows of buildings and dense vegetation.
7. Multiple diffraction analysis.
8. Parallel barrier analysis.
9. Contour analysis, including sound level contours, barrier insertion loss contours, and sound-level difference contours.

These components are supported by a scientifically founded and experimentally calibrated acoustic computation methodology, as well as a flexible database, made up of over 6000 individual pass-by events measured at forty sites across the country.