



March 21, 2025
45dB Project 24018

Project & Address: St. Therese Classical Academy 5073 Hollister Ave. Santa Barbara, CA 93111	Planner: CAM Land Use & Development Craig Minus craigminus@camlanduse.com	Client: St. Therese Classical Academy Attn: Matthew A. Najera, Headmaster mnajera@stclassical.com 5073 Hollister Ave. Santa Barbara, CA 93111
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Summary

45dB Acoustics LLC (“45dB”) has conducted an acoustical analysis of the proposed school activities for the St. Therese Classical Academy at the above address in Santa Barbara, CA. This analysis incorporates measured existing noise levels and published traffic counts input into a 3D noise propagation model (SoundPLAN®) along with expected sound levels for the proposed school activities. The potential impact of noise from the proposed school activities and the anticipated construction activity at nearby receiving land uses was evaluated in comparison to the existing noise environment.

Existing noise levels were measured and modeled for the site, including traffic from Hollister Ave and the school chime. The principal noise sources associated with the proposed school activities – children playing/talking outdoors, school bells, and pick-up and drop-off traffic – and outdoor amplified music events were added and compared to the maximum exterior noise level limits specified in the Santa Barbara County Noise Element and Environmental Thresholds and Guidelines Manual. Based on our analysis, levels at the neighboring residential properties are not expected to exceed Community Noise Equivalent Level, CNEL 65 dBA with less than 1 dB impact on the existing CNEL.

No mitigation is required for the proposed school activities associated with this project and, assuming all weekday activities occur during daytime and evening hours (between 7:00am and 10:00pm), it is expected that the proposed school and its expected activities will comply with the County’s noise limits. Outdoor events with amplified music held in the courtyard will also comply if the music is no louder than 75 dBA (at 10 feet), the event is held for no more than three hours, and it ends by 8:00 pm.

Construction noise and vibration are expected to be short-term and less than significant if proper mitigation is implemented. Recommendations for noise management include construction of a temporary construction noise barrier at the perimeter of the construction site and limiting the operation of heavy construction equipment to three or six hours per day, depending on the type of equipment used (only between the hours of 8:00am and 5:00pm).

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Introduction

This sound level assessment is intended to determine the potential noise impacts associated with the expected school activities at the proposed St. Therese Classical Academy in unincorporated Santa Barbara, California. The following topics are presented in this report in response to the County's requirements for exterior noise levels, as identified by the County's Noise Element and Environmental Thresholds and Guidelines Manual. 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 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 5073 Hollister Ave. in Santa Barbara, CA. The Project's location is shown in Figure 1, highlighted in yellow. All surrounding land uses are "Residential"¹.

The site plan, provided by the Client, is shown in Figure 2. The proposed school buildings (outlined in red) will be located to the south of the existing church buildings. The Client communicated on November 21, 2024, that building "A" (located closest to the south property line) will be shifted 10 feet to the west. Two additional church buildings (outlined in dashed blue lines) may be constructed in the future, however they were not included in this analysis.

We understand that normal operating hours for the school will be between 8:00am and 3:30pm on weekdays with a maximum of 85 students and 13 staff members. Student drop-off would occur between 7:30am and 8:10am and pick-up would be between 2:50pm and 3:20pm. The school will also host several evening and weekend events, which are considered as part of this analysis. Weekday evening events would have up to 20 people attending between 7:00 and 8:00pm. Weekend events include a barn dance with amplified music held in the courtyard with up to 150 attendees held between 5:00 and 8:00pm and a graduation ceremony, held indoors, with 100 attendees and 13 staff members, between 3:00 and 5:00pm.

Construction activity is anticipated to include light grading, pouring concrete, and trenching for electrical near the new modular classroom buildings.

¹ County of Santa Barbara, Planning & Development, Land Use Designation/Zoning Map.
<https://www.countyofsb.org/160/Planning-Development>

1 Regulatory Setting

1.1 Local Regulation

1.1.1 Code of Ordinances

The Santa Barbara County Code of Ordinances² describes the various types of noise, including amplified sounds and music, that are prohibited during nighttime hours, which are between 10pm and 7am on Sunday through Thursday and between midnight and 7am on Friday and Saturday.

1.1.2 Environmental Thresholds and Guidelines

Although the County Code of Ordinances does not specify any noise limits, the Santa Barbara County Environmental Thresholds and Guidelines Manual³, Section 13.B.3 (reprinted in Figure 3), specifies thresholds for determining noise impact at sensitive receptors.

1.1.2.1 Project Noise

For locations such as the residential properties surrounding the proposed school site where existing exterior noise levels are less than CNEL 65 dBA, the project cannot generate noise that would cause those levels to exceed CNEL 65 dBA. Existing interior noise levels at these sensitive receptors should also not increase the CNEL by more than 3 dB.

The Community Noise Equivalent Level, “CNEL”, is a 24-hour equivalent level that includes a 5 dB penalty for evening (7 – 10pm) hourly levels and a 10 dB penalty for nighttime (10pm – 7am) hourly levels. CNEL and L_{dn} (or DNL) typically agree within 1 dB and are considered approximately equivalent in this study. (See the Appendix for more background information about sound levels.)

1.1.2.2 Construction Noise

Because the proposed project is located up to 1,600 feet of residential properties, grading and construction noise may have a significant impact and evaluation is required. Mitigation may include limitations on construction hours and noise barriers to attenuate noise generated by construction equipment.

The County’s Noise Thresholds suggest that construction equipment with hourly noise levels up to 95 dBA L_{eq} are allowable during weekday hours, however due to the proximity of the closest residential properties (located up to 25-feet from the construction site), additional mitigation may be required. A detailed analysis is included in Section 7.

² Santa Barbara County Code of Ordinances, Section 40-2.

https://library.municode.com/ca/santa_barbara_county/codes/code_of_ordinances?nodeId=CH40NINORE_S40-2NOPR

³ Santa Barbara County Environmental Thresholds and Guidelines Manual, January. 2021.

https://www.sblafco.org/files/f2915ea5d/Information_Item_No_1_Attachment_B_Environmental_Thresholds_Amended_January_2021.pdf

1.1.3 Noise Element

The Santa Barbara County Noise Element⁴ states that exterior noise levels at the property lines of sensitive receptors, such as residential properties, cannot exceed a Day-Night level (“ L_{dn} ”) of 65 dBA.

2 Site Measurements

2.1 Existing Ambient Noise Level Measurements

Sound levels (L_{eq} , L_{max} , L_{min} , etc.) were measured by **45dB** at two locations near the project site, shown in Figure 4, for more than a 24-hour period between 6:30pm on May 23 and 2:30pm on May 25, 2024. Type/Class 2 calibrated sound level meters and calibrators were utilized. Calculation of the $L_{eq,d}$ (daytime), $L_{eq,e}$ (evening), and the $L_{eq,n}$ (nighttime) sound levels are based on 1-sec L_{eq} measurement data. Church activities were minimal/negligible for the measurement period, and as such, this is considered a representative measurement of the site ambient.

The hourly measured 24-hour sound levels for both locations are shown in Figure 5. The northwest location (“S2”) had daytime hourly levels ($L_{eq,d}$) of 53 dBA and the southeast location (“S1”) had daytime hourly levels of 50 dBA. See Table 2 in Section 3, below, for more detail and comparison to modeled levels.

Local weather was clear without precipitation, low/no winds, with temperatures in the mid 70’s Fahrenheit.

2.2 School Chime Measurement

Sound levels (L_{eq} , L_{max} , L_{min} , etc.) for the school chimes were measured by **45dB** on the morning of November 21, 2024. A Type/Class 2 calibrated sound level meter and calibrator was utilized. The chimes were measured at approximately 11:00am, which had an average sound level (L_{eq}) of 87 dBA at a distance of 6 feet, with a maximum sound level of 98 dBA. Each chime had a duration of approximately 6-8 seconds, with two chimes occurring every hour. See Figure 6 for a time series showing the measured sound levels. The chime’s measured sound levels were incorporated into the model for a typical school day, as discussed below in Section 3.2.

3 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 standards—for road traffic, this model utilizes the Federal Highway Administration’s Traffic Noise Model (TNM), and for other sources such as the school bell, 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, and potential adjustment by, the calculated noise levels due to the Project’s

⁴ Santa Barbara County Noise Element, May 2009.
<https://cosantabarbara.app.box.com/s/3yex3g6a5vex3cjpklxbxglpgvzp9kly>

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, for direct comparison to the applicable regulations.

3.1 Traffic Noise

The 3D outdoor 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 Hollister Ave. were obtained from the County of Santa Barbara Department of Traffic Operations⁵. Bus counts were also included for Douglas Blvd, based on the Santa Barbara MTD⁶ (routes #6 and #11) bus schedules. 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 2024 Projections

Road	Published AADT	Year	Years to Project	2024 AADT Projection with 1% Annual Growth
Hollister Ave.	14,231	2023	1	14,373

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, actual traffic counts may vary from this annualized average. Field measurements conducted by **45dB**, as discussed in Section 2, are expected to be generally representative of the expected sound levels at this location. The modeled traffic on Hollister Ave. was reduced slightly so that the existing ambient CNEL, daytime, and evening levels at these locations agreed within 1 dB of the measured levels. Minor differences can be attributed to slight variations in daily traffic.

Table 2: Comparison of May 23-25, 2024, Measured Levels with Predicted/Modeled Daytime and Nighttime Hourly Levels at Project Site

Receiver Location	Measured				Predicted/Modeled			
	CNEL / DNL (dBA)	Daytime Hourly Leq,d (dBA)	Evening Hourly Leq,e (dBA)	Nighttime Hourly Leq,n (dBA)	CNEL / DNL (dBA)	Daytime Hourly Leq,d (dBA)	Evening Hourly Leq,e (dBA)	Nighttime Hourly Leq,n (dBA)
S1	55	50	50	49	56	51	51	49
S2	57	53	51	50	57	52	51	50

⁵ County of Santa Barbara, County of Traffic Operations, *Engineering and Traffic Surveys (Speed Zones)*. <https://www.countyofsb.org/2126/Traffic-Operations>

⁶ Santa Barbara MTD, Bus schedules. (Accessed June 2024) <https://sbmtd.gov/>

3.2 Expected School Activity Noise Sources

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

- **Parking Lot Activity**
 - On weekdays between 7:00am – 9:00pm, modeled with parking activity for staff and parents throughout the day and in the evenings.
 - On weekends between 2:00 – 9:00pm, modeled with parking activity for event attendees throughout the event time.
- **Student Drop-off and Pick-up Vehicle Noise** – modeled as multiple car doors slamming shut near the southwest corner of the parking lot.
 - On weekdays, between 7:30 – 8:30am and 2:30 – 3:30pm.
 - On weekends for events, between 2:00 – 9:00pm.
- **School Chime** – modeled as a point source (on weekdays) with the following properties: a sound power level of 103 dBA (which would have a sound level of 87 dB at 6 feet from the source – as based upon **45dB**'s site measurements) with a maximum sound power of 113 dBA. The modeled chimes ring for a total of 14 seconds each hour between 7:00am and 3:00pm at a height of 3 feet above ground and are located near the southwest corner of the proposed school buildings.
- **Outdoor Activities** – modeled as groups of people talking outdoors in the areas between the proposed school buildings and west of the existing church buildings
 - On weekdays, for 30 minutes at 8:00am for student drop-off, 1 hour at 12:00pm for recess, 30 minutes at 3:00pm for student pick-ups, and 30 minutes in the evenings (between 5:00 and 9:00 pm) for evening events.
 - On weekends for events, between 2:00 – 9:00pm (only near the drop off area).
 - The Barn Dance included a group of 150 people in the courtyard west of the existing church buildings between 5:00 – 8:00pm.
- **Barn Dance Outdoor Amplified Music** – modeled as two directional point sources to represent loudspeakers directed towards the north property line (away from the nearby residences).
 - An initial setting was used the event sources (i.e., loudspeakers) to represent typical amplified music for events in the proposed event area, which is based upon our experience and knowledge of sound levels for these types of events. Please see Appendix, Section 10.1.
 - A particular change—either increase or decrease—of a noise source will result in the same decibel change at a receiver location for a given geometrical setup, including terrain, buildings, etc., assuming other noises can be neglected. Once the resulting levels at the property line are determined, conclusions may be drawn about the compliance of the levels occurring *at the event* and adjusted upward or

downward in order to determine levels that should not be exceeded *at the event* in order to remain compliant with the Code limits *at the specified property lines*.

- For each outdoor event area, a source with average sound pressure level (L_{eq}) of 75 dBA, as measured at a distance of 10 feet (3 meters), was included in the model to represent an amplified music group performance that is slightly quieter than a typical wedding or dinner-dance band, where attendees must raise their voices slightly to converse while standing 10ft from the loudspeakers/source. Table 8 in the Appendix has a general description of sound levels in different scenarios to help in understanding the levels discussed in this report.
- Loudspeakers are conservatively placed at a height of 6 feet (1.8 meters) in our model; this represents the center of the loudspeaker/PA system. L_{max} levels (generally an “instantaneous” 1-second L_{eq}) can be approximately 15 dB higher than the average sound levels.

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

4 Modeled Existing Ambient Noise Environment

Figure 8 shows the existing CNEL noise contours for the area (at a 5-ft height) due to road traffic. In general, the existing ambient sound levels along the property lines are anticipated to range between CNEL 51 – 60 dBA at various project property line locations adjacent to/shared with the residential property lines. Table 3 summarizes these levels.

5 Expected Noise Levels with Project

Figure 7 shows a 3D view of the acoustic model’s geometry with the proposed school buildings and activities in place. Terrain/elevation data is imported from Google Maps. Figure 8 shows the noise contours of the existing site without the project in place.

5.1 Typical School Day with Evening Events

The resulting noise contours for a typical school day and an evening event with the project in place are shown in Figure 9. These represent the sound levels with the expected school activities occurring between 7:30am and 3:30pm and an evening event between 5:00 and 9:00pm.

5.2 Weekend Event with Amplified Music

The resulting noise contours for a large outdoor weekend event (Barn Dance) having amplified music with the project in place are shown in Figure 10. These represent the sound levels with the outdoor event occurring between 5:00 and 8:00pm with up to 150 attendees and amplified music having a sound level of 75 dBA, as measured at distance of 10 feet in front of the stage.

Loudspeakers are positioned to direct sound towards the north.

6 Project Compliance Evaluation

The existing ambient CNEL, daytime, evening, and nighttime hourly levels are provided below in Table 3 for selected receiver locations along the property lines (as shown in Figure 8). Traffic noise from Hollister Ave. is the dominant noise source throughout the surrounding area.

The CNEL, daytime, evening, and nighttime hourly levels for a typical school day (with evening events) and the weekend Barn Dance event are provided in Table 4. A typical school day (without an evening event) and a weekend event held indoors (such as graduation) are expected to have lower levels than the levels shown in Table 4.

For residential locations along the property lines, CNEL levels are expected to remain below CNEL/ L_{dn} 65 dBA and should not increase by more than 1 dB on a CNEL basis. This applies to all expected events for the school, which include typical school days, school days with evening events, a weekend graduation event, and weekend events with amplified music having a sound level no greater than 75 dBA (as measured at 10 feet). For context, a level of 75dBA still allows for the audience/patrons to be able to carry on a close conversation with a slightly raised voice but not yelling when standing in front of the stage/speakers.

Of course, on a typical school day, the school bell and other related sounds would be audible at times; however, the CNEL increase is considered a negligible increase and would not have a significant impact on the surrounding residential land uses because they are short-term noises. However, although there are no restrictions on the L_{max} levels, we note that the maximum noise levels experienced at the property lines during an outdoor event with amplified music will be more noticeable at the neighboring residential properties. Since this event is only held once per year, we recommend discussing this with the neighboring residents.

Table 3: Existing Noise Levels at Selected Locations Along Residential Property Lines

Receiver ID (at Property Lines)	CNEL / L_{dn} (dBA)	Daytime Hourly Leq,d (dBA)	Evening Hourly Leq,e (dBA)	Nighttime Hourly Leq,n (dBA)
PL1	60	55	54	53
PL2	57	52	51	50
PL3	55	50	50	48
PL4	52	47	47	45
PL5	54	49	48	47
PL6	55	50	49	48
PL7	51	47	46	44
PL8	52	47	46	45
PL9	55	51	49	48
PL10	58	54	53	51

Table 4: Expected Noise Levels at Selected Receiver Locations for a Typical School Day and Weekend Outdoor Events with Amplified Music

Receiver ID (at Property Lines)	Expected Levels with Typical Weekday School Activities and Evening Events					Expected Levels with Weekend Event Having Outdoor Amplified Music				
	CNEL / Ldn (dBA)	Daytime Hourly Leq,d (dBA)	Evening Hourly Leq,e (dBA)	Nighttime Hourly Leq,n (dBA)	L _{max} (dBA)	CNEL / Ldn (dBA)	Daytime Hourly Leq,d (dBA)	Evening Hourly Leq,e (dBA)	Nighttime Hourly Leq,n (dBA)	L _{max} (dBA)
PL1	60	55	55	53	57	60	55	55	53	54
PL2	57	52	51	50	58	57	52	52	50	54
PL3	56	51	51	49	60	56	52	52	49	59
PL4	53	49	48	45	57	53	49	49	45	54
PL5	54	50	49	46	58	54	51	51	46	59
PL6	56	52	51	48	63	56	53	53	48	63
PL7	51	47	45	43	62	51	47	46	43	54
PL8	53	49	48	45	63	53	49	49	45	57
PL9	55	51	50	48	55	56	53	54	48	67
PL10	59	54	53	51	54	59	56	57	51	69

7 Construction Noise

7.1 Potential Activities

Construction of the project would generate noise that *may* temporarily increase noise levels at nearby residential receivers and other sensitive receptors. Noise impacts resulting from construction depend on the noise generated by various pieces of construction equipment operating on site, the timing and duration of noise generating activities, and the distance between construction noise sources and noise sensitive receptors.

Construction activity is only anticipated to include light grading, pouring concrete, and trenching for electrical near the new modular classroom buildings. Building framing, excavation, paving, blasting, and pile-driving are not expected for this project.

Although this construction is not a large-scale project and will only occur over a short duration of time, some heavy construction equipment is anticipated be required, as shown in Table 5, below.

Table 5: Large Equipment Used for Construction

Scope of Work	Anticipated Large Equipment
Grading	Dump Truck, Dozer, Backhoe
Utilities	Backhoe, Mini Excavator
Foundations and Pads	Concrete Mixer Truck, Concrete Pump

7.1.1 Expected Noise Levels

Short-term construction activities for a project of this scope can generate moderate noise levels, even when a limited amount of heavy equipment is used. For the construction equipment expected to be used at this Project, the typical hourly average noise levels generated can range

from about 76 dBA to 82 dBA L_{eq} , measured at a distance of 50 feet from the center of the construction area.

Construction-generated noise levels generally drop off at a rate of about 6 dBA per doubling of distance between the source and receptor. Shielding by buildings or terrain will result in lower construction noise levels at distant receptors.

Noise impacts resulting from construction depend on the noise generated by various pieces of construction equipment, the timing and duration of noise generating activities, and the distance between construction noise sources and noise sensitive receptors. Construction noise impacts primarily occur when construction activities are during noise-sensitive times of the day (early morning, evening, or nighttime hours), when construction occurs in areas immediately adjoining noise sensitive land uses, or when construction durations last over extended periods of time. Specific sound levels from the construction equipment anticipated to be used for this project are shown below in Table 6.

Table 6: Noise Levels for Construction Equipment Operations at Specified Distances

Equipment	Typical Noise Levels					
	25ft from Source	50ft from Source	400ft from Source	800ft from Source	1,000ft from Source	1,600ft from Source
Backhoe	84	78	60	54	52	48
Concrete Mixer	85	79	61	55	53	49
Bulldozer	88	82	64	58	56	52
Notes: 1) Noise levels are based on actual maximum measured noise levels at 50 feet (L_{max}). 2) Noise levels assume a noise attenuation rate of 6 dBA per doubling of distance.						
Source: FHWA Roadway Construction Noise Model (2006) Users Guide Table 1.						

For this project, where some project buildings are located approximately 25 feet from the nearest residential property lines (i.e., building “A” as shown in Figure 1), expected construction noise levels can reach up to an hourly average noise level of 88 dBA L_{eq} , which does not exceed the County’s construction noise threshold of 95 dBA. However, due to the proximity to the residential properties south of the construction site, we recommend mitigating these levels to avoid any disruption to the neighborhood by limiting the overall noise level to be no greater than CNEL 65 dBA at the nearest residential property line.

7.1.2 Recommended Mitigation

In order to maintain levels below CNEL 65 dBA at the residential property lines, we recommend the following:

- Heavy construction equipment activity should be limited to the following (only between the hours of 8:00am and 5:00pm):
 - If a bulldozer is used, all construction activity with heavy equipment should be limited to 3 hours per day
 - If no bulldozer activity is planned, all other heavy equipment use (i.e., concrete mixer and backhoe) should be limited to 6 hours per day.

7.2 Vibration

The Housing Element provides a threshold of 0.1 in/sec for continuous vibration levels at neighboring properties. Table 7 shows the human response to various levels of groundborne vibration. According to the FTA *Transit Noise and Vibration Assessment Manual*,⁷ a loaded truck would have a vibration level of 0.076 in/sec when measured at 25 feet. Since project buildings are expected to be located 25 feet or more from the nearest existing residences, project vibration levels are not anticipated to be strongly perceptible and are below the County's limits for groundborne vibration at neighboring properties. Any construction activities near the property lines are expected to be transient and unlikely to reach severe or disturbing levels.

Table 7: Human Response to Different Levels of Groundborne Vibration (PPV)

Human Response	Transient PPV (in/sec)	Continuous PPV (in/sec)
Barely perceptible	0.035	0.012
Distinctly perceptible	0.24	0.035
Strongly perceptible	0.9	0.1
Severe/Disturbing	2	0.4

8 Conclusion

Based on the above analysis, no mitigation is required for this project, and it is expected that this school and its associated outdoor activities will comply with the County's Noise Regulations. Outdoor events with amplified music held in the courtyard will also comply if the music is no louder than 75 dBA (at 10 feet), the event is held for no more than three hours, and it ends before 8:00 pm.

Construction noise and vibration are expected to be short-term and less than significant if proper mitigation is implemented. Recommendations for noise management include construction of a temporary construction noise barrier at the perimeter of the construction site and limiting the operation of heavy construction equipment to three or six hours per day, depending on the type of equipment used (only between the hours of 8:00am and 5:00pm).

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 concerning the proposed site plans, traffic volumes, proposed project-related sound source 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.

⁷ FTA Transit Noise and Vibration Assessment Manual, 2020. <https://www.transit.dot.gov/research-innovation/transit-noise-and-vibration-impact-assessment-manual-report-0123>

9 Figures

Figure 1: Site View (Google Maps)



Figure 2: Project Site Plan (reprinted from client drawings)

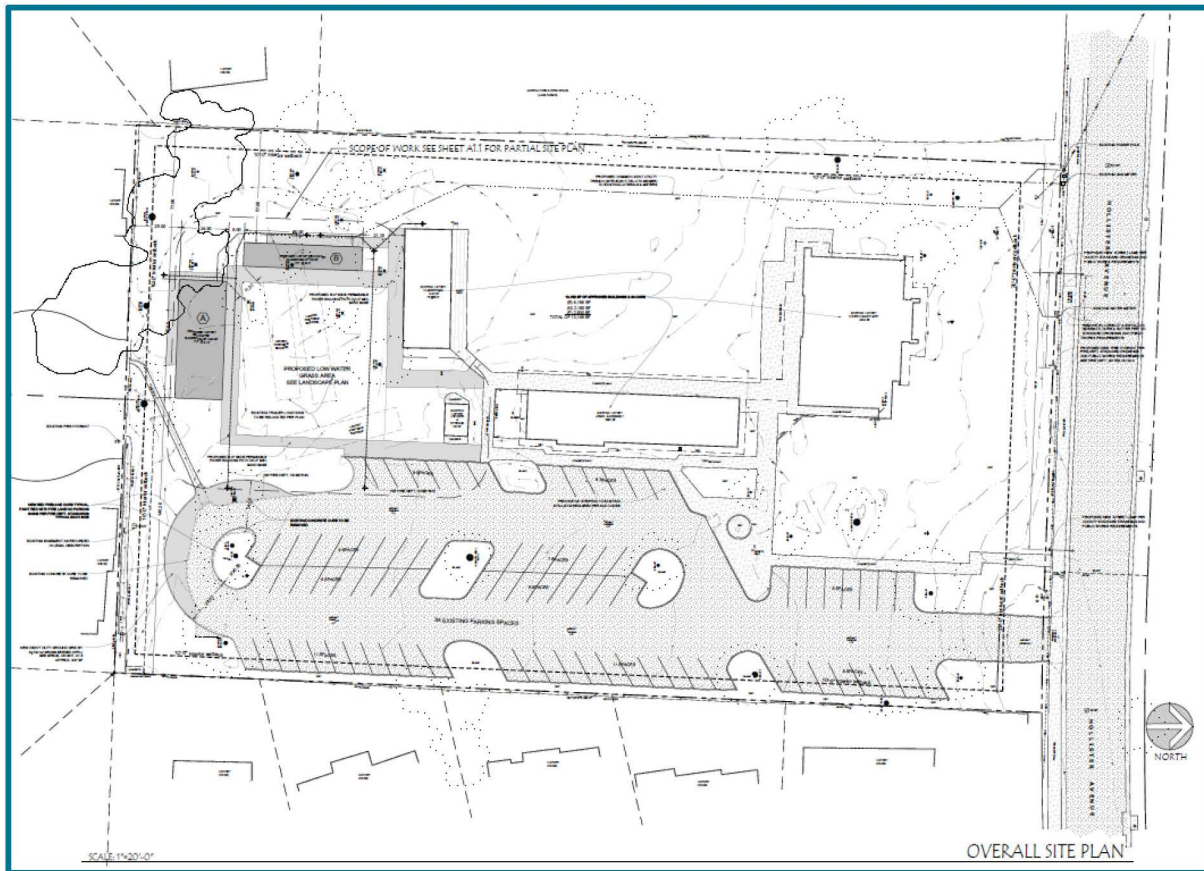


Figure 3: Santa Barbara County Environmental Thresholds and Guidelines Manual, Section 13.B.3 (excerpt)

3. Noise thresholds. The following are thresholds of significance for assisting in the determination of significant noise impacts.

- a. If existing exterior noise levels, including at outdoor living areas, experienced by sensitive receptors is below 65 dB(A) CNEL, and if the proposed project will generate noise that will cause the existing noise levels experienced by the sensitive receptors to exceed 65 dB(A) CNEL – either individually or cumulatively when combined with other noise-generating sources – then the proposed project is presumed to have a significant impact.
- b. If existing exterior noise levels, including at outdoor living areas, experienced by sensitive receptors exceeds 65 dB(A) CNEL, and if the proposed project will generate noise that will cause the existing noise levels experienced by the sensitive receptors to increase by 3 dB(A) CNEL – either individually or cumulatively when combined with other noise-generating sources – then the proposed project is presumed to have a significant impact.
- c. If existing noise levels experienced by sensitive receptors in interior living areas is below 45 dB(A) CNEL, and if the proposed project will generate noise that will cause the existing noise levels experienced by the sensitive receptors in interior living areas to exceed 45 dB(A) CNEL – either individually or cumulatively when combined with other noise-generating sources – then the proposed project is presumed to have a significant impact.
- d. If existing noise levels experienced by sensitive receptors in interior living areas exceeds 45 dB(A) CNEL, and if the proposed project will generate noise that will cause the existing noise levels experienced by the sensitive receptors in interior living areas to increase by 3 dB(A) CNEL – either individually or cumulatively when combined with other noise-generating sources – then the proposed project is presumed to have a significant impact.
- e. Noise from grading and construction activity proposed within 1,600 feet of sensitive receptors, including schools, residential development, commercial lodging facilities, hospitals or care facilities, would generally result in a potentially significant impact. According to EPA guidelines (see Figure 2) average construction noise is 95 dB(A) at a 50' distance from the source. A 6 dB drop occurs with a doubling of the distance from the source. Therefore, locations within 1,600 feet of the construction site would be affected by noise levels over 65 dB(A). To mitigate this impact, construction within 1,600 feet of sensitive receptors shall be limited to weekdays between the hours of 8 AM to 5 PM only. Noise attenuation barriers and muffling of grading equipment may also be required. Construction equipment generating noise levels above 95 dB(A) may require additional mitigation.

All noise studies evaluating ambient noise levels and changes resulting from project development should be prepared by licensed acoustical engineers.

Figure 4: Existing Sound Level Measurement Locations



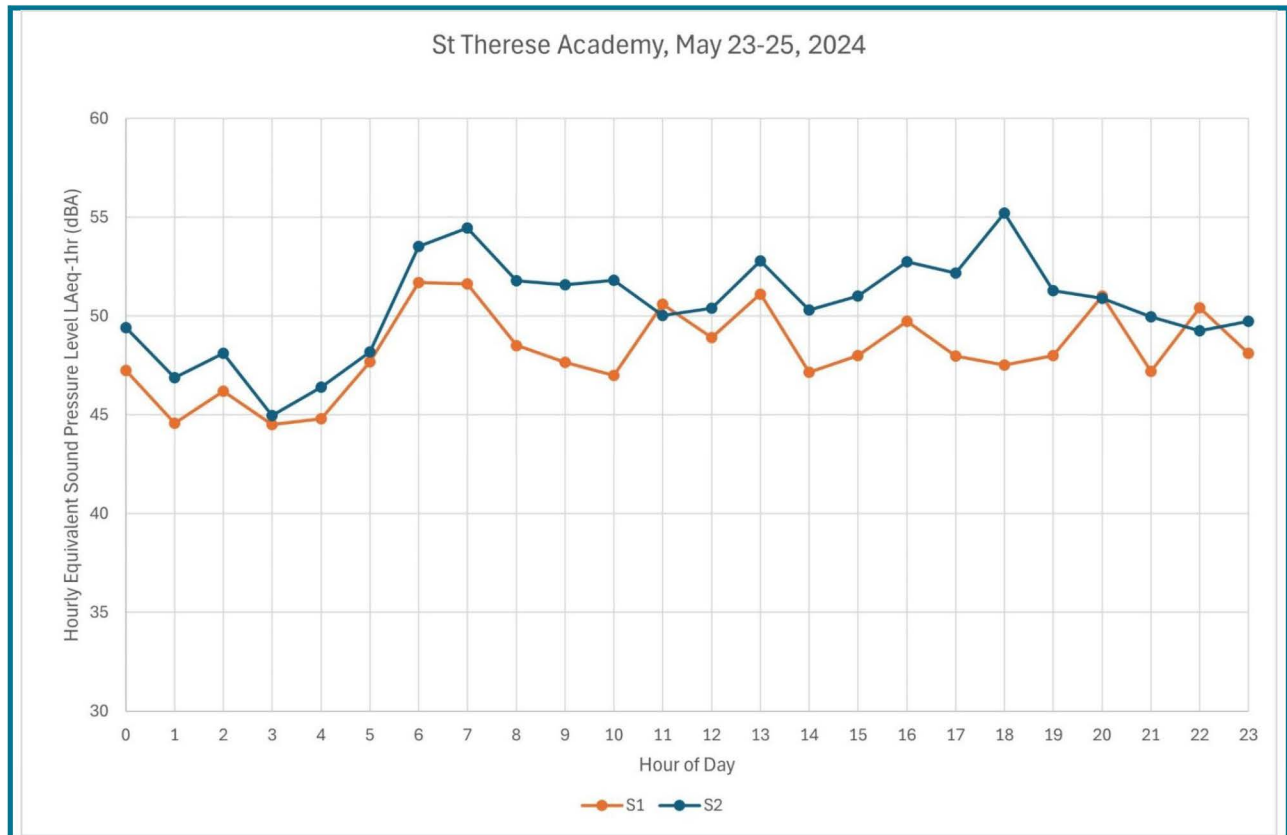
Figure 5: 24-Hour Measured Sound Levels

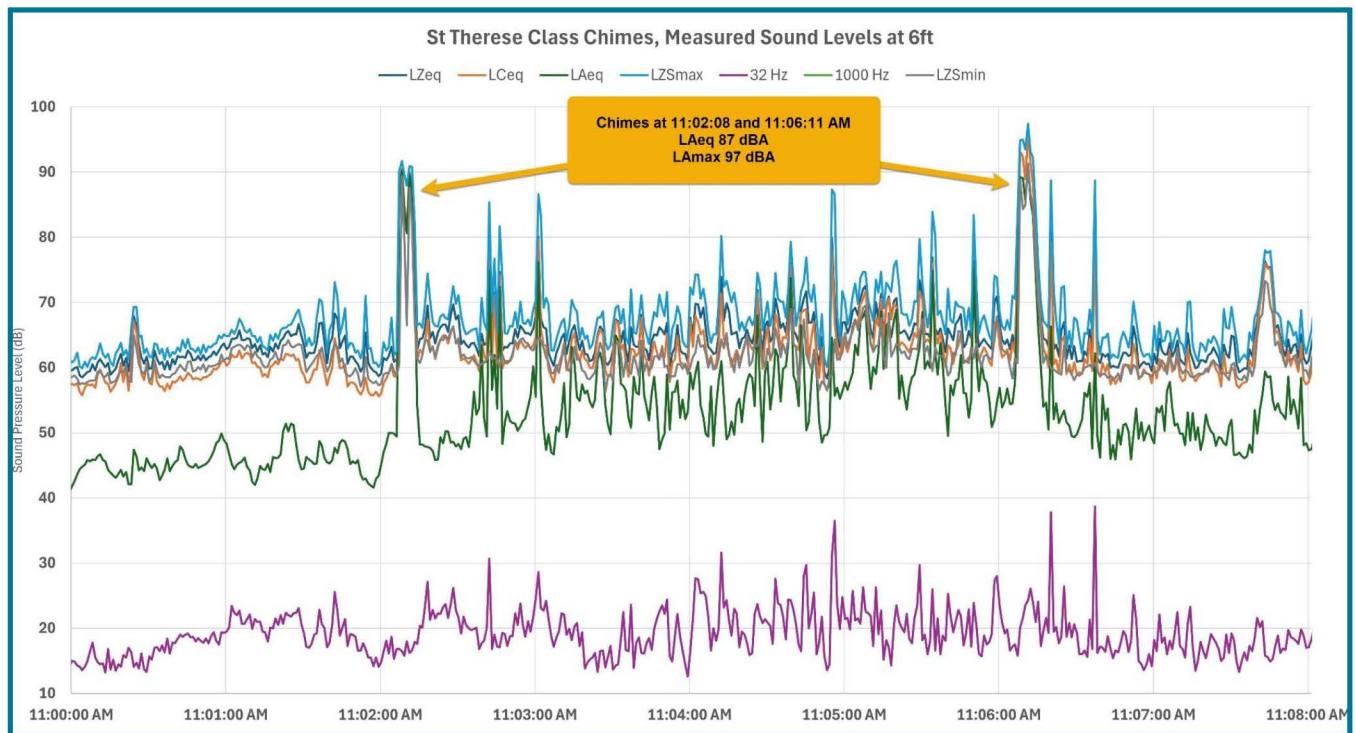
Figure 6: Measured Sound Levels of Chimes

Figure 7: 3D Perspective of Acoustic Model Geometry with Proposed School Buildings and Activities

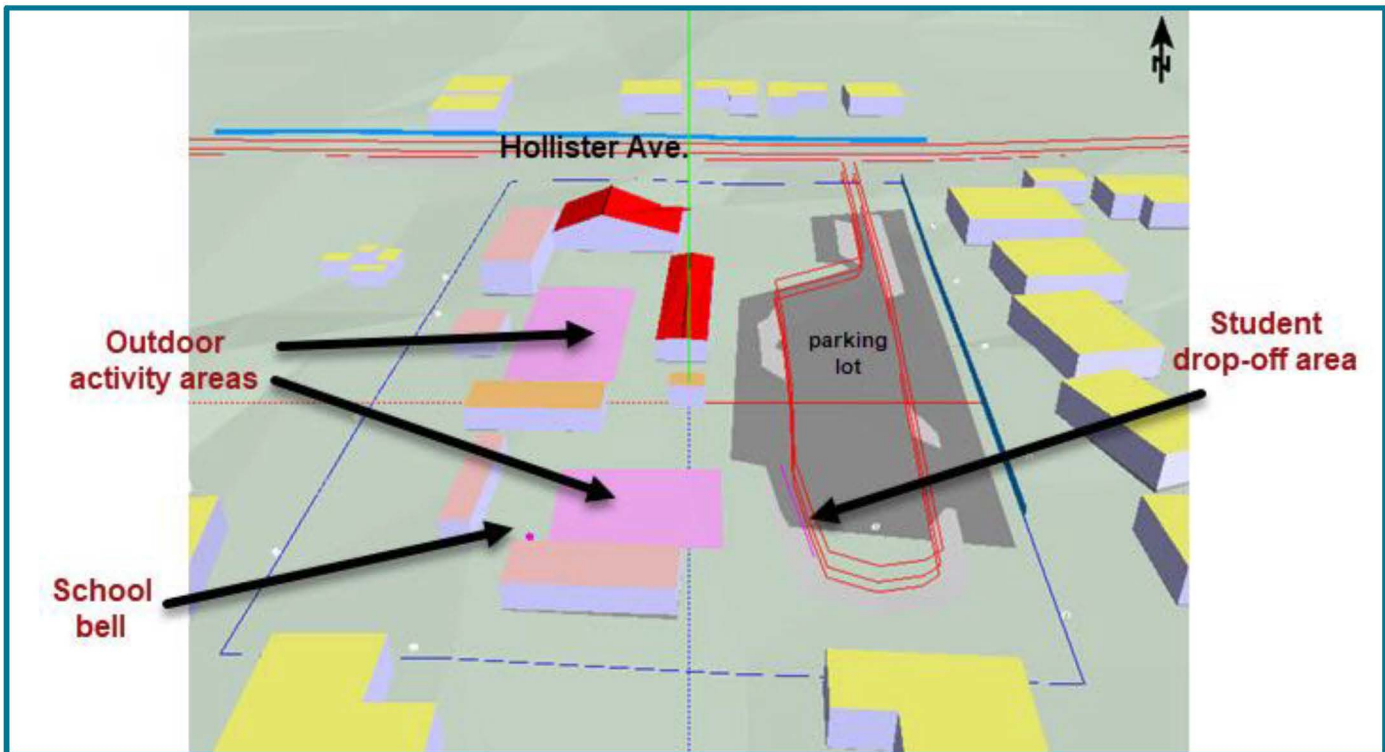


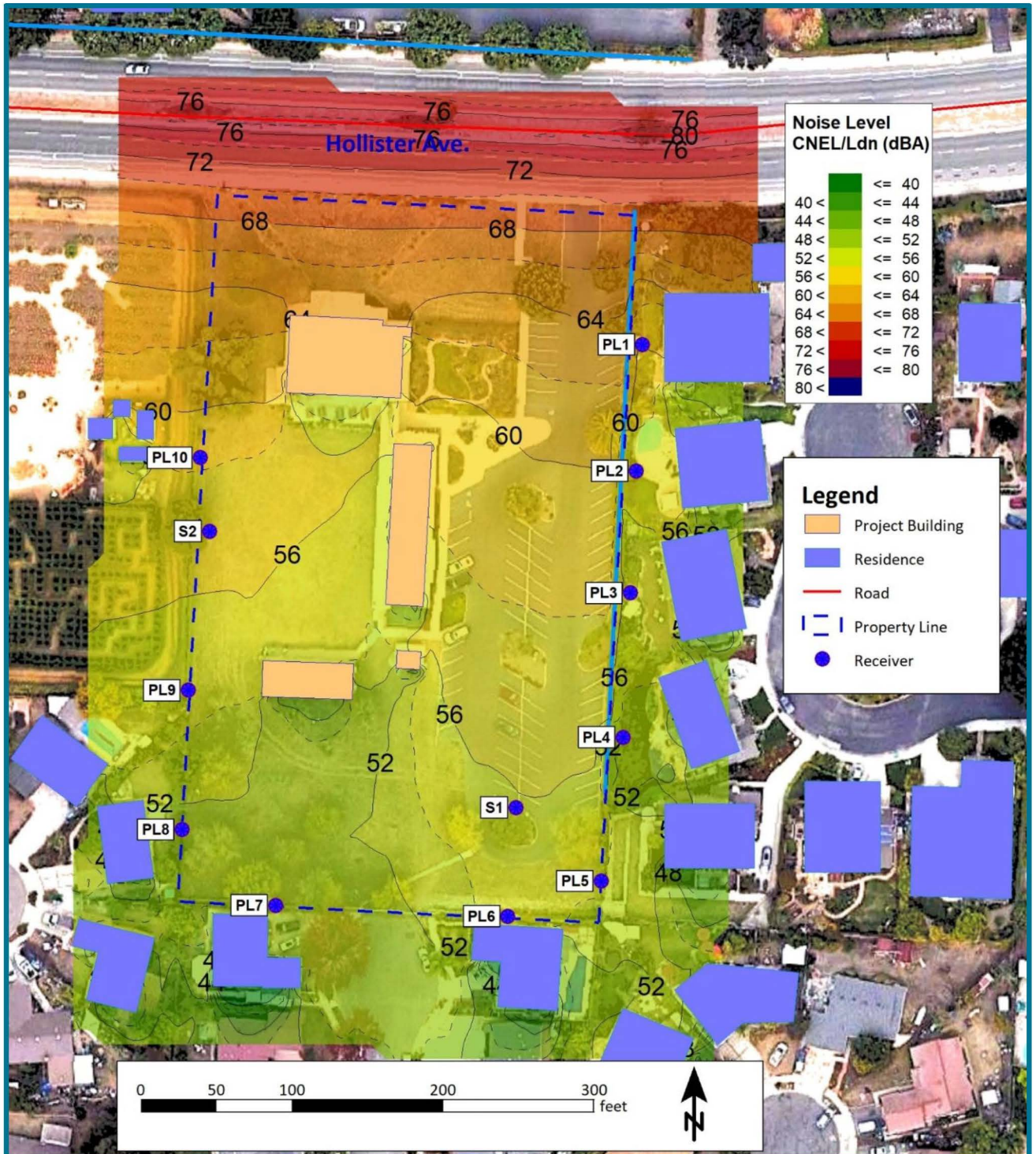
Figure 8: Existing Ambient Sound Level Contours, Plan View

Figure 9: Sound Level Contours for a Typical School Day with Evening Event, Plan View

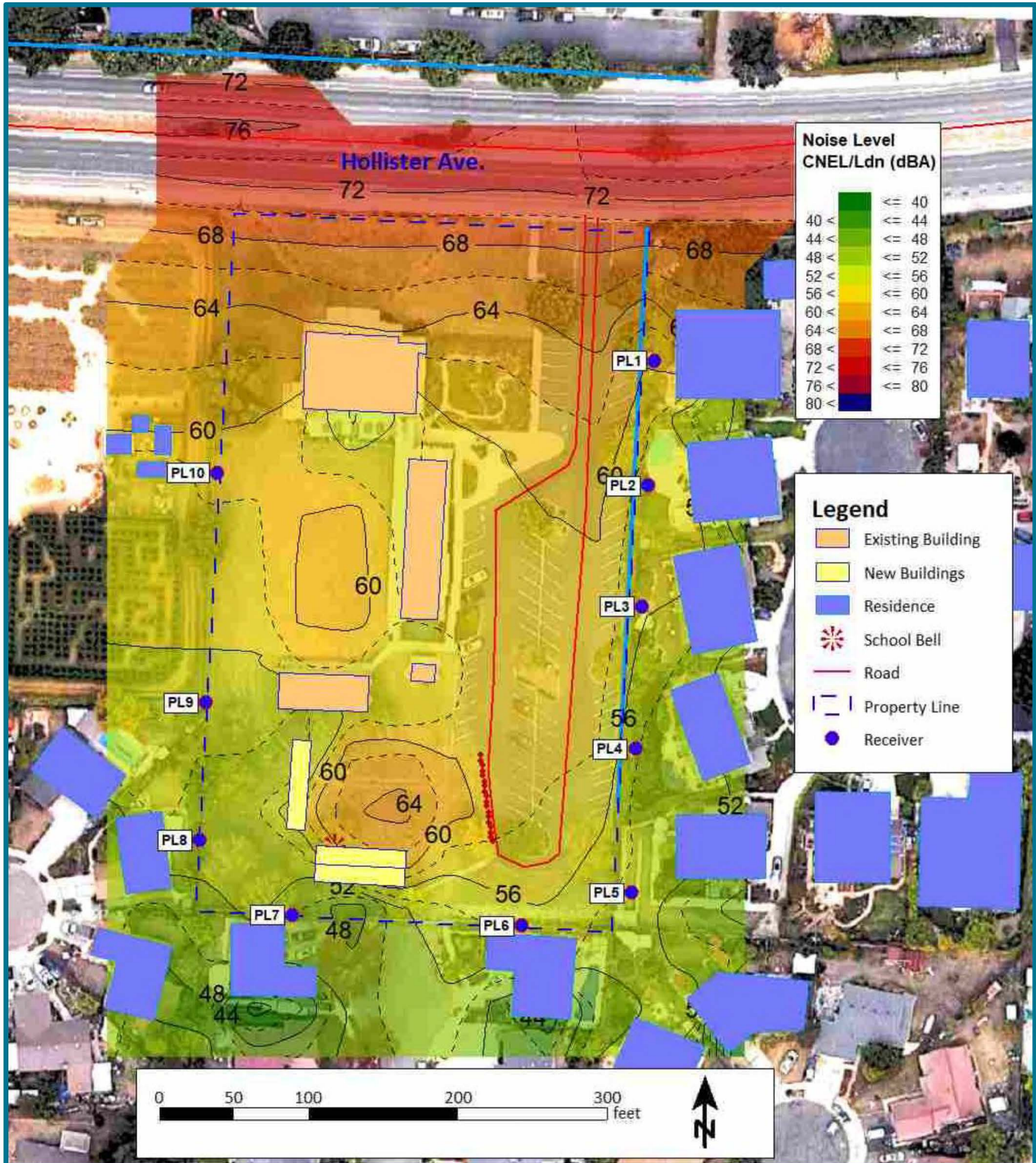
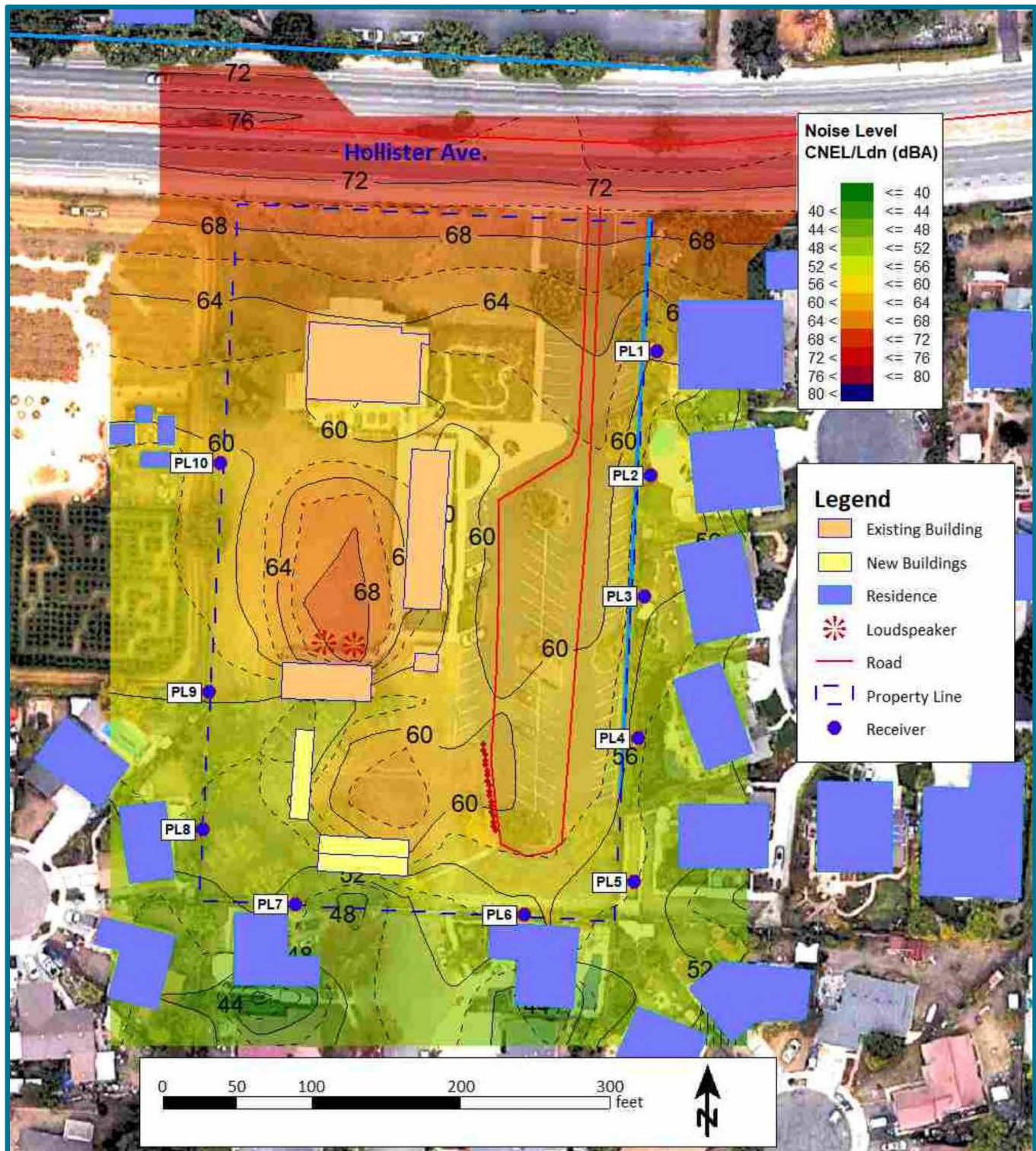


Figure 10: Sound Level Contours for a Weekend Event (Barn Dance) with Amplified Music, Plan View



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.

Table 8: Examples of Typical Sound Pressure Levels

SPL (dBA)	Description
0	<i>The threshold of hearing.</i> This is the quietest sound that a child or young adult with good hearing can detect at 1kHz. (It is not silence.)
10 – 20	Very faint. A gentle breeze through the trees.
20 – 30	A soft whisper (at 1 meter).
30 – 40	A quiet auditorium.
40 – 60	Background music in a cafe, bar, or restaurant.
60 – 70	Typical conversation levels (from the listener's position).
70 – 80	The cabin of an aircraft during normal cruise conditions.
80 – 90	Typical wedding or dinner-dance band (typical audience position).
90 – 100	Loud orchestra (playing <i>fff</i> , as it would sound in the front row of the audience).
100 – 110	Typical disco.
110 – 115	A loud rock band (front rows of audience).
115 – 130	<i>Threshold of pain.</i> Often given as 120 dB SPL, this varies with frequency and from person to person.
140	Jet engine at a distance of 3 meters.

Examples of sound levels are listed on websites such as:

- [“Time to Listen: Most Regular Patrons of Music Venues Prefer Lower Volumes”](#)
- [The Center for Hearing and Communication](#)
- [University of Michigan Health](#)
- [Expected Sound Levels at Concert Venues for Amplified Music](#)

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 9 below presents the subjective effect of changes in sound pressure levels.

Table 9: Sound Level Change Relative Loudness/Acoustic Energy Loss⁸

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 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

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.

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 L_{90} 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 facade 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, L_n

The noise level exceeded during n percent of the measurement period, where n is a number between 0 and 100 (e.g., L_{10} or L_{90})

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.