ATTACHMENT H

410 Noor Residences

South San Francisco, CA

Environmental Noise Study

25 February 2020

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Salter Project Number: 19-0338

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1.0 INTRODUCTION

We have conducted an environmental noise study for the proposed project at 410 Noor Avenue in South San Francisco. This study is an update to the 2017 noise study prepared by Papadimos Group[1] and includes updated on-site noise measurements.

This report is broken into the following sections:

- Section 1.0 – Introduction
- Section 2.0 – Acoustical Criteria
- Section 3.0 – Noise Environment
- Section 4.0 – Recommendations
- Appendix A – Fundamentals of Environmental Acoustics
- Appendix B – SFO ALUCP 2020 Contours, with Project Site Indicated
- Appendix C – 2019 SFO Noise Contour Map, with Project Site Indicated
- Appendix D – July 2019 Airport Director's Report, with Project Site and Nearby Monitors Indicated
- Appendix E – 2017 Noise Study prepared by Papadimos Group

Those readers not familiar with the fundamental concepts of environmental noise may refer to Appendix A and Figure A1 for additional information.

1.1 Executive Summary

The proposed project at 410 Noor Avenue will consist of three buildings, located near the corner of Noor Avenue and Huntington Avenue in South San Francisco. This noise study serves as an update to the 2017 noise study prepared by Papadimos Group (contained in **Appendix E**). In summary:

- Updated on-site noise measurements were consistent with the measurements conducted by Papadimos Group. The on-site noise measurements include both traffic and aircraft noise sources.

- The project site is located near the CNEL[2] 65 to 70 dB contours for airport noise for the three available site noise contour maps (See **Section 3.2** and **Appendices B, C, and D** for further information).

- Per the South San Francisco Noise Element, the Airport Land Use Commission (ALUC) uses the "latest quarterly noise contour report to determine the compatibility of land use plans". This quarterly noise contour is shown in **Appendix D**. The 2019 2nd Quarter contours indicate the site is outside of the CNEL 70 dB contour for airport noise.

- The project can achieve the State Building Code standard of CNEL 45 dB indoors with the use of commercially-available windows and conventional wood-frame construction.

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[1] *410 Noor Avenue Development Exterior Noise Study DRAFT*, prepared by Papadimos Group, dated 25 September 2017. See Appendix E

[2] CNEL (Community Noise Equivalent Level) – A descriptor for a 24-hour A-weighted average noise level. CNEL accounts for the increased acoustical sensitivity of people to noise during the evening and nighttime hours. CNEL penalizes sound levels by 5 dB during the hours from 7 PM to 10 PM and by 10 dB during the hours from 10 PM to 7 AM. For practical purposes, the CNEL and DNL are usually interchangeable.

2.0 ACOUSTICAL CRITERIA

2.1 State Noise Standards

Section 1207 of the 2016 California Building Code requires that the indoor noise level in multi-family residences not exceed CNEL 45 dB.

2.2 City Noise Standards

The City also has the following related policies:

- Policy 9-I-1: Work to adopt a pass-by (single event) noise standard to supplement the current 65 dB CNEL average noise level standard as the basis for aircraft noise abatement programs.
- Policy 9-I-2: Work to adopt a lower average noise standard for aircraft-based mitigation and land use controls.
- Policy 9-I-4: Ensure that project applications for all new noise-sensitive land uses (plans and specifications), including hospitals and residential units proposed within the CNEL 60 dB to CNEL 69 dB aircraft noise contour include an acoustical study prepared by a professional acoustic engineer, that specifies the appropriate noise mitigation features to be included in the design and construction of these uses, to achieve an interior noise level of not more than CNEL 45 dB in any habitable room, based on the latest official SFIA noise contours[3] and on-site noise measurement data.
- Policy 9-I-6: Require that applicants for new noise-sensitive development in areas subject to noise generators producing noise levels greater than 65 dB CNEL, obtain the services of a professional acoustical engineer to provide a technical analysis and design of mitigation measures.
- Policy 9-I-7: Where site conditions permit, require noise buffering for all noise-sensitive development subject to noise generators producing noise levels greater than 65 dB CNEL. This noise attenuation method should avoid the use of visible sound walls, where practical.
- Policy 9-I-10: Do not allow new residential or noise sensitive development in 70+ dB CNEL areas impacted by SFO operations, as required by Airport Land Use Commission infill criteria.
- Policy 9-I-11: Require new residential development in area between the most recent FAA-accepted 65 and 70 dB CNEL aircraft noise contours for San Francisco International Airport (SFO) to grant an avigation easement to the City and County of San Francisco, as proprietor of SFO.

The City of South San Francisco's Noise Element notes that the San Mateo County Airport Land Use Commission (ALUC) will need to approve new development prior to permit issuance. The Noise Element identifies the following ALUC land-use compatibility guidelines for residential land use:

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[3] We understand the latest noise contours are the 2019 2nd Quarter noise contours. See Appendix C.

Table 1: Land Use Criteria for Noise-Impacted Areas

CNEL Range	General Land Use Criteria
Less than 65 dB	Satisfactory; no special insulation requirements
65 to 70 dB	Development requires analysis of noise reduction requirements and noise insulation as needed
Over 70 dB	Development should not be undertaken

To determine if a site is in an aircraft noise-impacted area, the ALUC determines the CNEL 65 dB boundary using the following resources:

- The federal CNEL 65 dB boundary is determined using the most recent noise exposure map (NEM) as accepted by the FAA under the Federal Aviation Regulation (FAR) Part 150 Noise Compatibility Program. At this time, the latest accepted NEM is the Final 2019 Noise Exposure Map[4]. This map is included in **Appendix C** with the project site indicated.

- The state CNEL 65 dB boundary is determined from the quarterly noise contours, based on the required airport noise monitoring system. **Appendix D** contains the 2019 2nd Quarter noise contour overlay, as well as the directors report with the approximate location of the project site indicated.

Per the Noise Element, the ALUC uses the latest quarterly noise contour to determine the compatibility of land use plans. **Appendix D** contains the 2019 2nd Quarter Noise Contour overlay.

2.3 SFO Comprehensive Airport Land Use Compatibility Plan

Table IV-I of the November 2012 *Comprehensive Airport Land Use Compatibility Plan for the Environs of San Francisco International Airport* contains the following polices and compatibility criteria for evaluating multi-family residential land uses.

- Policy NP-1 Noise Compatibility Zones: For the purposes of the ALUCP, the projected 2020 CNEL noise contour map from the Draft Environmental Assessment for the Proposed Runway Safety Area Program shall define the boundaries within which noise compatibility policies described in this Section shall apply.

- Policy NP-2 Airport Noise/Land Use Compatibility Criteria: The compatibility of proposed land uses located in the Airport noise compatibility zones shall be determined according to the noise/land use compatibility criteria shown in Table IV-1 [excepts shown below as **Table 2**]. The criteria indicate the maximum accepted airport noise levels, described in terms of Community Noise Equivalent Level (CNEL), for the indicated land uses. The compatibility criteria indicate whether a proposed land use is “compatible”, “conditionally compatible”, or “not compatible” within each zone, designated by the identified CNEL ranges.

[4] Per www.flysfo.com, this NEM was submitted for approval in July 2018. The Final 2019 map is dated 13 August 2015.

Table 2: ALUCP Noise/Land Use Compatibility Criteria

CNEL Range	Land Use
Less than 65 dB	Land use and related structures compatible without restrictions.
65 to 70 dB	Land use and related structures are permitted, provided that sound insulation is provided to reduce interior noise levels from exterior sources to CNEL 45 dB or lower and that an avigation easement is granted to the City and County of San Francisco as operator of SFO.
70 dB to 75 dB	Land use and related structures are not compatible. However, use is conditionally compatible only on an existing lot of record zoned only for residential use as of the effective date of the ALUCP. Use must be sound-insulated to achieve an indoor noise level of CNEL 45 dB or less from exterior sources.
Over 75 dB	Land use and related structures are not compatible

- Policy NP-4 Residential Uses Within CNEL 70 dB Contour: As described in Table IV-1, residential uses are not compatible in areas exposed to noise above CNEL 70 dB and typically should not be allowed in high noise areas.
    - Policy NP-4.1 Situations Where Residential Use is Conditionally Compatible: Residential uses are considered conditionally compatible in areas exposed to noise above CNEL 70 dB only if the proposed use is on a lot of record zoned exclusively for residential use as of the effective date of the ALUCP. In such a case, the residential use must be sound-insulated to achieve an indoor noise level of CNEL 45 dB or less from exterior sources. The property owner also shall grant an avigation easement to the City and County of San Francisco in accordance with Policy NP-3 prior to issuance of a building permit for the proposed building or structure.

3.0 NOISE ENVIRONMENT

3.1 Project Description

The project is located on the corner of Noor Avenue and Huntington Avenue in South San Francisco. The project consists of three buildings: Building A is located along Huntington Avenue, Building C is located at the corner of Huntington Avenue and Noor Avenue, and Building B is between these Buildings A and C.

The noise environment at the site is predominantly controlled by vehicular traffic and aircraft overflights. To quantify the existing noise environment, we conducted two long-term noise measurements between 30 May and 5 June 2019 (see **Figure 1** for the measurement locations and measured noise levels). The monitors were located at a height of 12 feet above grade.

Data from the on-site noise measurements include traffic from local streets, as well as aircraft noise from SFO.

3.2 Noise from SFO

Per the published resources, the site is exposed to the following noise levels from SFO airport:

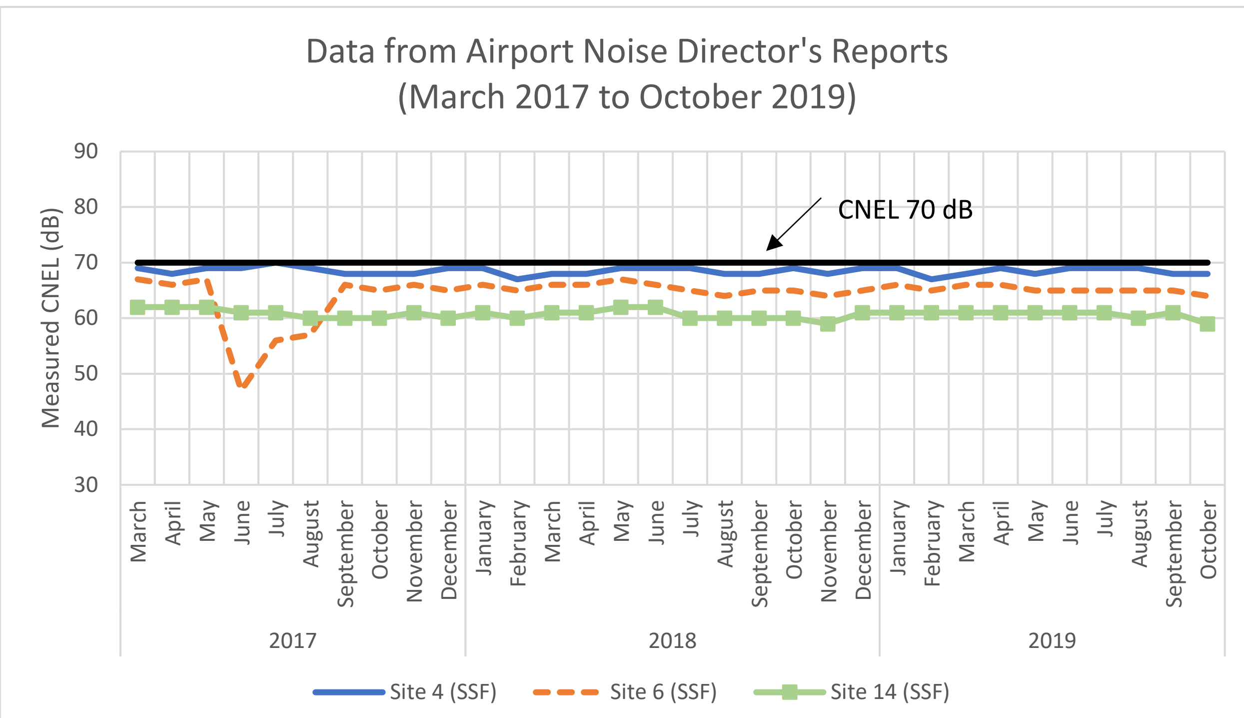
- *November 2012 Comprehensive Airport Land Use Compatibility Plan:* Exhibit IV-6 shows the majority of the site within the CNEL 70 dB contour. This exhibit references noise contours provided in 2011. See **Appendix B** for the project site location.

- *Final 2019 Noise Exposure Map:* **Appendix C** contains the Part 150 map generated by the San Francisco International Airport. Per the exhibit, it was submitted on 13 August 2015. This exhibit references sources from 2014 for the creation of the noise contours.

  Salter has added an overlay of the project site to the Part 150 map to clarify the project location. Per this map, the majority of the project site is located within the CNEL 65 to 70 dB contour. A portion of Building C will be located at the edge of the CNEL 70 dB contour.

- *July 2019 Airport Director's Report:* Per this overlay[5], the project site is fully within the CNEL 65 to 70 dB contour. This information is based on 2019 noise monitoring. See **Appendix D** for the approximate site location.

  GIS maps of historical quarterly noise reports are not available at this time. We have reviewed the noise levels provided in the monthly Airport Director's Reports dating back to March 2017. For the three noise monitors closest to the project site, noise levels are generally below CNEL 70 dB. The graph below shows the monthly measured noise levels since March 2017. Detailed information is provided in **Appendix D**, along with information on the noise monitor locations.



5 SFO 2nd Quarter CNEL Overlay, received as a Google Earth (".kmz") file on 24 September 2019 from the SFO Aircraft Noise Abatement Office.

3.3 Site Noise Context

The main noise sources at the project site include car pass-bys on the nearby roadways and aircraft overflights from SFO. We conducted noise measurements at the project site (see **Figure 1**), which collected noise data from both the car pass-bys and the aircraft overflights. We measured on-site noise levels of CNEL 72 dB at the project site (see **Figure 1**), which is consistent with the noise measurements conducted in 2017 by the Papadimos Group (see **Appendix E**).

Since both car and aircraft noise exist at the site, we have referenced the Airport Director's Report to determine the aircraft contribution to noise at the site. The Airport Director's Report summarizes the noise data from 29 noise monitors managed by the airport that continuously collect noise data. In general, these airport noise monitors are located away from major roadways, reducing the amount of traffic noise that is collected (see data for aircraft noise presented in **Appendix D**), so that the airport contribution can be determined.

Using the 2019 June Airport Director's Report, the contribution of airport noise at the site is expected to approximately CNEL 69 dB[6]. Logarithmically, subtracting the aircraft contribution from our noise measurements would result in a noise level of approximately CNEL 69 dB from traffic:

CNEL **72**[a] dB [from aircraft+traffic] **–** CNEL **69**[b] dB [from aircraft] **=** CNEL **69**[c] dB [from traffic]

a = measured at project site, see Figure 1
b = determined from 2019 July Airport Director's Report
c = calculated

See **Appendix A** for additional information on decibel mathematics.

Individual aircraft flyovers from SFO are significantly louder than individual car pass-bys, but the flyovers occur at a lower frequency than the car pass-bys, resulting in similar average overall noise levels (CNEL).

For reference, CNEL above 70 dB are common along large roadways and rail lines. Figure 9-2 of the South San Francisco Noise Element indicates that noise levels in South San Francisco were estimated to be above CNEL 70 dB in 2006 in the vicinity of I-280, I-380, US 101, and along the Caltrain line. Recent noise measurements indicate that noise levels are above CNEL 70 dB along portions of Linden Avenue in South San Francisco and along El Camino Real on the peninsula.

6 The project site is near Airport Noise Monitors 04, 06, and 14. We have referenced Monitor 04 for this CNEL level.

4.0 RECOMMENDATIONS

We used the Progress Set of Drawings dated 23 May 2019 for the unit dimensions and locations. We calculated the window and exterior door STC[7] ratings needed to meet the project criteria. We understand that there are various facades where glazing is still in development. For these facades, we used similar units with maximum glazing percentages to estimate STC ratings.

4.1 Residential Recommendations

For our calculations, we assumed that all rooms will have hard-surfaced flooring and all exterior wall assemblies achieve STC 45 at a minimum (e.g., 3-coat stucco, siding over one layer of cement board and one layer of plywood sheathing). To meet the indoor DNL 45 dB criterion, it will be necessary for the windows and exterior doors to have STC ratings as shown in **Figure 2 and 3**.

The recommended STC ratings are for full window assemblies (glass and frame) rather just the glass itself. Tested sound-rated assemblies should be used. For reference, typical construction-grade windows generally achieve STC 28. Where STC ratings are above 32, at least one pane of glass should be laminated.

Where windows need to be closed to achieve an indoor CNEL of 45 dB, an alternative method of supplying fresh air (e.g., mechanical ventilation) should be considered. This issue should be discussed with the project mechanical engineer.

4.2 Exterior Recommendations

The project site has outdoor-use spaces in the following locations:

- Courtyard A1, exposed to Huntington Avenue
- Courtyard A2, exposed to Huntington Avenue
- Courtyard B1, enclosed within the B building

At Courtyards A1 and A2, exterior noise levels are estimated to be approximately CNEL 69 dB due to traffic. At Courtyard B1, exterior noise levels are estimated to be approximately CNEL 60 dB due to traffic.

Policy 9-I-7 notes that exterior noise levels should be reduced to CNEL 65 dB where site conditions permit. This noise level is met at Courtyard B1 without mitigation.

At Courtyards A1 and A2, a six-foot barrier would be needed along the roadway to reduce noise from Huntington Avenue to CNEL 65 dB. A barrier would not reduce noise from aircraft. We understand that visual sound walls are not desired by the City.

If used, the barrier should be constructed of a material with a minimum surface density of 3 lbs/ft, continuous from grade to top, and contain no cracks or gaps.

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[7] STC (Sound Transmission Class) – A single-number rating defined in ASTM E90 that quantifies the airborne sound insulating performance of a partition under laboratory conditions. Increasing STC ratings correspond to improved airborne sound insulation.

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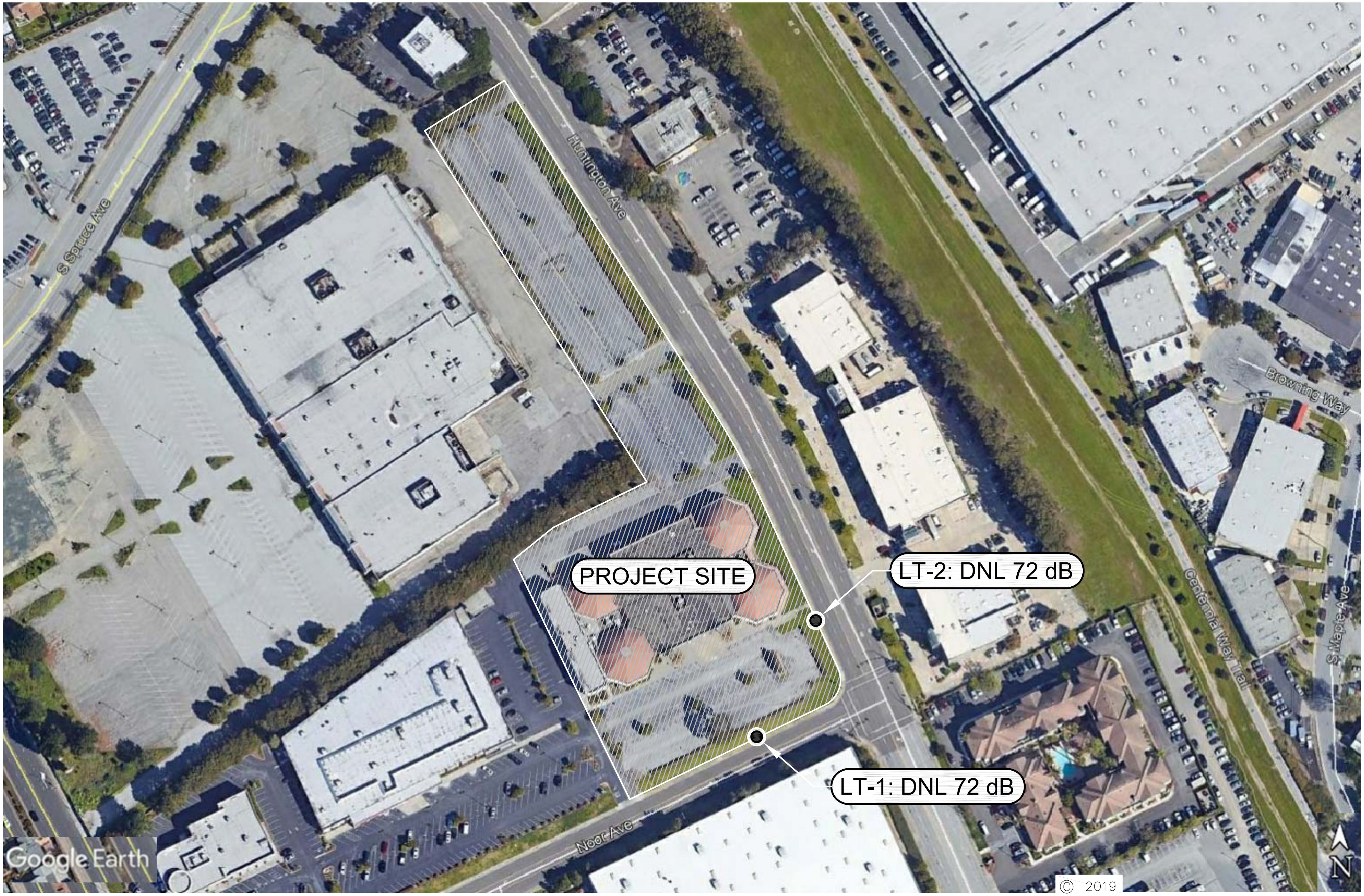

410 NOOR AVENUE
MEASUREMENT LOCATIONS AND MEASURED NOISE LEVELS

FIGURE 1

Salter # 19-0338 LVB/VCS 09.13.19

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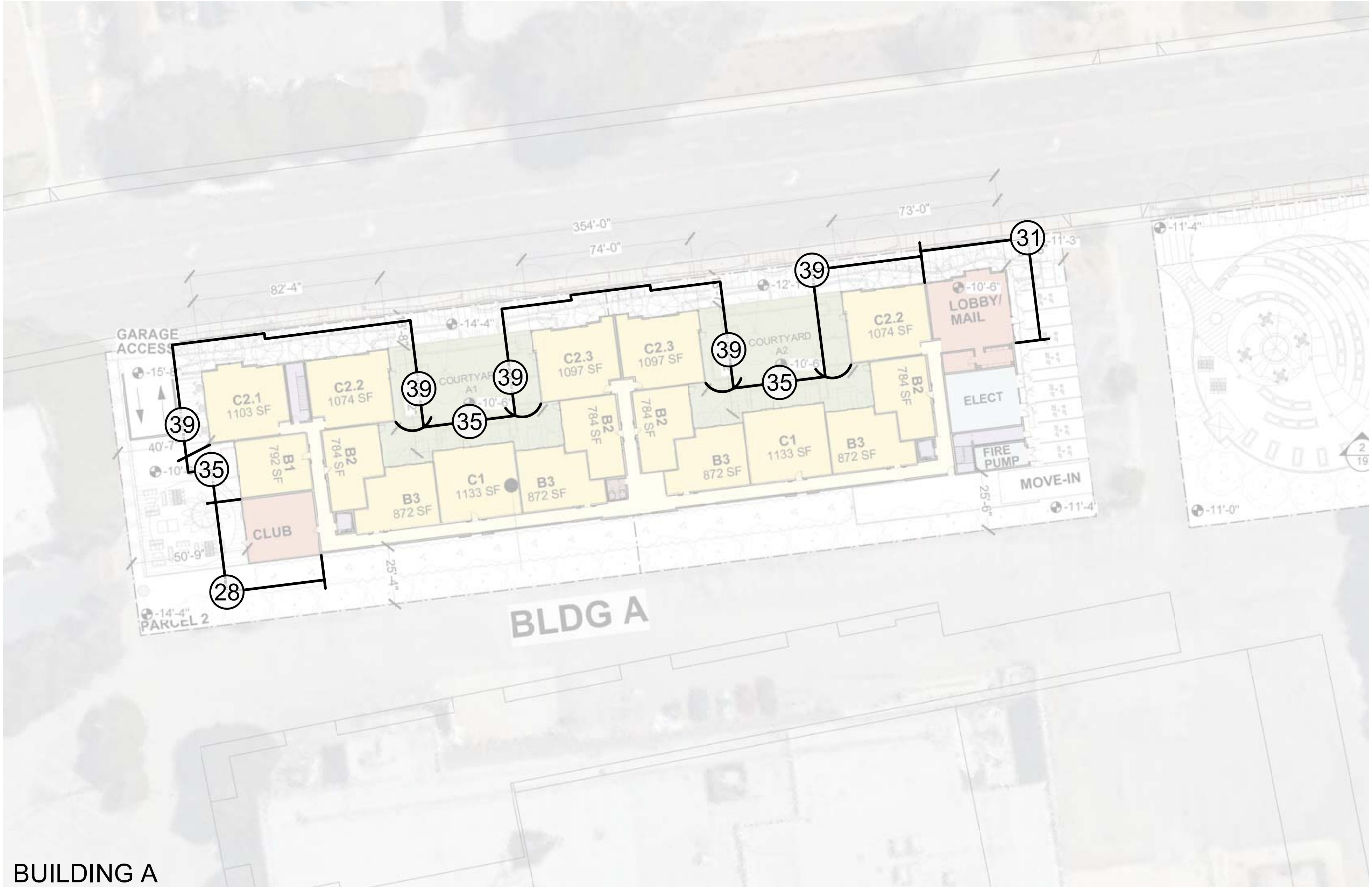

NOTE: STC RATINGS ARE FOR THE COMPLETE ASSEMBLY (E.G., GLASS, FRAME, AND OPERABLE SECTIONS) BASED ON TEST REPORTS FROM AN NVLAP-ACCREDITED LAB

410 NOOR AVENUE
MINIMUM CODE–REQUIRED STC RATINGS FOR WINDOWS AND EXTERIOR DOORS (FLOOR 1)

FIGURE 2

Salter # 19–0338

LVB/VCS 06.19.19

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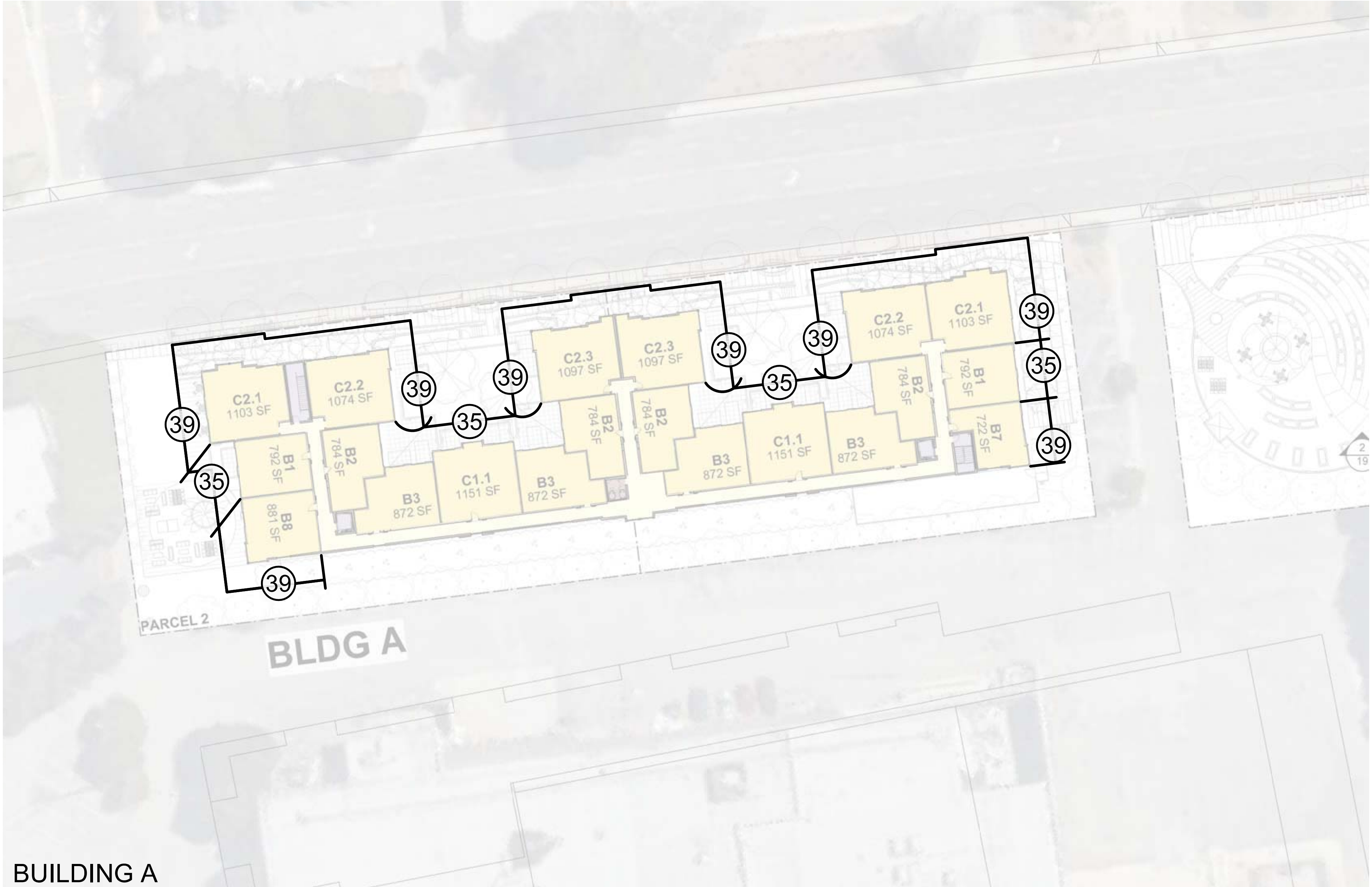

NOTE: STC RATINGS ARE FOR THE COMPLETE ASSEMBLY (E.G., GLASS, FRAME, AND OPERABLE SECTIONS) BASED ON TEST REPORTS FROM AN NVLAP-ACCREDITED LAB

410 NOOR AVENUE
MINIMUM CODE–REQUIRED STC RATINGS FOR WINDOWS AND EXTERIOR DOORS (FLOORS 2 TO 5)

FIGURE 3

Salter # 19–0338

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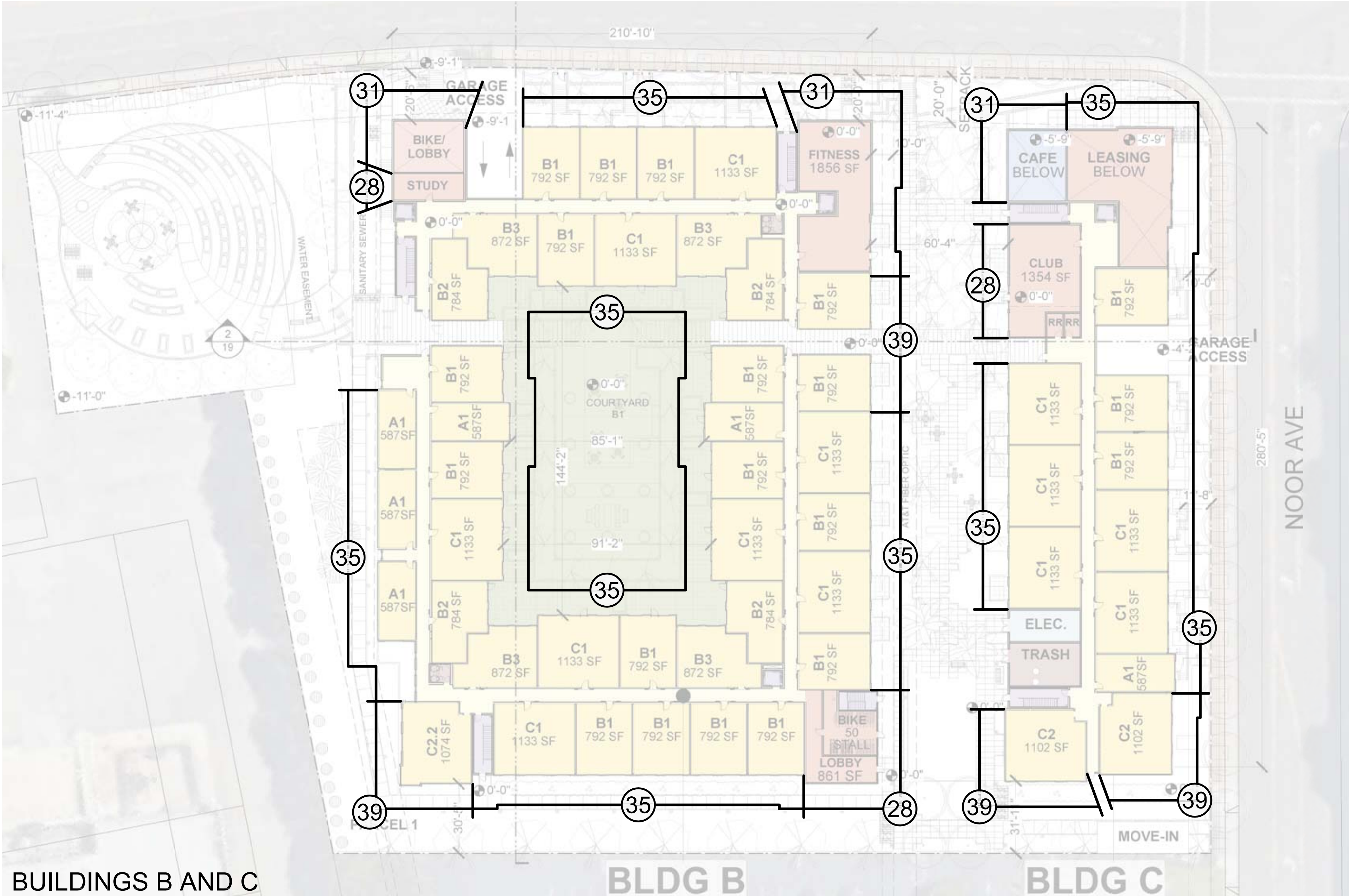

NOTE: STC RATINGS ARE FOR THE COMPLETE ASSEMBLY (E.G., GLASS, FRAME, AND OPERABLE SECTIONS) BASED ON TEST REPORTS FROM AN NVLAP-ACCREDITED LAB

410 NOOR AVENUE
MINIMUM CODE–REQUIRED STC RATINGS FOR WINDOWS AND EXTERIOR DOORS (FLOOR 1)

FIGURE 4

Salter # 19–0338

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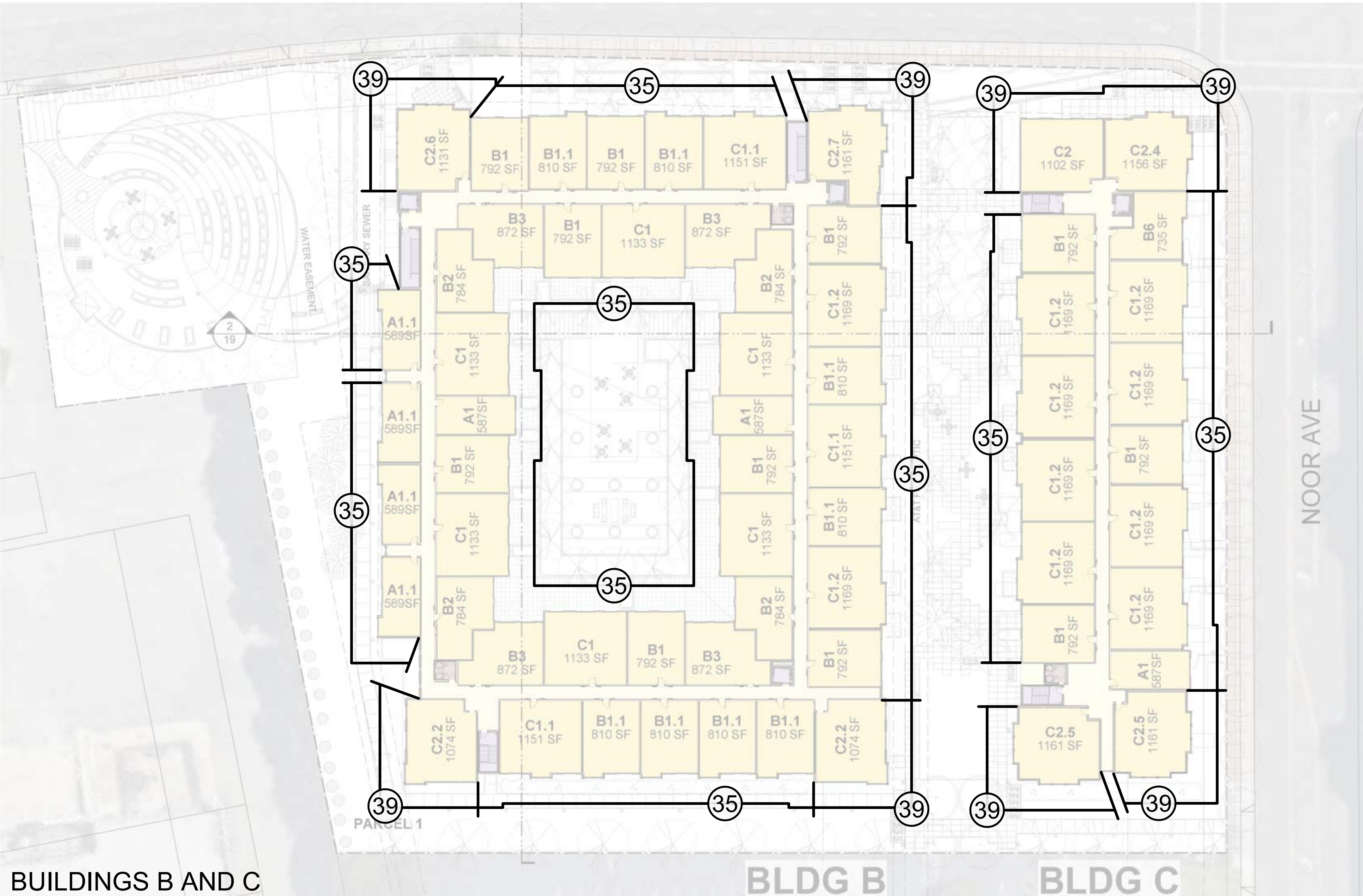


NOTE: STC RATINGS ARE FOR THE COMPLETE ASSEMBLY (E.G., GLASS, FRAME, AND OPERABLE SECTIONS) BASED ON TEST REPORTS FROM AN NVLAP-ACCREDITED LAB

410 NOOR AVENUE
MINIMUM CODE–REQUIRED STC RATINGS FOR WINDOWS AND EXTERIOR DOORS (FLOORS 2 TO 5)

FIGURE 5

Salter # 19–0338

LVB/VCS 06.19.19

APPENDIX A

Fundamental Concepts of Environmental Noise

This section provides background information to aid in understanding the technical aspects of this report.

Three dimensions of environmental noise are important in determining subjective response. These are:

- The intensity or level of the sound
- The frequency spectrum of the sound
- The time-varying character of the sound

Airborne sound is a rapid fluctuation of air pressure above and below atmospheric pressure. Sound levels are usually measured and expressed in decibels (dB), with 0 dB corresponding roughly to the threshold of hearing.

The "frequency" of a sound refers to the number of complete pressure fluctuations per second in the sound. The unit of measurement is the cycle per second (cps) or hertz (Hz). Most of the sounds, which we hear in the environment, do not consist of a single frequency, but of a broad band of frequencies, differing in level. The name of the frequency and level content of a sound is its sound spectrum. A sound spectrum for engineering purposes is typically described in terms of octave bands, which separate the audible frequency range (for human beings, from about 20 to 20,000 Hz) into ten segments.

Many rating methods have been devised to permit comparisons of sounds having quite different spectra. Surprisingly, the simplest method correlates with human response practically as well as the more complex methods. This method consists of evaluating all of the frequencies of a sound in accordance with a weighting that progressively de-emphasizes the importance of frequency components below 1000 Hz and above 5000 Hz. This frequency weighting reflects the fact that human hearing is less sensitive at low frequencies and at extreme high frequencies relative to the mid-range.

The weighting system described above is called "A"-weighting, and the level so measured is called the "A-weighted sound level" or "A-weighted noise level." The unit of A-weighted sound level is sometimes abbreviated "dB." In practice, the sound level is conveniently measured using a sound level meter that includes an electrical filter corresponding to the A-weighting characteristic. All U.S. and international standard sound level meters include such a filter. Typical sound levels found in the environment and in industry are shown in **Figure A-1**.

Although a single sound level value may adequately describe environmental noise at any instant in time, community noise levels vary continuously. Most environmental noise is a conglomeration of distant noise sources, which results in a relatively steady background noise having no identifiable source. These distant sources may include traffic, wind in trees, industrial activities, etc. and are relatively constant from moment to moment. As natural forces change or as human activity follows its daily cycle, the sound level may vary slowly from hour to hour. Superimposed on this slowly varying background is a succession of identifiable noisy events of brief duration. These may include nearby activities such as single vehicle pass-bys, aircraft flyovers, etc. which cause the environmental noise level to vary from instant to instant.

To describe the time-varying character of environmental noise, statistical noise descriptors were developed. "L10" is the A-weighted sound level equaled or exceeded during 10 percent of a stated time period. The L10 is considered a good measure of the maximum sound levels caused by discrete noise events. "L50" is the A-weighted sound level that is equaled or exceeded 50 percent of a stated time period; it represents the median sound level. The "L90" is the A-weighted sound level equaled or exceeded during 90 percent of a stated time period and is used to describe the background noise.

As it is often cumbersome to quantify the noise environment with a set of statistical descriptors, a single number called the average sound level or "L_{eq}" is now widely used. The term "L_{eq}" originated from the concept of a so-called equivalent sound level which contains the same acoustical energy as a varying sound level during the same time period. In simple but accurate technical language, the L_{eq} is the average A-weighted sound level in a stated time period. The L_{eq} is particularly useful in describing the subjective change in an environment where the source of noise remains the same but there is change in the level of activity. Widening roads and/or increasing traffic are examples of this kind of situation.

In determining the daily measure of environmental noise, it is important to account for the different response of people to daytime and nighttime noise. During the nighttime, exterior background noise levels are generally lower than in the daytime; however, most household noise also decreases at night, thus exterior noise intrusions again become noticeable. Further, most people trying to sleep at night are more sensitive to noise. To account for human sensitivity to nighttime noise levels, a special descriptor was developed. The descriptor is called the L_{dn} (Day/Night Average Sound Level), which represents the 24-hour average sound level with a penalty for noise occurring at night. The L_{dn} computation divides the 24-hour day into two periods: daytime (7:00 am to 10:00 pm); and nighttime (10:00 pm to 7:00 am). The nighttime sound levels are assigned a 10 dB penalty prior to averaging with daytime hourly sound levels.

For highway noise environments, the average noise level during the peak hour traffic volume is approximately equal to the L_{dn}.

The effects of noise on people can be listed in three general categories:

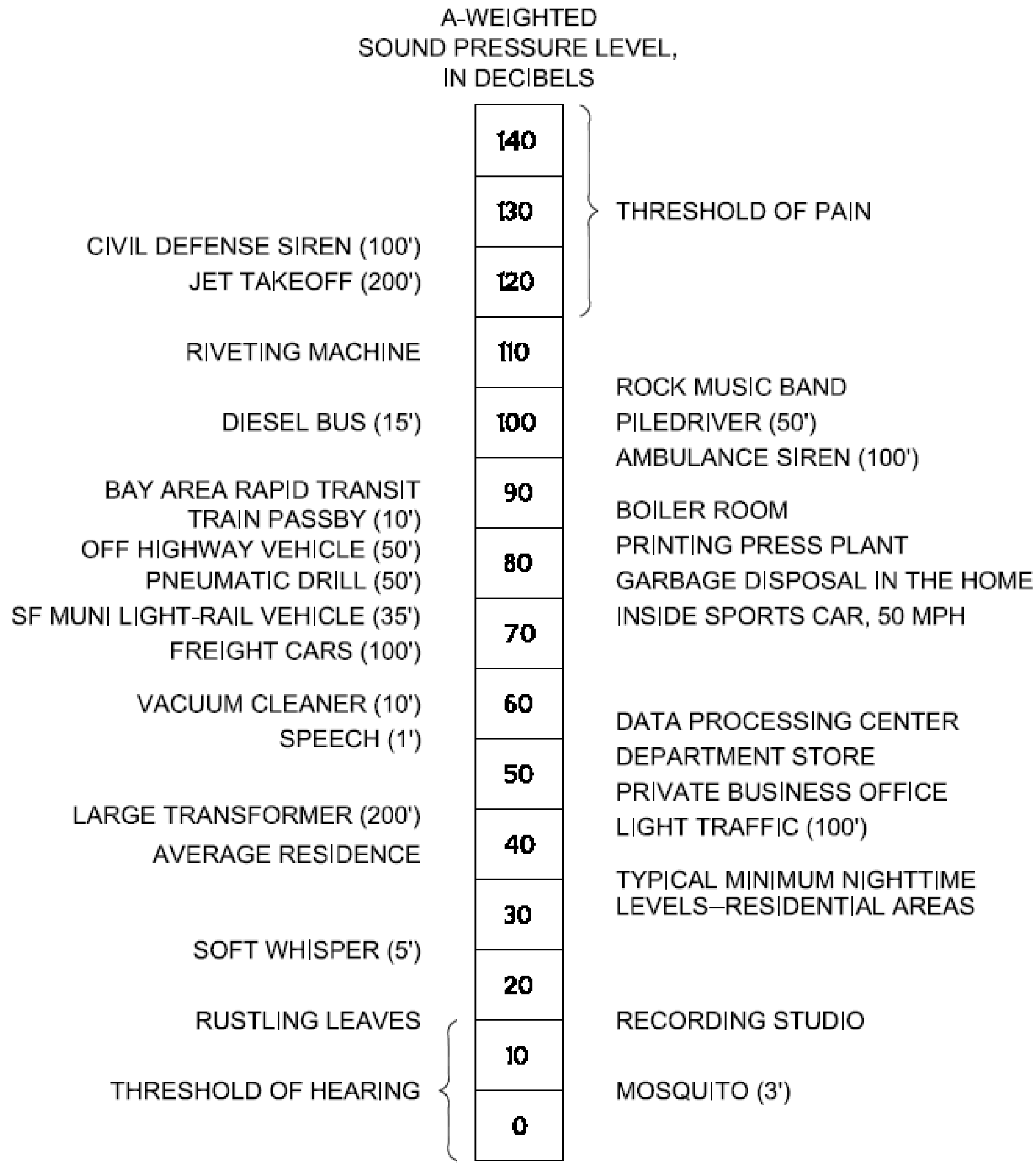
- Subjective effects of annoyance, nuisance, dissatisfaction
- Interference with activities such as speech, sleep, and learning
- Physiological effects such as startle, hearing loss

The sound levels associated with environmental noise usually produce effects only in the first two categories. Unfortunately, there has never been a completely predictable measure for the subjective effects of noise nor of the corresponding reactions of annoyance and dissatisfaction. This is primarily because of the wide variation in individual thresholds of annoyance and habituation to noise over time.

Thus, an important factor in assessing a person's subjective reaction is to compare the new noise environment to the existing noise environment. In general, the more a new noise exceeds the existing, the less acceptable the new noise will be judged.

With regard to increases in noise level, knowledge of the following relationships will be helpful in understanding the quantitative sections of this report:

Except in carefully controlled laboratory experiments, a change of only 1 dB in sound level cannot be perceived. Outside of the laboratory, a 3 dB change is considered a just-noticeable difference. A change in level of at least 5 dB is required before any noticeable change in community response would be expected. A 10 dB change is subjectively heard as approximately a doubling in loudness, and would almost certainly cause an adverse community response.



(100') = DISTANCE IN FEET BETWEEN SOURCE AND LISTENER

TYPICAL SOUND LEVELS MEASURED IN THE ENVIRONMENT AND INDUSTRY

FIGURE A1

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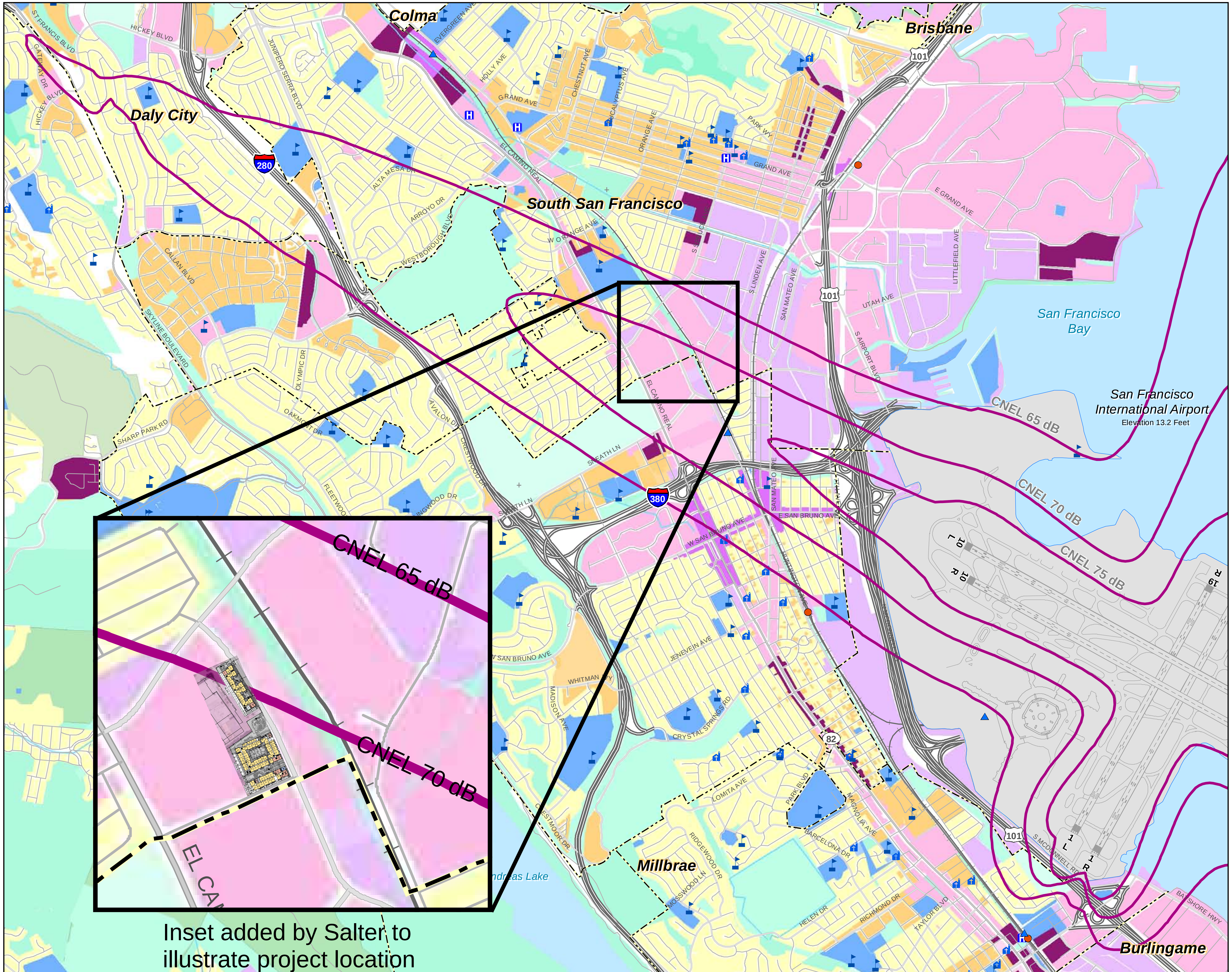
APPENDIX B

SFO ALUCP 2020 Contours, with Project Site Indicated



LEGEND

- CNEL Contour, 2020 Forecast
- Airport Property
- BART Station
- CALTRAIN Station
- School
- Place of Worship
- Hospital
- Municipal Boundary
- Railroad
- Freeway
- Road

Planned Land Use Per General Plans:

- Public
- Multi-Family Residential
- Single Family Residential
- Mixed Use
- Transit Oriented Development
- Commercial
- Industrial, Transportation, and Utilities
- Local Park, Golf Course, Cemetery
- Regional Park or Recreation Area
- Open Space
- Planned use not mapped

Sources:

Noise Contour Data:
- Draft Environmental Assessment, Proposed Runway Safety Area Program, San Francisco International Airport. URS Corporation and BridgeNet International, June 2011

County Base Maps:
- San Mateo County Planning & Building Department, 2007

Local Plans:
- Burlingame Bayfront Specific Area Plan, August 2006
- Burlingame Downtown Specific Plan, January 2009
- Burlingame General Map, September 1984
- North Burlingame/ Rollins Road Specific Plan, February 2007
- Colma Municipal Code Zoning Maps, December 2003
- Daly City General Plan Land Use Map, 1987
- Hillsborough General Plan, March 2005
- Millbrae Land Use Plan, November 1998
- Pacifica General Plan, August 1996
- San Bruno General Plan, December 2008
- San Mateo City Land Use Plan, March 2007
- San Mateo County Zoning Map, 1992
- South San Francisco General Plan, 1998

NORTH

0 0.1 0.2 0.4 Miles

Exhibit IV-6

NOISE COMPATIBILITY ZONES -- DETAIL

Comprehensive Airport Land Use Plan for the Environs of San Francisco International Airport

C/CAG

City/County Association of Governments of San Mateo County, California

APPENDIX C

2019 SFO Part 150 Noise Contour Map, with Project Site Indicated


Inset added by Salter to illustrate project location
Spruce Ave
CNEL 65 dB
CNEL 70 dB
CNEL 70 dB
Bay
Airport Property Boundary
Aircraft Noise Contour
Municipal Boundary
NOISE SENSITIVE FACILITIES
School
Hospital
Place of Worship
Historic Structures
GENERALIZED EXISTING LAND USE
Single Family Residential
Multi-Family Residential
Commercial
Industrial
Public
Mixed Use
Open Space/Recreation/Preservation
Park/Golf Course/Cemetery
Water
Vacant/Unknown
CNEL – Community Noise Equivalent Level
dB – Decibel
0 2,000
Feet
1 Inch = 2,000 Feet
SOURCES: ESRI, 2014; San Mateo County Planning and Building Department, 2014; BridgeNet International, 2014; ESA Airports, 2014
BRISBANE LAGOON
BRISBANE
COLMA
SOUTH SAN FRANCISCO
DALY CITY
SAN BRUNO
PACIFICA
MILLBRAE
BURLINGAME
HILLSBOROUGH
SAN MATEO
FOSTER CITY
UNINCORPORATED
Pacific Ocean
San Andreas Lake
San Francisco International Airport
Southgate Ave
Serramonte Blvd
Junipero Serra Blvd
Hillside Blvd
Hickey Blvd
Skyline Blvd
Gellert Blvd
Oceana Blvd
Callan Blvd
Westborough Blvd
Grand Ave
E. Grand Ave
S. Airport Blvd
Spruce Ave
Sharp Park Rd
Fleetwood Dr
Sneath Ln
San Mateo Ave
Huntington Ave
San Bruno Ave W
El Camino Real
Crystal Springs Rd
Crestmoor Dr
Lomita Ave
Ludeman Ln
Fassler Ave
Linda Mar Blvd
Manzanita Dr
Millbrae Ave
Trousdale Dr
Old Bayshore Hwy
Airport Blvd
Adeline Dr
Hillside Dr
Carmelita Ave
Howard Ave
Peninsula Ave
N. Amphlett Blvd
E. 3rd Ave
101
380
280
1
35
82
92
10L
10R
19R
19L
28R
28L
1L
1R
CNEL 75 dB
CNEL 70 dB
CNEL 65 dB
2019 Noise Exposure Map
The Noise Exposure Maps and accompanying documentation, including the description of consultation and opportunity for public involvement, for San Francisco International Airport are submitted in accordance with 14 CFR Part 150 and are hereby certified as true and complete under penalty of 18 U.S.C. 1001. It is hereby certified that interested persons were afforded adequate opportunity to submit their views, data, and comments concerning the correctness and adequacy of the Noise Exposure Maps and descriptions of forecast aircraft operations.
AUG 1 3 2015
John L. Martin, Airport Director
San Francisco International Airport
Date

APPENDIX D

1) 2019 2nd Quarter CNEL Overlay (from Google Earth Contours)

2) July 2019 Airport Director's Report, with Project Site Indicated

3) Monthly Noise Monitor Data from Historical Airport Director's Reports[8]

[8] Accessed from https://www.flysfo.com/community/noise-abatement/reports-and-resources/airport-directors-report

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130 Sutter Street San Francisco California 94104 Tel. 415 397 0442 www.cmsalter.com

410 NOOR AVENUE
2019 2ND QUARTER SFO NOISE CONTOUR
(FROM SFO AIRCRAFT NOISE ABATEMENT OFFICE)

FIGURE D1

Salter # 19–0338

LVB/VCS 10.02.19

Airport Director's Report

Presented at the October 2, 2019
Airport Community Roundtable Meeting

Aircraft Noise Abatement Office
July 2019

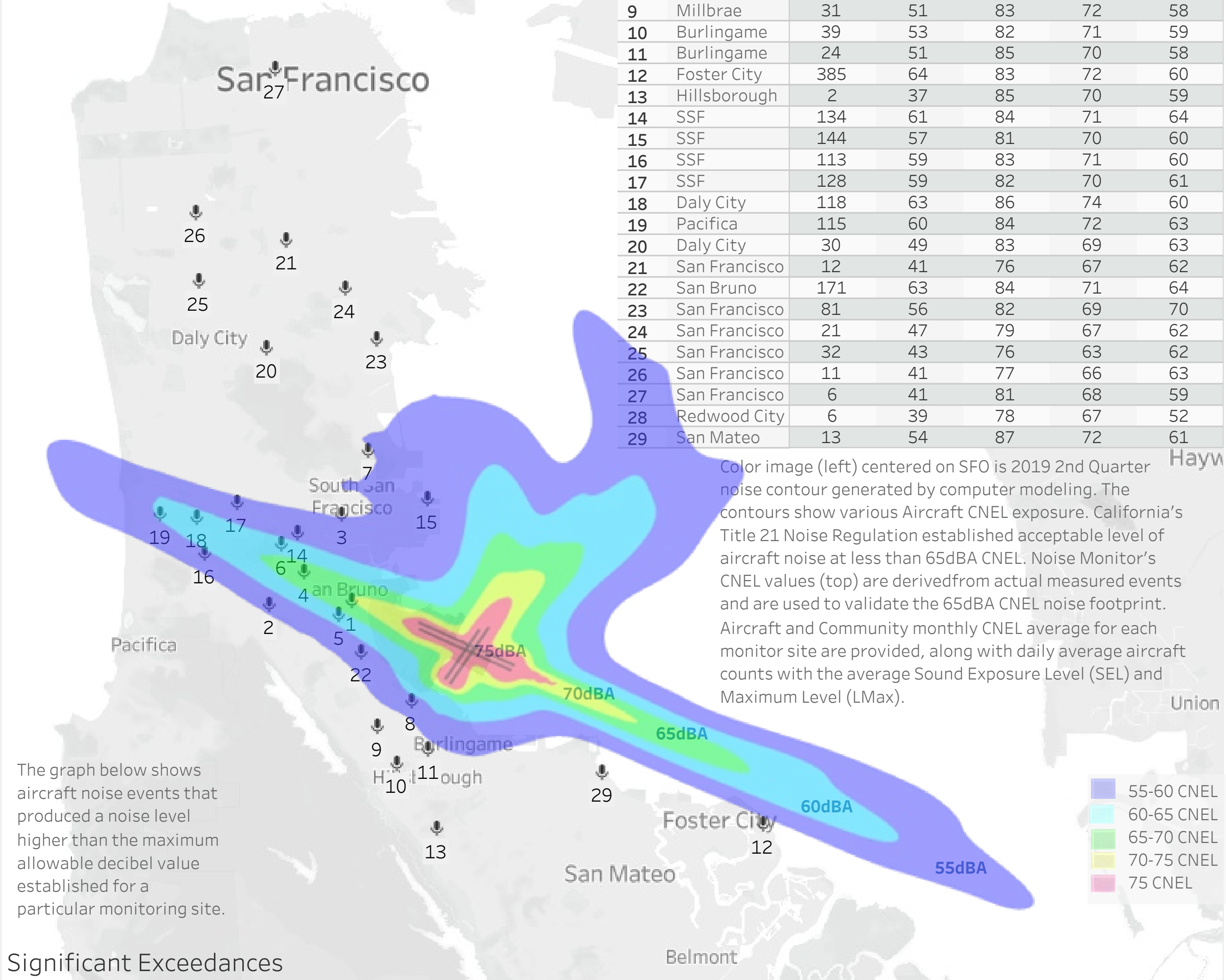
SFO San Francisco International Airport

Aircraft Noise Levels

July 2019

The map shows 29 aircraft noise monitoring locations that keep track of noise levels in the communities around the airport. Image centered on SFO airport shows quartlerly aircraft noise levels (dBA) exposure. The green zone marks 65dBA Community Noise Exposure Level (CNEL). The CNEL metric is used to assess and regulate aircraft noise exposure in communities surrounding the airport.

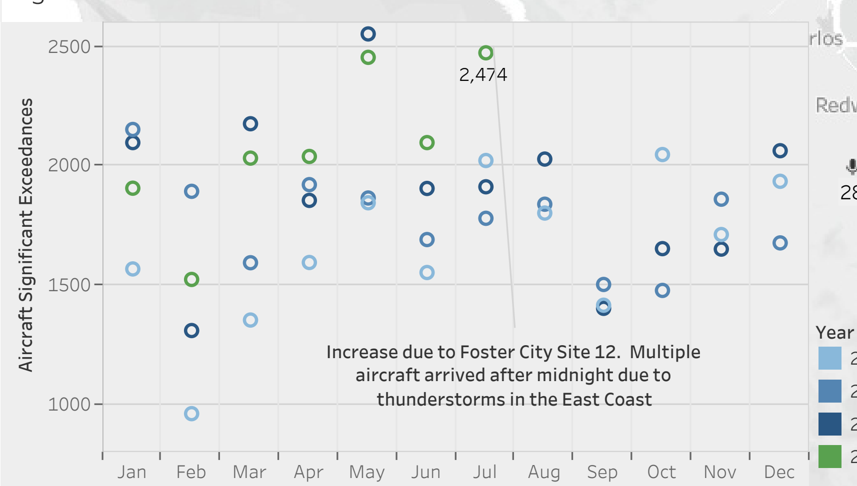
		Noise Events	Aircraft			Community
Site	City	(AVG Day)	CNEL (dBA)	SEL (dBA)	LMax (dBA)	CNEL (dBA)
1	San Bruno	227	74	93	78	68
3	SSF	76	54	80	69	65
4	SSF	151	69	90	78	61
5	San Bruno	165	68	89	76	64
6	SSF	136	65	87	76	60
7	Brisbane	22	50	79	70	60
8	Millbrae	233	62	82	69	66
9	Millbrae	31	51	83	72	58
10	Burlingame	39	53	82	71	59
11	Burlingame	24	51	85	70	58
12	Foster City	385	64	83	72	60
13	Hillsborough	2	37	85	70	59
14	SSF	134	61	84	71	64
15	SSF	144	57	81	70	60
16	SSF	113	59	83	71	60
17	SSF	128	59	82	70	61
18	Daly City	118	63	86	74	60
19	Pacifica	115	60	84	72	63
20	Daly City	30	49	83	69	63
21	San Francisco	12	41	76	67	62
22	San Bruno	171	63	84	71	64
23	San Francisco	81	56	82	69	70
24	San Francisco	21	47	79	67	62
25	San Francisco	32	43	76	63	62
26	San Francisco	11	41	77	66	63
27	San Francisco	6	41	81	68	59
28	Redwood City	6	39	78	67	52
29	San Mateo	13	54	87	72	61



Color image (left) centered on SFO is 2019 2nd Quarter noise contour generated by computer modeling. The contours show various Aircraft CNEL exposure. California's Title 21 Noise Regulation established acceptable level of aircraft noise at less than 65dBA CNEL. Noise Monitor's CNEL values (top) are derivedfrom actual measured events and are used to validate the 65dBA CNEL noise footprint. Aircraft and Community monthly CNEL average for each monitor site are provided, along with daily average aircraft counts with the average Sound Exposure Level (SEL) and Maximum Level (LMax).

The graph below shows aircraft noise events that produced a noise level higher than the maximum allowable decibel value established for a particular monitoring site.

Significant Exceedances



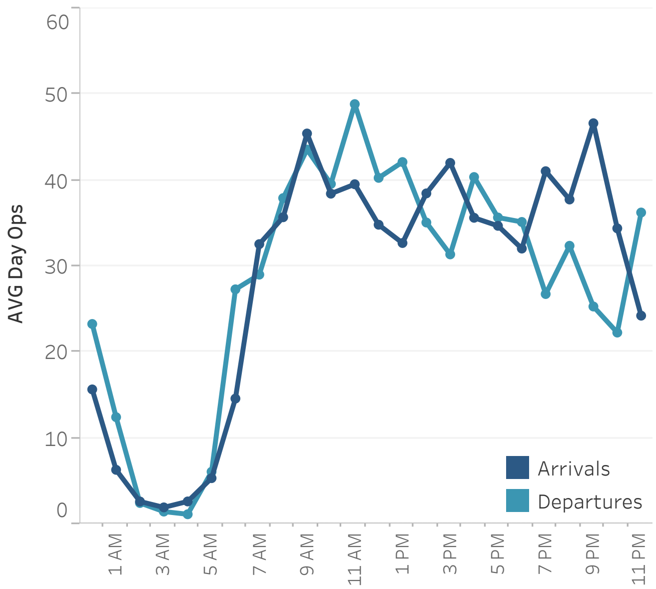
Note: Site 2 is currently not operational

Operations

July 2019

Monthly Ops	AVG Daily Ops	12 Month AVG	YOY Growth
41,836	1,350	38,111	1.0%

July 2019 Average Day (Hourly)



Major Arrival and Departure Routes (West Flow)

West Flow is depicted in the above image and is a predominate flow at SFO.

West Flow
100%

Top Destinations

Los Angeles	Seattle
6%	6%

Down the Bay vs Peninsula

1.1 BDEGA East	29%
1.2 BDEGA West	71%

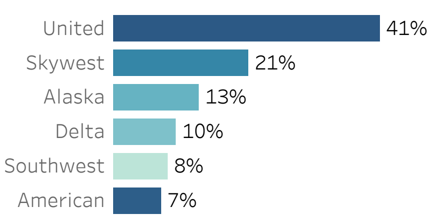
Arrival Route

1. BDEGA	29%
2. DYAMD	39%
3. SERFR	27%
4. OCEANIC	6%

Departure Route

A. GAP	21%
B. SSTIK	26%
C. NIITE	8%
D. TRUKN RWY 01	41%
D. TRUKN RWY 28	3%

Airlines with the Most Operations



Non Airline

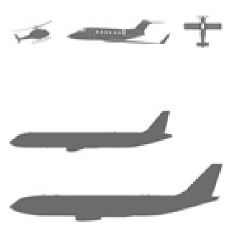
6%

Narrow Body

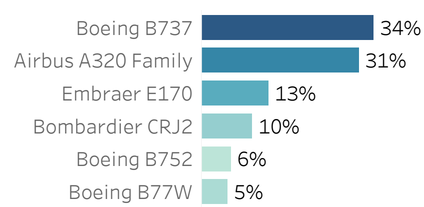
80%

Wide Body

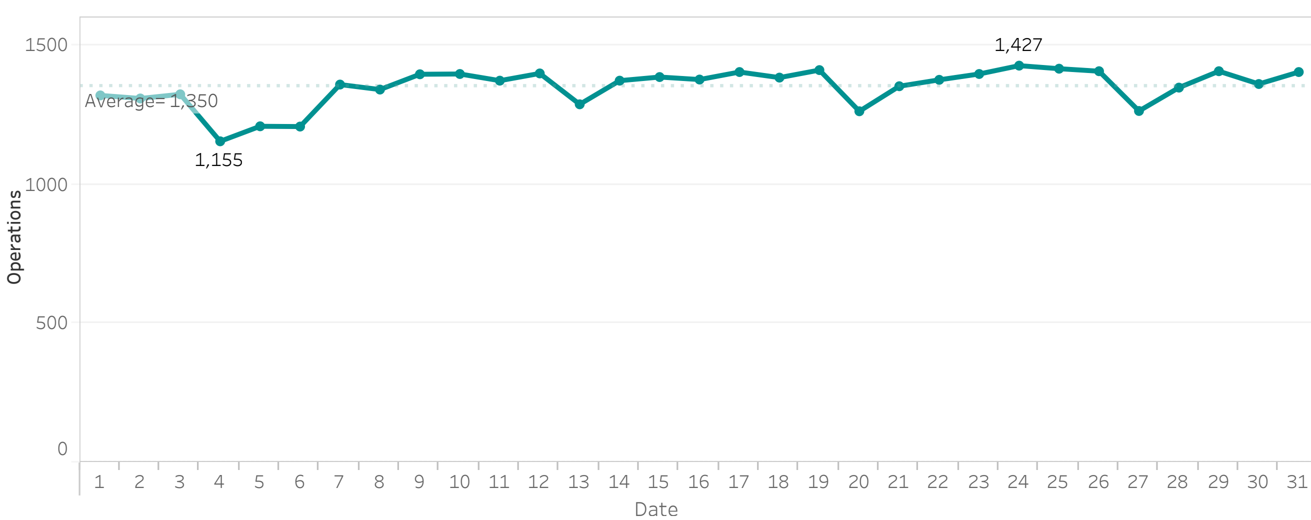
15%



Most Utilized Aircraft Types



Daily Aircraft Operations



Runway Usage and Nighttime Operations

Monthly Runway usage is shown for arrivals and departures, futher categorized by all hours and nightttime hours. Graph at the bottom of the page shows hourly nighttime operations for each day. Power Runup locations are depicted on the airport map with airlines nighttime power runup counts shown below. Percent [%] is rounded to the nearest whole number.

Runway Utilization

	Arrivals	Departures
01 L/R		77% 15,151
10 L/R		0% 1
28 L/R	100% 19,555	23% 4,430

Late Night Preferential Runway Use (1 am - 6 am)

	Departures
10 L/R	0% 1
01 L/R	48% 324
28 L/R	52% 350

Runway Utilization

Arrivals

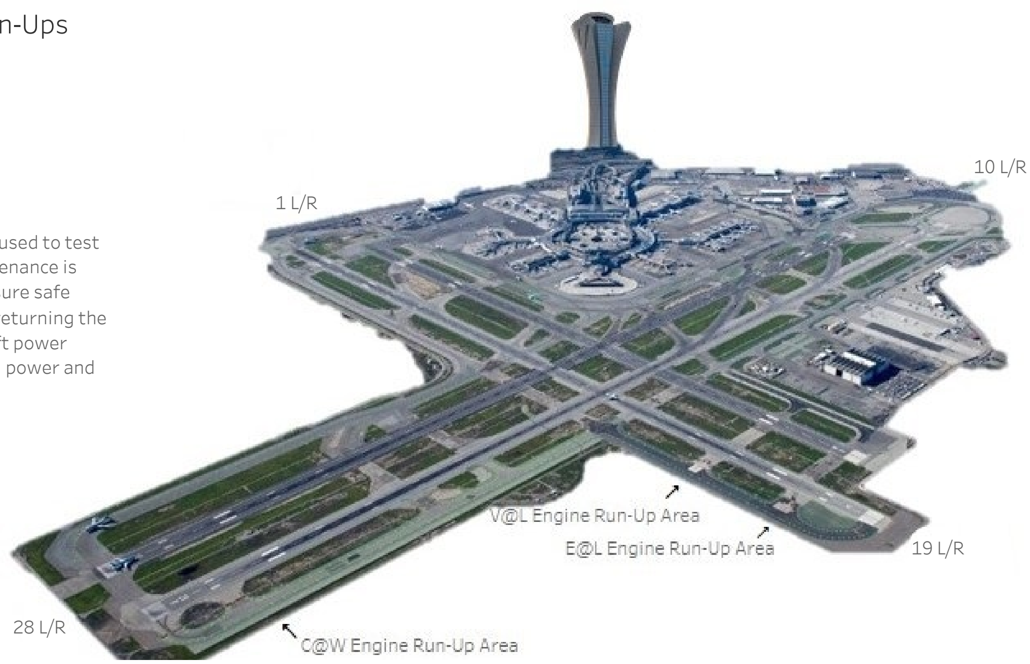
	28L	28R
	48%	52%
Night (10pm-7am)	42%	58%

Nighttime Power Run-Ups

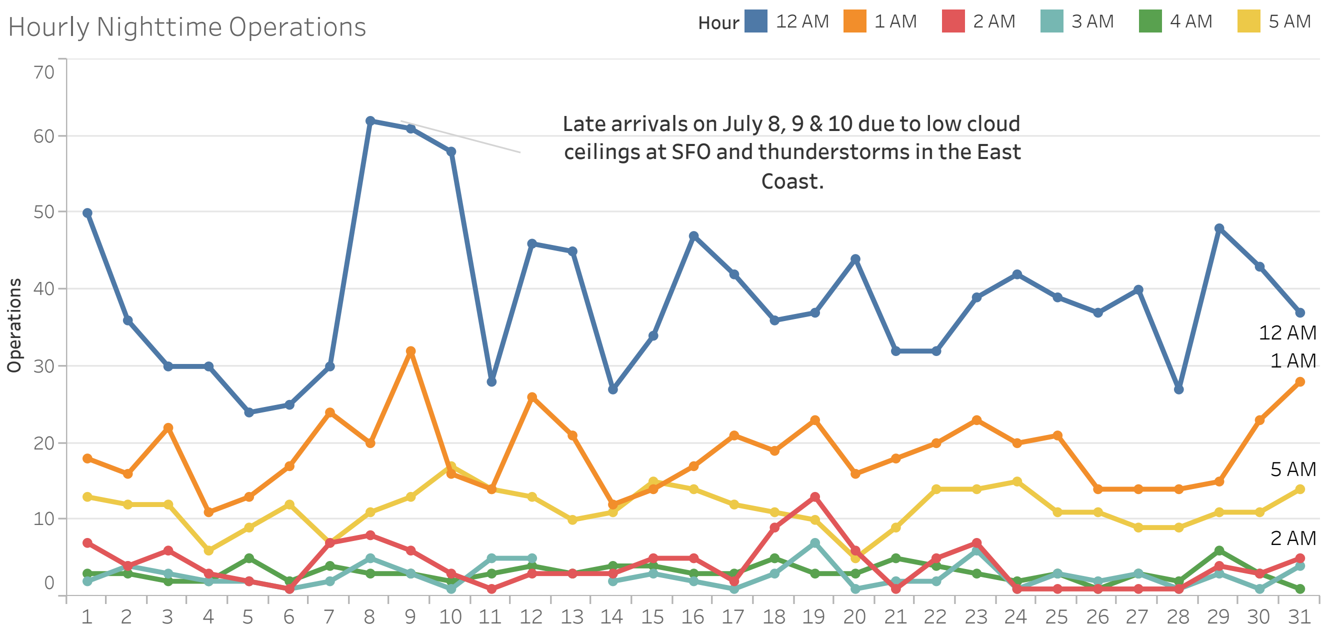
10pm-7am

Alaska Airlines	7
American Airlines	10
Delta Airlines	2
Southwest Airlines	1
United Airlines	8

A power runup is a procedure used to test an aircraft engine after maintenance is completed. This is done to ensure safe operating standards prior to returning the aircraft to service. The Aircraft power settingsrange from idle to full power and may vary in duration.



Hourly Nighttime Operations



Noise Reports

July 2019

Noise Reporters / Noise Reports

		Noise Reporters	Noise Reports
Roundtable	Atherton	6	1,601
	Belmont	3	328
	Brisbane	20	1,680
	Burlingame	13	210
	Daly City	6	994
	El Granada	1	974
	Foster City	18	853
	Hillsborough	7	90
	Menlo Park	23	1,610
	Millbrae	4	14
	Pacifica	29	3,133
	Portola Valley	33	7,251
	Redwood City	12	1,902
	San Bruno	9	565
	San Carlos	3	161
	San Francisco	37	4,598
	San Mateo	22	2,413
	South San Francisco	17	195
	Woodside	11	1,394
Other	Aptos	10	477
	Ben Lomond	5	36
	Berkeley	4	1,039
	Bonny Doon	2	57
	Boulder Creek	9	228
	Brookdale	1	6
	Capitola	18	2,452
	Carmel Valley	2	67
	Castro Valley	1	17
	Cupertino	1	693
	Danville	1	2
	East Palo Alto	1	1
	Emerald Hills	10	4,580
	Felton	13	932
	Fremont	1	180
	Hayward	1	46
	Lafayette	1	115
	Los Altos	117	18,144
	Los Altos Hills	26	10,240
	Los Gatos	121	20,549
	Montara	1	738
	Moraga	3	281
	Morgan Hill	2	299
	Moss Beach	1	2
	Mountain View	32	3,756
	Oakland	26	7,117
	Orinda	2	157
	Palo Alto	192	45,740
	Penngrove	1	6
	Richmond	4	3,271
	San Jose	1	4
	Santa Clara	1	10
	Santa Cruz	121	24,294
	Saratoga	4	336
	Scotts Valley	67	13,134
	Soquel	71	10,978
	Stanford	5	518
	Sunnyvale	5	348
	Union City	1	381
	Watsonville	1	174
	Grand Total	1,160	201,371

Reporters Annual AVG

1,240

Reports Annual AVG

186,436

New Reporters

46

New Reporters Top City

Foster City

Furthest Report

88 Miles

Reports per SFO Operation

4

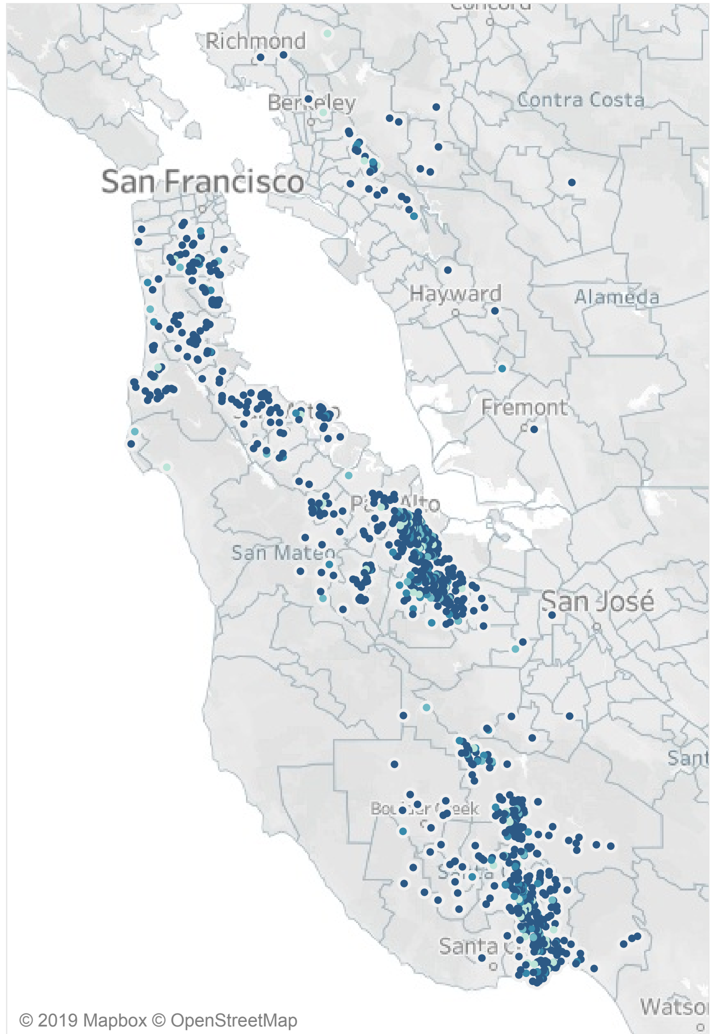
Top Aircraft Type

B737
A320
E75L

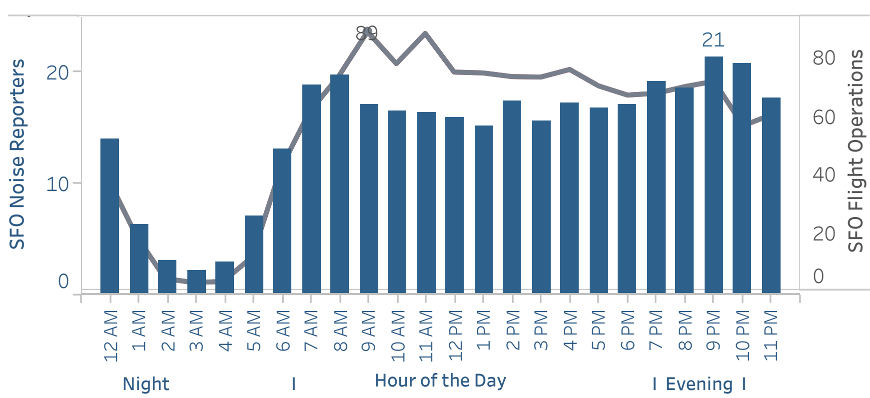
Top Flight Number

ASA1947
DAL1381
UAL2201

Noise Reporters Location Map



Hourly Noise Reports (Average Day in a Month)



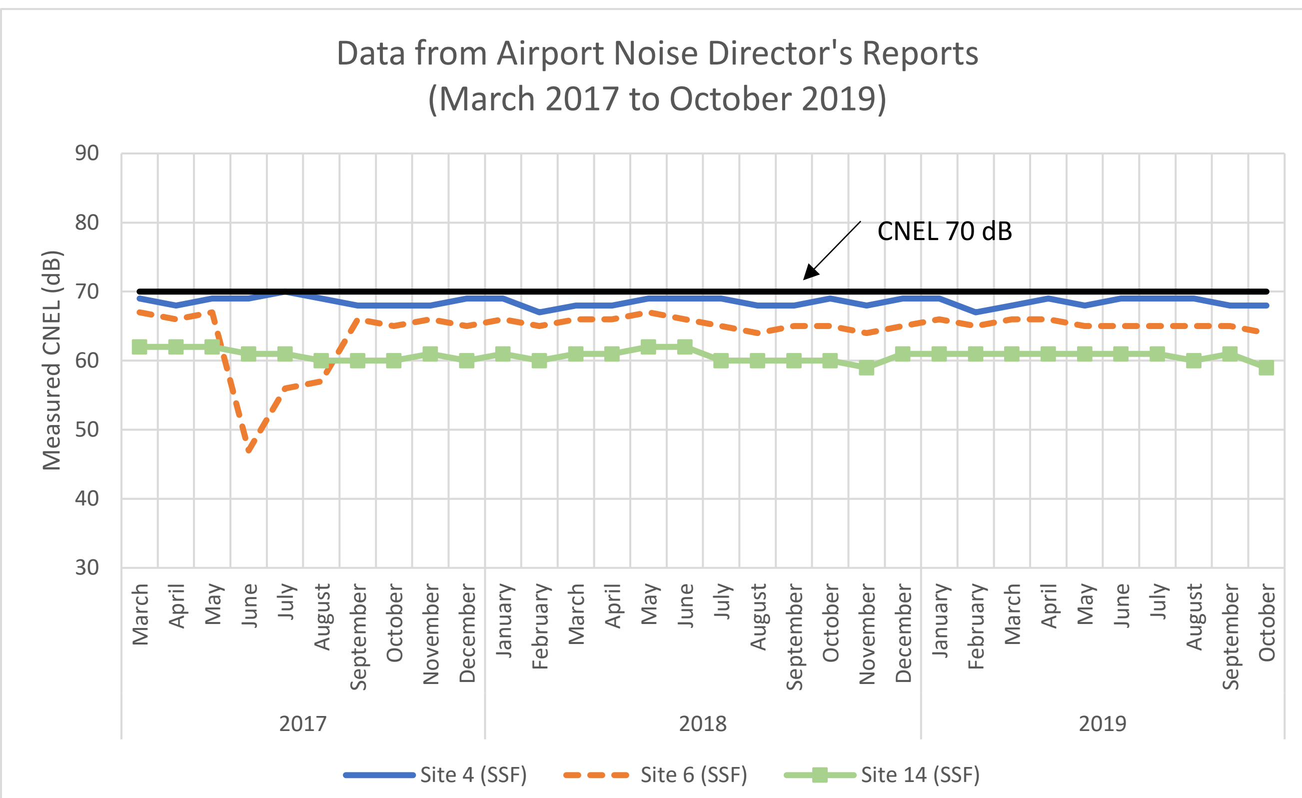
Airport

100% of noise reports correlate to a flight origin/destination airport.

Source: SFO Intl Airport Noise Monitoring System

Notes: Address validation Relies on USPS-provided ZIP Code look up table and USPS-specified default city values.

The following noise monitors (Monitors 4, 6, and 14) appear to be closest to the site at 410 Noor.



The table below summarizes noise levels from October 2019 to March 2017 at the three locations closest to the 410 Noor Site. Noise levels were below 70 dB at all locations at all times, with the exception of July 2017 at Site 4, where noise levels were exactly 70 dB. Note that this location is closer to SFO than the 410 Noor project site.

Year	Month	Aircraft CNEL (dBA) from Directors Reports		
		Site 4 (SSF)	Site 6 (SSF)	Site 14 (SSF)
2019	October	68	64	59
	September	68	65	61
	August	69	65	60
	July	69	65	61
	June	69	65	61
	May	68	65	61
	April	69	66	61
	March	68	66	61
	February	67	65	61
	January	69	66	61
2018	December	69	65	61
	November	68	64	59
	October	69	65	60
	September	68	65	60
	August	68	64	60
	July	69	65	60
	June	69	66	62
	May	69	67	62
	April	68	66	61
	March	68	66	61
	February	67	65	60
	January	69	66	61
2017	December	69	65	60
	November	68	66	61
	October	68	65	60
	September	68	66	60
	August	69	57	60
	July	**70**	56	61
	June	69	47	61
	May	69	67	62
	April	68	66	62
	March	69	67	62

APPENDIX E

2017 Noise Study Prepared by Papadimos Group

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410 NOOR AVENUE DEVELOPMENT

South San Francisco, California

Exterior Noise Study DRAFT

25 September 2017

S U B M I T T E D T O :

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TABLE OF CONTENTS

1.0 EXECUTIVE SUMMARY

- This report summarizes the results of an environmental noise study carried out at 410 Noor Avenue in August 2017 to analyze exterior noise exposure for a proposed multi-family residential development and determine requirements for exterior-to-interior noise control to meet relevant regulations and guidelines.
- This study is based on results of a site noise survey over several days from August 16 to 23, 2017 to confirm the existing noise exposure for the project site.
- The project site is about two miles northwest of the San Francisco International Airport and directly under a departure path for runways 28R & 28L, which is the primary source of noise exposure for the site.
- The site is also exposed to vehicular traffic noise that is at least 10 dB lower than aircraft noise on the average. Addressing aircraft noise as described below will also automatically address vehicular traffic noise.
- Based on the results of the noise survey, the site noise exposure is currently CNEL 72 dB and attributed to aircraft departures. This is also generally consistent with the SFO ALUC noise exposure maps. For the purposes of this study, a 1 dB increase has been applied to measured data resulting in CNEL 73 dB to account for future conditions in the 10 to 20-year horizon.
- Existing and predicted future noise exposure therefore would exceed the CNEL 70 dB threshold of incompatibility for residential developments as established in the South San Francisco General Plan and SFO Airport Land Use Compatibility Plan (ALUCP).
- To facilitate further review for the project by local jurisdictions, this study outlines minimum exterior-to-interior sound isolation performance to meet California Building Code requirements for exterior noise inside residential spaces (CNEL 45 dB).
- To meet CNEL 45 dB inside residential spaces per the California Building Code, the exterior building shell inclusive of walls, glazing and the roof must be designed to provide sound isolation with Outdoor-Indoor Transmission Class (OITC) values ranging from 30 to 35 as described in the *Recommendations* section of this report.
- Such performance requires detailed design of exterior constructions and upgrades above and beyond the typical minimum standard for multifamily residential buildings. In general, this would include exterior wall and roof constructions with additional layers of mass and/or resilient attachment of interior drywall, glass systems with deep increased airspace and use of heavier or laminated glazing, sound-rated exterior door assemblies and properly designed sound attenuating elements in ventilation systems.
- The South San Francisco General Plan also recognizes the need for controlling single-event maximum aircraft noise for residential uses, but has no specific noise limits.
- This study proposes limits for aircraft single-event maximum noise based on minimizing sleep disturbance (50 dBA and 70 dBC) and provides OITC ratings for the building exterior shell based on site noise exposure to achieve such performance which is above and beyond the minimum building code requirement for average interior

noise (CNEL 45 dB). Such performance is difficult to achieve with wood framed structures and generally requires concrete roof construction and heavy or double exterior wall designs in addition to double glazing systems with deep airspace cavities.

2.0 INTRODUCTION

This report summarizes the results and findings of an environmental noise study carried out for a proposed residential development consisting of 300 apartment units at 410 Noor Avenue in South San Francisco, CA.

The purpose of this study was to confirm the existing noise exposure for the site and develop design requirements for meeting relevant regulations and guidelines regarding exterior-to-interior noise control for residential uses.

Noise analysis is based on a noise survey that included on-site attended noise readings and unattended noise readings over several days from August 16 to 23, 2017 and review of relevant regulatory documents that included the Noise Element of the General Plan for the City of South San Francisco and the SFO Airport Land Use Policies.

3.0 BACKGROUND INFORMATION

The current development proposal includes approximately 300 apartment units in wood-framed buildings between 4 and 5 floors above below-grade parking.

The project location at 410 Noor Avenue in South San Francisco, California is about two miles northwest of the SFO airport and directly under a departure path for runways 28R & 28L. Immediately adjacent to the project site are local streets (Huntington Avenue and Noor Avenue) and existing commercial/industrial uses.

For definitions of acoustical terms and fundamentals of environmental acoustics refer to Appendix A. Relevant codes and regulatory information as it pertains to exterior noise and in particular aircraft noise and recommended criteria to address single-event aircraft noise based on previous experience are provided in the subsections below.

3.1 California Building Code

The California Building Code (Title 24, Part 2, Chapter 12, Section 1207 has the following requirement regarding interior noise from exterior sources. This study includes exterior-to-interior sound isolation recommendations for meeting this standard based on measured site noise exposure.

> ***1207.4 Allowable interior noise levels.*** *Interior noise levels attributable to exterior sources shall not exceed 45 dB in any habitable room. The noise metric shall be either the day-night average sound level (Ldn) or the community noise equivalent level (CNEL), consistent with the noise element of the local general plan.*

3.2 South San Francisco General Plan

The following excerpt from page 9-4 of the South San Francisco General Plan (downloaded from City of South San Francisco website August 2017) references the 65 dB CNEL contour impact boundary previously established by the San Mateo County Airport Land Use Commission (ALUC) and state regulations.

> "ALUC's 1995 SFO Land Use Plan establishes the 65 dB CNEL contour as the noise impact boundary for SFO, consistent with noise restrictions in the California Administrative Code, Title 21, Subchapter 6 "Noise Standards." Local plans, policy actions, or development activities that affect areas within that boundary must receive ALUC approval or have a finding of overriding consideration prior to local permit issuance."

The General Plan has the following land-use compatibility criteria (excerpts from Table 9.2-1) regarding noise exposure for residential development as well as open land uses which may be relevant for outdoor occupied uses on the project:

Table 9.2-1

Land Use Criteria for Noise-Impacted Areas

Land Use	*CNEL Range*	*General Land Use Criteria*
Residential	Less than 65	Satisfactory; no special insulation requirements
	65 to 70	Development requires analysis of noise reduction requirements and noise insulation as needed
	over 70 be undertaken	Development should not
Open	less than 75	Satisfactory; no special insulation requirements
	over 75	Avoid uses involving concentrations of people or animals

Implementing policy 9-I-10 also limits residential development where aircraft noise exposure exceeds CNEL 70 dB:

> *9-I-10* *Do not allow new residential or noise sensitive development in 70 dB+ CNEL areas impacted by SFO operations, as required by Airport Land Use Commission infill criteria. (Amened by City Council Resolution 31-2010)*

Furthermore, the General Plan seeks to address pass-by (single-event) noise in addition to the long-term average (CNEL) through the following implementing policy (9-I-1), although no specific limits for single event noise are given.

> *9-I-1* *Work to adopt a pass-by (single event) noise standard to supplement the current 65 dB CNEL average noise level standard as the basis for aircraft noise abatement programs.*

The General Plan also includes a noise contour map for rail and road noise only (Figure 9-2), indicating noise exposure in the absence of aircraft would be CNEL 60 dB or less on the project site and vicinity and the site is therefore fully compatible for residential development with regards to vehicular traffic noise exposure.

3.3 Airport Land Use Compatibility Plan (ALUCP)

The *Comprehensive Airport Land Use Compatibility Plan for the Environs of San Francisco International Airport* (November 2012) shows the project site currently within the CNEL 70-75 dB noise contour forecast for 2020 (Exhibit III-1, p. III-9). This means that according to the South San Francisco General Plan requirements described above, the proposed residential project would be technically incompatible under the current ALUCP without proper review and approval by local jurisdictions.

3.4 Federal Guidelines

The Federal Aviation Administration (FAA) identifies 65 Ldn (similar metric to CNEL) as the threshold of incompatibility for residential uses exposed to aircraft noise (Code of Federal Regulations, Title 14, Part 150 – Airport Noise Compatibility Planning). This is consistent with other federal guidelines issued by the Environmental Protection Agency and Department of Housing and Urban Development.

3.5 San Francisco International Airport (SFO) Noise Maps

According to the *Noise Exposure Map Report* published by SFO in August 2015 as required for compliance with federal regulations (14 CFR Part 150), the project site is entirely within the CNEL 65-70 dB range based on the 2014 noise exposure map (Exhibit 5-1 in SFO report). The 2019 forecast (Exhibit 5-2 in SFO report) indicates the CNEL 70 dB contour line crossing the southwest corner of the project site while most of the project site remains in the CNEL 65-70 dB range.

The same report also forecasts a 2% annual compound growth rate in aircraft operations between 2013 and 2033 (Table 2-4). This translates to a 22% increase in aircraft operations over 10 years and 49% increase over 20 years. This information is used later in this study to predict future aircraft noise exposure.

3.6 South El Camino Real General Plan Amendment

The project site is part of the planning area captured in the November 2009 Draft EIR for the South El Camino Real General Plan Amendment. Airport noise contours are included in the EIR for a 2001 baseline condition and 2006 projection and indicate that the project site is within the CNEL 65-70 dB range. The EIR does not include more recent noise contours.

Proposed Amendment Policies (p. 3.2-18 in the EIR) include requiring an acoustical analysis for any proposed residential development within the CNEL 60 to 69 dB range (Policy 9-I-4) and not allowing such development where noise exposure is CNEL 70 dB or higher (Policy 9-I-11).

3.7 Recommended Criteria for Single-Event Interior Noise

The California Building Code interior noise requirement (45 dBA CNEL) is based on a 24-hour average and does not address maximum single-event noise associated with individual aircraft. Such events would typically be the prime source of annoyance and sleep disturbance in residential spaces. Given the site proximity to the airport, such noise associated with individual aircraft should be taken into consideration to address speech interference and sleep disturbance.

We recommend consideration of the following single-event criteria for limiting maximum aircraft noise inside residential units, in addition to CNEL 45 dB as required by code. Similar criteria have previously been adopted by other local communities[1] and the same or more stringent limits are recommended by current industry guidelines[2].

- A-weighted limit: *50 dBA (single-event maximum)*
- C-weighed limit: *70 dBC (single-event maximum)*

The 50 dBA limit above is based on previous field studies showing up to a 5% probability for sleep awakenings from a single aircraft flyover (refer to Appendix A, Figure 2) and the 70 dBC limit is based on minimizing low-frequency aircraft noise intrusion that could potentially induce rattling and vibration of lightweight constructions and fixtures.

3.8 Noise Exposure for Outdoor Uses

For outdoor occupied uses such as courtyard seating areas or green roof areas where groups of people would gather for limited periods of time, speech interference would be the primary consideration regarding noise exposure.

If continuous noise sources such as steady traffic or mechanical equipment are controlled below 60 dBA, conditions are generally favorable for normal conversation.

While noise levels during jet aircraft departures above the site are commonly in the 80 to 90 dBA range and would interfere with most speech communication, this may be acceptable for casual outdoor uses given the short duration of aircraft overflights.

There is also no practical way to control aircraft noise outdoors since the aircraft are flying over the site and we are not aware of any previous instances where this has been addressed.

4.0 SITE NOISE EXPOSURE

4.1 Noise Survey

The noise survey carried out between August 16 and 23, 2017 included unattended and attended noise readings at the positions shown in Figure 1 below ('ST' refers to short-term attended readings and 'LT' refers to unattended long-term readings).

[1] City of Fremont, California General Plan, Chapter 10, 2011, Page 10-64
[2] ASHRAE 2015 Applications Handbook, Chapter 48, Table 1

Unattended readings were taken using Larson Davis model 820 sound level meters placed in trees at two positions on the project site. These meters recorded the average noise level (Leq) in hourly intervals and maximum noise levels for single events above 75 dBA.

The Community Noise Equivalent Levels (CNEL) for each full day of unattended readings were the calculated using the measured hourly average (Leq) levels. The results are provided in Table 1 below and charts that show measured hourly noise levels along with evening and nighttime penalties as required by the CNEL metric are provided in Appendix B (Charts 1a thru 2b).

To statistically assess single-event noise, histograms of maximum noise levels during individual loud events were produced and are shown in Charts 3 and 4 in Appendix B. While these events are largely attributed to aircraft departures and generally consistent with our attended observations, certain loud activities near the unattended sound level meters such as dogs barking, etc. could also have influenced measured levels shown on the histograms. However, such events would be rare compared to noise exposure from aircraft. When considering that the two unattended sound level meters should have near agreement in measured noise for aircraft overflights, the loudest 1%, 5% and 10% of aircraft single event noise levels are assessed at 95 dBA, 92 dBA and 91 dBA, respectively. This is generally consistent with attended observations as discussed below.

Table 1 – CNEL at Unattended Measurement Positions

Date	Duration (hours)	Measured CNEL (dBA)	
		Position LT-1	Position LT-2
Thursday, Aug. 17, 2017	24	72.5	72.3
Friday, Aug. 18, 2017	24	71.7	71.4
Saturday, Aug. 19, 2017	24	72.5	72.8
Sunday, Aug. 20, 2017	24	70.3	70.6
Monday, Aug. 21, 2017	24	70.8	71.6
Tuesday, Aug. 22, 2017	24	71.2	71.9
5-Day CNEL	**--**	***71.7***	***71.8***

Attended noise readings were taken using a hand-held acoustic analyzer (Bruel &Kjaer model 2250) at various locations across the site to directly observe aircraft and other noise sources and capture representative frequency spectra for subsequent exterior-to-interior noise analysis.

Attended noise readings were synchronized with the unattended sound levels meters at Positions LT-1 and LT-2 and the results of these readings are reported in Table 2 below. Refer to Chart 5 for representative frequency spectra of aircraft overflights.

FIGURE 1: Map of Measurement Positions

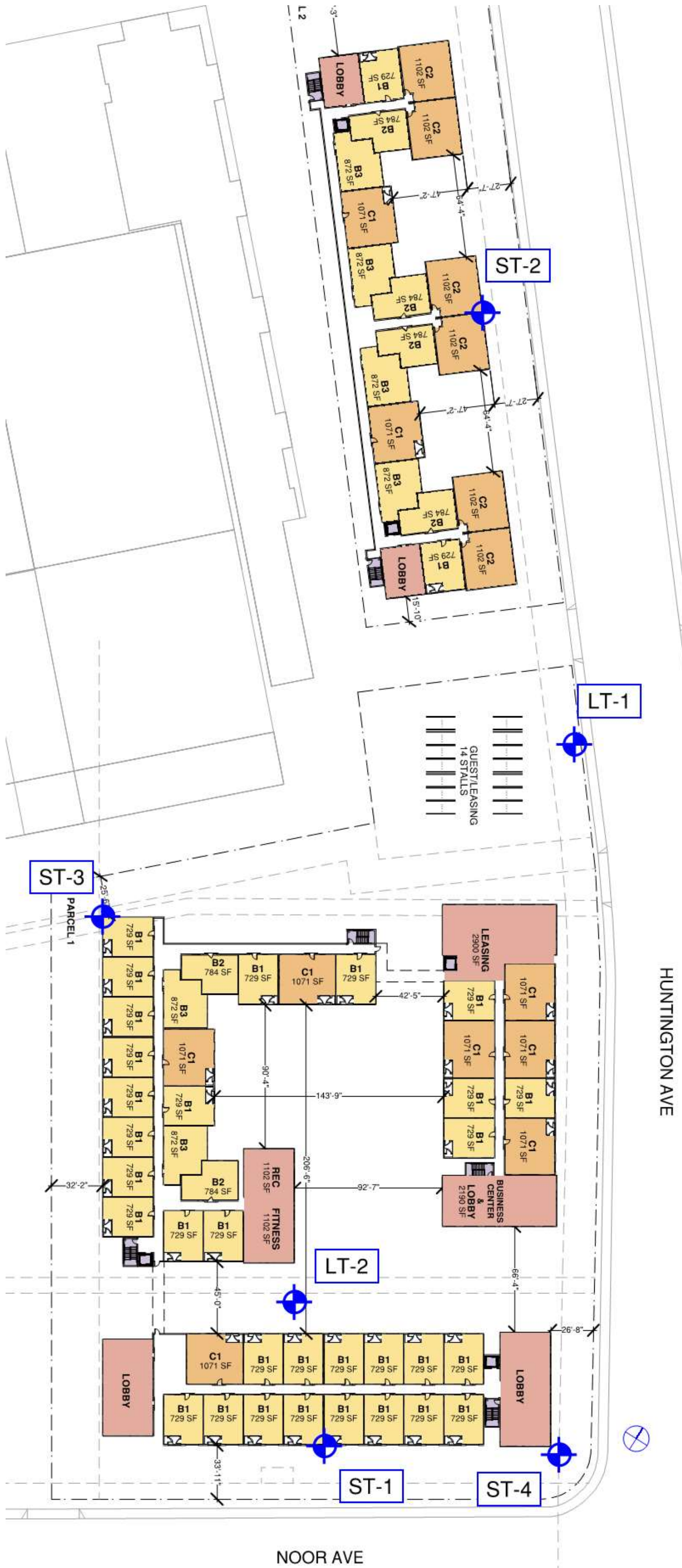


Table 2 – Short Term Attended Noise Readings

Start Time (Duration)	Position	Measured Noise Level, dBA		
		Average (Leq)	Minimum	Single-events (maximum)
8/16/17 1:35 pm (15 min)	ST-1	68	50	84, 86 (aircraft)
	LT-1	69	53	80, 84 (aircraft)
	LT-2	69	51	84, 87 (aircraft)
8/16/17 2:20 pm (15 min)	ST-2	70	50	82, 90 (aircraft)
	LT-1	72	54	84, 91 (aircraft)
	LT-2	74	52	86, 94 (aircraft)
8/23/17 8:45 am (15 min)	ST-3	53	46	89 (loud car) (no aircraft)
	ST-4	65	50	
	LT-1	65	51	
	LT-2	56	48	

4.2 Existing Conditions

Based on the results of the noise survey described above, site noise exposure is assessed at ***CNEL 72 dB***. This is attributed to aircraft departures from SFO and not local street traffic. According to the San Francisco General Plan, road and rail traffic for the project site is predicted below CNEL 60 dB and this is consistent with our attended noise readings during a period without any aircraft departures. Additionally, both unattended sound level meters measured nearly the same 5-day averaged values (CNEL 71.7 for LT-1 and CNEL 71.8 dB for LT-2) despite having very different setback distances from local street traffic (see Figure 1), further indicating that long-term average noise exposure for the site is not influenced by street traffic.

4.3 Future Increases

Using information from the *Noise Exposure Map Report* published by SFO, aircraft operations are predicted to increase by 22% over 10 years and 49% over 20 years. On the assumption that each doubling in aircraft volume results in 3 dB noise increase, this would amount to a 1 dB increase over 10 years and 2 dB over 20 years. However, the trend historically has been towards quieter aircraft designs that partially offsets increased aircraft operations in terms of noise exposure near airports. Therefore, only a 1 dB adjustment has been applied to the existing measured noise levels to account for future conditions, resulting in a future worst-case aircraft noise exposure of ***CNEL 73 dB*** for the purposes of this study.

5.0 EXTERIOR-TO-INTERIOR NOISE ANALYSIS

The following calculation has been used to determine the required sound transmission loss for exterior façades in terms of Outdoor-Indoor Transmission Class (OITC). Review of measured spectra for typical aircraft overflights has confirmed consistency between OITC ratings and A-weighted exterior-to-interior sound isolation for aircraft spectra.

OITC = Exterior Noise Level – Interior Noise Limit – 10log(S/A) + ADJ

Where: *10log(S/A)* is the room effect

S = total room sound absorption (in Sabines)

A = exterior wall and roof areas (ft^2)

Note: For this analysis, residential interiors are assumed to have hard flooring and typical furnishings, resulting in the term 10log(S/A) estimated at 2 dB for rooms with only wall areas exposed to aircraft noise and 5 dB for rooms with both wall and roof areas are exposed to aircraft noise (top floors).

ADJ = up to 3 dB to account for sound reflections such as in courtyard areas.

6.0 RECOMMENDATIONS

Using the methodology described in the previous section, building exterior constructions would need to meet the following minimum acoustic performance for code compliance (CNEL 45 dB interior):

- Roof: OITC 33
- Walls: OITC 30 to 35 (refer to Figures 2 thru 4)

For meeting the recommended single-event interior noise criteria (50 dBA and 70 dBC) based on all but the loudest 10% of aircraft (up to 90 dBA and 96 dBC), the building exterior constructions would need to provide the following minimum acoustical performance:

- Roof: OITC 45
- Walls: OITC 42 to 45 (refer to Figures 5 thru 7)

FIGURE 2 – Min. OITC Ratings for code compliance (CNEL 45 dB inside) - Floors 1-3

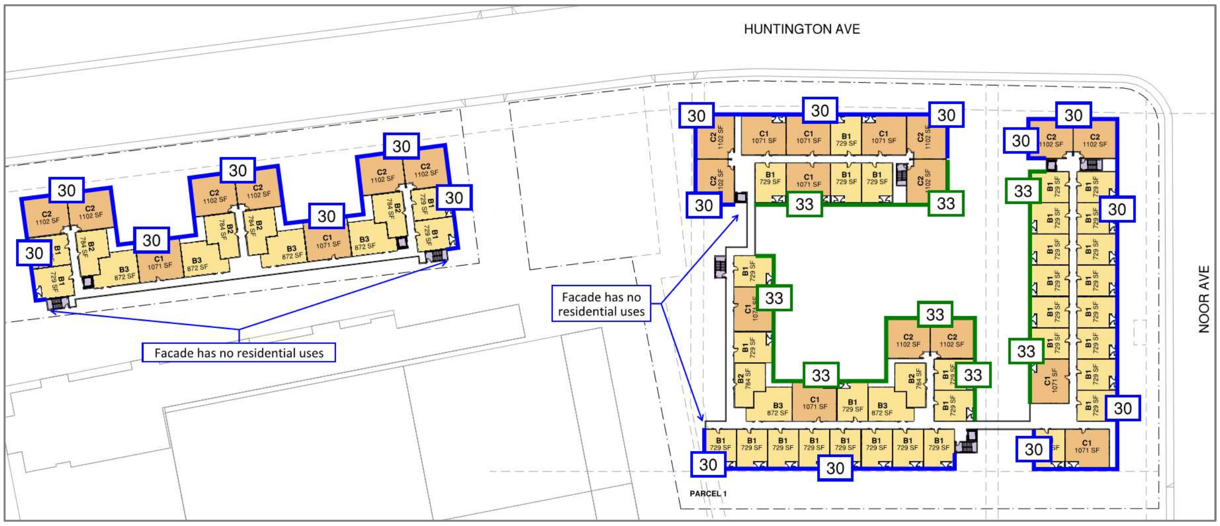


FIGURE 3 – Min. OITC Ratings for code compliance (CNEL 45 dB inside) – Floor 4

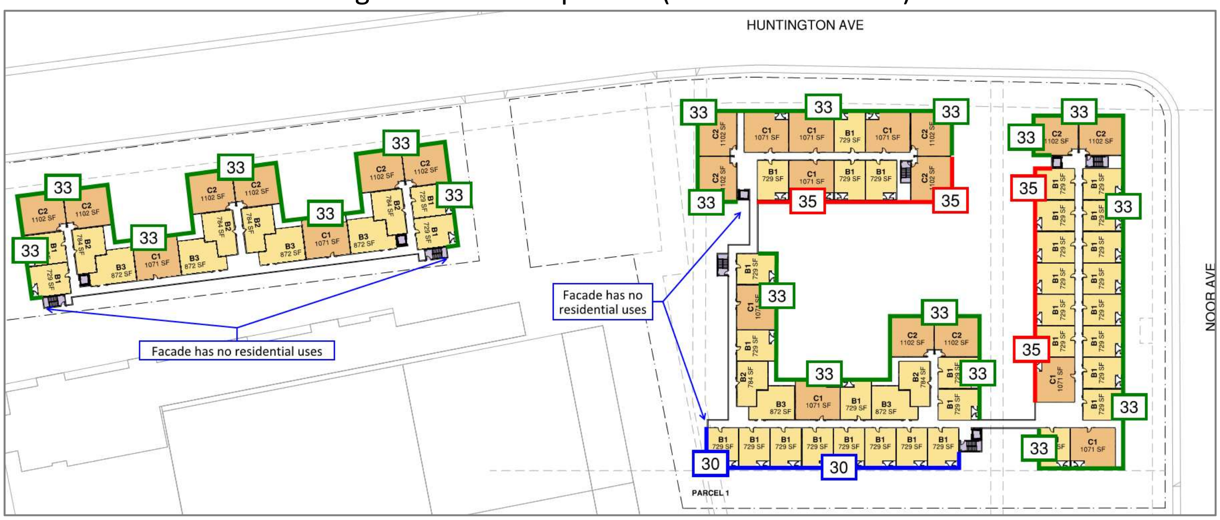


FIGURE 4 – Min. OITC Ratings for code compliance (CNEL 45 dB inside) – Floor 5

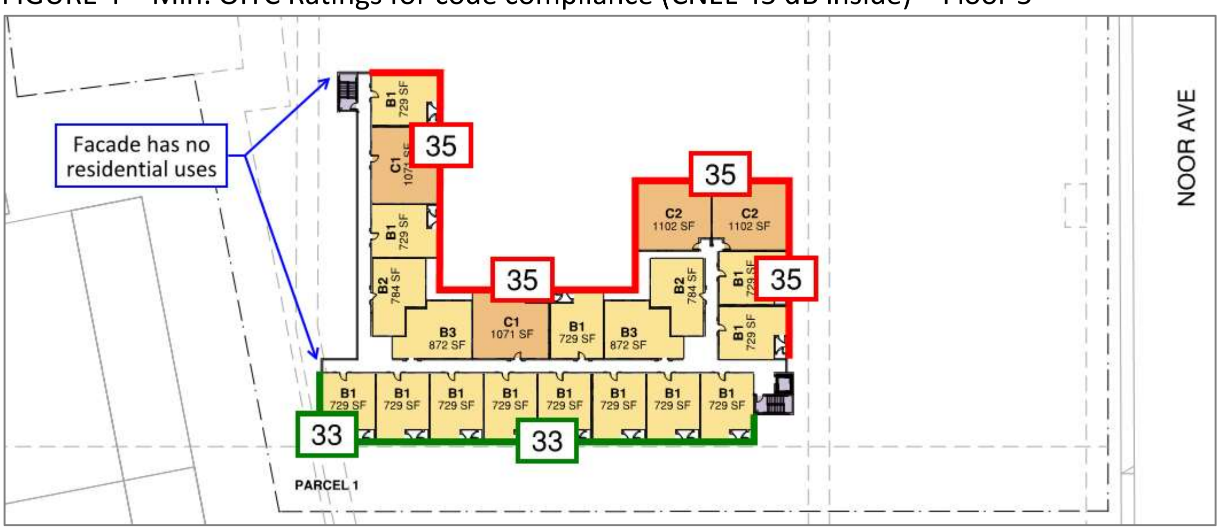


FIGURE 5 – Min. OITC Ratings for single-event noise control (50 dBA max. inside) – Floors 1-3

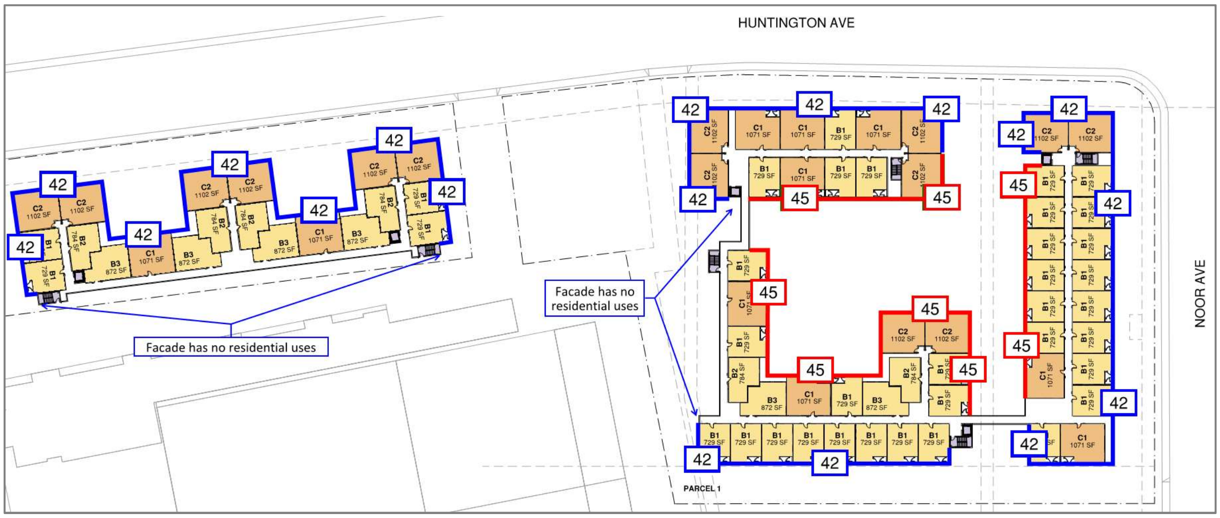


FIGURE 6 – Min. OITC Ratings for single-event noise control (50 dBA max. inside) – Floor 4

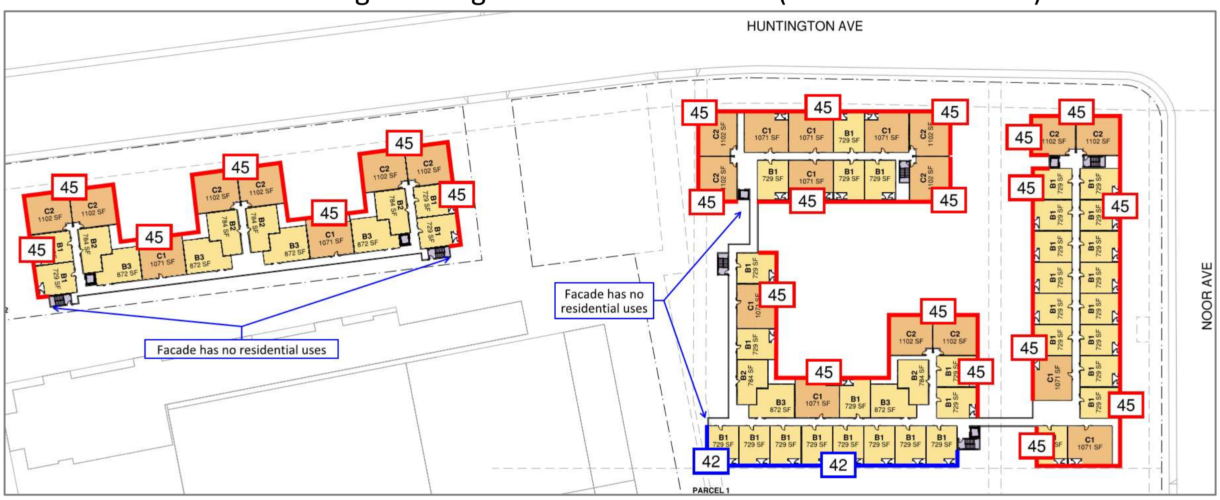
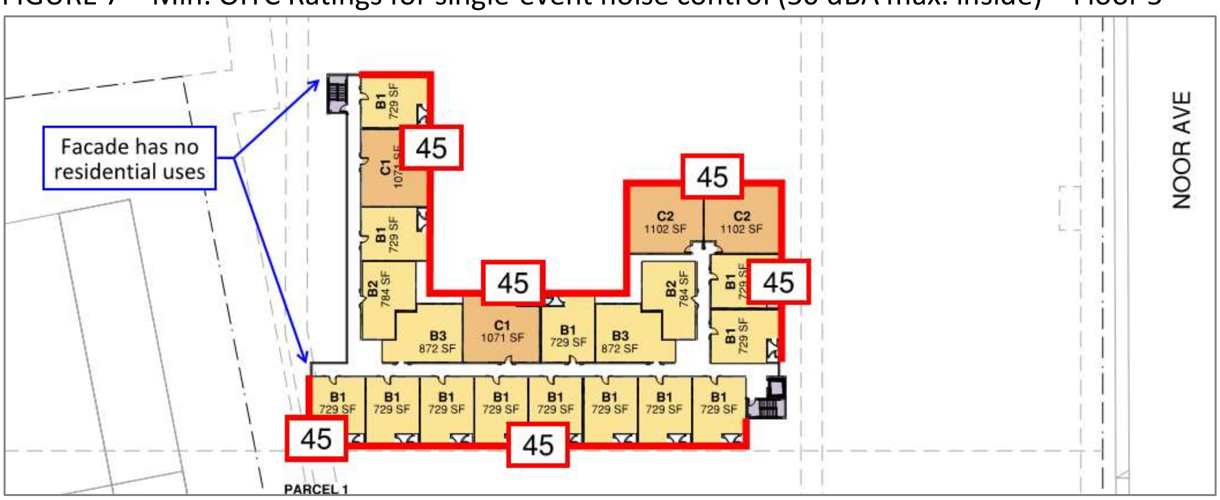


FIGURE 7 – Min. OITC Ratings for single-event noise control (50 dBA max. inside) – Floor 5



The OITC values stated above refer to total composite acoustical performance of entire exterior wall and roof systems inclusive of solid areas, glazing, doors and ventilation openings. Appropriate design analysis and/or laboratory testing will be necessary to properly assess the overall performance of various constructions and confirm minimum specified OITC values are met.

Some typical constructions for various OITC ratings are listed below as a guideline:

- OITC 25: This is generally achievable with standard acoustically sealed exterior constructions, fully gasketed solid core wood or metal insulated exterior doors and standard 1" insulating glass.
- OITC 30: For glazing this usually requires laminated glass on at least one side or increasing the total system depth to roughly 1-½" with thicker glazing and/or airspace. Solid wall sections and roof sections should have multiple layers of exterior plywood layers and/or multiple layers of interior drywall to increase mass. Doors to be sound-rated total assemblies with demonstrated laboratory-tested performance.
- OITC 35: This generally requires glazing systems with laminated glass and overall depth of 2" or more. Solid wall sections generally require additional layering for min. 10 psf surface weight on the exterior side (i.e. stucco) and may also require multiple drywall layers on the interior. Doors must be sound-rated total assemblies with laboratory-tested performance. Roof potentially achieve this level of performance with adequate mass on the top (min. 10 psf) and multiple layers of interior drywall but require detailed review.
- OITC 40: This generally requires laminated-insulated systems of substantial glazing (½" or thicker each side) and deep airspace (4" or more) and specially designed solid wall and roof sections with resilient interior drywall attachment and demonstrated laboratory tested performance.
- OITC above 40: This is difficult to achieve with wood framed construction and generally requires double exterior wall systems with inner and outer separate framing in addition to substantial glazing and a concrete roof.

Verifying Acoustic Performance of Exterior Wall Systems

Since the specified OITC ratings refer to the total performance of overall exterior wall systems, each specific component of the exterior wall system in conjunction with interior gypsum board construction should be reviewed and analyzed in detail to verify the total system performance and determine any necessary upgrades.

Such an evaluation should be carried out using sound transmission loss data for each component based on laboratory acoustic tests in accordance with relevant ASTM standards. For prefabricated components, this is typically available from the manufacturer, or in the absence of such test data, previous acoustical tests of similar systems and/or theoretical calculations based on mass and area of the framing system may be provided to estimate sound transmission performance. For built-up components including interior drywall sections, detailed information including material types, dimensions and details of perimeter conditions should be used to estimate sound transmission performance and the resulting OITC ratings.

Ventilation Systems

Because open windows only provide 10 to 15 dB of exterior to interior attenuation, the project must also include forced-air ventilation systems properly designed to provide fresh air intake and condition interior spaces while maintaining specified OITC ratings. Treatments such as z-ducts or other sound-attenuating air intake ducts can potentially be effective but require detailed design review to ensure that total composite sound isolation performance of exterior constructions is maintained.

7.0 CONCLUSIONS

In summary, based on the noise survey described in this report, noise exposure for the project site exceeds local, state and federal land use planning guidelines as they pertain to average aircraft noise exposure (CNEL 70 dB). At a minimum, sound-rated exterior constructions as described in this report are required to comply with California Building Code requirements for interior noise due to exterior sources (CNEL 45 dB).

Also relevant and identified in the South San Francisco General Plan without specific limits, is maximum aircraft noise inside residences from single events. This is important for minimizing the potential for sleep interference and other effects on indoor residential activities. Based on limits proposed in this assessment upgraded building constructions not typically achievable with wood framed construction would be required to provide control of single event aircraft noise; however, this is above and beyond the minimum standards established by the California Building Code for control of average noise.

Aircraft noise in outdoor use areas for the development cannot be practically controlled since the aircraft fly overhead. We understand common use areas will be indoors and similar provisions outlined in this report for residential spaces to comply with the Building Code should be considered.

I trust you will find this information useful but please do not hesitate to contact our office if you have any questions or require any additional information.

Sincerely,
THE PAPADIMOS GROUP, INC.

Roman Wowk
Senior Associate

Chris Papadimos
Principal

APPENDIX A

FUNDAMENTALS OF ENVIRONMENTAL ACOUSTICS

Noise may be defined as unwanted sound. Noise is usually objectionable because it is disturbing or annoying. The objectionable nature of sound is typically due to its *pitch* or its loudness. *Pitch* is the height or depth of a tone or sound, depending on the relative rapidity (frequency) of the vibrations by which it is produced. Higher pitched signals sound louder to humans than sounds with a lower pitch. *Loudness* is intensity of sound waves combined with the reception characteristics of the ear. Intensity may be compared with the height of an ocean wave in that it is a measure of the amplitude of the sound wave.

In addition to the concepts of pitch and loudness, there are several noise measurement scales, which are used to describe noise in a particular location. *A decibel (dB)* is a unit of measurement, which indicates the relative amplitude of a sound. The zero on the decibel scale is based on the lowest sound level that the healthy, unimpaired human ear can detect. Sound levels in decibels are calculated on a logarithmic basis. An increase of 10 decibels represents a ten-fold increase in acoustic energy, while 20 decibels is 100 times more intense, 30 decibels is 1,000 times more intense, etc. There is a relationship between the subjective noisiness or loudness of a sound and its intensity. Each 10-decibel increase in sound level is perceived as approximately a doubling of loudness over a fairly wide range of intensities. Technical terms are defined in Table 1.

There are several methods of characterizing sound. The most common method is the *A-weighted sound level, (dBA) which* gives greater weight to frequencies of sound to which the human ear is most sensitive. Representative outdoor and indoor noise levels in dBA are shown in Table 2.

Because sound levels can vary markedly over a short period of time, a method for describing either the average character of the sound or the statistical behavior of the variations must be utilized. Most commonly, environmental sounds are described 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}. The most common averaging period is hourly, but L_{eq} can describe any series of noise events of arbitrary duration.

Environmental noise fluctuates in intensity over time and sensitivity to noise and the potential for sleep disturbance is the highest during times that ambient levels are the lowest, i.e. evening, night and early morning hours. Therefore, time-weighted, average noise levels have been developed and are used to quantify and describe a noise environment and determine impacts. The two average noise level descriptors most commonly used are L_{dn} (also referred to as DNL) and CNEL.

The scientific instrument used to measure noise is the sound level meter. Sound level meters can accurately measure environmental noise levels to within 1 dB (Type 1 instrument). Various computer models have been commercially developed and can be used to predict environmental noise levels from sources, such as roadways and airports.

One way of anticipating a person's subjective reaction to a new noise is to compare the new noise with the existing noise environment to which the person has become adapted, i.e., the so-called "ambient" noise level. With regards to increases in A-weighted noise levels, knowledge of the following relationships is helpful:

- Except in carefully controlled laboratory experiments, a change of one dBA cannot be perceived.

- Outside of the laboratory, a three dBA change is considered a just-perceivable difference.
- A change in noise level of at least five dBA is required before any noticeable change in community response would be expected.
- A 10 dBA increase is subjectively heard as approximately a doubling in loudness, and would almost certainly cause an adverse change in community response.

TABLE 1: Definitions of Acoustical Terms

Term	**Definitions**
Decibel, dB	A unit describing the amplitude of sound, equal to 20 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to the reference pressure, which is 20 μPa.
Frequency, Hz	The number of complete pressure fluctuations per second above and below atmospheric pressure.
A-Weighted Sound Level, dBA	The sound pressure level in decibels as measured on a sound level meter using the A-weighting filter network. The A-weighting filter de-emphasizes the very low and very high frequency components of the sound in a manner similar to the frequency response of the human ear and correlates well with subjective reactions to noise.
L_1, L_{10}, L_{50}, L_{90}	The A-weighted noise levels that are exceeded 1%, 10%, 50%, and 90% of the time during the measurement period.
Equivalent Noise Level, Leq	The average A-weighted noise level during the measurement period.
Community Noise Equivalent Level, CNEL	The average A-weighted noise level during a 24-hour day, obtained after addition of 5 decibels in the evening from 7:00 P.M. to 10:00 P.M. and after addition of 10 decibels to sound levels measured in the night between 10:00 P.M. and 7:00 A.M.
Day/Night Noise Level, Ldn (or DNL)	The average A-weighted noise level during a 24-hour day, obtained after addition of 10 decibels to levels measured in the night between 10:00 P.M. and 7:00 A.M.
Lmax, Lmin	The maximum and minimum A-weighted noise level during a measurement period.
Ambient Noise Level	The composite of noise from all sources near and far. The normal or existing level of environmental noise at a given location.
Background Noise	The sound pressure level in a given environment from all sources. For the purposes of outdoor noise measurements it is the residual steady noise level in an environment due to a combination of sources near and far and excluding intermittent noises.
Intrusive	That noise which intrudes over and above the existing ambient noise at a given location. The relative intrusiveness of a sound depends upon its amplitude, duration, frequency, and time of occurrence and tonal or informational content as well as the prevailing ambient noise level.

Sound level meter	An instrument that measures sound in dB. Various features are incorporated into such instrument including frequency bands, integration of sound over time and display of average, minimum, and maximum levels.
Sound pressure level	The ratio, expressed in decibels, of the mean-square sound pressure level to a reference mean-square sound pressure level that by convention has been selected to approximate the threshold of hearing (0.0002 μbar)
Octave band	The frequency range of one octave of sound frequencies. The upper limit is always twice the frequency of the lower limit. Octave bands are identified by the geometric mean frequency or center between the lower limit and the upper limit.
One-third octave band	The frequency range of one-third of one octave of sound frequencies. The upper limit is $2^{1/3}$ (1.26) times the lower limit. One-third octave bands are identified by the geometric mean frequency or center between the lower limit and the upper limit.

TABLE 2: Typical Sound Levels Measured in the Environment

At a Given Distance from Noise Source	A-Weighted Sound Level in dBA	Noise Environments	Subjective Impression
	140		
Civil Defense Siren (100’)	130		
Jet Takeoff (200’)	120		Pain Threshold
	110	Rock Music Concert	
Diesel Pile Driver (100’)	100		Very Loud
	90	Boiler Room Printing Press Plant	
Freight Cars (50’) Pneumatic Drill (50’)	80		
Freeway (100’) Vacuum Cleaner (10’)	70	Garbage Disposal in Kitchen	Moderately Loud
	60	Data Processing Center	
Light Traffic (100’) Large Transformer (200’)	50	Department Store	
	40	Private Business Office	Quiet
Soft Whisper (5’)	30	Quiet Bedroom	
	20	Recording Studio	
	10		Threshold of Hearing
	0		

Effects of Noise

Hearing Loss

While physical damage to the ear from an intense noise impulse is rare, a degradation of auditory acuity can occur even within a community noise environment. Hearing loss occurs mainly due to chronic exposure to excessive noise, but may be due to a single event such as an explosion. Natural hearing loss associated with aging may also be accelerated from chronic exposure to loud noise.

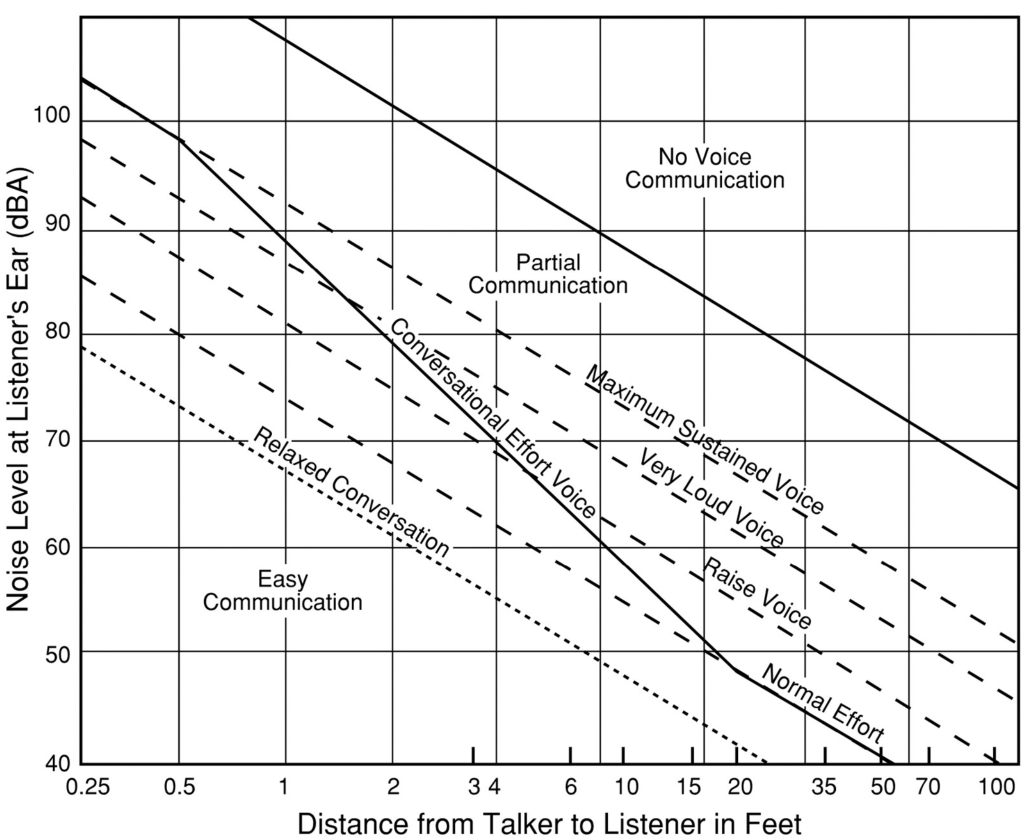
The Occupational Safety and Health Administration (OSHA) has a noise exposure standard which is set at the noise threshold where hearing loss may occur from long-term exposures. The maximum allowable level is 90 dBA averaged over eight hours. If the noise is above 90 dBA, the allowable exposure time is correspondingly shorter.

Speech Interference and Sleep Disturbance

The threshold for speech interference indoors is 45 dBA if the noise is steady and 55 dBA if the noise is fluctuating, depending on room acoustic conditions. Outdoors a threshold of at least 10 dBA higher may be considered for steady noise where the required distance between a talker and listener is reduced as the noise level increases, as shown in Figure 1 below.

FIGURE 1: Outdoor noise effect on distance at which ordinary speech can be understood

(*Federal Agency Review of Selected Airport Noise Analysis Issues,* FICON, 1992, p. 3-9)

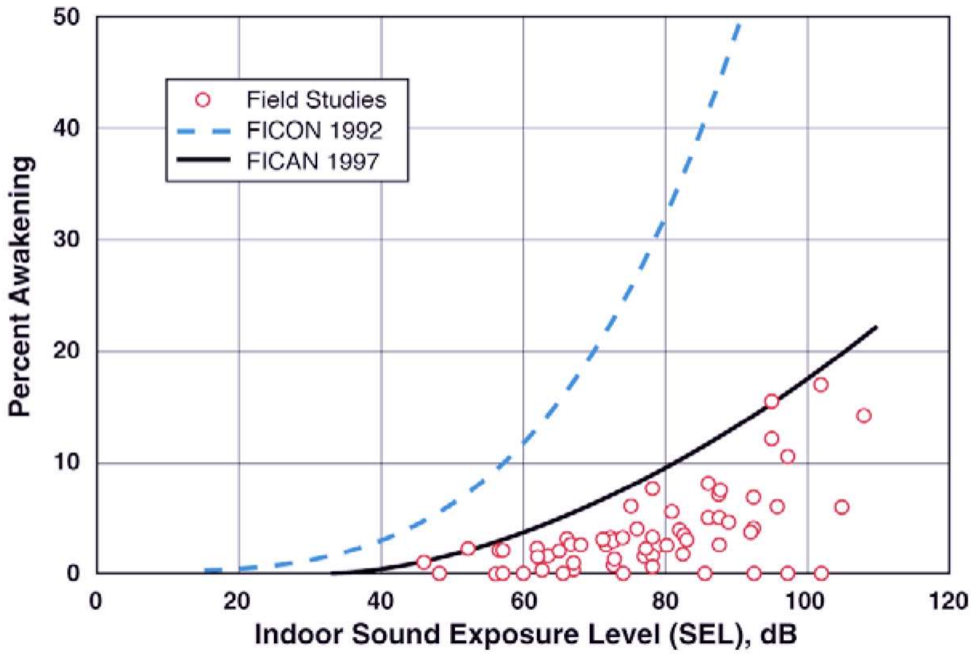


Steady noises of sufficient intensity (above 35 dBA) and fluctuating noise levels above about 45 dBA have been shown to affect sleep and therefore require due consideration in project planning and criterion selection.

Figure 2 below shows the relationship between noise level and probability to be awakened, in terms of Sound Exposure Level (SEL). The SEL corresponds to the total energy of an individual noise event which for typical aircraft operations is often 10 dB higher than the maximum noise level of the event. On that basis using the studies shown in Figure 2, if indoor noise levels stay below 50 dBA (i.e. 60 dBA SEL) there is less than 5% likelihood for sleep awakenings.

FIGURE 2: Sleep disturbance as a function of indoor noise exposure

(*Effects of Aviation Noise on Awakenings from Sleep,* Federal Interagency Committee on Aviation Noise, 1997)



Exterior to interior attenuation in buildings is typically in the 15 dBA range with open windows. With standard insulated windows in good condition and closed, the noise attenuation factor is at least 20 dBA for typical transportation noise sources.

Noise levels of 55-60 dBA are common along collector streets and secondary arterials, while 65-70 dBA is typical for primary/major arterials. Noise levels of 75-80 dBA are normal at the first row of development outside a freeway right-of-way. If the outdoor level is kept below 70 dBA then a typical residential structure with windows closed would limit typical transportation noise in the interior to 50 dBA, but this needs to be properly analyzed and validated on a case-by-case basis taking into consideration the specific spectral content of the intruding noise. In addition, some noise sources with high content of low frequency such as commercial jet aircraft, trains and trucks have the potential of inducing vibration into structures and this is an area with limited research but requires proper consideration during project development.

Annoyance

Attitude surveys are used for measuring the annoyance felt in a community for noises intruding into homes or affecting outdoor activity areas. In these surveys, it was determined that the causes for annoyance include interference with speech, radio and television, house vibrations, and interference with sleep and rest.

Twenty-four hour noise metrics such as DNL (or CNEL) have been found to provide a valid correlation of noise level and the percentage of people annoyed. People have been asked to judge the annoyance caused by aircraft noise and ground transportation noise. There continues to be disagreement about the relative annoyance of these different sources.

When measuring the percentage of the population highly annoyed, the threshold for ground vehicle noise is about 55 dBA DNL. At about 60 dBA DNL, approximately 2 percent of the population is found to be highly annoyed. When the DNL increases to 70 dBA, the percentage of the population highly annoyed increases to over 10 percent of the population. There is, therefore, an increase of about 1 percent per dBA from 60 to 70 dBA DNL. Between 70 and 80 dBA DNL, each decibel increase results in about 2 percent increase on percentage of the population highly annoyed.

People appear to respond more adversely to aircraft noise. When the DNL is 60 dBA, approximately 10 percent of the population is believed to be highly annoyed. Each decibel increase to 70 dBA DNL adds about 2 percentage points to the number of people highly annoyed. Above 70 dBA DNL, each decibel increase results in about a 3 percent increase on population highly annoyed.

APPENDIX B

NOISE MEASUREMENT CHARTS

Chart 1a - Unattended Noise Readings
Sound Level Meter at Position LT-1 (Fri thru Sun)

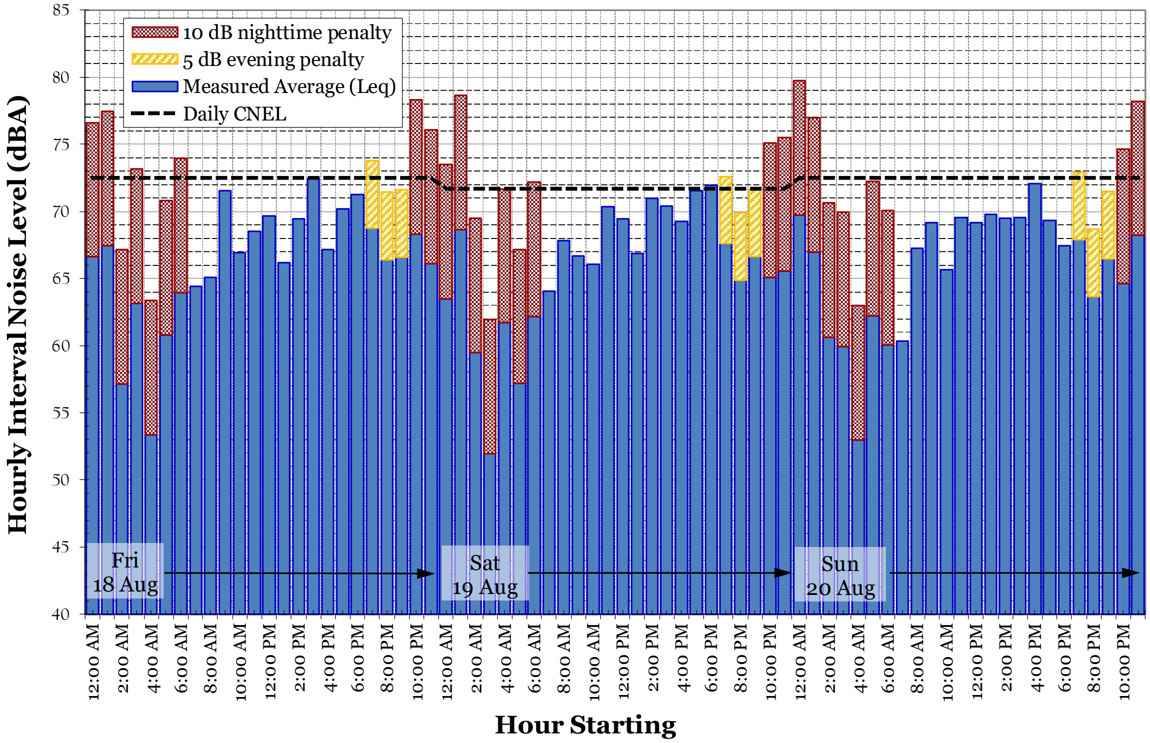


Chart 1b - Unattended Noise Readings
Sound Level Meter at Position LT-1 (Mon & Tues)

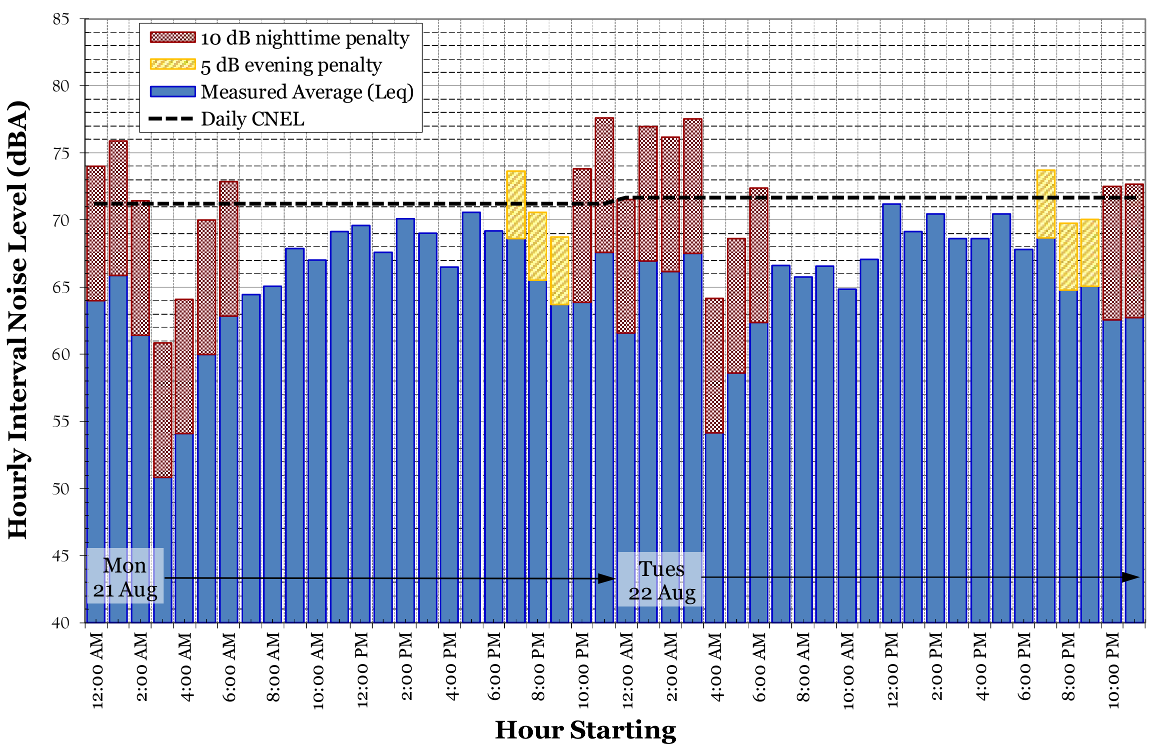


Chart 2a - Unattended Noise Readings
Sound Level Meter at Position LT-2 (Fri thru Sun)

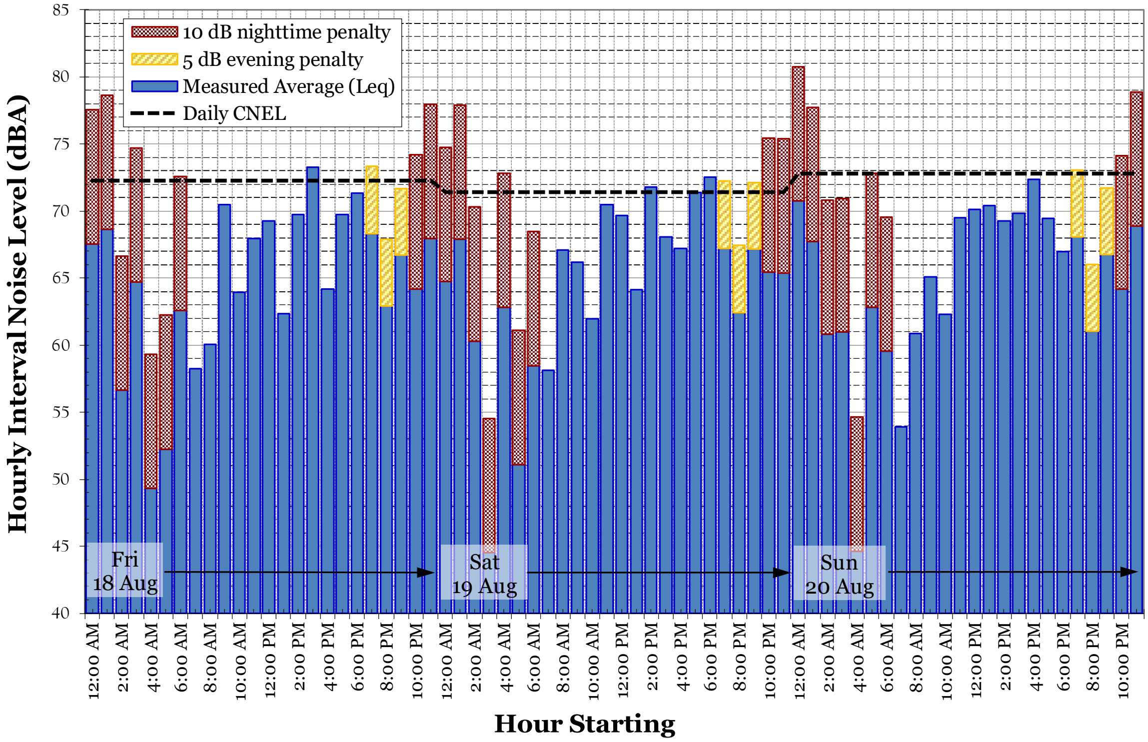
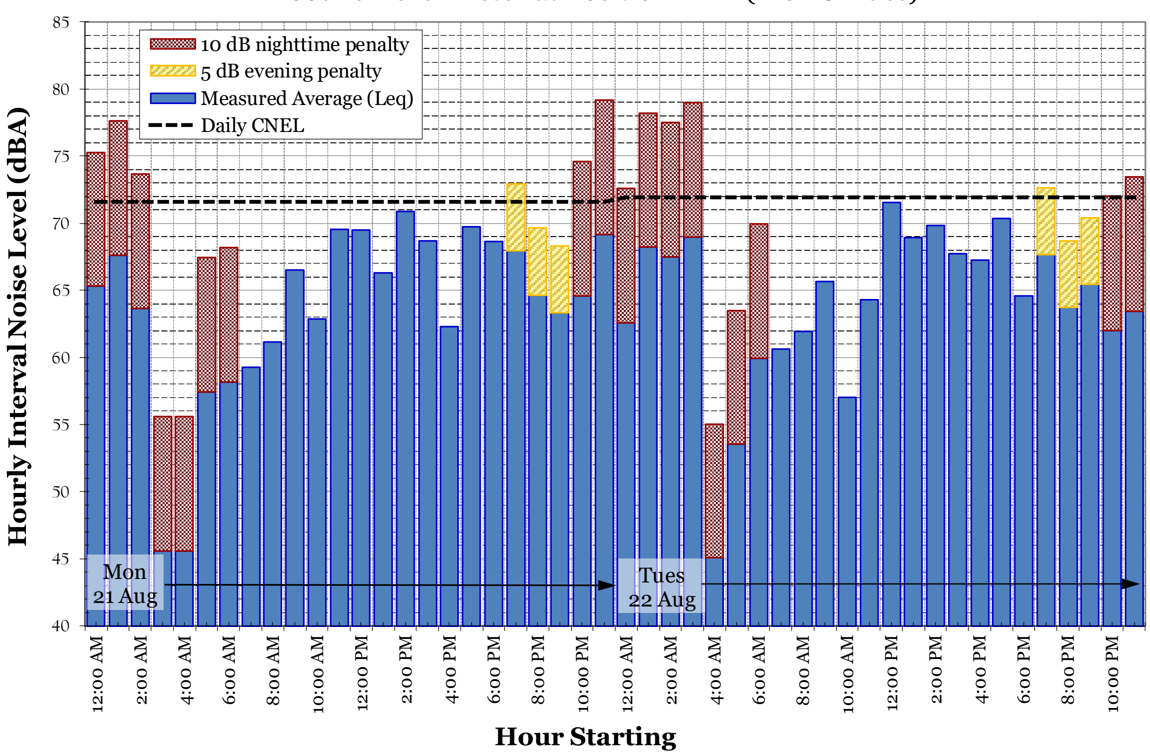


Chart 2b - Unattended Noise Readings
Sound Level Meter at Position LT-2 (Mon & Tues)



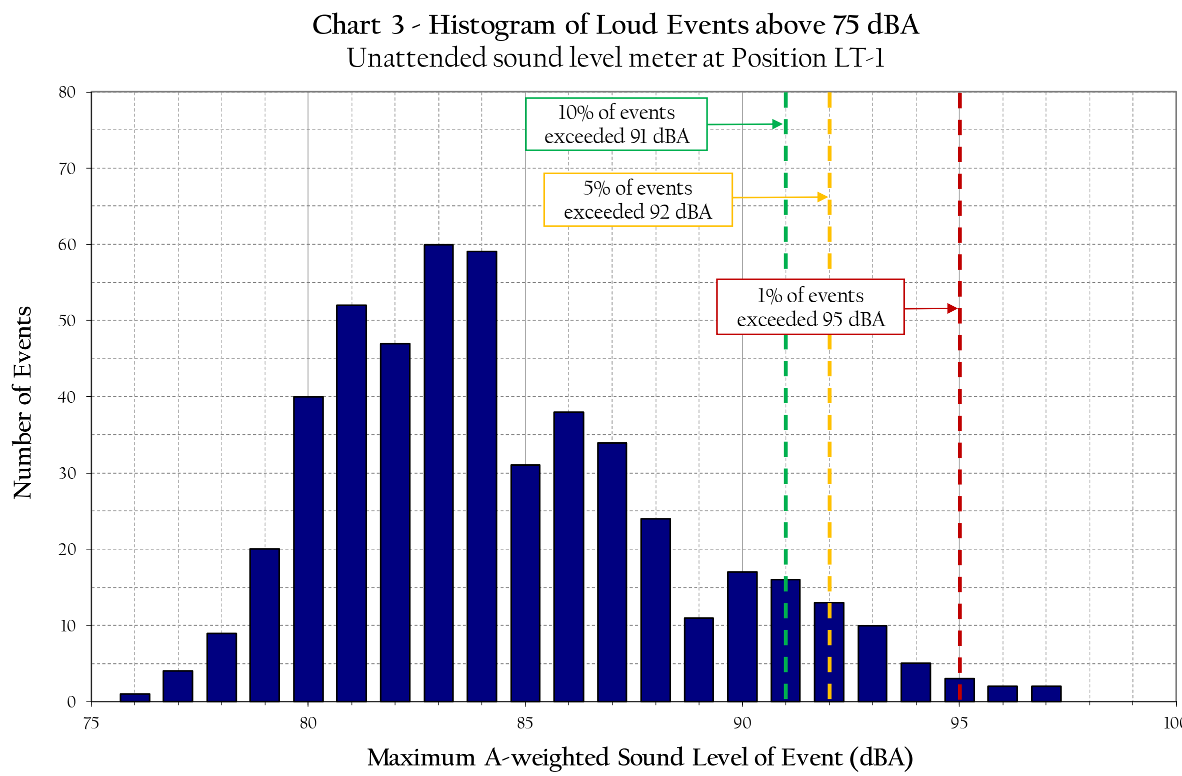


Chart 3 - Histogram of Loud Events above 75 dBA
Unattended sound level meter at Position LT-1
10% of events exceeded 91 dBA
5% of events exceeded 92 dBA
1% of events exceeded 95 dBA
Number of Events
Maximum A-weighted Sound Level of Event (dBA)

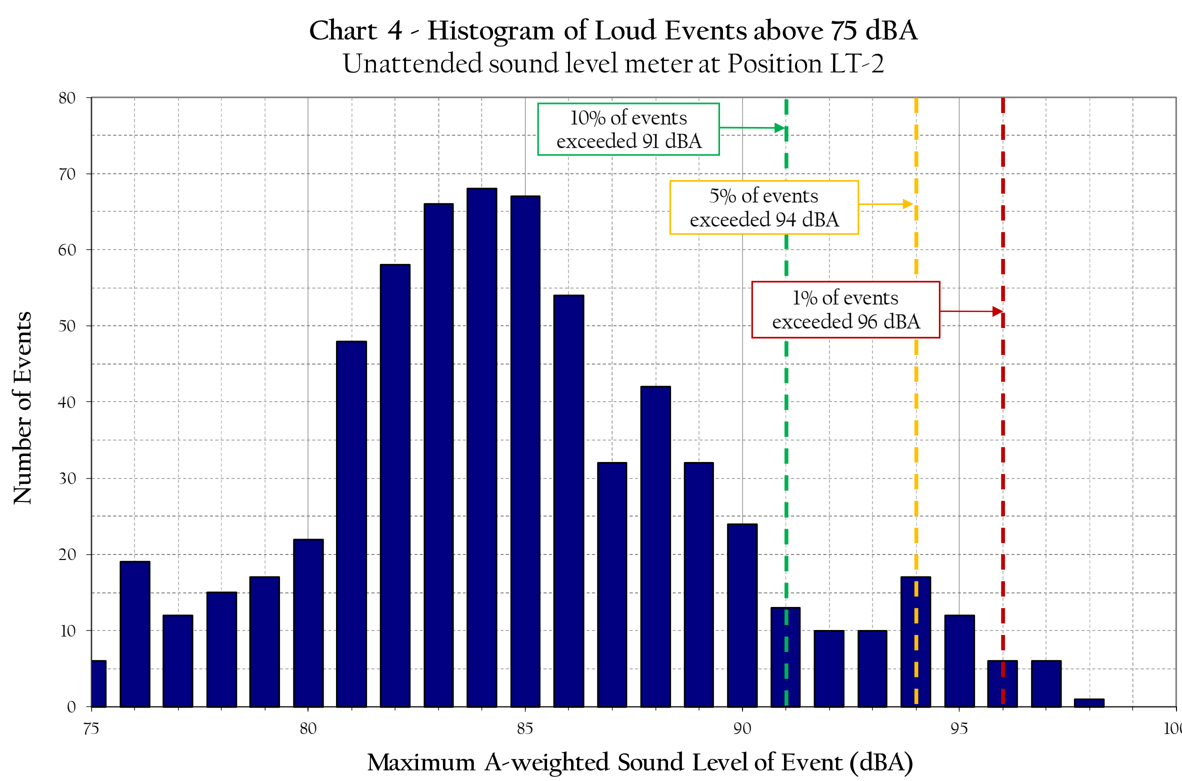
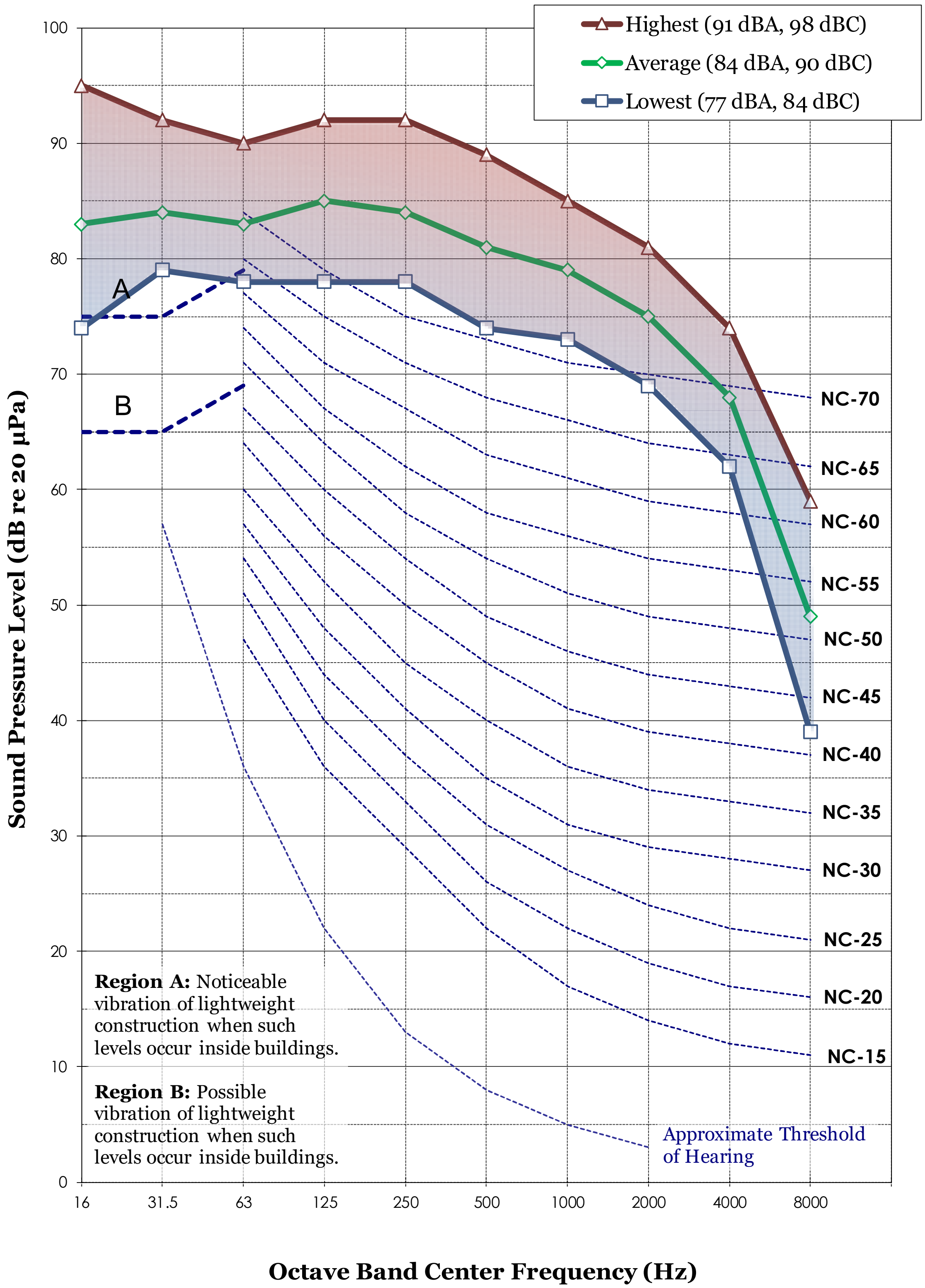


Chart 4 - Histogram of Loud Events above 75 dBA
Unattended sound level meter at Position LT-2
10% of events exceeded 91 dBA
5% of events exceeded 94 dBA
1% of events exceeded 96 dBA
Number of Events
Maximum A-weighted Sound Level of Event (dBA)

Chart 5:
Range of measured aircraft spectra
Several aircraft departures



Appendix I: Traffic Impact Analysis (TIA)