Environmental Noise & Vibration Assessment

Sacramento Music Hall

Sacramento, California

BAC Job # 2021-037

Prepared For:

Sacramento Music House, LLC.

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CEQA Checklist

NOISE AND VIBRATION – **Would the Project Result in:**	**Effect will be studied in the EIR**	**Effect can be mitigated to less than significant**	**No additional significant environmental effect**
a) Generation of substantial temporary or permanent increase in ambient noise levels in the vicinity of the project in excess of standards established in the local general plan or noise ordinance, or in other applicable local, state, or federal standards?		**X**	
b) Generation of excessive groundborne vibration or groundborne noise levels?			**X**
c) For a project located within the vicinity of a private airstrip or an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?			**X**

Introduction

The Sacramento Music Hall (project) is located at 2950 Ramona Avenue in Sacramento, California. The project proposes the renovation of an existing building to develop an indoor live entertainment venue/performing arts center. The proposed venue is approximately 29,342 square feet with a parking lot that will provide 467 parking spaces.

Existing land uses in the project vicinity vary, including industrial, commercial, park/public facilities, and residential. The project area and site plan are shown on Figures 1 and 2, respectively. The project floor plan is shown on Figure 3.

Due to the potential for elevated project generated noise levels at the nearest sensitive receptors (residential land uses to the north, south and west), Bollard Acoustical Consultants, Inc. (BAC) was retained by the project applicant to prepare this noise and vibration assessment. Specifically, the purposes of this assessment are to quantify existing ambient noise and vibration levels at the boundary of the project site and existing residential community, to predict the noise and vibration generation of various aspects of the project, and to compare project-generated noise and vibration levels against both the applicable City of Sacramento criteria as well as against the ambient noise and vibration environment.

Noise and Vibration Fundamentals

Noise

Noise is often described as unwanted sound. Sound is defined as any pressure variation in air that the human ear can detect. If the pressure variations occur frequently enough (at least 20 times per second), they can be heard, and thus are called sound. Measuring sound directly in terms of pressure would require a very large and awkward range of numbers. To avoid this, the decibel scale was devised. The decibel scale allows a million-fold increase in pressure to be expressed as 120 dB. Another useful aspect of the decibel scale is that changes in levels (dB) correspond closely to human perception of relative loudness. Appendix A contains definitions of Acoustical Terminology. Figure 4 shows common noise levels associated with various sources.

The perceived loudness of sounds is dependent upon many factors, including sound pressure level and frequency content. However, within the usual range of environmental noise levels, perception of loudness is relatively predictable, and can be approximated by weighing the frequency response of a sound level meter by means of the standardized A-weighing network. There is a strong correlation between A-weighted sound levels (expressed as dBA) and community response to noise. For this reason, the A-weighted sound level has become the standard tool of environmental noise assessment. All noise levels reported in this section are in terms of A-weighted levels in decibels.

Legend

- Project Boundary (approximate)
- Music Hall Building (approximate)
- # Noise Monitoring Site

N

Scale (Feet)

0 250 500

Sacramento Music Hall

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Project Site Plan and Noise Survey Locations

Figure 1

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Legend

A	Top View (north at top of page)
B	Rendering Looking Southwest
C	Rendering Looking Northeast
D	Rendering Looking Southeast

Sacramento Music Hall

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Project Site Plan and Renderings

Figure 2

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Legend

Stage

Kitchen

Audience (standing area)

Loading Dock

Sacramento Music Hall

Sacramento, CA

Project Floor Plan

Figure 3

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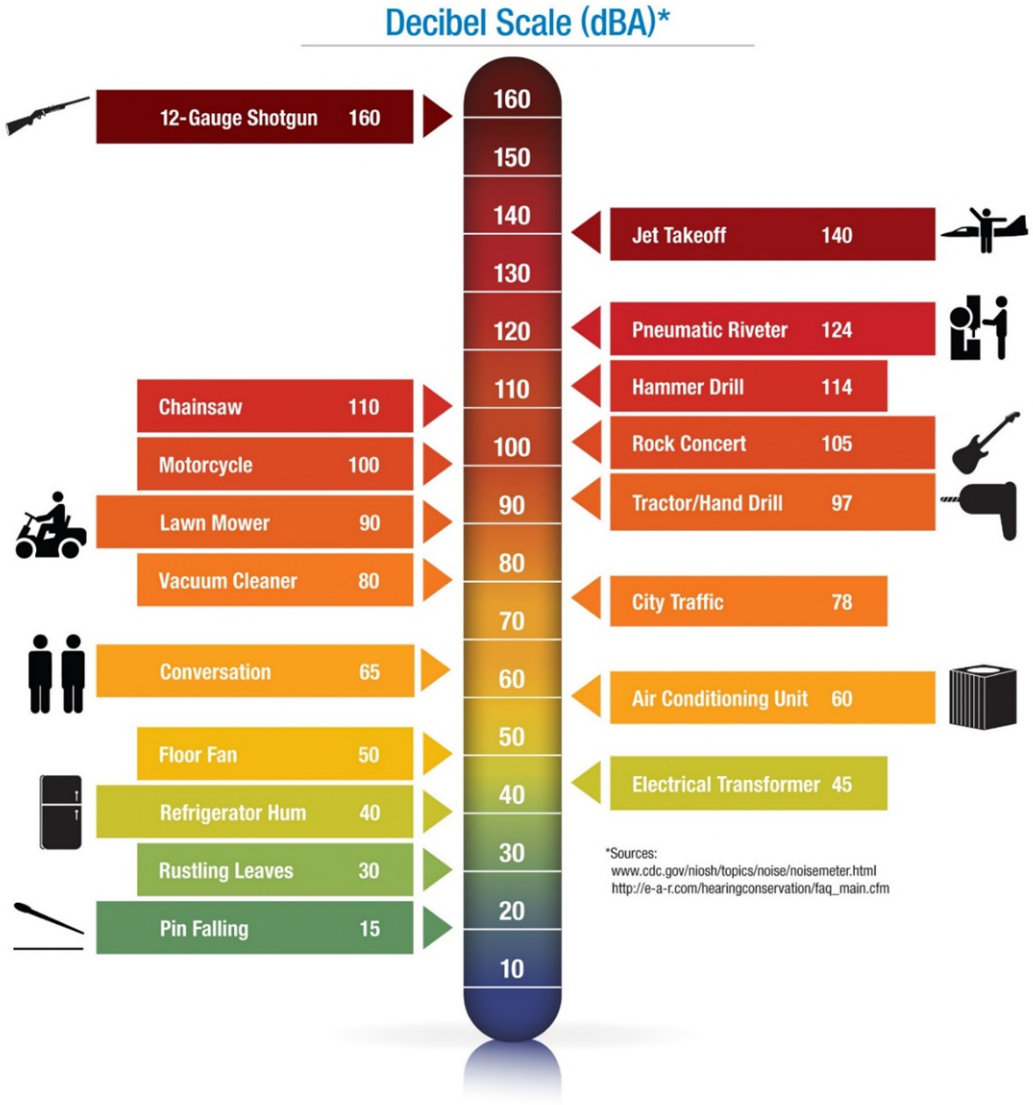
Figure 4
Noise Levels Associated with Common Noise Sources



Community noise is commonly described in terms of the "ambient" noise level, which is defined as the all-encompassing noise level associated with a given noise environment. A common statistical tool to measure the ambient noise level is the average, or equivalent, sound level (L_{eq}) over a given time period (usually one hour). The L_{eq} is the foundation of the Day-Night Average Level noise descriptor, DNL, and shows very good correlation with community response to noise.

The Day-Night Average Level (DNL) is based upon the average noise level over a 24-hour day, with a +10 decibel weighting applied to noise occurring during nighttime (10:00 p.m. to 7:00 a.m.) hours. The nighttime penalty is based upon the assumption that people react to nighttime noise exposures as though they were twice as loud as daytime exposures. Because DNL represents a 24-hour average, it tends to disguise short-term variations in the noise environment. DNL-based noise standards are commonly used to assess noise impacts associated with traffic, railroad, and aircraft noise sources.

Vibration

Vibration is like noise in that it involves a source, a transmission path, and a receiver. While vibration is related to noise, it differs in that noise is generally considered to be pressure waves transmitted through air, while vibration is usually associated with transmission through the ground or structures. As with noise, vibration consists of an amplitude and frequency. A person's response to vibration will depend on their individual sensitivity as well as the amplitude and frequency of the source.

Vibration can be described in terms of acceleration, velocity, or displacement. A common practice is to monitor vibration in terms of velocity in inches per second peak particle velocity (IPS, PPV) or root-mean-square (VdB, RMS). Standards pertaining to perception as well as damage to structures have been developed for vibration in terms of peak particle velocity as well as RMS velocities.

As vibrations travel outward from the source, they excite the particles of rock and soil through which they pass and cause them to oscillate. Differences in subsurface geologic conditions and distance from the source of vibration will result in different vibration levels characterized by different frequencies and intensities. In all cases, vibration amplitudes will decrease with increasing distance. The maximum rate, or velocity of particle movement, is the commonly accepted descriptor of the vibration "strength".

Human response to vibration is difficult to quantify. Vibration can be felt or heard well below the levels that produce any damage to structures. The duration of the event has an effect on human response, as does frequency. Generally, as the duration and vibration frequency increase, the potential for adverse human response increases.

According to the Transportation and Construction-Induced Vibration Guidance Manual (Caltrans, June 2004), operation of construction equipment and construction techniques generate ground vibration. Traffic traveling on roadways can also be a source of such vibration. At high enough amplitudes, ground vibration has the potential to damage structures and/or cause cosmetic damage. Ground vibration can also be a source of annoyance to individuals who live or work close to vibration-generating activities. However, traffic, including heavy trucks traveling on a roadway, rarely generates vibration amplitudes high enough to cause structural or cosmetic damage.

Existing Noise and Vibration Environments

Sensitive Land Uses in the Project Vicinity

Noise-sensitive land uses are generally defined as locations where people reside or where the presence of unwanted sound could adversely affect the primary intended use of the land. Places where people live, sleep, recreate, worship, and study are generally considered to be sensitive to noise because intrusive noise can be disruptive to these activities.

For this project, the noise-sensitive land uses which would potentially be affected by the project consist primarily of residential uses. Specifically, multi-family residential land uses are located to the north and west of the project site (identified as "Apartments" on Figure 1), and single-family residential uses are located to the south of the project site ("SFR" on Figure 1). Existing industrial and commercial uses located in the vicinity of the project site are not considered to be noise-sensitive.

Existing Ambient Noise Environment in the Immediate Project Vicinity

The ambient noise environment within the immediate project vicinity is defined primarily by noise from traffic on Ramona Avenue to the east and by distant Highway 50 traffic. Railroad noise from the adjacent tracks to the west and nearby tracks to the east also contribute to the local ambient noise environment, but on an intermittent basis.

To quantify existing ambient noise levels in the project vicinity, short-term daytime ambient noise surveys were conducted at 11 locations on the morning of March 11, 2021. In addition, short-term nighttime ambient noise surveys were conducted at the locations of the two nearest residential receptors to the project on April 20, 2021. The noise survey locations are shown on Figure 1. Photographs of the noise survey locations are provided in Appendices B-1 and B-2.

Larson Davis Laboratories (LDL) Model 831 and 820 precision integrating sound level meters were used to complete the ambient noise level measurement surveys. The meters were calibrated before use with an LDL Model CAL200 acoustical calibrator to ensure the accuracy of the measurements. The equipment used meets all specifications of the American National Standards Institute requirements for Type 1 sound level meters (ANSI S1.4).

The ambient noise survey results are summarized in Table 1 and are shown graphically in Appendices C and D.

Table 1
Ambient Noise Survey Results
Sacramento Music Hall Project Vicinity

Site[1]	Description[1]	Date	Time	L_{50}	L_{max}
1	Northern Site Property Line	3/11/21	11:02 AM	60	67
2	Northeastern Site Property Line	3/11/21	11:18 AM	62	71
3	Eastern Site Property Line 1	3/11/21	11:30 AM	60	69
4	Eastern Site Property Line 2	3/11/21	11:46 AM	60	77
5	Southeastern Site Property Line	3/11/21	11:54 AM	58	77
6	Nearest SFR to South (Daytime)	3/11/21	12:01 PM	58	80
6	Nearest SFR to South (Nighttime)	4/20/21	10:22 PM	43	72
7	Northwestern Site Property Line	3/11/21	11:02 AM	52	54
8	Apartments to North – 1	3/11/21	11:54 AM	59	71
9	Apartments to North – 2 (Daytime)	3/11/21	11:46 AM	60	67
9	Apartments to North – 2 (Nighttime)	4/20/21	10:06 PM	46	62
10	Apartments to West	3/11/21	11:30 AM	57	75
11	Little League Park to East	3/11/21	11:18 AM	59	69

[1] Ambient noise monitoring locations are identified on Figure 1.
Source: Bollard Acoustical Consultants, Inc. (2021)

As indicated in Table 1, noise levels ranged from 52-62 dB L_{50} and 54-80 dB L_{max} during daytime hours. Measured noise levels during nighttime hours at the nearest residential locations (Sites 6 & 9) ranged from 43-46 dB L_{50} and 62-72 dB L_{max}. At the nearest residential locations, baseline ambient noise exposure in terms of DNL is predicted to be approximately 55 dB DNL based on the short-term ambient noise survey results.

Existing Ambient Vibration Environment in Project Vicinity

During a site visit on March 11, 2021, BAC staff noted that vibration levels were below the threshold of perception at all locations surrounding the project site and in the immediate project vicinity. Therefore, the existing vibration environment in the immediate project vicinity is considered to be negligible. It should be noted that, during the passage of trains on the nearby railroad tracks, vibration levels within 100 feet of the tracks would be expected to be perceptible, but otherwise ambient vibration conditions are considered negligible.

Criteria for Acceptable Noise and Vibration Exposure

Federal

There are no federal noise or vibration criteria which would be directly applicable to this project.

California Environmental Quality Act (CEQA)

The State of California has established regulatory criteria that are applicable to this assessment. Specifically, Appendix G of the State of California Environmental Quality Act (CEQA) Guidelines are used to assess the potential significance of impacts pursuant to local General Plan policies, Municipal Code standards, or the applicable standards of other agencies. According to Appendix G of the CEQA guidelines, the project would result in a significant noise or vibration impact if the following occur:

A. Generation of substantial temporary or permanent increase in ambient noise levels in the vicinity of the project in excess of standards established in the local general plan or noise ordinance, or in other applicable local, state, or federal standards?

B. Generation of excessive groundborne vibration or groundborne noise levels?

C. For a project located within the vicinity of a private airstrip or an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?

It should be noted that audibility is not a test of significance according to CEQA. If this were the case, any project which added any audible amount of noise to the environment would be considered unacceptable according to CEQA. Because every physical process creates noise, the use of audibility alone as significance criteria would be unworkable. CEQA requires a substantial increase in noise levels before noise impacts are identified, not simply an audible change.

Sacramento 2035 General Plan

The Environmental Constraints (EC) chapter of the Sacramento 2035 General Plan contains the following policies which would be applicable to project-generated noise and vibration sources:

EC 3.1.1 **Exterior Noise Standards.** The City shall require noise mitigation for all development where the projected exterior noise levels exceed those shown in Table 2 (General Plan Table EC 1), to the extent feasible.

EC 3.1.2 **Exterior Incremental Noise Standards.** The City shall require noise mitigation for all development that increases existing noise levels by more than the allowable increment shown in Table 3 (General Plan EC 2), to the extent feasible.

EC 3.1.5 **Interior Vibration Standards.** The City shall require construction projects anticipated to generate a significant amount of vibration to ensure acceptable interior vibration levels at nearby residential and commercial uses based on the current City or Federal Transit Administration (FTA) criteria.

EC 3.1.8 **Operational Noise.** The City shall require mixed-use, commercial, and industrial projects to mitigate operational noise impacts to adjoining sensitive uses when operational noise thresholds are exceeded.

EC 3.1.10 **Construction Noise.** The City shall require development projects subject to discretionary approval to assess potential construction noise impacts on nearby sensitive uses and to minimize impacts on these uses, to the extent feasible.

Table 2
Exterior Noise Compatibility Standards for Various Land Uses

Land Use Type	Highest Level of Noise Exposure that is Regarded as "Normally Acceptable"[a] (DNL[b] or CNEL[c])
Residential–Low Density Single Family, Duplex, Mobile Homes	60 dBA[d,e]
Residential–Multi-family	65 dBA
Urban Residential Infill[f] and Mixed-Use Projects[g]	70 dBA
Transient Lodging–Motels, Hotels	65 dBA
Schools, Libraries, Churches, Hospitals, Nursing Homes	70 dBA
Auditoriums, Concert Halls, Amphitheaters	Mitigation based on site–specific study
Sports Arena, Outdoor Spectator Sports	Mitigation based on site–specific study
Playgrounds, Neighborhood Parks	70 dBA
Golf Courses, Riding Stables, Water Recreation, Cemeteries	75 dBA
Office Buildings–Business, Commercial, and Professional	70 dBA
Industrial, Manufacturing, Utilities, Agriculture	75 dBA

a. As defined in the Guidelines, "Normally Acceptable" means that the "specified land use is satisfactory, based upon the assumption that any building involved is of normal conventional construction, without any special noise insulation requirements."
b. DNL or Day Night Average Level is an average 24-hour noise measurement that factors in day and night noise levels.
c. CNEL or Community Noise Equivalent Level measurements are a weighted average of sound levels gathered throughout a 24-hour period.
d. dBA or A-weighted decibel scale is a measurement of noise levels.
e. The exterior noise standard for the residential area west of McClellan Airport known as McClellan Heights/Parker Homes is 65 dBA
f. With land use designations of Central Business District, Urban Neighborhood (Low, Medium, or High) Urban Center (Low or High), Urban Corridor (Low or High).
g. All mixed-use projects located anywhere in the City of Sacramento.

Source: Governor's Office of Planning and Research, State of California General Plan Guidelines 2003, October 2003

Table 3
Exterior Incremental Noise Impact Standards for Noise-Sensitive Uses (dBA)

Residences and buildings where people normally sleep [a]		Institutional land uses with primarily daytime and evening uses [b]	
Existing DNL	**Allowable Noise Increment**	**Existing Peak Hour L_{eq}**	**Allowable Noise Increment**
45	8	45	12
50	5	50	9
55	3	55	6
60	2	60	5
65	1	65	3
70	1	70	3
75	0	75	1
80	0	80	0

a. This category includes homes, hospitals, and hotels where a nighttime sensitivity to noise is assumed to be of utmost importance.
b. This category includes schools, libraries, theaters, and churches where it is important to avoid interference with such activities as speech, meditation, and concentration on reading material.

Source: Federal Transit Administration, Transit Noise Impact and Vibration Assessment, May 2006

Sacramento City Code

The Sacramento City Code Chapter 8.68 Noise Control sets limits for exterior noise levels on designated residential property and interior noise levels pertaining to multiple dwelling units (reproduced below in Table 4). The ordinance states that exterior noise shall not exceed 55 dB during any cumulative 30-minute period in any hour during the day (7 a.m. to 10 p.m.) and 50 dB during any cumulative 30-minute period in any hour during the night (10 p.m. to 7 a.m.). The ordinance sets higher noise limits for noise sources present for shorter durations of the hour; however, noise in residential areas must never exceed 75 dB during the day and 70 dB at night.

It should be noted that the City Code standards are not applicable to traffic on public roadways. As a result, the City Code standards would only be applicable to noise generated within the Music Hall venue, to HVAC equipment on the roof of the venue, and to parking lot operations within the venue parking area.

Table 4
Sacramento City Code Noise Standards for Agricultural and Residential Property

Noise Metric	Cumulative Period	Standards (dB) Day (7 AM TO 10 PM) / Night (10 PM TO 7 AM)
Exterior Noise Standards [1, 3]		
L_{50}	30 min/hr	55 / 50
L_{25}	15 min/hr	60 / 65
L_{08}	5 min/hr	65 / 60
L_{02}	1 min/hr	70 / 65
L_{max}	Never to exceed	75 / 70
Interior Noise Standards [2, 4]		
L_{08}	5 min/hr	45
L_{02}	1 min/hr	50
L_{max}	Any period of time	55

[1] Noise created over the designated period at any location may not cause the noise levels on a designated agricultural or residential property to exceed these standards.
[2] Noise created over the designated period in an apartment, condominium, townhouse, duplex, or multiple dwelling units may not cause the noise level in a neighboring unit to exceed these standards.
[3] Exterior noise limits must be reduced by 5 dBA for impulsive or simple tone noises, or for noises consisting of speech or music.
[4] If the ambient level exceeds the fifth noise level category for exterior noise standards, the maximum ambient noise level shall be the noise limit for the category.

Source: City of Sacramento Municipal Code

As noted in Footnote 3 of Table 4, the exterior noise limits shown in Table 4 are reduced by 5 dB for noise sources consisting of speech or music. Therefore, the noise standards applicable to music being generated at the project site would be 5 dB lower than the Table 4 standards. Noise generated by parking lot movements, truck deliveries, and mechanical equipment would be subject to the Table 4 standards without adjustment.

As noted in Footnote 4 of Table 4, if the ambient level exceeds the fifth noise level category (Lmax), for exterior noise standards, the maximum ambient noise level shall be the noise limit for the category. Although the measured daytime maximum noise levels exceeded 75 dB at a few of the noise measurement locations in the immediate project vicinity (see Table 1), the nighttime maximum noise levels were below or near the Table 4 standards. To provide a conservative assessment of potential project noise impacts at the nearest residences to the project site, the Table 4 standards were used without adjustment.

Chapter 8.68 of the Sacramento City Code provides the following exemption applicable to construction noise:

8.68.080 Exemptions

A. Noise sources due to the erection (including excavation), demolition, alteration or repair of any building or structure between the hours of seven a.m. and six p.m. on Monday, Tuesday, Wednesday, Thursday, Friday and Saturday, and between nine a.m. and six p.m. on Sunday; provided, however, that the operation of an internal combustion engine shall not be exempt

pursuant to this subsection if such engine is not equipped with suitable exhaust and intake silencers which are in good working order. The director of building inspections may permit work to be done during the hours not exempt by this subsection in the case of urgent necessity and in the interest of public health and welfare for a period not to exceed three days. Application for this exemption may be made in conjunction with the application for the work permit or during progress of the work.

Vibration Standards Applied to this Project

Although no discernible vibration was observed at the project site, the City of Sacramento Noise Element Policies EC 3.1.5 and EC 3.1.7 pertain to vibration generated by construction as well as impacts on historic structures. On other projects, the City of Sacramento has indicated that an appropriate vibration threshold 0.5 inches/second peak particle velocity for proposed new residential uses and 0.2 inches/second for historic structures and archaeological sites. Although this project does not propose residential development, a standard of 0.5 inches per second is utilized as a threshold of significance at the nearby residences.

Impacts and Mitigation Measures

Thresholds of Significance

The following criteria based on policies and ordinances identified in the City of Sacramento 2035 General Plan and City of Sacramento Municipal Code were used to evaluate the significance of environmental noise resulting from the project:

- A significant noise impact would be identified if the project would expose persons to or generate noise levels that would exceed applicable noise standards presented in the Municipal Code (Table 4), with adjustments to those standards for the music component of the project.

- A significant impact would be identified if off-site traffic or on-site activities generated by the project would substantially increase noise levels at sensitive receptors in the vicinity. A substantial increase would be identified relative to the exterior incremental noise impact criteria established in General Plan Policy EC 3.1.2 (Table 3 of this report).

- A significant impact would be identified if construction activities would expose persons to excessive vibration levels. Specifically, an impact would be identified if groundborne vibration levels due to project construction activities or proposed on-site operations exceed 0.5 inches/second peak particle velocity at nearby residences.

- Because the project area is not located within 2 miles of a private or public airport, no analysis of aircraft noise impacts are required for this assessment.

Noise Impacts Associated with Off-Site Traffic

On days when events occur at the proposed music hall, traffic volumes on the local roadway network will increase. Those increases in traffic volumes will result in a corresponding increase in traffic noise levels at existing uses located along those roadways, but for relatively short periods of time, and not likely during the typical peak hour traffic conditions.

The Federal Highway Administration Highway Traffic Noise Prediction Model (FHWA-RD-77-108) was used with traffic data provided included in the project traffic study (*Transportation Impact Study for the Sacramento Music Hall and Performing Arts Center*, March 18, 2022, prepared for the City of Sacramento by Fehr & Peers), to predict project traffic noise levels on the local roadway network for days during which events would occur at the facility. The FHWA Model Inputs for Project conditions are provided in Appendix E.

The project transportation study indicates that the majority of project traffic will access the site via Power Inn Road to Cucamonga Avenue to Ramona Avenue. Traffic will also access the project site via Folsom Boulevard to Ramona Avenue, but at significantly lower volumes than the other route. The only identified noise-sensitive land uses along these site access routes consist of "The Crossings" apartments to the north (at the roundabout of Ramona and Brighton Avenues), and 3 single-family residences to the south (at the intersection of Ramona and Cucamonga Avenues). There are no residential uses located on Cucamonga Avenue between Power Inn Road and Ramona Avenue.

The FHWA Analysis indicate that project-generated traffic on Ramona Avenue would result in traffic noise levels of 47 dB DNL at the apartments to the north of the venue and 54 dB DNL at the single-family residences to the south of the venue on days when the venue would be hosting sold-out events. The FHWA analysis also assumes the sold-out event would conclude after 10 pm, thereby resulting in 50% of the event-generated traffic occurring during nighttime hours. For events concluding during daytime hours, or events which would not reach the capacity limitations of the venue, resulting noise levels at the nearest residences would be appreciably lower.

Because existing baseline ambient conditions at the apartments to the north and single-family residences to the south are estimated to be approximately 55 dB DNL, the increases in those ambient noise levels resulting from the project would range from 0.8 to 2.5 dB DNL.

Impact 1: Noise Impacts Associated with Off-Site, Project-Generated, Traffic

The predicted, project-generated, Ramona Avenue traffic noise levels of 48 to 54 dB DNL at the nearest residences to the north and south of the project site are satisfactory relative to the City of Sacramento 65 and 60 dB DNL exterior noise standards applicable to those residential uses, respectively. In addition, for a baseline ambient condition of 55 dB DNL, Table 3 indicates that a 3 dB increase in DNL values resulting from the project would be considered acceptable. Because the project-related increases in DNL at the nearest residential land uses to the proposed music venue are predicted to be 2.5 dB DNL or less, the Table 3 thresholds would not be exceeded. Because project-generated traffic is predicted to satisfy both the Table 2 DNL limits for single-family and multi-family residential uses, and because the project-related increase in DNL values

is below the 3 dB threshold identified in Table 3, noise impacts related to project-generated traffic are predicted to be ***less than significant***.

Noise Impacts Associated with Proposed On-Site Activities and Noise Sources

The proposed project would generate noise from the following sources: Music generated during events, heavy truck deliveries at the proposed loading dock prior to events, parking lot movements prior to and after events, and rooftop mechanical equipment used to control temperature within the venue during facility usage. Each of these on-site noise sources are evaluated separately below.

Impact 2: On-Site Heavy Truck Circulation/Loading Dock Noise Impacts

The project proposes the creation of a truck unloading area (dock) on the southwest façade of the building, as indicated in Figure 2. The truck unloading area will be used to load and unload instruments, sound amplification equipment, staging, food, other concessions, etc., related to events held at the venue.

SoundPlan Version 8.2 was used to model the noise generation of truck deliveries at the project site. The SoundPlan model accounts for shielding provided by intervening topography and structures, the frequency content of the noise source, and the effects of atmospheric conditions on sound propagation.

For a conservative estimate of on-site truck circulation, loading and unloading noise generation, it was assumed that 4 trucks could access the site, unload (or load), and depart the site in the span of a one-hour period. BAC noise measurement data for slow-moving heavy truck passbys and unloading (including backup beepers), indicates that maximum noise levels of approximately 74 dB at 50 feet are typical with sound exposure levels for individual events of 83 dB SEL being typical. Using these assumptions with the SoundPlan model, the predicted median (L_{50}) and maximum (L_{max}) noise contours for truck circulation / deliveries at the site were predicted and are shown on Figures 5A and 5B, respectively.

As indicated on Figure 5A, predicted median noise levels for on-site truck operations do not approach or exceed the City of Sacramento 50 dB L_{50} nighttime noise standard at any of the nearest existing residential locations to the project site. Similarly, as indicated on Figure 5B, predicted maximum noise levels for on-site truck operations do not approach or exceed the City of Sacramento 70 dB L_{max} nighttime noise standard at any of the nearest existing residential locations to the project site. In addition, the noise generation of this source would be well below measured existing daytime and nighttime ambient conditions at the nearest residences. As a result, noise impacts associated with on-site truck circulation, loading or unloading, are considered ***less than significant.***

Figure 5A

Sacramento Music Hall
Truck Delivery Median
Noise Contours (L50)

Based on 3 truck arrivals, loading/unloading, and departure in an hour.

Median noise level standard for truck passby/unloading activities - applicable at exterior areas of residential uses:

Daytime: 55 dBA
Nighttime: 50 dBA

L50, dB(A)

>=	80		
75	-	80	
70	-	75	
65	-	70	
60	-	65	
55	-	60	
50	-	55	

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Figure 5B

Sacramento Music Hall
Truck Delivery Maximum
Noise Contours (Lmax)

Maximum noise level standard for truck passby/unloading activities - applicable at exterior areas of residential uses:

Daytime: 75 dBA
Nighttime: 70 dBA

Lmax, dB(A)

>=	100
95 -	100
90 -	95
85 -	90
80 -	85
75 -	80
70 -	75

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Impact 3: On-Site Parking Lot Activity Noise Impacts

The project proposes the creation of a parking area behind and to the south of the proposed music venue as indicated in Figure 2. Approximately 470 parking spaces are proposed for this venue. SoundPlan Version 8.2 was used to model the noise generation of parking lot activities at the project site. For a reasonably conservative estimate of on-site parking lot noise generation, it was assumed that every parking space could fill or empty in the span of a one-hour period. BAC noise measurement data for parking lot movements (vehicles arriving, car doors opening/closing, people conversing, engines starting, etc.), indicates that maximum noise levels of approximately 63 dB at 50 feet are typical with sound exposure levels for individual events of 72 dB SEL being typical. Using these assumptions with the SoundPlan model, the predicted median (L_{50}) and maximum (L_{max}) noise contours for parking lot activities at the site were predicted and are shown on Figures 6A and 6B, respectively.

As indicated on Figure 6A, predicted median noise levels for peak hour parking lot activity do not approach or exceed the City of Sacramento 50 dB L_{50} nighttime noise standard at any of the nearest existing residential locations to the project site. Similarly, as indicated on Figure 6B, predicted maximum noise levels for peak hour parking lot activity do not approach or exceed the City of Sacramento 70 dB L_{max} nighttime noise standard at any of the nearest existing residential locations to the project site. In addition, the noise generation of this source would be well below measured existing daytime and nighttime ambient conditions at the nearest residences. As a result, noise impacts associated with peak (worst-case), parking lot activities occurring at the project site are considered ***less than significant.***

Impact 4: Rooftop Mechanical Equipment Noise Impacts

The project proposes the use of approximately 8 packaged rooftop refrigeration units to satisfy the heating, ventilating, and air conditioning (HVAC) requirements of the building, as indicated in Figure 2. For purposes of this analysis, BAC assumed those packaged rooftop units would provide approximately 12 tons of refrigeration each. Using the reference noise publication, *Noise Control for Buildings and Manufacturing Plants* (BBN, Inc.), the sound power level of packaged HVAC rooftop units can be calculated using the formula: $L_w=87+12 * \log_{10}(CC)$ where CC is the cooling capacity in tons. The resulting linear sound power level per unit computes to 100 dB. It should be noted that the rooftop units, the locations of which are shown on Figure 2, would be shielded from view of any nearby sensitive uses by the building parapets, also as indicated on Figure 2. This shielding was included in the computations of HVAC noise at nearby residences.

Using the assumptions cited above with the SoundPlan model, the predicted median (L_{50}) noise contours for rooftop mechanical equipment at the site were predicted and are shown on Figure 7. Because the rooftop mechanical equipment would generate steady-state noise levels, analysis of maximum (L_{max}) noise levels associated with the HVAC equipment would yield similar results as the analysis of median noise levels. As a result, only median noise levels were evaluated for the rooftop mechanical equipment.

Figure 6A

Sacramento Music Hall Parking Lot Median Noise Contours (L50)

Based on parking lot filling or emptying during a peak hour.

Median noise level standard for parking lot movements - applicable at exterior areas of residential uses:

Daytime: 55 dBA
Nighttime: 50 dBA

L50, dB(A)

	>=		80
75	-		80
70	-		75
65	-		70
60	-		65
55	-		60
50	-		55

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Figure 6B

Sacramento Music Hall
Parking Lot Maximum
Noise Contours (Lmax)

Maximum noise level standard for parking lot movements - applicable at exterior areas of residential uses:

Daytime: 75 dBA
Nighttime: 70 dBA

Lmax, dB(A)

>=	100
95 -	100
90 -	95
85 -	90
80 -	85
75 -	80
70 -	75

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Figure 7

Sacramento Music Hall Rooftop Mechanical Equipment Median Noise Contours (L50)

Based on continuous hourly operations of packaged rooftop HVAC systems.

Median noise level standard for parking lot movements - applicable at exterior areas of residential uses:

Daytime: 55 dBA
Nighttime: 50 dBA

L50, dB(A)

	>=	75	
70	-	75	
65	-	70	
60	-	65	
55	-	60	
50	-	55	
45	-	50	

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As indicated on Figure 7, predicted median noise levels for rooftop HVAC operations do not approach or exceed the City of Sacramento 50 dB L_{50} nighttime noise standard at any of the nearest existing residential locations to the project site. In addition, the noise generation of this source would be well below measured existing daytime and nighttime ambient conditions at the nearest residences. As a result, noise impacts associated with rooftop mechanical equipment operations at the project site are considered ***less than significant.***

Impact 5: Amplified Music/Crowd Noise Impacts

The containment of sound generated by amplified music and crowds during events held at the proposed venue within the proposed building will undoubtedly be of primary importance to both the City of Sacramento and nearest residences to the proposed venue.

The existing building construction consists of 8-inch thick tilt up concrete walls and a wood joist ceiling with multiple skylights and two large metal roll-up doors on the northwest and southwest sides of the building. The proposed construction will continue to consist of the 8-inch concrete exterior shell but the roof assembly will be replaced with a built-up assembly and three of the four existing roll-up doors will be removed and sealed (both on the northwest side and one on the southwest side).

To quantify the level of sound containment provided by the existing structure, BAC conducted an event simulation at the project site on March 11, 2021. The simulation consisted of playing music amplified to approximately 105 dBA from the approximate location of the proposed stage (approximate because the interior configuration of the building will change with the project), while simultaneously conducting noise measurements both inside the venue and at the 11 locations shown on Figure 1.

Sound amplification equipment used for the simulation consisted of four matched 1,100-Watt Yamaha DXR12 speakers with a matched 950 Watt Yamaha DXS15 subwoofer using an MP3 player as input. Noise measurements conducted during the simulation utilized Larson Davis Laboratories (LDL) Model 831 and 820 precision integrating sound level meters. Appendix B-3 provides photos of the noise measurement site and simulation equipment.

The simulation results are provided in Appendix C for each of the 11 sites monitored while amplified music was being played. The meters were time-synchronized and the sound levels present inside the building while music was played are overlaid on the graphs showing the measured exterior noise levels at each site.

Appendix C-1 shows the sound levels measured inside the building and immediately outside the building along the northern project site boundary (Figure 1 shows the measurement locations). As seen in Appendix C-1, the baseline ambient noise level at Site 1 was approximately 60 dBA prior to and after the music was played, with levels just exceeding 70 dB outside the building while music was being played inside. This indicates that the existing building provided approximately 35 dB of music noise reduction at Site 1. Site 1 is considered to be worst-case due to both its proximity to the location where the music was generated and the relatively poor seal provided by the existing roll-up doors on the northwest side of the building.

Appendices C-2 – C-11 show similar information as C-1, but the increase in noise levels at the monitoring sites while music was playing was inconsequential at most of the measurement locations, indicating that the existing building is performing relatively well at containing high levels of music being generated within. With the proposed modifications to the building, an even greater degree of sound containment is expected from the building shell.

BAC utilized the simulation results to check the accuracy of the SoundPlan model in predicting the noise reduction provided by the building envelope. That process indicated that the model accuracy was very good (within 2 dB). Following the calibration process, the model inputs were altered to match the proposed building construction modifications (roll-up door locations, new roof, front door entrance, etc.).

The SoundPlan model was then used to predict the level of sound which would potentially "escape" the building during a production with highly amplified sound levels. For the modelling process, a theoretical band and crowd was placed inside the building generating median and maximum sound levels of 105 dB L_{50} and 110 dB L_{max}. These inputs are conservative for most bands but realistic for others (BAC recently measured similar levels at a Pitbull concert). The frequency content of the music was shaped to be representative of a high degree of low-frequency content, as is typical for most concerts.

The predicted median (L_{50}) and maximum (L_{max}) noise contours for music events held within the proposed building are shown on Figures 8A and 8B, respectively.

As indicated on Figure 8A, predicted median noise levels for amplified music events do not approach or exceed the City of Sacramento 45 dB L_{50} nighttime noise standard applicable to music sources (see footnote 3 of Table 4), at any of the nearest existing residential locations to the project site. Similarly, as indicated on Figure 8B, predicted maximum noise levels for amplified music events do not approach or exceed the City of Sacramento 65 dB L_{max} nighttime noise standard applicable to music sources at any of the nearest existing residential locations to the project site. In addition, the amplified music sound levels received at the nearest residential land uses are predicted to be well below measured existing daytime and nighttime ambient conditions. As a result, noise impacts associated with the playing of amplified music and associated crowd noise within the proposed venue are considered ***less than significant***

Figure 8A

Sacramento Music Hall
Median Music
Noise Contours (L50)

Based on an interior sound level of 105 dBA L50 during performances.

Note: Venue Doors are in CLOSED position.

Median noise level standard for music - applicable at exterior areas of residential uses:

Daytime: 50 dBA
Nighttime: 45 dBA

L50, dB(A)

	>=	85	
80	-	85	
75	-	80	
70	-	75	
65	-	70	
60	-	65	
55	-	60	
50	-	55	
45	-	50	

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Figure 8B

Sacramento Music Hall
Maximum Music
Noise Contours (Lmax)

Based on an interior sound level of 110 dBA Lmax during performances.

Note: Venue doors are in CLOSED position.

Maximum noise level standard for music - applicable at exterior areas of residential uses:

Daytime: 70 dBA
Nighttime: 65 dBA

L50, dB(A)

	>=		90
	85	-	90
	80	-	85
	75	-	80
	70	-	75
	65	-	70

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Impact 6: Cumulative Project Noise Generation

For the evaluation of cumulative (combined) project noise generation of all sources, it is important to note that not all of the project noise sources will be present simultaneously. For example, for traffic management and logistics purposes, on-site truck deliveries would occur well prior to event patrons arriving within the parking area and well after event patrons have departed the site following an event. As a result, event parking lot generated noise and truck delivery noise would not be generated concurrently. Similarly, truck deliveries and parking lot arrivals would be completed well prior to music beginning within the venue, and would not resume until after the concert or show has been completed. As a result, sound generated by amplified music is not anticipated to occur concurrently with either peak parking lot movements or truck deliveries. Therefore, the only noise sources which would effectively be present concurrently would be rooftop mechanical equipment and the other sources (deliveries, parking lot movements, amplified music).

As indicated in Figure 7, noise generated by HVAC operations is inconsequential off-site and would not contribute appreciably to the other sources of noise. As a result, noise associated with the concurrent operation of the rooftop HVAC systems and other project noise sources is considered to be well below the City's daytime and nighttime noise standards, and well below measured daytime and nighttime ambient noise conditions at the nearest residences to the venue. Therefore, cumulative project noise impacts are considered ***less than significant.***

Impact 7: Project Construction Noise Impacts

During the construction phases of the proposed project, noise from construction activities would add to the noise environment in the immediate project vicinity, but the majority of the noise generating activities would occur within the building structure. Activities involved in typical construction would generate maximum noise levels, as indicated in Table 5, ranging from 77 to 90 dB at a distance of 50 feet. Not all the equipment listed in Table 5 would be required during project construction.

Table 5
Typical Construction Equipment Noise

Equipment Description	Maximum Noise Level at 50 feet, dBA
Backhoe	80
Compactor (ground)	80
Compressor (air)	80
Concrete mixer truck	85
Concrete pump truck	82
Concrete saw	90
Crane (mobile or stationary)	85
Dozer	85
Dump truck	84
Excavator	85
Flatbed truck	84
Front end loader	80
Generator (more than 25 kVA)	82
Grader	85
Jackhammer	85
Mounted impact hammer (hoe ram)	90
Paver	85
Pneumatic tools	85
Pumps	77
Scraper	85
Tractor	84
Vacuum street sweeper	80
Source: Federal Highway Administration 2006	

The nearest noise-sensitive land uses (residences) to the project site are located approximately 400 or more feet from the nearest locations where construction activities would occur on the project site. At that distance, maximum noise levels from project construction would be expected to be approximately 59 to 72 dB L_{max}. Although noise levels in that range would generally fall within the range of measured maximum noise levels in the project vicinity (Sites LT-1 and LT-2), it is possible that a portion of the project construction equipment could result in a substantial short-term increase over ambient maximum noise levels shown in Table 2.

As noted in the Regulatory Setting Section of this report, Section 8.68.080 of the Sacramento City Code exempts noise sources associated with the erection (including excavation), demolition, alteration or repair of any building or structure provided such activities take place between the hours of 7:00 a.m. and 6:00 p.m. on Monday, Tuesday, Wednesday, Thursday, Friday and Saturday, and between 9:00 a.m. and 6:00 p.m. on Sunday. Provided project construction activities do not occur during these hours, construction activities would be exempt and this impact would be considered ***less than significant***.

However, if construction activities are proposed during the hours not exempted by City Code Section 8.68.080, noise levels generated by construction activities could exceed the maximum noise level standards identified in Table 5 at the nearest residences. As a result, noise impacts associated with construction activities are identified as being ***potentially significant.***

Mitigation for Impact 7: Construction Noise Control Measures

MM-1: To the maximum extent practical, the following measures should be incorporated into the project construction operations:

- Noise-generating construction activities shall not occur within the hours identified in City Code Section 8.68.080.
- Pursuant to City Code Section 8.68.080, all noise-producing project equipment and vehicles using internal-combustion engines shall be equipped with manufacturers-recommended mufflers/silencers and be maintained in good working condition.
- All mobile or fixed noise-producing equipment used on the project site that are regulated for noise output by a federal, state, or local agency shall comply with such regulations while in the course of project activity.
- Electrically powered equipment shall be used instead of pneumatic or internal-combustion-powered equipment, where feasible.

Significance of Impact Following Mitigation: ***Less than Significant***

Vibration Impacts Associated with the Project

Impact 8: Vibration Generated by Project Construction Activities

No discernible off-site vibration was detected by BAC staff at any of the 11 measurement locations during the amplified music event simulation. As a result, vibration levels at the nearest sensitive receptors are predicted to be well below City vibration standards during operations at the venue.

During project construction, heavy equipment would be used for grading excavation, paving, and building construction, which would generate localized vibration in the immediate vicinity of the construction. The nearest residence to the project area is located approximately 400 feet away. The range of vibration source levels for construction equipment commonly used in similar projects are shown in Table 6. The vibration levels depicted in Table 6 are representative of locations 25 feet from the equipment source. At the nearest sensitive receptors 400 feet from the construction activities, vibration levels would be dramatically lower.

Table 6
Vibration Source Levels for Construction Equipment

Equipment	PPV at 25 feet (in/sec)	Approximate RMS L_V[1] at 25 feet
Hoe ram	0.089	87
Large bulldozer	0.089	87
Caisson drilling	0.089	87
Loaded trucks	0.076	86
Jackhammer	0.035	79
Small bulldozer	0.003	58

[1] RMS velocity in decibels (VdB) re 1 micro-inch/second

Source: Federal Transit Administration, Transit Noise and Vibration Impact Assessment Manual (2018)

Because vibration levels generated by the type of construction equipment which will be required for this project dissipates very rapidly with distance, vibration levels at the nearest residences are predicted to be well below 0.01 inches/second peak particle velocity at those receptors over the course of project construction activities (well below the thresholds of perception or damage to structures). As a result, this impact is considered ***less than significant***.

Conclusions and Recommendations

This analysis concludes that the proposed project construction and operations would be satisfactory relative to the applicable City of Sacramento noise and vibration standards at the nearest sensitive land uses to the project site. Nonetheless, the following recommendations are provided to ensure compliance with those standards and minimize the potential for adverse public reaction to noise generated at the facility.

1. The construction noise mitigation measures cited previously in this report should be implemented to the maximum extent feasible.

2. The exterior doors, including roll-up door, of the venue shall remain closed to the maximum extent possible during periods when amplified music is being generated within the building.

This concludes BAC's analysis of the potential noise and vibration impacts of the Sacramento Music Hall project. Please contact BAC at (530) 537-2328 or paulb@bacnoise.com if you have any comments or questions regarding this report.

Appendix A
Acoustical Terminology

Acoustics The science of sound.

Ambient Noise The distinctive acoustical characteristics of a given space consisting of all noise sources audible at that location. In many cases, the term ambient is used to describe an existing or pre-project condition such as the setting in an environmental noise study.

Attenuation The reduction of an acoustic signal.

A-Weighting A frequency-response adjustment of a sound level meter that conditions the output signal to approximate human response.

Decibel or dB Fundamental unit of sound. A Bell is defined as the logarithm of the ratio of the sound pressure squared over the reference pressure squared. A Decibel is one-tenth of a Bell.

CNEL Community Noise Equivalent Level. Defined as the 24-hour average noise level with noise occurring during evening hours (7 - 10 p.m.) weighted by a factor of three and nighttime hours weighted by a factor of 10 prior to averaging.

Frequency The measure of the rapidity of alterations of a periodic signal, expressed in cycles per second or hertz.

IIC Impact Insulation Class (IIC): A single-number representation of a floor/ceiling partition's impact generated noise insulation performance. The field-measured version of this number is the FIIC.

L_{dn} Day/Night Average Sound Level. Similar to CNEL but with no evening weighting.

L_{eq} Equivalent or energy-averaged sound level.

L_{max} The highest root-mean-square (RMS) sound level measured over a given period of time.

Loudness A subjective term for the sensation of the magnitude of sound.

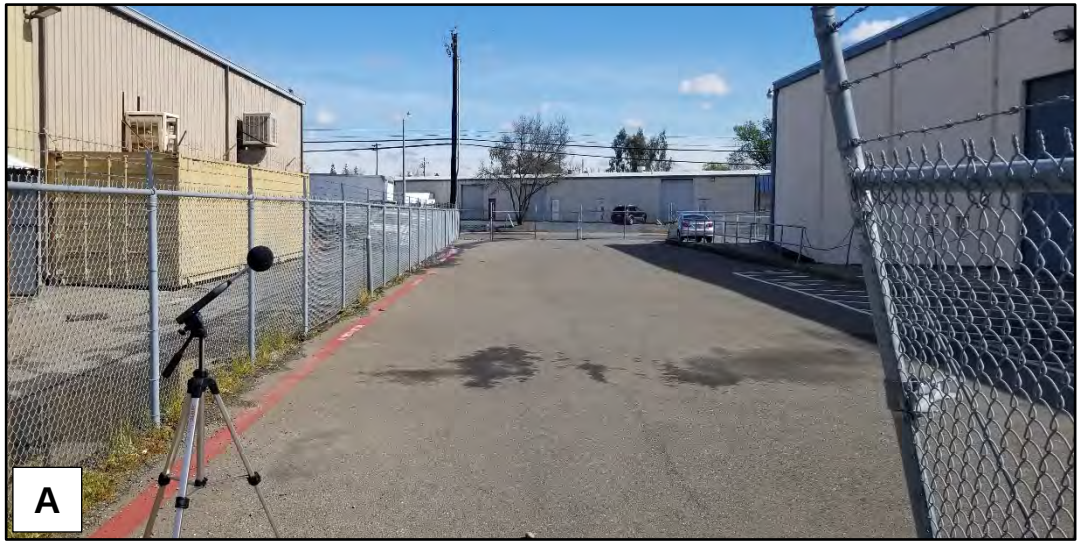
Masking The amount (or the process) by which the threshold of audibility is for one sound is raised by the presence of another (masking) sound.

Noise Unwanted sound.

Peak Noise The level corresponding to the highest (not RMS) sound pressure measured over a given period of time. This term is often confused with the "Maximum" level, which is the highest RMS level.

RT_{60} The time it takes reverberant sound to decay by 60 dB once the source has been removed.

STC Sound Transmission Class (STC): A single-number representation of a partition's noise insulation performance. This number is based on laboratory-measured, 16-band (1/3-octave) transmission loss (TL) data of the subject partition. The field-measured version of this number is the FSTC.



Legend

A: Short-Term Monitoring Site 1 Facing Northeast
B: Short-Term Monitoring Site 3 Facing Southwest
C: Short-Term Monitoring Site 6 Facing South

Sacramento Music Hall

Sacramento, California

Photographs of Survey Locations

Appendix B-1

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Legend

A: Short-Term Monitoring Site 7 Facing Northeast
B: Short-Term Monitoring Site 9 Facing Southwest
C: Short-Term Monitoring Site 11 Facing North

Sacramento Music Hall

Sacramento, California

Photographs of Survey Locations

Appendix B-2

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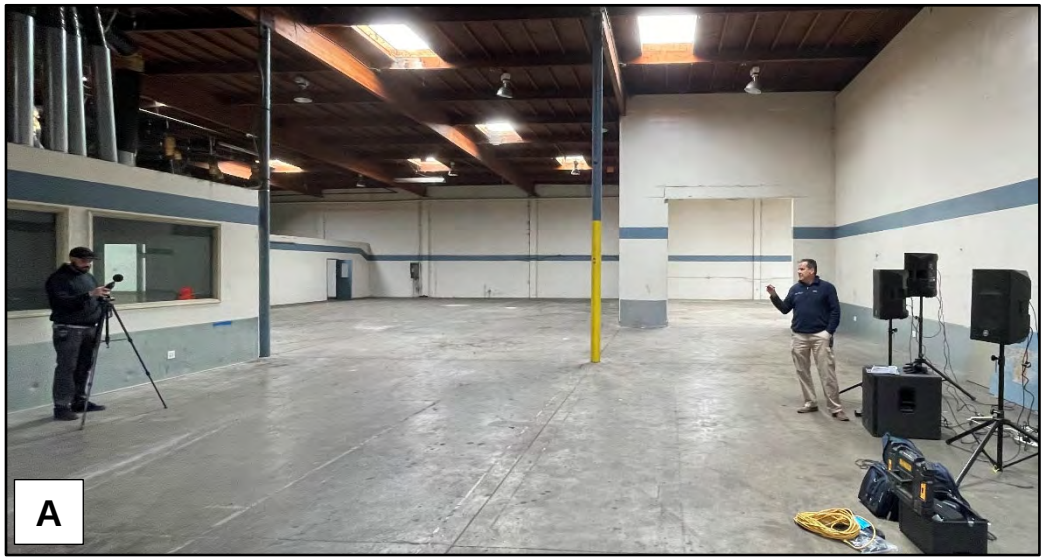

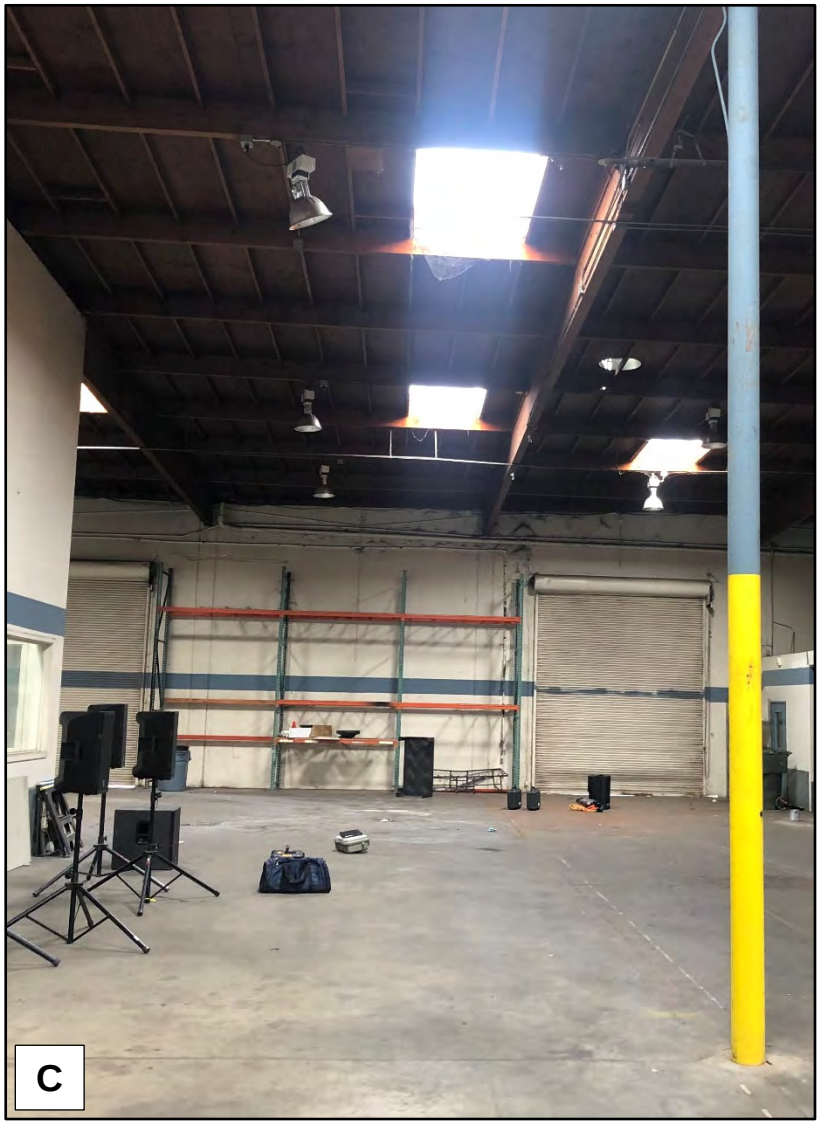

Legend

A: Concert Simulation Inside Music Hall
B: Inside Space Facing Northeast
C: Northwest Wall Inside Music Hall

Sacramento Music Hall

Sacramento, California

Photographs of Survey Locations

Appendix B-3

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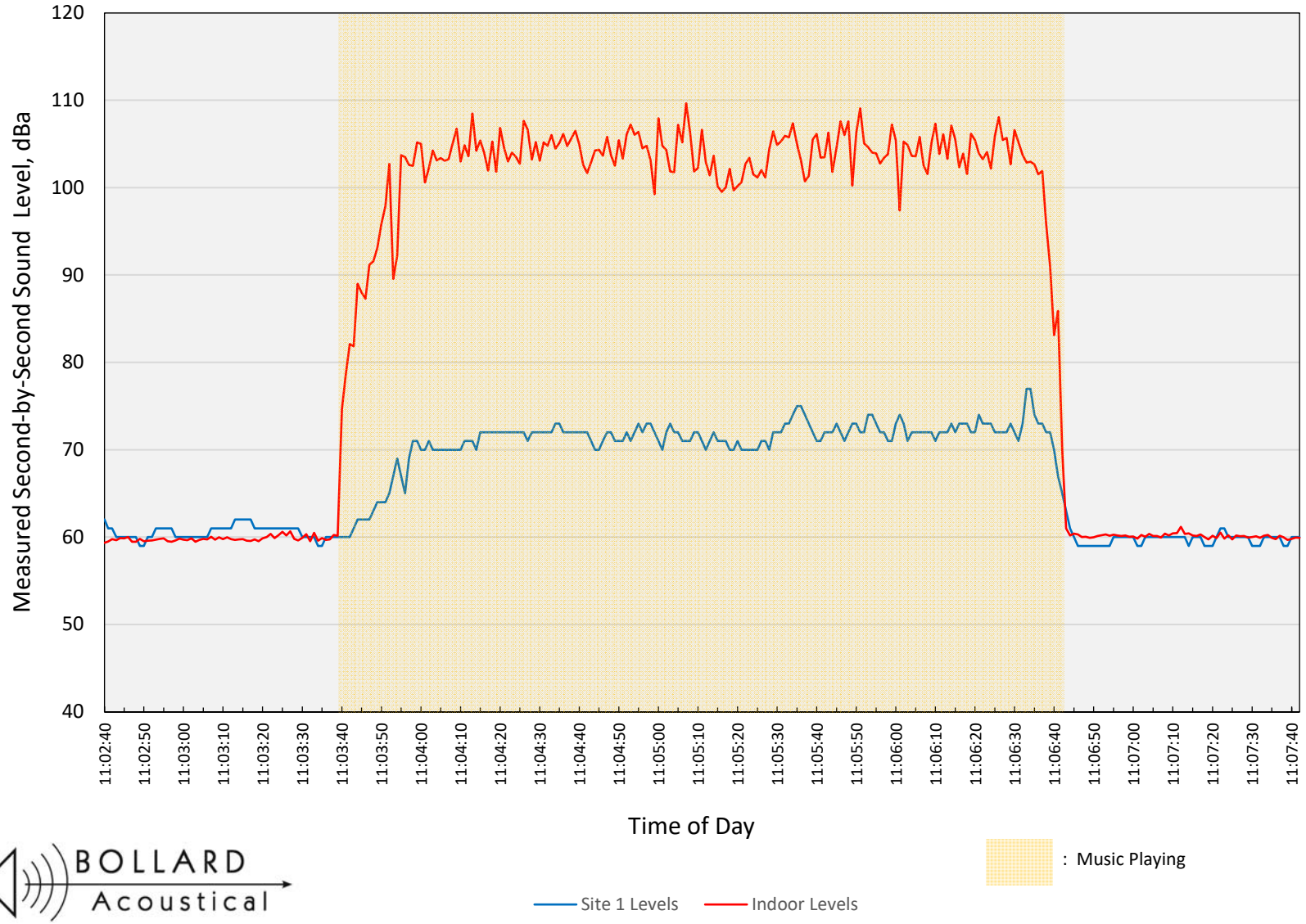
Appendix C-1

Measured Sound Levels: Site 1

Sacramento, CA - March 11, 2021 - 11:02:40 am -11:07:42 am



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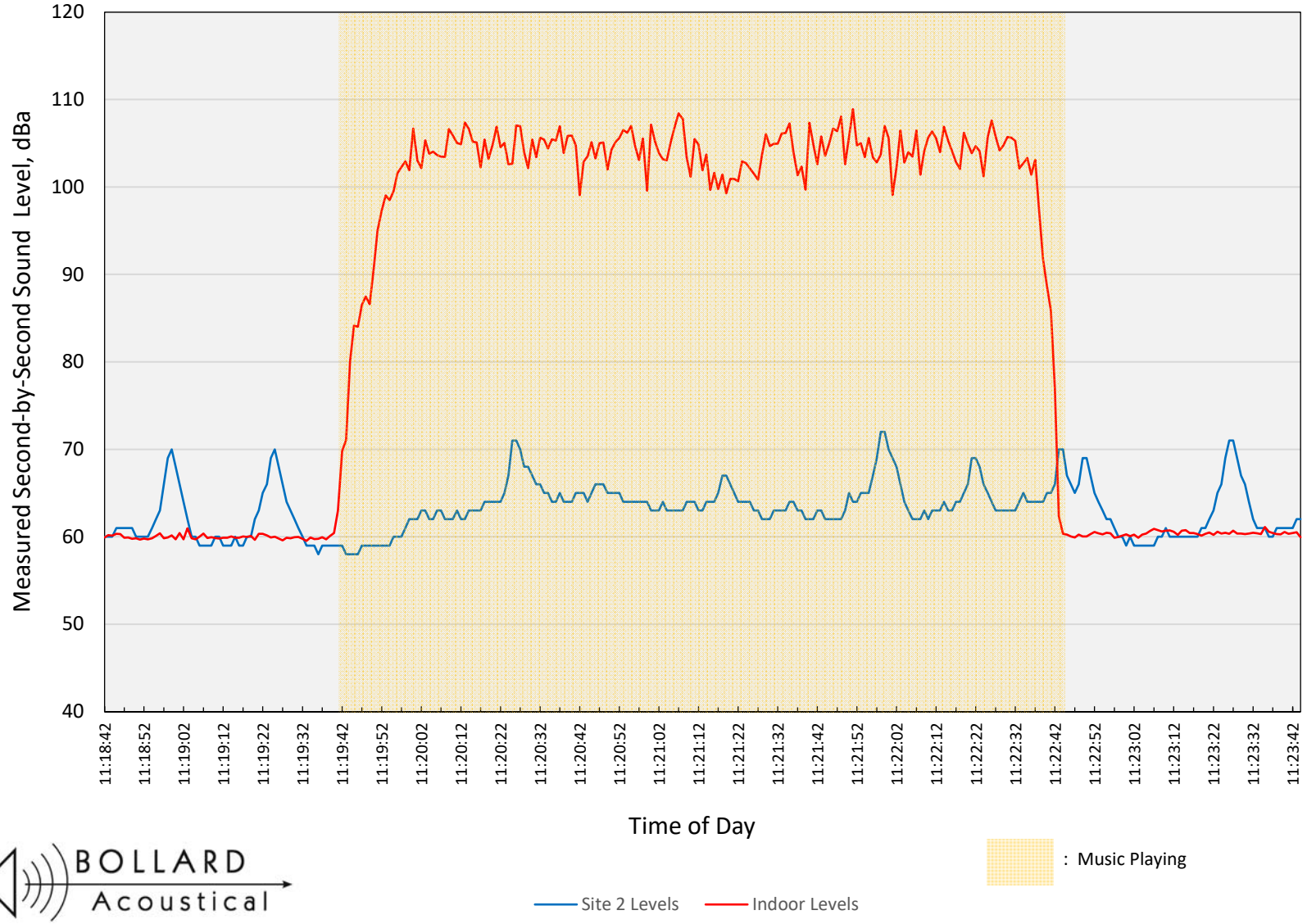
Appendix C-2
Measured Sound Levels: Site 2
Sacramento, CA - March 11, 2021 - 11:18:42 am -11:23:44 am



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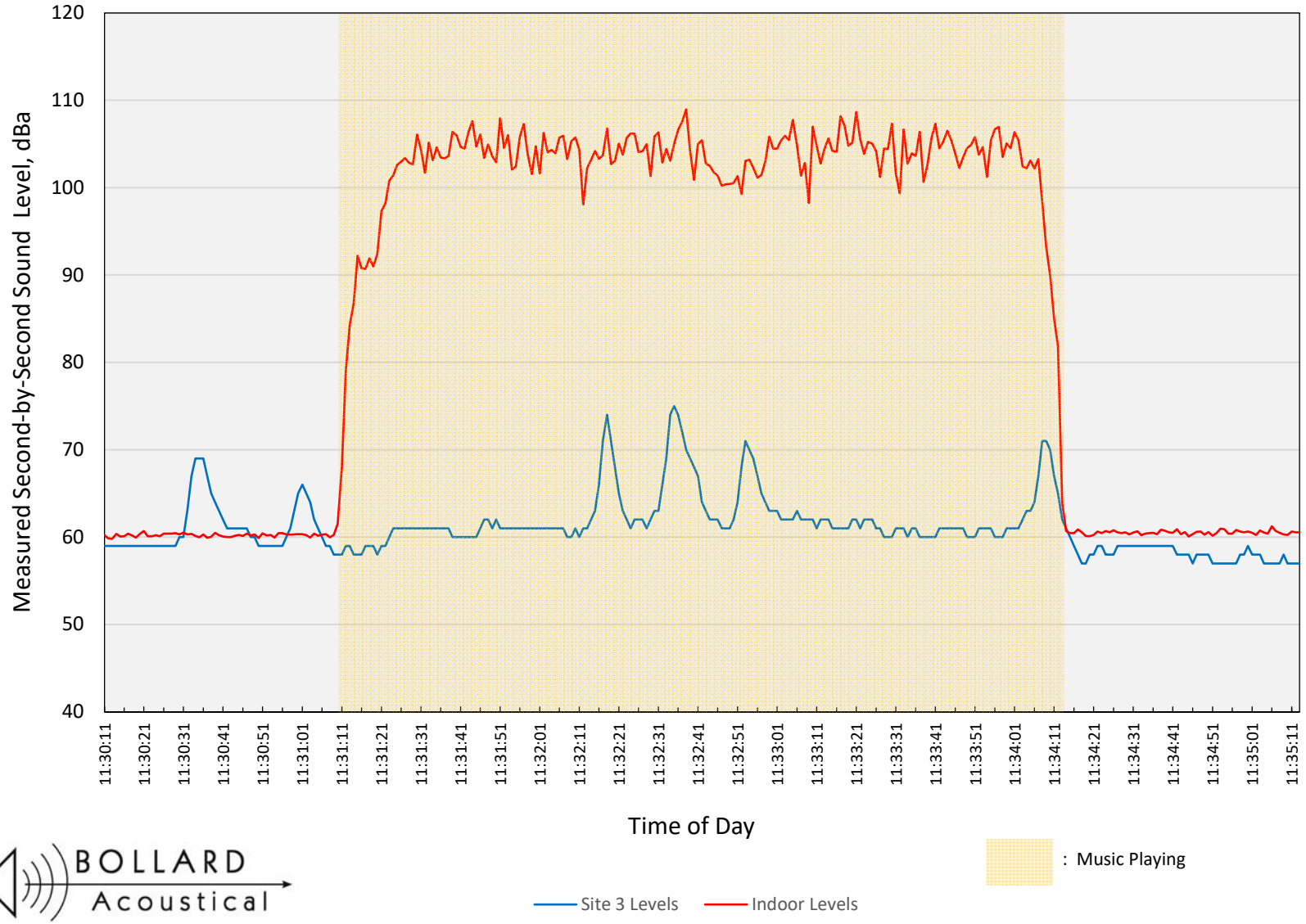
Appendix C-3
Measured Sound Levels: Site 3
Sacramento, CA - March 11, 2021 - 11:30:11 am -11:35:13 am



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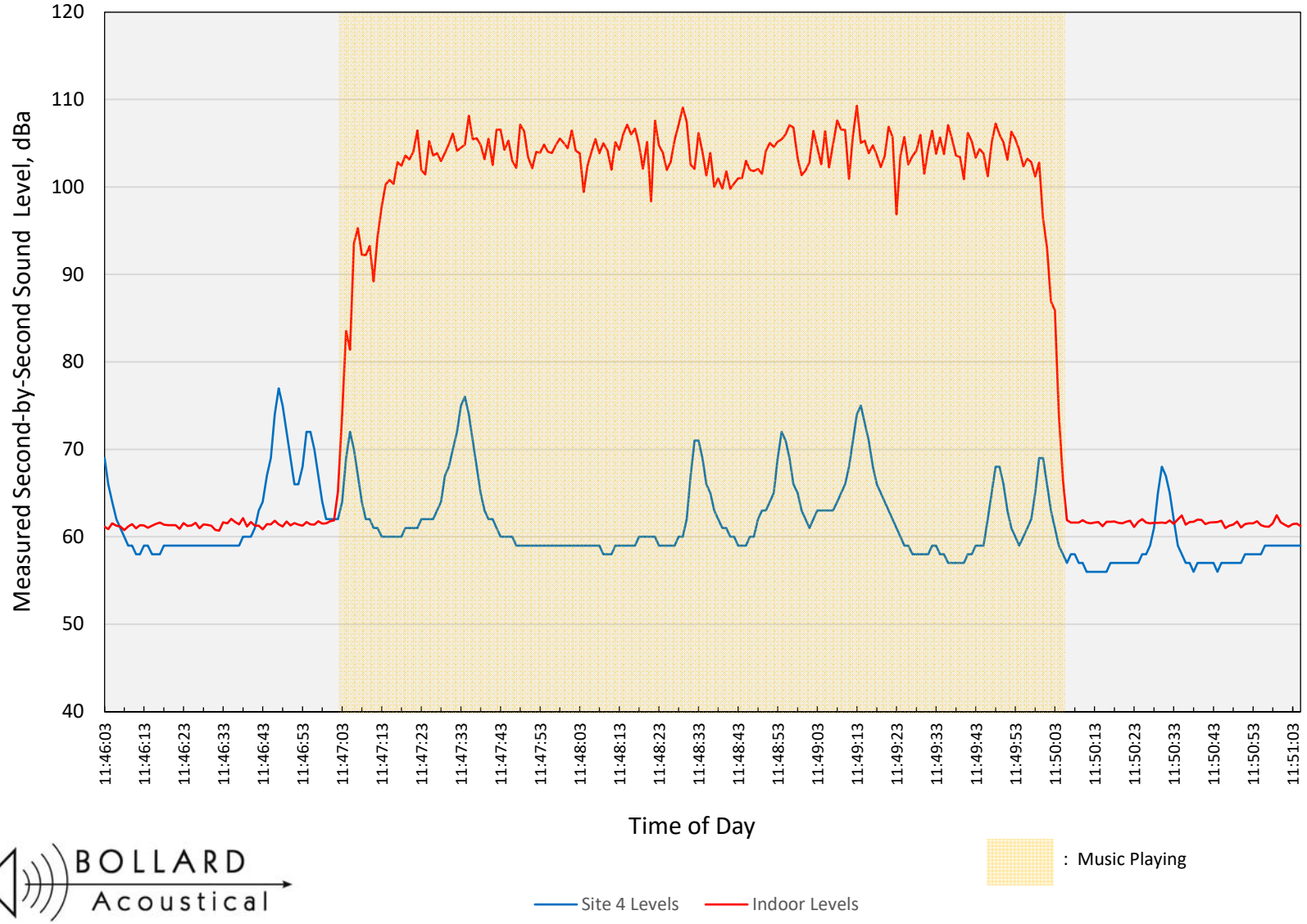
Appendix C-4
Measured Sound Levels: Site 4
Sacramento, CA - March 11, 2021 - 11:46:03 am -11:51:05 am



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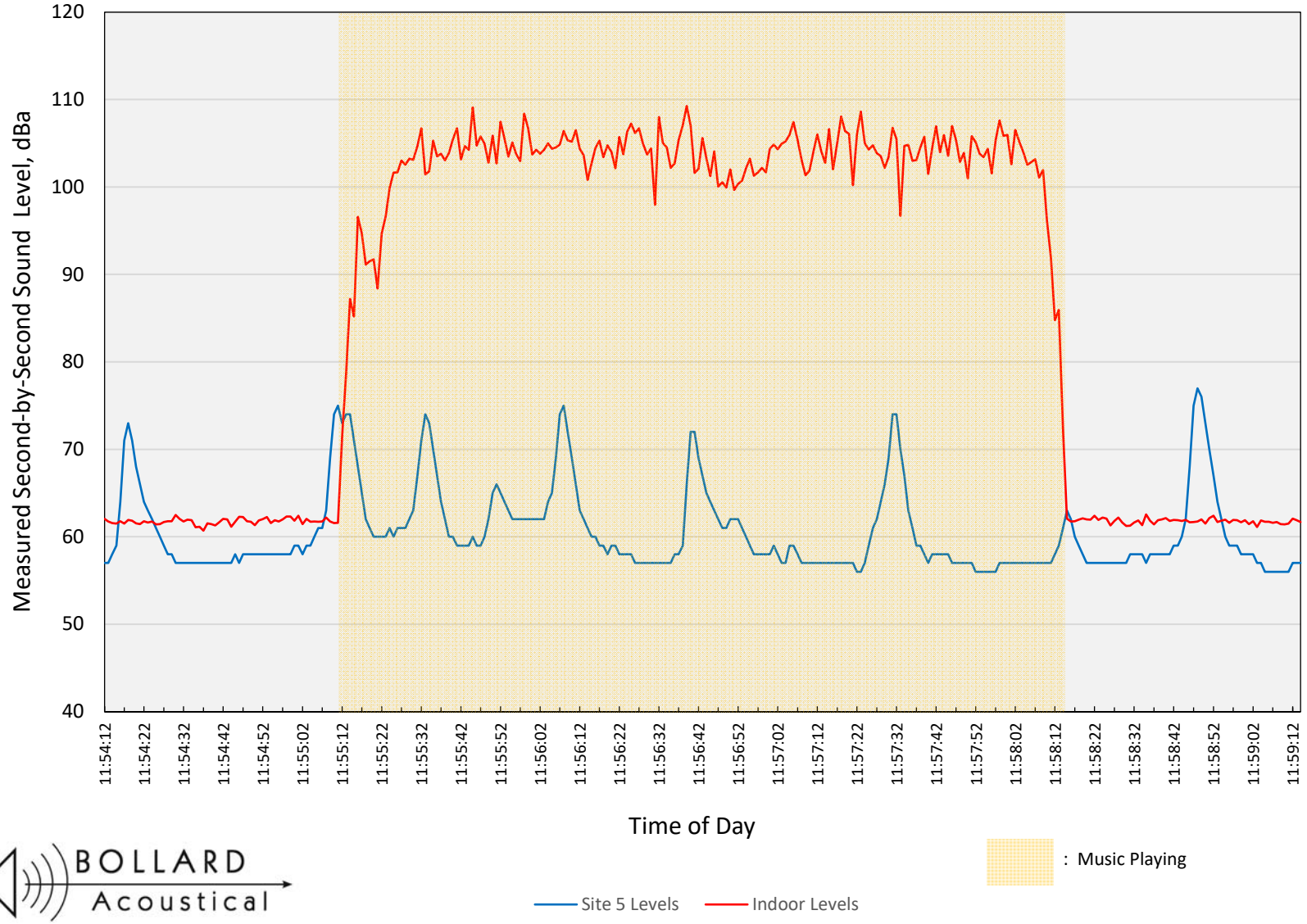
Appendix C-5
Measured Sound Levels: Site 5
Sacramento, CA - March 11, 2021 - 11:54:12 am -11:59:14 am



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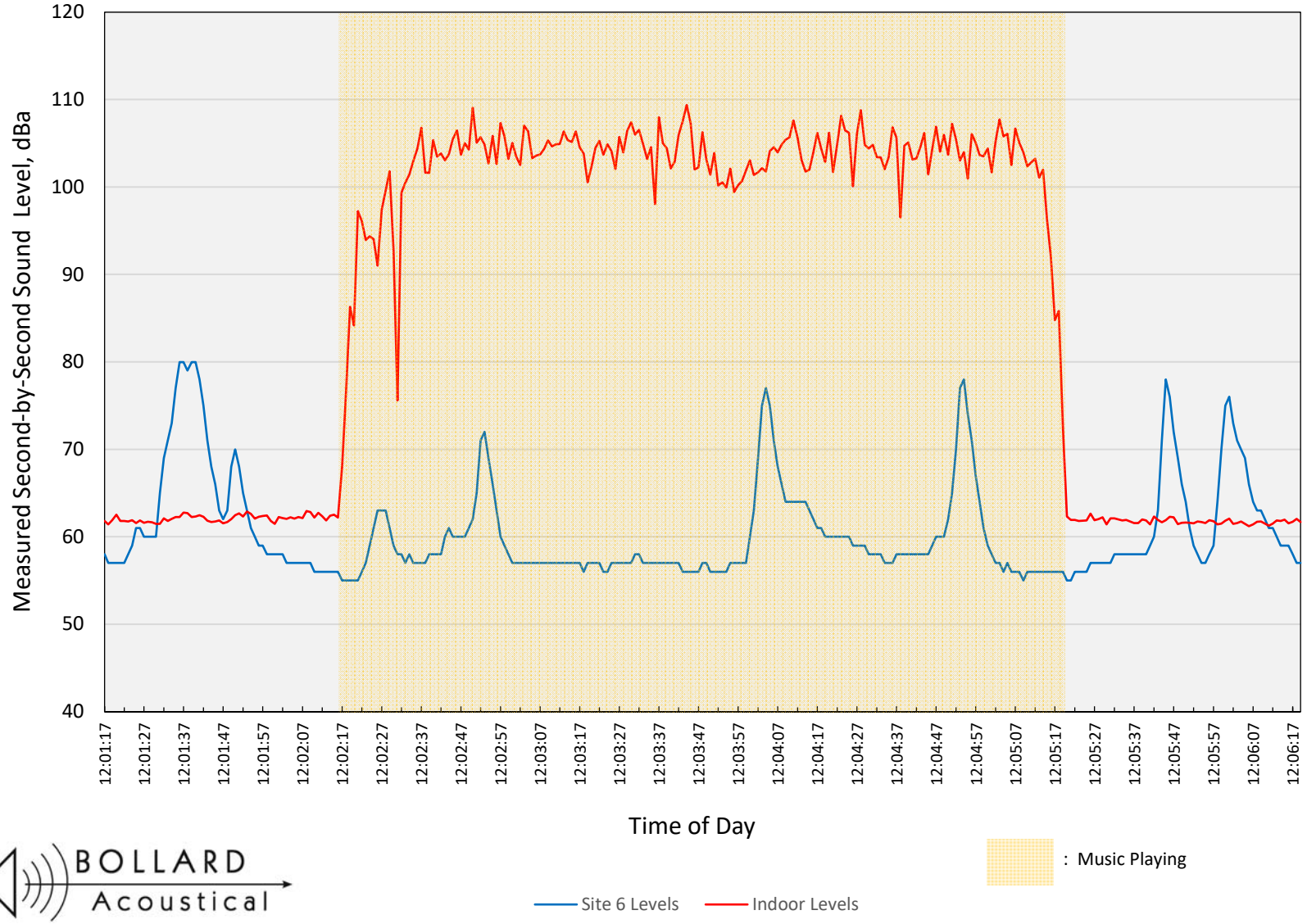
Appendix C-6
Measured Sound Levels: Site 6
Sacramento, CA - March 11, 2021 - 12:01:17 pm - 12:06:19 pm



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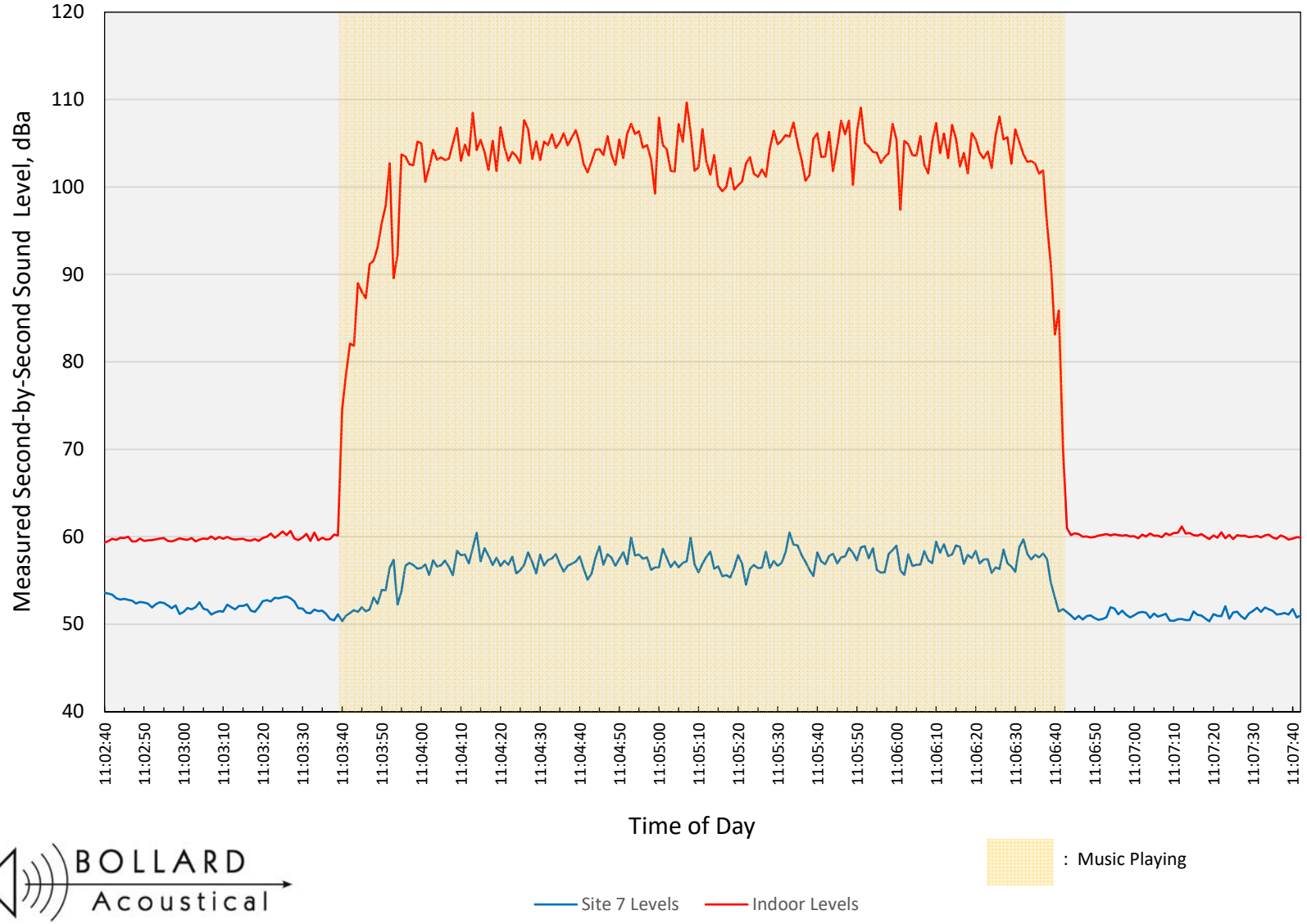
Appendix C-7
Measured Sound Levels: Site 7
Sacramento, CA - March 11, 2021 - 11:02:40 am -11:07:42 am



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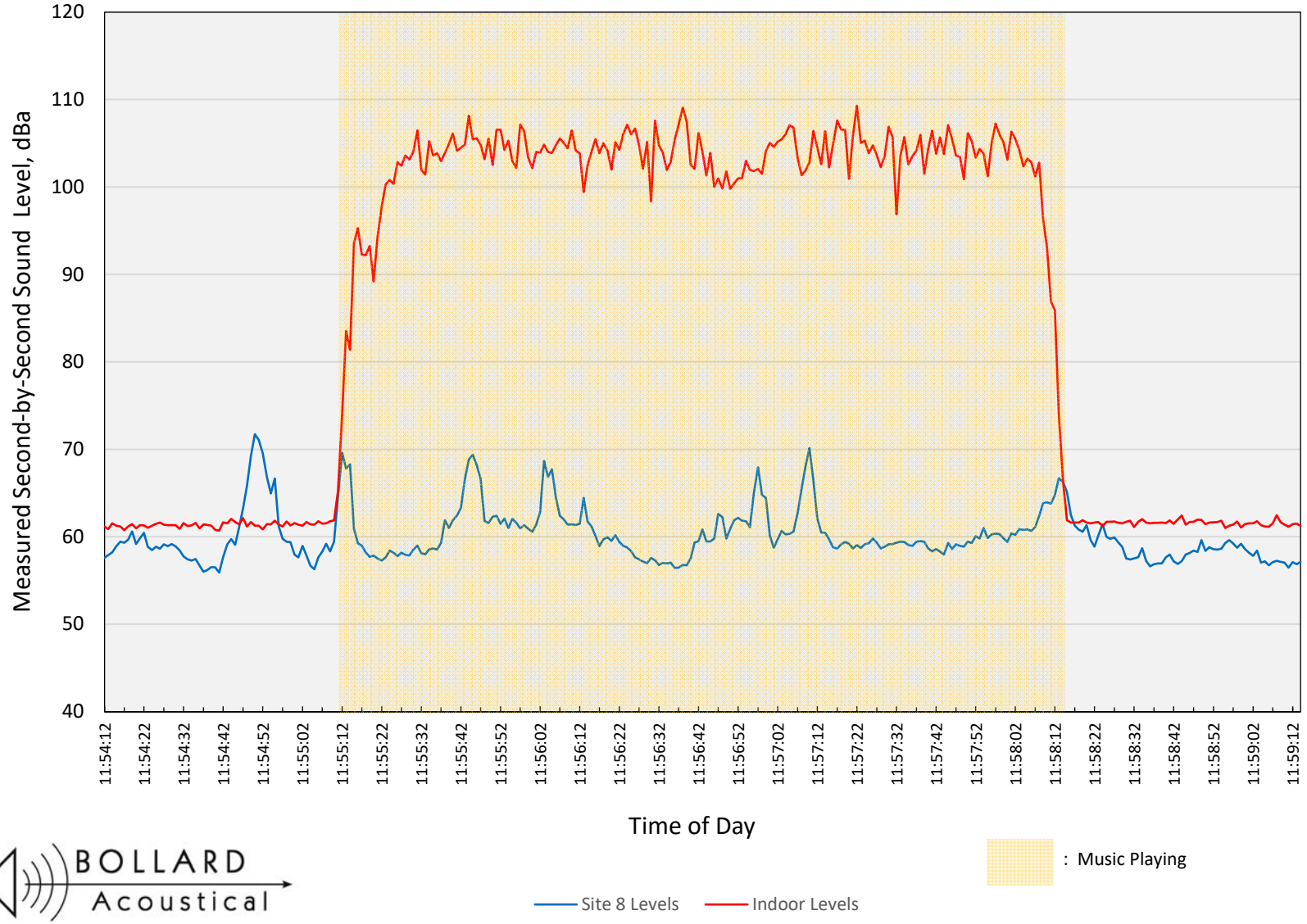
Appendix C-8
Measured Sound Levels: Site 8
Sacramento, CA - March 11, 2021 - 11:54:12 am -11:59:14 am



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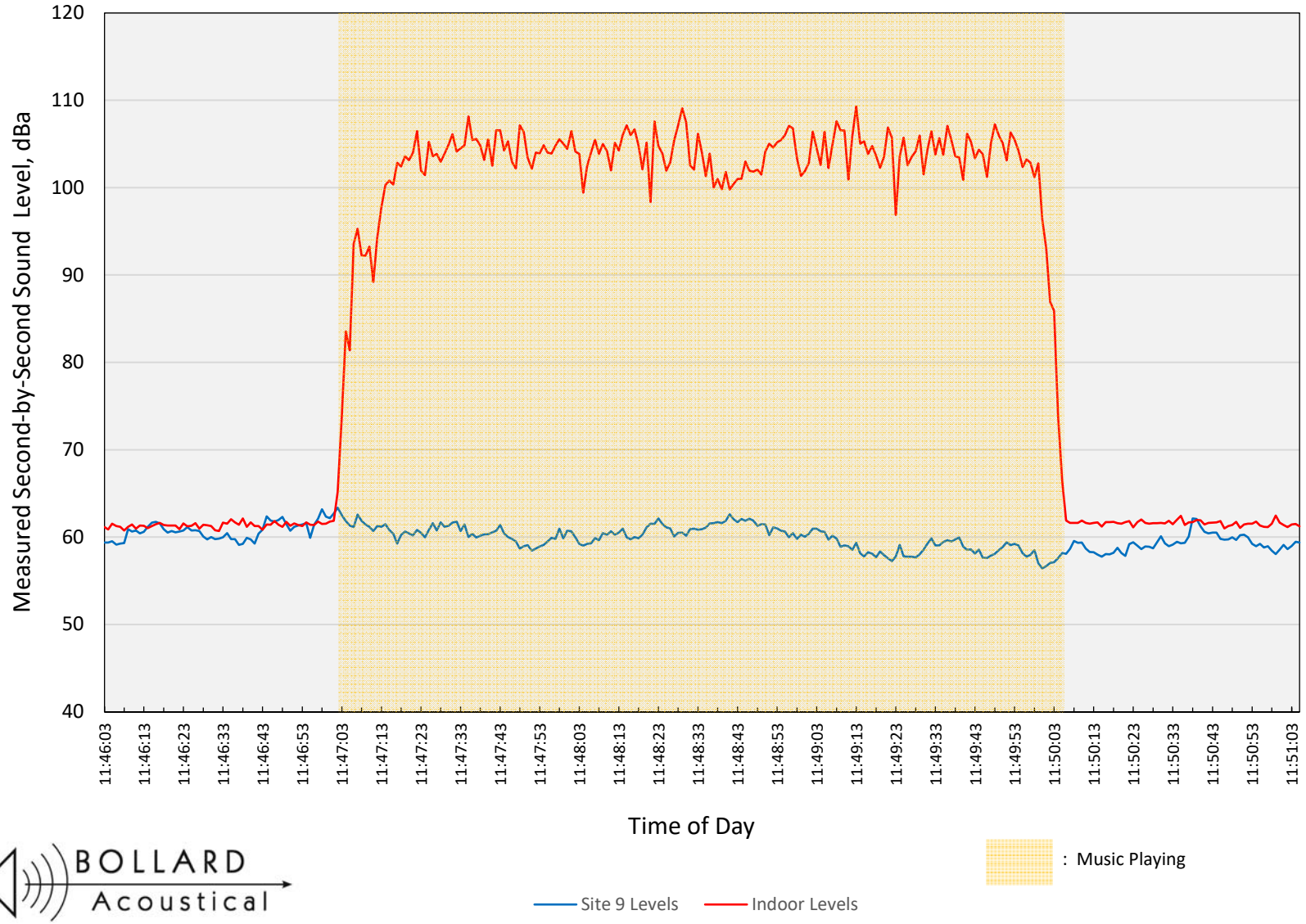
Appendix C-9
Measured Sound Levels: Site 9
Sacramento, CA - March 11, 2021 - 11:46:03 am -11:51:05 am



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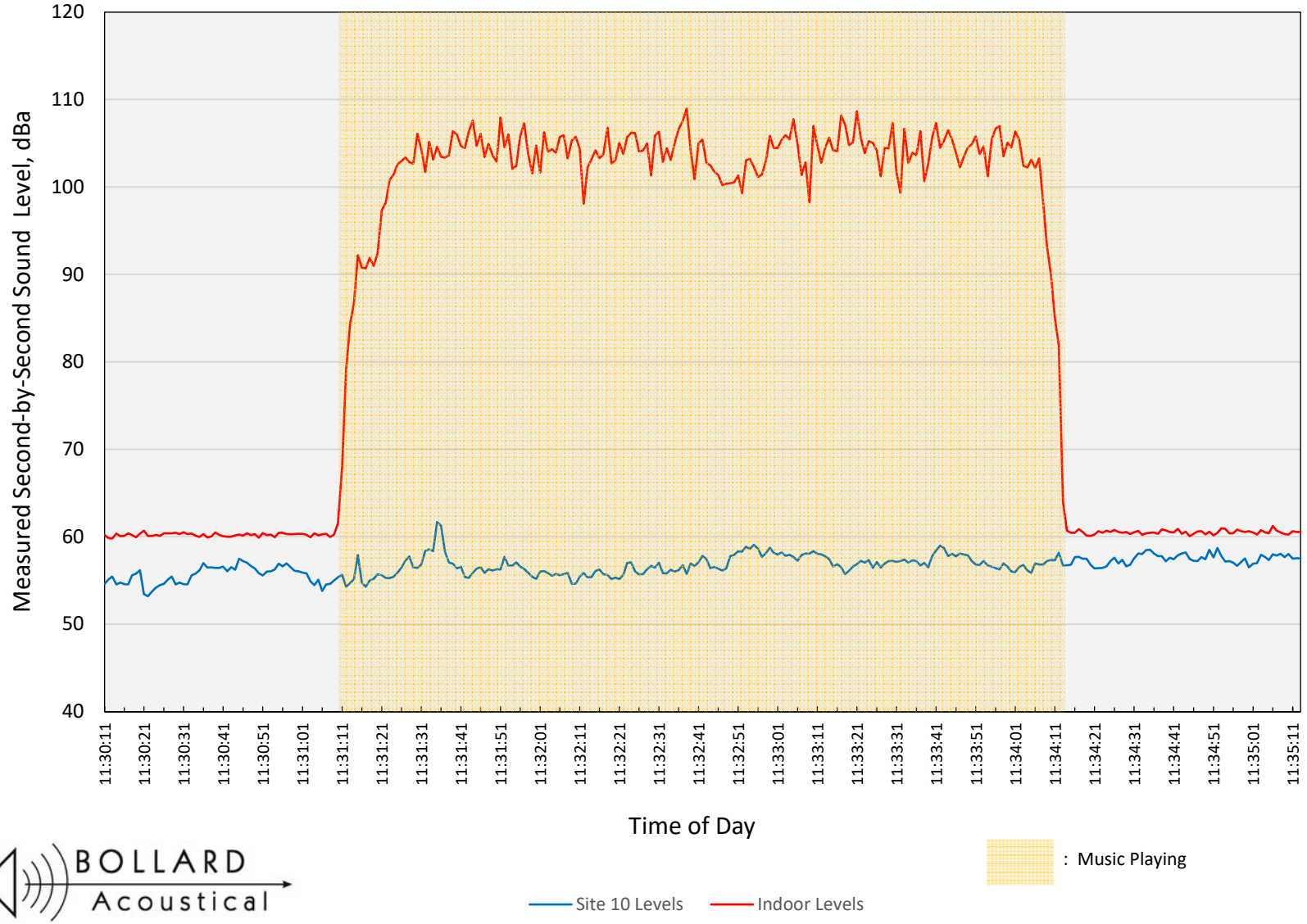
Appendix C-10
Measured Sound Levels: Site 10
Sacramento, CA - March 11, 2021 - 11:30:11 am -11:35:13 am



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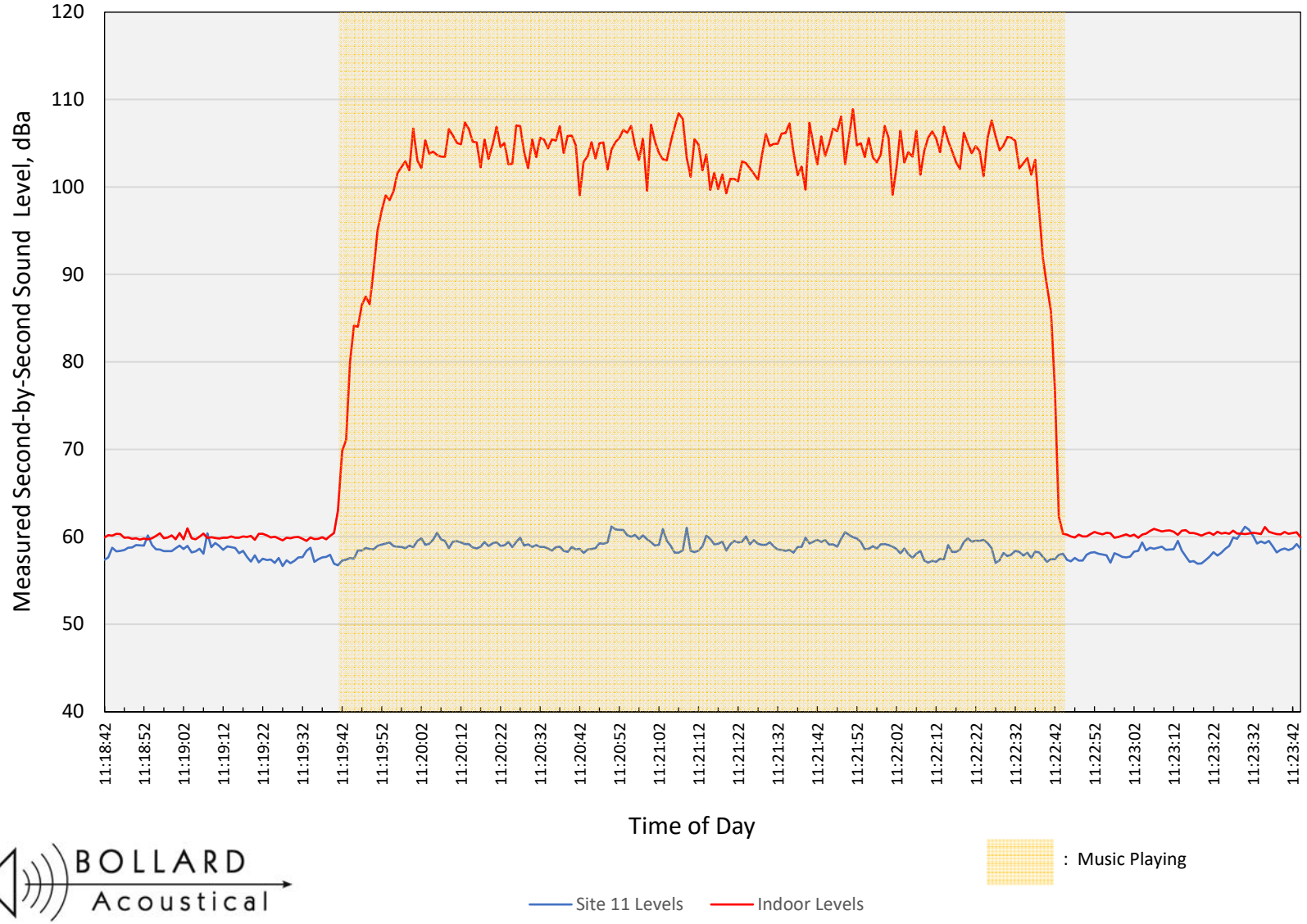
Appendix C-11
Measured Sound Levels: Site 11
Sacramento, CA - March 11, 2021 - 11:18:42 am -11:23:44 am



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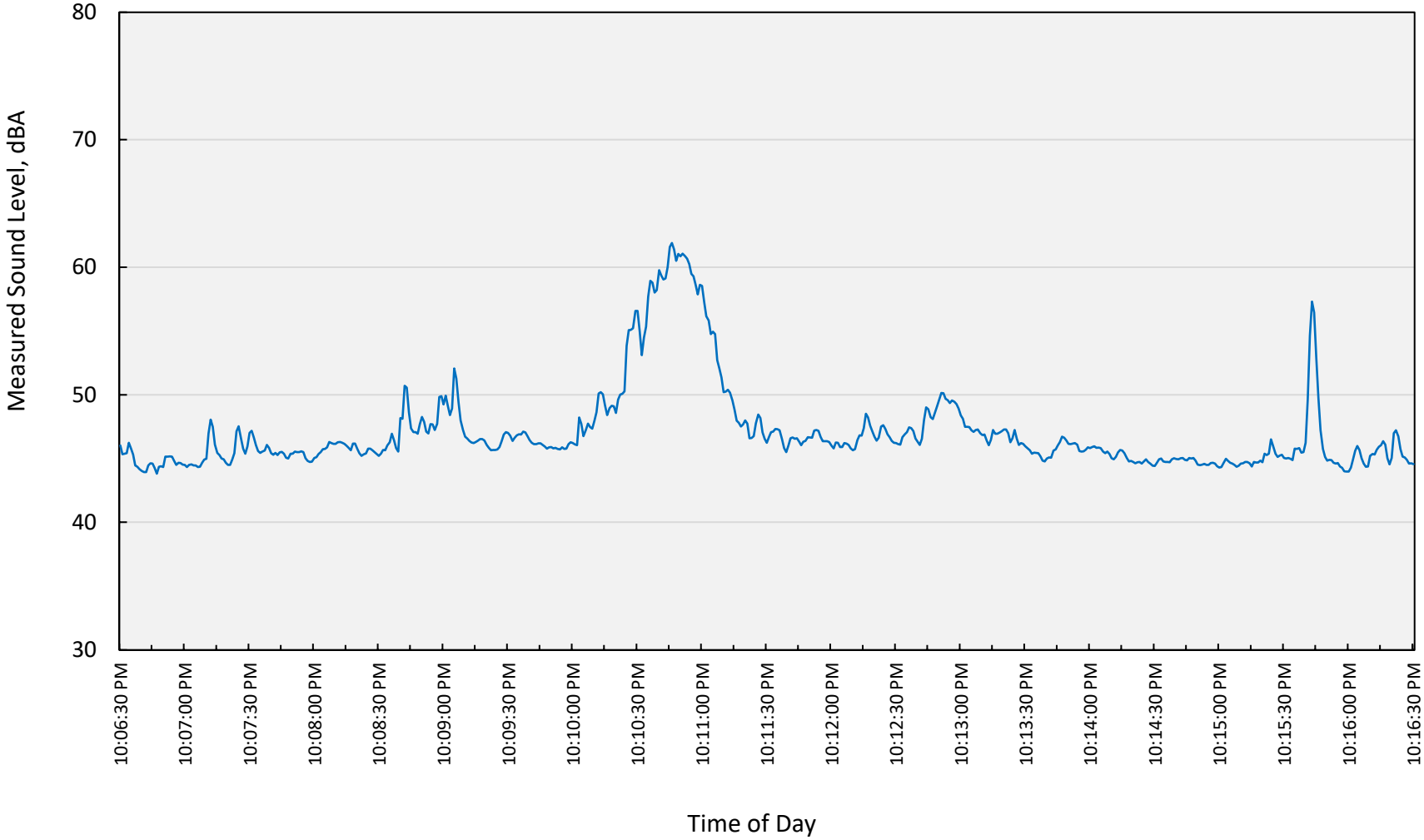
Appendix D-1
Measured Nighttime Ambient Sound Levels: Site 9
Sacramento, CA - April 20, 2021



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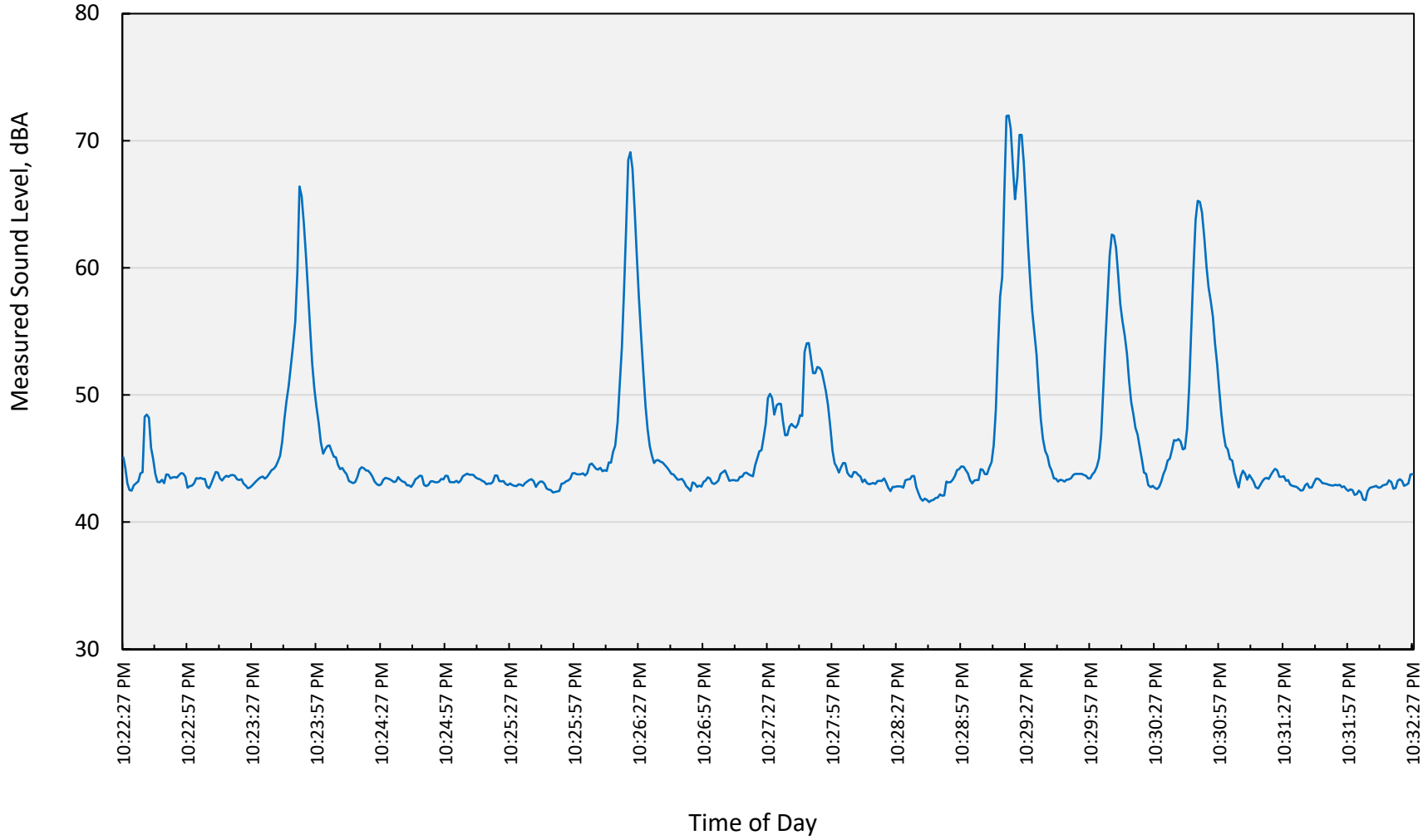
Appendix D-2
Measured Nighttime Ambient Sound Levels: Site 6
Sacramento, CA - April 20, 2021



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Appendix E

FHWA-RD-77-108 Highway Traffic Noise Prediction Model
Data Input Sheet

Project #: 2021-037
Description: Project-Generated Traffic Only
Ldn/CNEL: Ldn
Hard/Soft: Soft

Segment	Roadway Name	Segment Description	ADT	Day %	Eve %	Night %	% Med. Trucks	% Hvy. Trucks	Speed	Distance	Offset (dB)
1	Ramona Avenue	North of the Project Site Entrance	276	50		50	0.1	0.1	25	50	
2	Ramona Avenue	South of the Project Site Entrance	1,215	50		50	0.1	0.1	25	50	