Appendix D

Noise and Vibration Assessment

550 O'FARRELL STREET PROJECT NOISE AND VIBRATION ASSESSMENT

San Francisco, California

Case No. 2017-004557ENV

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Introduction

This report summarizes the evaluation of noise and vibration levels attributable to the construction and operation of the 550 O'Farrell Street project in San Francisco, California. The report first describes the project, and then summarizes the applicable regulatory criteria used in the assessment. Existing noise levels in the project vicinity are described, followed by evaluations of project-generated noise and vibration levels. Measures are recommended to avoid the effects of temporary construction noise and vibration and permanent operational noise.

A brief discussion of the fundamentals of environmental noise and groundborne vibration is presented in Appendix A for those unfamiliar with acoustical terms or concepts. Appendix B displays the noise data collected at the project site.

Noise Analysis Study Area

Figure 1 is an aerial image showing the proposed project site, adjacent land uses, and noise monitoring locations selected during the noise survey. Figure 2 is the project site plan showing nearby sensitive receptors. The project site is located on the north side of O'Farrell Street on the block bounded by O'Farrell Street to the south, Geary Street to the north, Jones Street to the east, and Leavenworth Street to the west. The project site and block are located in the Uptown Tenderloin National Register Historic District.

The project site consists of an 86-foot-wide by 138-foot-deep rectangular lot, currently developed as a two-story-over-basement public parking garage. Table 1 summarizes the land uses near the project site, all of which are considered either noise or vibration sensitive receptors for the purpose of this assessment. Four adjacent properties border the site (one to the east, one to the west, and two to the north). A two-story hotel building over ground-floor retail, at 570 O'Farrell Street, occupies the site to the west. A six-story apartment building, at 540 O'Farrell Street, occupies the site to the east. The adjacent properties to the north include a five-story apartment building at 665 Geary Street and a vacant lot containing the brick rubble remains of a demolished structure at 651 Geary Street. The properties directly south of the project site, across O'Farrell Street, include a six-story residential building (555 O'Farrell Street) and a five-story residential building (545 O'Farrell Street). All of the aforementioned buildings are contributory buildings to the Uptown Tenderloin National Register Historic District, and therefore considered historic resources for the purpose of California Environmental Quality Act (CEQA) review.

FIGURE 1 Aerial Image Showing Site Plan, Noise Monitoring Locations, and Nearby Land Uses

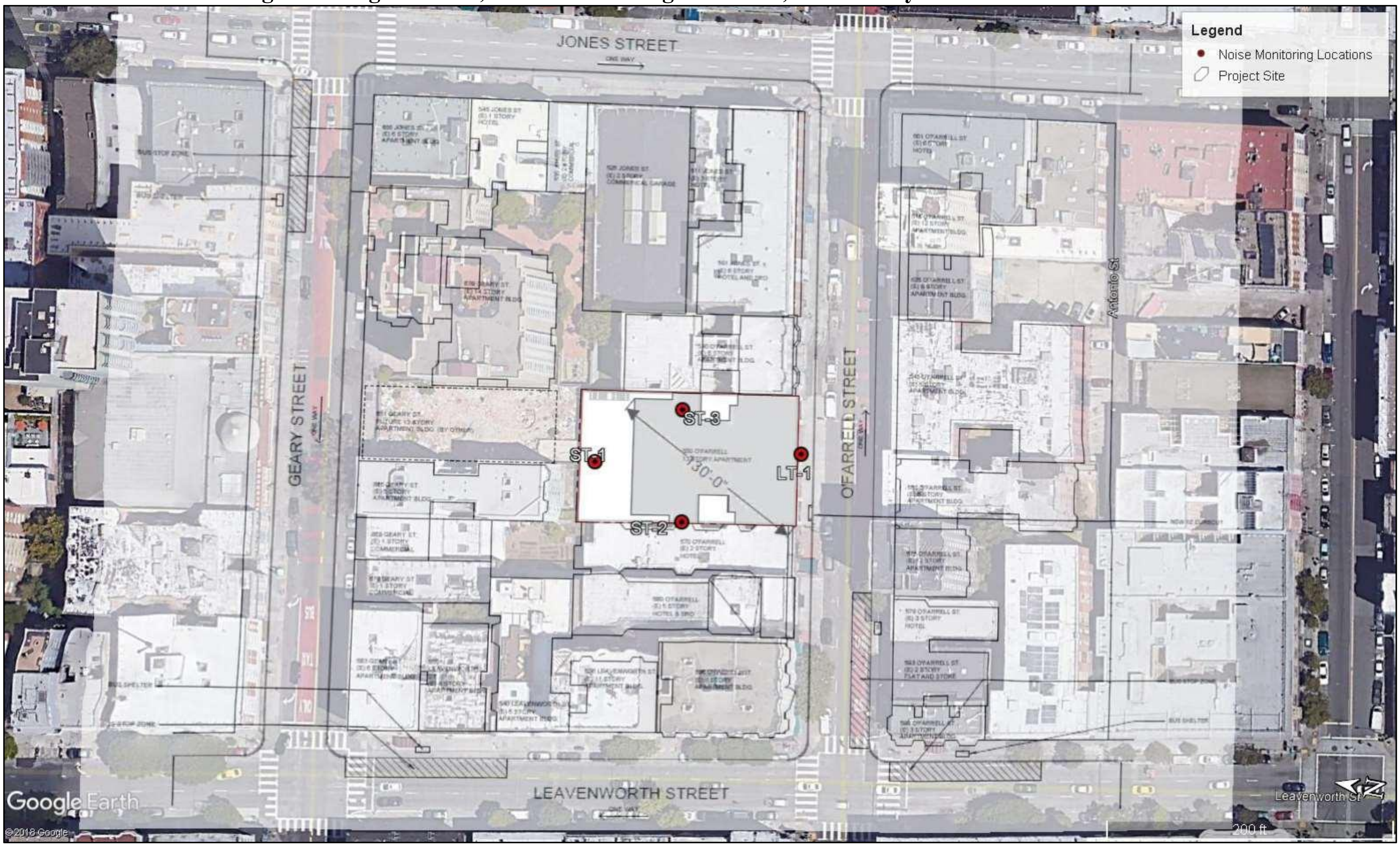


FIGURE 2 Site Plan Showing Nearby Sensitive Receptors

TABLE 1 Existing Noise- and Vibration-Sensitive Receptors within Site Vicinity

Type of Sensitive Receptor	Location Address	Historic Resource / Contributing Building to Historic District	Minimum Distance from Project Site Boundaries (feet)	Representative Monitoring Location
	West of Project Site			
Hotel	570 O'Farrell Street	Yes	0	LT-1/ST-2
Hotel and SRO	580 O'Farrell Street	Yes	35	LT-1/ST-2
	East of Project Site			
Apartment Building	540 O'Farrell Street	Yes	0	LT-1/ST-3
Hotel and SRO	501 Jones Street	Yes	60	LT-1ST-3
	South of the Project Site			
Apartment Building	545 O'Farrell Street	Yes	75	LT-1
Apartment Building	555 O'Farrell Street	Yes	75	LT-1
Apartment Building	575 O'Farrell Street	Yes	75	LT-1
	North of the Project Site			
Apartment Building	639 Geary Street	No	25	ST-1
Apartment Building (Future)	651 Geary Street	No	25	ST-1
Apartment Building	665 Geary Street	Yes	25	ST-1
	SOURCE: Illingworth & Rodkin, Inc., 2019.			

Project Description

The project sponsor proposes the 550 O'Farrell Street project, with retained elements of the existing 550 O'Farrell Street structure, as well as a project variant that would involve complete demolition of the existing building. The proposed project would be a an approximately 104,946-sf, 13-story-over-basement, mixed-use building with 111 dwelling units, approximately 1,300 sf of ground-floor active space and basement- and ground-level 156 class 1 bicycle parking spaces. The project variant would be an approximately 106,515-sf, 13-story-over-basement, mixed-use building with 116 dwelling units, approximately 1,300 sf of ground-floor active space and basement- and ground-level 156 class 1 bicycle parking spaces. For purposes of this noise and vibration assessment, the proposed project and project variant would have similar effects, and are referred to herein as the "project" or the "proposed project."

The proposed project would require excavation of a majority of the site to depths of approximately 11 feet (rear of building) and 4.5 feet (front of building) below existing basement grades. In addition, a portion (approximately 490 cubic yards) of the rear of the building would be backfilled, to accommodate a larger rear yard than existing conditions. The excavation would deepen the existing half basement, creating a full basement across a majority of the site, and remove enough soil for the installation of a new reinforced concrete mat slab foundation with grade beams and elevator pits. Total excavation depth would be about 16 feet below the existing sidewalk grade. Up to approximately 2,205 cubic yards of soil would be removed from the proposed project site, and below-grade excavation would require temporary shoring of excavation side walls. Up to 6,900 cubic yards of demolition debris would also be removed from the project site. Two existing 26- to 28-foot-wide curb cuts along the O'Farrell Street frontage would be removed.

The project sponsor anticipates that construction for the proposed project, or the project variant, would begin in spring 2021, span approximately 21 months and be conducted in three phases: (1) demolition, (2) excavation and shoring, and (3) construction. Demolition would last approximately one month, excavation and shoring approximately 2 months, and construction approximately 18 months. Heavy construction equipment, such as front loaders, backhoes, drilling equipment, tractors, graders, and trucks would be used for the project. In addition, jackhammers, cranes, pumps, and generators (to a limited degree) would be used. The proposed project would use a mat slab foundation system, which does not require pile driving. However, if piles were to be required, the project sponsor would implement torque-down piles, which do not generate excessive noise or vibration. Noise and vibration levels resulting from the installation of torque-down piles are similar to the levels produced by drilling (discussed under Impacts 1 and 2). The project sponsor is also contemplating incorporating prefabricated volumetric modular construction techniques to reduce construction costs and the construction period. These techniques are also beneficial in terms of reducing noise levels in the surrounding area by minimizing the construction equipment and construction activities at the site, as well as, and the overall noise-generating construction period. Construction activities would occur during the daytime only (between 7:00 a.m. and 8:00 p.m.).

Once constructed, the proposed building would be 13 stories tall, reaching 130 feet in height (146 feet in height to the top of the elevator penthouse). The building's parapet wall would be 2 feet in height, the mechanical and stair penthouse would be 10 feet in height, and the elevator penthouse would be 16 feet above the roofline, respectively. Rooftop equipment would include a cooling tower, exhaust fans, heat pumps, and an emergency generator, which would be enclosed in a room. The remainder of the roof-top equipment would be acoustically screened by metal panels, which would provide additional noise reduction. The proposed building would be set back approximately 31 feet from the rear property line. The proposed building (or project variant) would include a common rear yard and private rear decks at the ground floor and a common rear deck at the 13th floor.

Existing Noise Environment

Ambient noise levels were measured by *Illingworth & Rodkin, Inc.* between Wednesday, May 22, 2019 and Friday, May 24, 2019. Noise measurements were made with Larson Davis Model 820 Integrating Sound Level Meters (SLMs) set at "slow" response. The sound level meters were equipped with G.R.A.S. Type 40 AQ1/2–inch random incidence microphones fitted with windscreens. The sound level meters were calibrated prior to the noise measurements using a Larson Davis Model CAL200 acoustical calibrator. The response of the system was checked after each measurement session and was always found to be within 0.2 dBA. At the completion of monitoring, the measured interval noise level data were obtained from the SLM using the Larson

Davis SLM utility software program. All instrumentation meets the requirements of the American National Standards Institute (ANSI) SI 4-1983 for Type I use.

Weather conditions during the measurement period were good for noise monitoring. Meteorological conditions on Wednesday, Thursday, and Friday consisted of mostly clear skies, calm to light winds (0 to 5 mph), and seasonable temperatures (55° F to 65° F during midday).

Noise measurements were made to document ambient noise levels at the site at locations that were also representative of the nearest sensitive receptors including a hotel building to the west (570 O'Farrell Street), an apartment building to the east (at 540 O'Farrell Street), an apartment building to the north at 665 Geary Street, and residential buildings (545 and 555 O'Farrell Street) to the south (see Table 1, Figure 1 and Figure 2).

Appendix B displays the noise data collected at Site LT-1, which was at the southern edge of the rooftop of the existing building. The predominant noise source at Site LT-1 was the traffic noise along O'Farrell Street. This noise measurement location was selected to represent the noise environment at the proposed building façade along O'Farrell Street, as well as existing conditions at receptors in the project vicinity. Daytime noise levels at LT-1 typically ranged from 64 to 75 dBA L_{eq}, and nighttime noise levels typically ranged from 57 to 64 dBA L_{eq}. The day-night average noise level at Site LT-1 ranged from 70 to 71 dBA L_{dn} over the approximate 48-hour noise monitoring period, and was 71 dBA L_{dn} over the 24-hour noise monitoring period on Thursday, May 23, 2019.

Short-term, observed, noise measurements were made at locations ST-1, ST-2, and ST-3, which were also on the roof of the existing building. The noise levels measured at each of these sites were similar, with average noise levels ranging from 56 to 57 dBA L_{eq} during each 10-minute noise measurement. Vehicle traffic along O'Farrell and Geary Streets produced maximum instantaneous noise levels ranging from 58 to 64 dBA L_{max} and helicopter overflights produced maximum instantaneous noise levels ranging from 65 to 67 dBA L_{max}. The estimated day-night average noise levels at locations ST-1, ST-2, and ST-3 ranged from 62 to 63 dBA L_{dn}.

Noise measurement data are summarized in Table 2.

TABLE 2 Summary of Noise Monitoring (dBA)

Measurement Location	Time Period	Noise Level	Audible Noise Sources
Long-Term Measurements (24 hours or more)			
LT-1 – Rooftop of 550 O'Farrell Street Garage, south boundary, approximately 40 feet from roadway centerline.	5/22/19 to 5/24/19 Daytime Average: Nighttime Average: 24-hour Average:	68 L_{eq} 61 L_{eq} 71 L_{dn}	Local Traffic along O'Farrell and Geary Streets
Short-Term Measurements (10 minutes)			
ST-1 - Rooftop of 550 O'Farrell Street Garage, north boundary.	Date: 5/22/19 Time: 10:50 am	56 L_{eq}	Local Traffic along Geary Street
ST-2 - Rooftop of 550 O'Farrell Street Garage, west boundary.	Date: 5/22/19 Time: 11:00 am	57 L_{eq}	Local Traffic along O'Farrell and Geary Streets, Helicopter, Siren
ST-3 - Rooftop of 550 O'Farrell Street Garage, east boundary.	Date: 5/22/19 Time: 11:10 am	57 L_{eq}	Local Traffic along O'Farrell and Geary Streets

SOURCE: Illingworth & Rodkin, Inc., 2019.

Noise and Vibration Impacts and Recommended Control Measures

This section describes the significance criteria used to evaluate project impacts under CEQA, provides a discussion of each project impact, and recommends control measures, where necessary, to reduce potential noise or vibration effects .

The following criteria were used to evaluate the significance of environmental noise resulting from the project:

1. **Temporary or Permanent Noise Increases in Excess of Established Standards.** A significant impact would be identified if project construction would result in a substantial temporary increase in ambient noise levels in the vicinity of the project in excess of noise standards contained in the Police Code or applicable standards of other agencies. The FTA establishes a noise threshold of 90 dBA L_{eq} for residential land uses. The planning department also evaluates whether construction noise would result in an increase of 10 dBA over existing noise levels ("Ambient + 10 dBA") at sensitive receptors, which generally represents a perceived doubling of loudness. A significant impact would be identified if project operations would result in a substantial permanent increase in ambient noise levels in the vicinity. For operational noise sources such as mechanical equipment, the Police Code establishes a noise limit of 5 dBA above ambient for residential land uses. For operational noise sources such as increased vehicle traffic, a threshold of 3 dBA L_{dn} is used.

2. **Generation of Excessive Groundborne Vibration.** A significant impact would be identified if the construction of the project would generate excessive vibration levels. Caltrans establishes a vibration threshold of 0.25 in/sec PPV for historic buildings exposed to continuous or frequent intermittent vibration events.

3. **Exposure of Residents or Workers to Excessive Noise Levels in the Vicinity of a Private Airstrip or an Airport Land Use Plan.** A significant impact would be identified if the project would expose people residing or working in the project area to excessive aircraft noise levels in the vicinity of a private airstrip or an airport land use plan. Noise levels exceeding 65 dBA CNEL are considered incompatible with residential land uses.

Impact 1: **Noise Levels in Excess of Standards.** The proposed project could generate noise levels at the nearby sensitive receptors in excess of the standards established by the City of San Francisco or the Federal Transit Administration.

Temporary Construction Noise

Noise impacts resulting from construction depend upon the noise generated by various pieces of construction equipment, the timing and duration of noise-generating activities, and the distance between construction noise sources and noise-sensitive areas. Construction noise impacts primarily result when construction activities occur during noise-sensitive times of the day (e.g., early morning, evening, or nighttime hours), the construction occurs in areas immediately adjoining noise-sensitive receptors, or when construction lasts over extended periods of time.

The project sponsor anticipates that construction would begin in spring 2021, span approximately 21 months and be conducted in three phases: (1) demolition, (2) excavation and shoring, and (3) construction. Demolition would last approximately one month, excavation and shoring approximately 2 months, and construction approximately 18 months. Heavy construction equipment, such as excavators, tractors, loaders, backhoes, and rollers would be used for the project. In addition, a crane, air compressors, concrete saws, generators, mixers, forklifts, and welders would be used. Pile driving is not currently proposed as the proposed project would use a mat slab foundation system. Construction activities would not occur at night (between 8:00 p.m. of any day and 7:00 a.m. of the following day).

During each stage of construction, there would be a different mix of equipment operating, and noise levels would vary by stage and vary within stages, based on the amount of equipment in operation and the location at which the equipment is operating. Table 3 summarizes the construction noise levels calculated with the RCNM model based on construction equipment assumptions provided by the project applicant. The maximum instantaneous noise levels (L_{max}) and average noise level (L_{eq}) is shown for each type of equipment, The average noise level for the construction phase (L_{eq}) was calculated assuming the operation of the two loudest pieces of construction equipment simultaneously. Construction noise levels decrease by 6 dBA with each doubling of distance between the noise source and receptor. Table 4 summarizes the hourly average noise levels expected at the nearest receptors during project construction activities.

TABLE 3 Construction Noise Levels at 50 Feet (dBA)

Construction Phase	Equipment Type	Equipment Lmax	Equipment Leq	Construction Phase Leq
Demolition	Air Compressors	78	74	85
	Concrete/Industrial Saws	90	83	
	Excavators	81	77	
	Tractors/Loaders/Backhoes	84	80	
	Generator Sets	81	78	
Excavation & Shoring	Excavators	81	e	82
	Rollers	80	73	
	Tractors/Loaders/Backhoes	84	80	
Building Construction	Air Compressors	78	74	80
	Cement and Mortar Mixers	80	77	
	Cranes	81	73	
	Forklifts	75	68	
	Generator Sets	81	78	
	Welders	74	70	

Source: Illingworth & Rodkin, Inc., August 2019.

TABLE 4 Construction Noise Levels at Nearest Sensitive Receptors (dBA L_{eq})

Construction Phase	Leq at 50 feet	Leq at 40 feet[1]	Leq at 90 feet[2]	Leq at 120 feet[3]	Exceeds 90 dBA Leq Threshold for Residences?	Exceeds Ambient (56 dBA) by 10 dBA or more?
Demolition	85	87	80	77	No	Yes (21-31 dBA)
Excavation & Shoring	82	84	77	74	No	Yes (18-28 dBA)
Building Construction	80	82	75	72	No	Yes (16-26 dBA)

Notes: 1. Represents buildings immediately adjacent to the site (540 and 570 O'Farrell Street).
2. Represents buildings north and east of the site (639, 651, and 665 Geary Street, and 501 Jones Street).
3. Represents buildings south of the site (545, 555, 575 and 580 O'Farrell Street).
Source: Illingworth & Rodkin, Inc., August 2019.

Construction activities generate considerable amounts of noise, especially during earth-moving activities and during the construction of the building's foundation when heavy equipment is used. The highest noise levels would be generated during grading, excavation, and foundation construction. The hauling of excavated materials and construction materials would generate truck trips on local roadways, as well. Noise-sensitive residential and commercial land uses surround the site (see Table 1 and Figure 2). As shown in Table 4, during project construction, construction noise levels would generally fall within the range of 72 to 87 dBA L_{eq} at the nearest receptors. Construction noise levels would not exceed the FTA's 90 dBA L_{eq} threshold established for daytime construction activities, but would exceed the background noise level at sensitive receptor locations by 16 to 31 dBA throughout the duration of project construction.

Section 2907 of the Police Code states that, "it shall be unlawful for any person to operate any powered construction equipment if the operation of such equipment emits noise at a level in excess of 80 dBA when measured at a distance of 100 feet from such equipment, or an equivalent sound level at some other convenient distance." Based on the data contained in Table 3, the operation of concrete saws would have the potential to exceed the 86 dBA at 50 feet (or equivalent 80 dBA at 100 feet) noise limit for construction equipment (as specified in section 2907 of the police code) by up to 6 dBA. However, Section 2907 does not apply to impact tools and equipment when properly muffled, or pavement breakers and jackhammers when equipped with acoustical shields or shrouds. Additionally, the concrete saw would require the appropriate shielding as required by the noise ordinance.

Permanent Noise Increase due to Project-Generated Traffic Noise

A significant impact would result if traffic generated by the project would substantially increase noise levels at sensitive receptors in the vicinity. A substantial increase would occur if: a) the noise level increase is 5 dBA L_{dn} or greater, with a future noise level of less than 60 dBA L_{dn}, or b) the noise level increase is 3 dBA L_{dn} or greater, with a future noise level of 60 dBA L_{dn} or greater. Residences near the project site are exposed to existing noise levels greater than 60 dBA L_{dn}; therefore, a significant noise increase would occur if project-generated traffic would permanently increase noise levels by 3 dBA L_{dn}. For reference, a 3 dBA L_{dn} noise increase would be expected if the project would double existing traffic volumes along a roadway.

The proposed project would remove the existing 550 O'Farrell Street garage that currently occupies the project site with 119 vehicle parking spaces. The reduced number of parking spaces and change in land uses would correlate to reduced vehicle trips. The travel demand generated by the proposed project or variant would be up to approximately 241 vehicle trips per day (15 vehicle trips during the p.m. peak period) and is too small to double existing traffic volumes along roadways serving the site. Therefore, the project's contribution to increased traffic noise levels along roadways serving the site would be below the 3 dBA L_{dn} criteria. Traffic noise level increases in the project vicinity would not be considered substantial.

Permanent Noise Increase due to Project Fixed Mechanical Equipment

High-rise structures typically include various fixed mechanical equipment for heating, ventilation, and air-conditioning needs, as well as back-up power generation, and the operation of such mechanical equipment would increase ambient noise levels at receptors in the project vicinity. Rooftop equipment would include a cooling tower, exhaust fans, heat pumps, and an emergency generator, which would be enclosed in a generator room. The remainder of the roof-top equipment would be acoustically screened by metal panels, which would cause most of the noise to be projected upward and away from neighboring properties.

Section 2909 of the Police Code establishes noise limits from mechanical sources for various land uses throughout the community. For noise generated by residential uses, the limit is 5 dBA in excess of the ambient noise. The nighttime ambient noise level is 46 dBA based on the results of the noise monitoring; therefore, the mechanical equipment noise limit would be 51 dBA. The Noise Ordinance also provides an interior noise limit for fixed noise sources, such as mechanical equipment. Fixed noise sources may not exceed 45 dBA between the hours of 10:00 p.m. to 7:00 a.m. or 55 dBA between the hours of 7:00 a.m. to 10:00 p.m. with windows open, except where building ventilation is achieved through mechanical systems that allow windows to remain closed. Assuming standard residential construction methods, exterior noise levels at the nearby receptor building façades would have to exceed 60 dBA in order to exceed 45 dBA indoors.

Manufacturer's noise data for the cooling tower and garage exhaust fan (i.e., the predominant rooftop noise sources) were reviewed to calculated noise levels at the property lines of the nearest receptors. A review of these data indicates that the cooling tower produces a noise level of 57 dBA at 50 feet and the garage exhaust fan produces a noise level of 72 dBA at 5 feet (or 52 dBA at 50 feet). The combined noise level resulting from the operation of this equipment is calculated to be 58 dBA at 50 feet. The mechanical equipment screen would provide a minimum of 5 dBA of noise reduction where the line of sight from receptors to the equipment is interrupted by the barrier assuming that the screen is solid over the face and at the base of the barrier. Receptors to the west and east of the project site are located in buildings that are six-stories or less in height. A minimum of 11 dBA of additional acoustical attenuation would be provided by the building itself for adjacent receptors to the west and east because these receptors would have a very limited to no direct view of the equipment proposed on the roof of the building. Noise levels are calculated to be 45 dBA or less at the nearest receptors to the west and east, 47 dBA at the nearest property line to the south, and 45 dBA at the nearest property line to the north. Operation noise levels due to roof-top mechanical equipment would not exceed ambient noise conditions by 5 dBA, nor produce noise levels that would exceed 45 dBA inside the nearest residences between the hours of 10:00 p.m. to 7:00 a.m. or 55 dBA between the hours of 7:00 a.m. to 10:00 p.m. with windows open.

Cumulative Construction Noise

Cumulative projects proposed within 160 feet of the project site could produce noise levels during construction that could contribute to noticeably higher construction noise levels at nearby sensitive receptors. Construction noise levels from projects located further than 160 feet from the site would not measurably contribute to construction noise levels generated on site. A review of the cumulative project list dated July 12, 2019[1] indicates that the only cumulative project that could contribute to higher construction noise levels is the 13-story apartment building proposed at 651 Geary Street, immediately north of the project site (see Figures 1 and 2 – 651 Geary Street). Cumulative noise increases associated with project construction could result if this project were to be constructed at the same time and affect the same sensitive receptors bordering the two sites. Given the project similarities, it is reasonable to assume that the construction of the 651 Geary Street project would produce similar noise levels as the construction of the proposed project. The relative increase in noise levels resulting from the simultaneous construction of the two projects, as opposed to the construction of a single project only, would be about 3 dBA L_{eq}. Such a noise level increase would be perceived as a just noticeable increase in construction noise levels. The Police Code construction noise level limit would be enforced at both construction sites, limiting maximum instantaneous noise levels to 80 dBA at 100 feet. Maximum instantaneous noise levels from cumulative construction activities would be limited as specified in the Police Code and cumulative construction noise levels would not be substantially increased. Cumulative construction noise levels would exceed the background noise level at sensitive receptor locations by more than 10 dBA.

[1] San Francisco Planning Department, *Cumulative Projects within One Quarter-Mile of 550 O'Farrell Street*, July 12, 2019.

Recommended Noise Control Measures for Construction Noise - Construction Noise Logistics Plan:

The potential short-term noise impacts associated with the construction of the project would be reduced with the implementation of a construction noise logistics plan, which would include, but not be limited to, the following measures to reduce construction noise levels as low as feasible:

- Equip all internal combustion engine-driven equipment with mufflers, which are in good condition and appropriate for the equipment.

- Utilize 'quiet' models of air compressors and other stationary noise sources where technology exists.

- Locate stationary equipment as far away as possible from adjacent land uses and/or construct temporary noise barriers, where feasible, to screen such equipment. Temporary noise barrier fences would provide a 5 dBA noise reduction if the noise barrier interrupts the line-of-sight between the noise source and receptor and if the barrier is constructed in a manner that eliminates any cracks or gaps.

- Unnecessary idling of internal combustion engines should be strictly prohibited.
- The construction staging area should be located on O'Farrell Street and as far as feasible from noise-sensitive receptors. Locate material stockpiles, as well as maintenance/equipment staging and parking areas, as far as feasible from residential receptors.

- Control noise from construction workers' radios to a point where they are not audible at existing residences bordering the project site.

- Where feasible, temporary power service from local utility companies should be used instead of portable generators.

- Locate cranes as far from adjoining noise-sensitive receptors as possible.

- During final grading, substitute graders for bulldozers, where feasible. Wheeled heavy equipment are quieter than track equipment and should be used where feasible.

- Substitute nail guns for manual hammering, where feasible.

- Avoid the use of hydra break rams and hoe rams during demolition.

- Avoid the use of concrete saws, circular saws, miter/chop saws, and radial arm saws near the adjoining noise-sensitive receptors. Where feasible, shield saws with a solid screen with material having a minimum surface density of 2 lbs/ft^2 (e.g., such as ¾" plywood).

- During interior construction, the exterior windows facing noise-sensitive receptors should be closed.

- During interior construction, locate noise-generating equipment within the building to break the line-of-sight to the adjoining receptors.

- The contractor shall prepare a detailed construction schedule for major noise-generating construction activities. The construction plan shall identify a procedure for coordination with adjacent residential land uses so that construction activities can be scheduled to minimize noise disturbance.

- Designate a Construction Manager who shall:

    - Clearly post his/her name and phone number(s) on signs visible during each phase of the construction program.
    - Notify area residents of construction activities, schedules, and impacts.
    - Receive and act on complaints about construction noise disturbances.
    - Determine the cause(s) and implement remedial measures as necessary to alleviate potentially significant problems related to construction noise.

      Request night noise permits from the San Francisco Department of Building Inspection (DBI) if any activity, including deliveries or staging, is anticipated outside of work hours that has the potential to exceed noise standards. If such activity is required in response to an emergency or other unanticipated conditions, night noise permits shall be requested as soon as feasible for any ongoing response activities. Notify the Planning Department's Development Performance Coordinator at the time that night noise permits are requested or as soon as possible after emergency/unanticipated activity causing noise with the potential to exceed noise standards has occurred.

- The Noise Control Plan shall be reviewed and approved by the San Francisco Planning Department prior to implementation. Noise monitoring shall be completed by a qualified noise consultant.

- A noise monitoring log report shall be prepared by the Construction Manager or other designated person(s) on a weekly basis and shall be made available to the Planning Department when requested. The log shall include any complaints received, whether in connection with an exceedance or not, as well as any complaints received through calls to 311 or DBI if the contractor is made aware of them (for example, via a DBI notice, inspection, or investigation). Any weekly report that includes an exceedance or for a period during which a complaint is received should be submitted to the Development Performance Coordinator within 3 business days following the week in which the exceedance or complaint occurred. A report also shall be submitted to the Planning Department Development Performance Coordinator at the completion of each construction phase. The report shall document noise levels, exceedances of threshold levels, if reported, and corrective action(s) taken.

The implementation of the reasonable and feasible controls outlined above would reduce construction noise levels emanating from the site, minimizing disruption and annoyance.

Impact 2: **Generation of Excessive Groundborne Vibration.** Construction-related vibration levels would exceed 0.25 in/sec PPV at nearby historic buildings.

Figure 2 shows the project site and surrounding buildings. Historic buildings to the west and east directly abut the project site. The nearest buildings to the north are approximately 25 feet from the project site, and the nearest buildings to the south are approximately 75 feet from the project site; of these buildings, all but 639 Geary Street and 651 Geary Street are historic resources.

Vibration impacts to structures are usually significant if construction vibration could potentially result in structural or cosmetic damage or, in the case of an historic resource, materially alter the resource pursuant to CEQA Guidelines section 15064.5. This analysis establishes a vibration limit of 0.25 in/sec PPV to minimize the potential for cosmetic damage to nearby sensitive structures. The FTA has established this guideline for "historic and some old buildings" that are subjected to continuous or frequent intermittent sources of vibration (see Appendix Table C2). As discussed in detail below, vibration levels exceeding this threshold would be capable of cosmetically damaging adjacent historic buildings. Cosmetic damage (also known as threshold damage) is defined as hairline cracking in plaster, the opening of old cracks, the loosening of paint or the dislodging of loose objects. Minor damage is defined as hairline cracking in masonry or the loosening of plaster. Major structural damage is defined as wide cracking or the shifting of foundation or bearing walls.

Table 5 presents typical vibration levels from construction equipment at 25 feet. Jackhammers typically generate vibration levels of 0.035 in/sec PPV, and drilling typically generates vibration levels of 0.09 in/sec PPV at 25 feet. Vibration levels would vary depending on soil conditions, construction methods, and equipment used. Table 5 also presents construction vibration levels at various distances from the construction equipment. Calculations were made to estimate vibration levels at distances of 5 feet from project construction areas, to represent adjacent buildings to the west and east, as well as distances of 25, 35, 60, and 75 feet from the site to represent other nearby buildings.

TABLE 5 Vibration Levels for Construction Equipment at Various Distances

Equipment		**PPV at 5 ft.[1] (in/sec)**	**PPV at 25 ft.[2] (in/sec)**	**PPV at 35 ft.[3] (in/sec)**	**PPV at 60 ft.[4] (in/sec)**	**PPV at 75 ft.[5] (in/sec)**
Clam shovel drop		**1.186**	0.202	0.140	0.077	0.060
Hydromill (slurry wall)	in soil	0.047	0.008	0.006	0.003	0.002
	in rock	0.100	0.017	0.012	0.006	0.005
Vibratory Roller		**1.233**	0.210	0.145	0.080	0.063
Hoe Ram		**0.523**	0.089	0.061	0.034	0.027
Large bulldozer		**0.523**	0.089	0.061	0.034	0.027
Caisson drilling		**0.523**	0.089	0.061	0.034	0.027
Loaded trucks		**0.446**	0.076	0.052	0.029	0.023
Jackhammer		0.206	0.035	0.024	0.013	0.010
Small bulldozer		0.018	0.003	0.002	0.001	0.001

Notes: 1. Represents buildings immediately adjacent to the site (540 and 570 O'Farrell Street).
2. Represents buildings north of the site (639, 651, and 665 Geary Street).
3. Represents building west of the site (580 O'Farrell Street).
4. Represents building east of the site (501 Jones Street).
5. Represents buildings south of the site (545 and 555 O'Farrell Street).
6. Vibration levels are highest close to the source, and then attenuate with increasing distance at the rate $(D_{ref}/D)^{1.1}$, where D is the distance from the source in feet and D_{ref} is the reference distance of 25 feet.
7. **Red values** indicate an exceedance of the 0.25 in/sec PPV criteria established for historic buildings.

Source: Transit Noise and Vibration Impact Assessment Manual, Table 7-4, Federal Transit Administration, Office of Planning and Environment, U.S. Department of Transportation, September 2018, as modified by Illingworth & Rodkin, Inc., June 2019.

Project construction activities, such as drilling, the use of jackhammers, rock drills and other high-power or vibratory tools, and rolling stock equipment (tracked vehicles, compactors, etc.) may generate substantial vibration in the immediate vicinity of historic properties located at 540 and 570 O'Farrell Street. Some activities would occur at distances of about 5 feet, and at this distance, vibration levels due to construction are conservatively calculated to reach up to 1.2 in/sec PPV, which would exceed the 0.25 in/sec PPV threshold for historic buildings.

The US Bureau of Mines has analyzed the effects of blast-induced vibration on buildings in USBM RI 8507,[2] and these findings have been applied to vibrations emanating from construction equipment on buildings.[3] As shown in Figure 3, these studies indicate an approximate 20% probability of "threshold damage" (referred to as cosmetic damage elsewhere in this report) at vibration levels of 1.2 in/sec PPV or less and no observations of "minor damage" or "major damage" were made at vibration levels of 1.2 in/sec PPV or less. Figure 3 presents the damage probability, as reported in USBM RI 8507 and reproduced by Dowding, assuming a maximum vibration level of 1.2 in/sec PPV. Based on these data, cosmetic or threshold damage would be manifested in the form of hairline cracking in plaster, the opening of old cracks, the loosening of paint or the dislodging of loose objects. However, minor damage (e.g., hairline cracking in masonry or the loosening of plaster) or major structural damage (e.g., wide cracking or shifting of

[2] Siskind, D.E., M.S. Stagg, J.W. Kopp, and C.H. Dowding, Structure Response and Damage Produced by Ground Vibration form Surface Mine Blasting, RI 8507, Bureau of Mines Report of Investigations, U.S. Department of the Interior Bureau of Mines, Washington, D.C., 1980.
[3] Dowding, C.H., Construction Vibrations, Prentice Hall, Upper Saddle River, 1996.

foundation or bearing walls) would not occur at the nearest buildings to the site, assuming a maximum vibration level of 1.2 in/sec PPV.

Heavy vibration-generating construction equipment, such as vibratory rollers or clam shovel drops, would have the potential to produce vibration levels of 0.25 in/sec PPV or more at historic buildings within 20 feet of the project site (i.e., 540 and 570 O'Farrell Street).

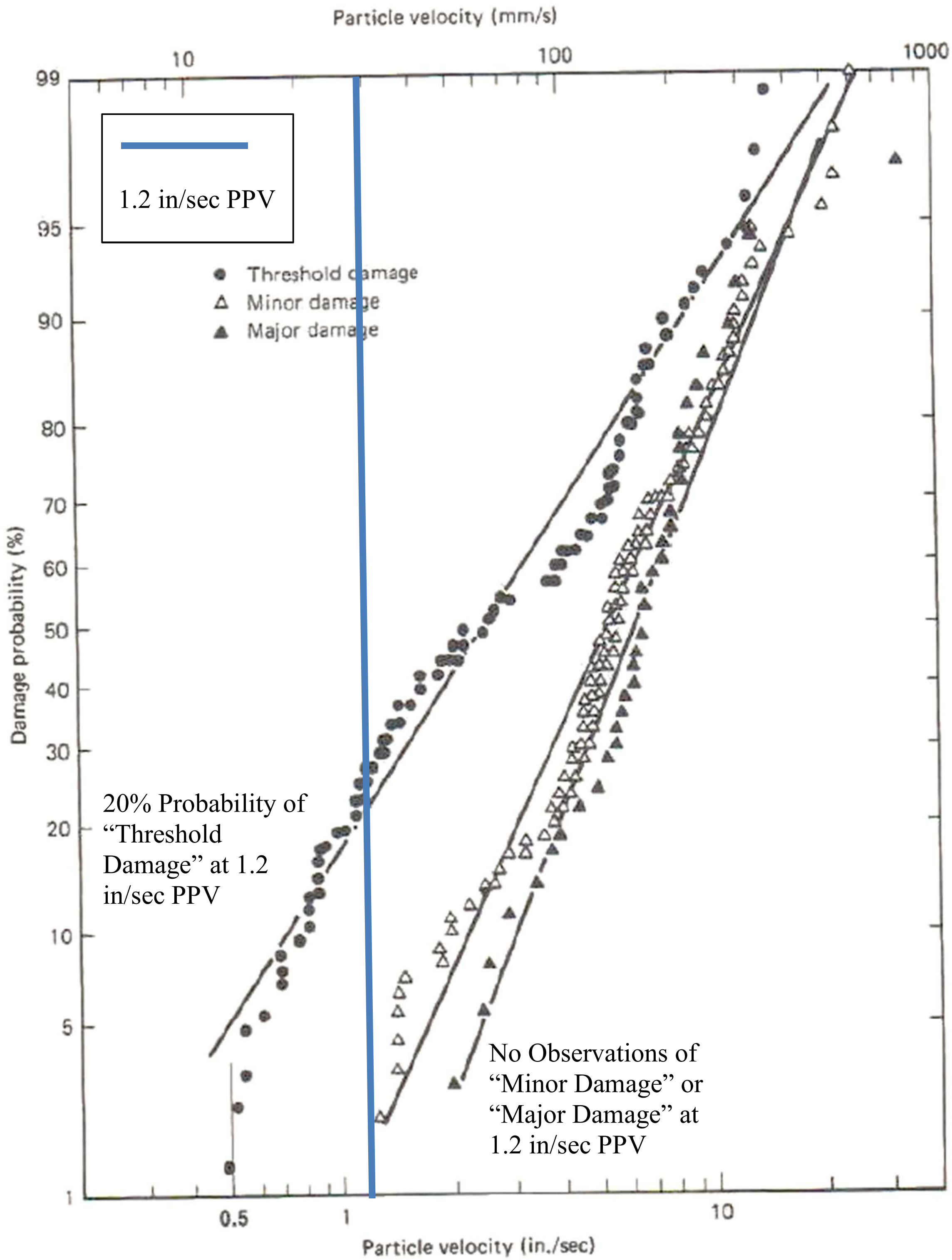
At these locations, and in other surrounding areas where vibration would not be expected to cause cosmetic damage, vibration levels may still be perceptible. However, as with any type of construction, perceptible vibration would be anticipated. Given the intermittent and short duration of the phases that have the highest potential of producing vibration (use of jackhammers and other high-power tools), the use of administrative controls, such as notifying neighbors of scheduled construction activities and scheduling construction activities with the highest potential to produce perceptible vibration during hours with the least potential to affect nearby businesses, would minimize annoyance due to perceptible vibration at nearby sensitive receptors.

In summary, the construction of the project would generate vibration levels exceeding the threshold of 0.25 in/sec PPV at historic properties within 20 feet of the site. Such vibration levels would be capable of causing building damage of the adjacent buildings to the west and east (i.e., 540 and 570 O'Farrell Street). A series of recommended Construction Vibration Controls are discussed below; these controls would avoid substantial adverse vibration effects on adjacent buildings.

Cumulative Construction Vibration

Specific construction schedules and plans for cumulative construction projects are not available at this time; therefore, it is not possible to determine time periods where overlapping construction may occur and exact vibration levels at sensitive receptors due to project and cumulative construction projects. Vibration levels drop off rapidly with distance from the vibration source, so there is a very low chance that a cumulative increase in ground vibration would occur from cumulative construction activities occurring on separate construction sites. In general, additional construction equipment resulting from cumulative construction projects would result in more frequent vibration events, though not necessarily higher overall vibration levels. The chance is very low that the vibration levels from project and cumulative construction would occur at precisely the same time, occur within very close proximity to the same receptor, and add to one another. In the rare instance that overlapping construction would occur and contribute to higher vibration levels, the implementation of the project's construction vibration controls would be sufficient reduce the potential for a cumulative vibration impact.

FIGURE 3 Probability of Cracking and Fatigue from Repetitive Loading



Construction Vibration Controls - 540 and 570 O'Farrell Street:

- Vibration levels from heavy construction equipment known to produce high vibration levels (i.e., loaded trucks, large drills, tracked vehicles, vibratory rollers, hoe rams) shall be monitored during operation.

- Place operating equipment on the construction site as far as possible from vibration-sensitive receptors.

- Use smaller equipment to minimize vibration levels below the limits.

- Avoid using vibratory rollers and tampers near sensitive areas.

- Select demolition methods not involving impact tools.

- Modify/design or identify alternative construction methods to reduce vibration levels below the limits.

- Avoid dropping heavy objects or materials.

- The project sponsor shall retain the services of a qualified structural engineer or vibration consultant and preservation architect that meet the Secretary of the Interior's Historic Preservation Professional Qualification Standards to conduct a Pre-Construction Assessment at historic properties within 20 feet of the site (i.e., 540 and 570 O'Farrell Street).

  Prior to any demolition or ground-disturbing activity, the Pre-Construction Assessment shall be prepared to establish a baseline and shall contain written and photographic descriptions of the existing condition of the visible exteriors from public rights-of-way of the adjacent buildings and in interior locations upon permission of the owners of the adjacent properties. The Pre-Construction Assessment shall determine specific locations to be monitored and include annotated drawings of the buildings to locate accessible digital photo locations and locations of survey markers and/or other monitoring devices to measure vibrations. The Pre-Construction Assessment shall be submitted to the Planning Department along with the Demolition and Site Permit Applications.

  The structural engineer and/or vibration consultant in consultation with the preservation architect shall develop, and the project sponsors shall implement, a Vibration Management and Monitoring Plan to protect nearby historic buildings against damage caused by vibration or differential settlement caused by vibration during project construction activities. In this plan, the maximum vibration level not to be exceeded at each building shall be 0.25 inch per second, or a level determined by the site-specific assessment made by the structural engineer and/or the vibration consultant in coordination with the preservation architect for the project. The Vibration Management and Monitoring Plan shall document the criteria used in establishing the maximum vibration level for the project. The plan shall include pre-construction surveys and continuous vibration monitoring throughout the duration of the major construction project activities that would require heavy-duty equipment to ensure that vibration levels do not exceed the established standard. The Vibration Management and Monitoring Plan shall be submitted to Planning Department Preservation staff prior to issuance of any demolition or construction permits.

Should vibration levels be observed in excess of the standard, or if damage to adjacent buildings is observed, construction shall be halted and alternative techniques put in practice, to the extent feasible. The structural engineer and/or vibration consultant and the historic preservation consultant shall conduct regular periodic inspections of digital photographs, survey markers, and/or other monitoring devices during ground-disturbing activity at the project site. The buildings shall be protected to prevent further damage and remediated to pre-construction conditions as shown in the Pre-Construction Assessment with the consent of the building owner. Any remedial repairs shall not require building upgrades to comply with current San Francisco Building Code standards. A final report on the vibration monitoring shall be submitted to Planning Department Preservation staff prior to the issuance of a Certificate of Occupancy.

Impact 3 Exposure of Residents or Workers to Excessive Noise Levels in the Vicinity of a Private Airstrip or an Airport Land Use Plan. The project site would not be exposed to excessive aircraft noise.

The project site is located over 10 miles from both San Francisco International Airport and Oakland International Airport. Noise levels from aircraft associated with these airports are best represented by noise contour information published by each airport.[4,5] The project site lies well outside each airport's 65 dBA CNEL noise contour and noise levels resulting from aircraft would be compatible with the proposed land use.

[4] San Francisco International Airport 14 Code of Federal Regulations (CFR) Part 150 Study Update Noise Compatibility Program, July 2018, https://media.flysfo.com/media/sfo/noise-abatement/sfo_p150_2019-nem-36x24-plot-signed_ada.pdf, accessed May 16, 2019.

[5] Oakland International Airport Annual 2018 Noise Contours, March 2019, http://flyquietoak.com/sites/default/files/documents/2019-04/302551_005_OAK_Annual_2018_Contour.pdf, accessed May 16, 2019.

Appendix A – Noise and Vibration Fundamentals

Fundamentals of Environmental Noise

Noise may be defined as unwanted sound. Noise is usually objectionable because it is disturbing or annoying. The objectionable nature of sound could be caused by 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 A1.

There are several methods of characterizing sound. The most common in California is the *A-weighted sound level (dBA).* This scale gives greater weight to the frequencies of sound to which the human ear is most sensitive. Representative outdoor and indoor noise levels in units of dBA are shown in Table A2. 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.

The scientific instrument used to measure noise is the *sound level meter*. Sound level meters can accurately measure environmental noise levels to within about plus or minus 1 dBA. Various computer models are used to predict environmental noise levels from sources, such as roadways and airports. The accuracy of the predicted models depends upon the distance the receptor is from the noise source. Close to the noise source, the models are accurate to within about plus or minus 1 to 2 dBA.

Since the sensitivity to noise increases during the evening and at night -- because excessive noise interferes with the ability to sleep -- 24-hour descriptors have been developed that incorporate artificial noise penalties added to quiet-time noise events. The *Community Noise Equivalent Level (CNEL)* is a measure of the cumulative noise exposure in a community, with a 5 dB penalty added to evening (7:00 pm - 10:00 pm) and a 10 dB addition to nocturnal (10:00 pm - 7:00 am) noise levels. The *Day/Night Average Sound Level* (L_{dn}) is essentially the same as CNEL, with the exception that the evening time period is dropped and all occurrences during this three-hour period are grouped into the daytime period.

Effects of Noise

Sleep and Speech Interference

The thresholds for speech interference indoors are about 45 dBA if the noise is steady and above 55 dBA if the noise is fluctuating. Outdoors the thresholds are about 15 dBA higher. Steady noises of sufficient intensity (above 35 dBA) and fluctuating noise levels above about 45 dBA have been shown to affect sleep. Interior residential standards for multi-family dwellings are set by the State of California at 45 dBA L_{dn}. Typically, the highest steady traffic noise level during the daytime is about equal to the L_{dn} and nighttime levels are 10 dBA lower. The standard is designed for sleep and speech protection and most jurisdictions apply the same criterion for all residential uses. Typical structural attenuation is 12 to 17 dBA with open windows. With closed windows in good condition, the noise attenuation factor is around 20 dBA for an older structure and 25 dBA for a newer dwelling. Sleep and speech interference is therefore possible when exterior noise levels are about 57 to 62 dBA L_{dn} with open windows and 65 to 70 dBA L_{dn} with standard construction if the windows are closed.

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. The L_{dn} as a measure of noise has 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 50 dBA L_{dn}. At a L_{dn} of about 60 dBA, approximately 12 percent of the population is highly annoyed. When the L_{dn} increases to 70 dBA, the percentage of the population highly annoyed increases to about 25 to 30 percent of the population. There is, therefore, an increase of about 2 percent per dBA between a L_{dn} of 60 to 70 dBA. Between a L_{dn} of 70 to 80 dBA, each decibel increase, increases by about 3 percent, the percentage of the population highly annoyed. People appear to respond more adversely to aircraft noise. When the L_{dn} is 60 dBA, approximately 30 to 35 percent of the population is believed to be highly annoyed.

TABLE A1 Definition of Acoustical Terms Used in this Report

Term	Definition
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. The reference pressure for air is 20 micro Pascals.
Sound Pressure Level	Sound pressure is the sound force per unit area, usually expressed in micro Pascals (or 20 micro Newtons per square meter), where 1 Pascal is the pressure resulting from a force of 1 Newton exerted over an area of 1 square meter. The sound pressure level is expressed in decibels as 20 times the logarithm to the base 10 of the ratio between the pressures exerted by the sound to a reference sound pressure (e. g., 20 micro Pascals). Sound pressure level is the quantity that is directly measured by a sound level meter.
Frequency, Hz	The number of complete pressure fluctuations per second above and below atmospheric pressure. Normal human hearing is between 20 Hz and 20,000 Hz. Infrasonic sound are below 20 Hz and Ultrasonic sounds are above 20,000 Hz.
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.
Equivalent Noise Level, L_{eq}	The average A-weighted noise level during the measurement period.
L_{max}, L_{min}	The maximum and minimum A-weighted noise level during the measurement period.
L_{01}, 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.
Day/Night Noise Level, L_{dn} 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 pm and 7:00 am.
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 pm to 10:00 pm and after addition of 10 decibels to sound levels measured in the night between 10:00 pm and 7:00 am.
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.
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.

Source: Handbook of Acoustical Measurements and Noise Control, Harris, 1998.

TABLE A2 Typical Noise Levels in the Environment

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

Source: Technical Noise Supplement (TeNS), California Department of Transportation, September 2013.

Fundamentals of Groundborne Vibration

Ground vibration consists of rapidly fluctuating motions or waves with an average motion of zero. Several different methods are typically used to quantify vibration amplitude. One method is the Peak Particle Velocity (PPV). The PPV is defined as the maximum instantaneous positive or negative peak of the vibration wave. In this report, a PPV descriptor with units of mm/sec or in/sec is used to evaluate construction generated vibration for building damage and human complaints. Table A3 displays the reactions of people and the effects on buildings that continuous vibration levels produce. The guidelines in Table A3 represent syntheses of vibration criteria for human response and potential damage to buildings resulting from construction vibration.

Construction activities can cause vibration that varies in intensity depending on several factors. The use of pile driving and vibratory compaction equipment typically generates the highest construction related groundborne vibration levels. Because of the impulsive nature of such activities, the use of the PPV descriptor has been routinely used to measure and assess groundborne vibration and almost exclusively to assess the potential of vibration to induce structural damage and the degree of annoyance for humans.

The two primary concerns with construction-induced vibration, the potential to damage a structure and the potential to interfere with the enjoyment of life, are evaluated against different vibration limits. Human perception to vibration varies with the individual and is a function of physical setting and the type of vibration. Persons exposed to elevated ambient vibration levels, such as people in an urban environment, may tolerate a higher vibration level.

Structural damage can be classified as cosmetic only, such as paint flaking or minimal extension of cracks in building surfaces; minor, including limited surface cracking; or major, that may threaten the structural integrity of the building. Safe vibration limits that can be applied to assess the potential for damaging a structure vary by researcher. The damage criteria presented in Table A3 include several categories for ancient, fragile, and historic structures, the types of structures most at risk to damage. Most buildings are included within the categories ranging from “Historic and some old buildings” to “Modern industrial/commercial buildings”. Construction-induced vibration that can be detrimental to the building is very rare and has only been observed in instances where the structure is at a high state of disrepair and the construction activity occurs immediately adjacent to the structure.

The annoyance levels shown in Table A3 should be interpreted with care since vibration may be found to be annoying at lower levels than those shown, depending on the level of activity or the sensitivity of the individual. To sensitive individuals, vibrations approaching the threshold of perception can be annoying. Low-level vibrations frequently cause irritating secondary vibration, such as a slight rattling of windows, doors, or stacked dishes. The rattling sound can give rise to exaggerated vibration complaints, even though there is very little risk of actual structural damage.

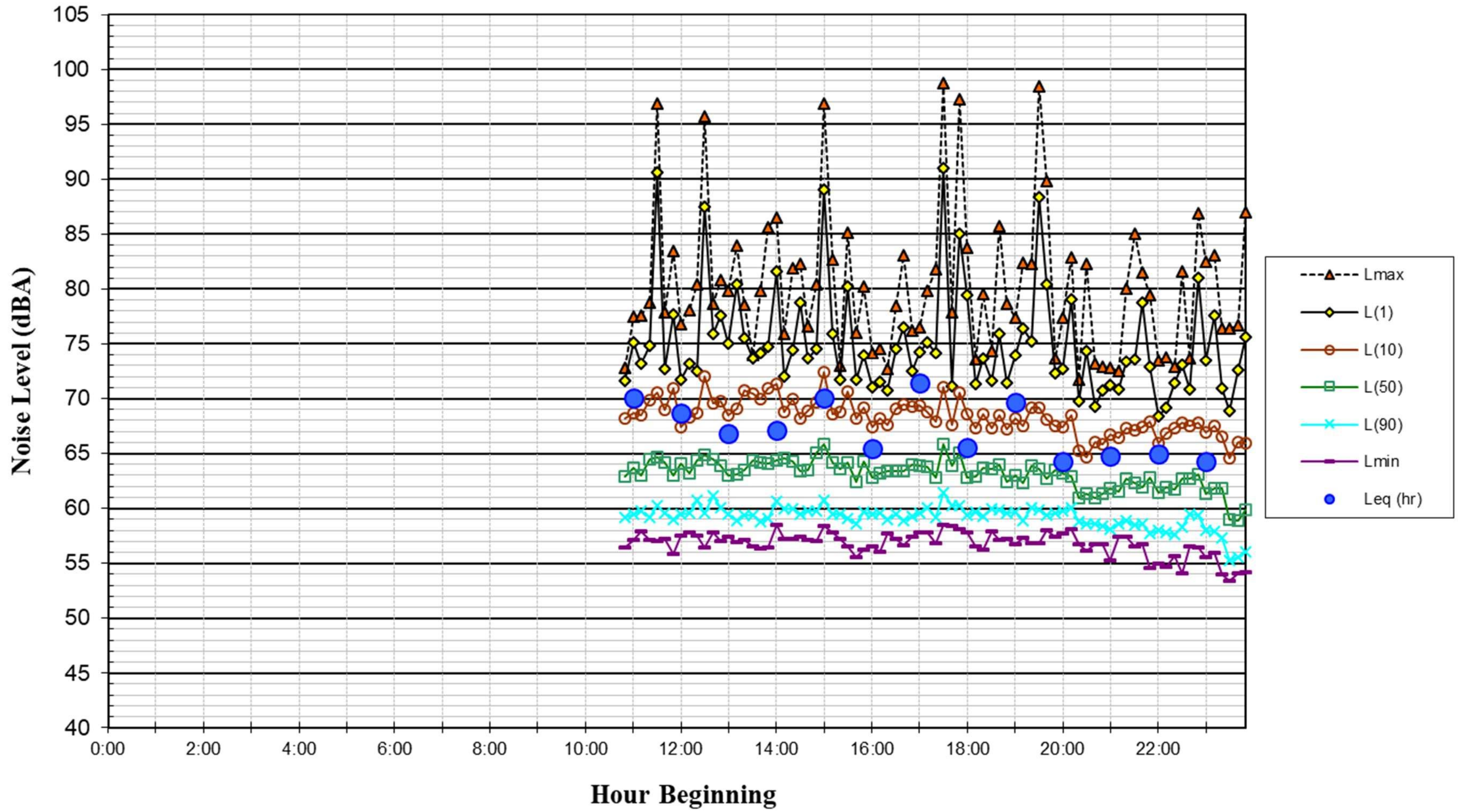
TABLE A3 Reaction of People and Damage to Buildings from Continuous or Frequent Intermittent Vibration Levels

Velocity Level, PPV (in/sec)	Human Reaction	Effect on Buildings
0.01	Barely perceptible	No effect
0.04	Distinctly perceptible	Vibration unlikely to cause damage of any type to any structure
0.08	Distinctly perceptible to strongly perceptible	Recommended upper level of the vibration to which ruins and ancient monuments should be subjected
0.1	Strongly perceptible	Threshold at which there is a risk of damage to fragile buildings with no risk of damage to most buildings
0.25	Strongly perceptible to severe	Threshold at which there is a risk of damage to historic and some old buildings.
0.3	Strongly perceptible to severe	Threshold at which there is a risk of damage to older residential structures
0.5	Severe - Vibrations considered unpleasant	Threshold at which there is a risk of damage to new residential and modern commercial/industrial structures

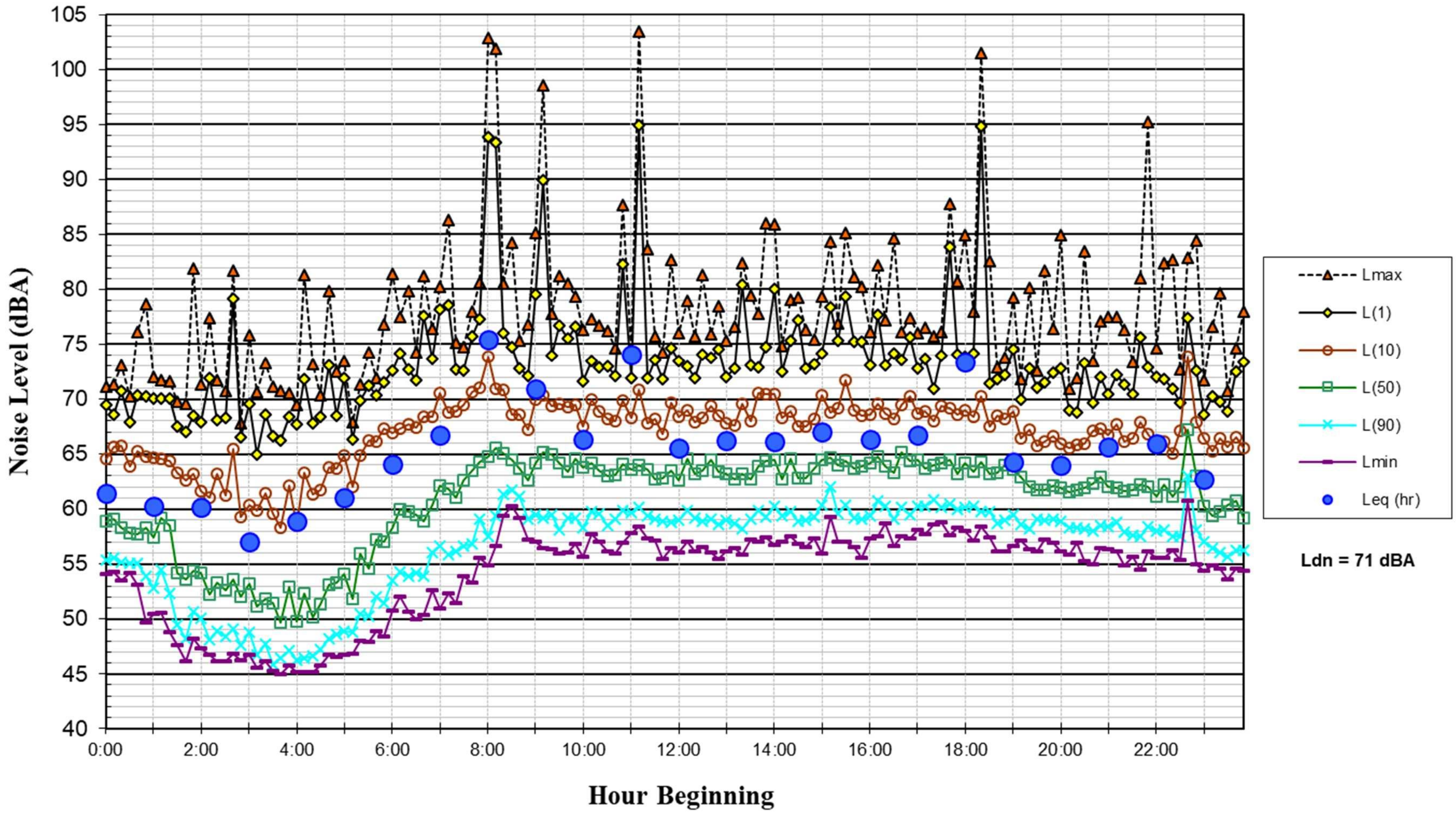
Source: Transportation and Construction Vibration Guidance Manual, California Department of Transportation, September 2013.

Appendix B –Noise Data

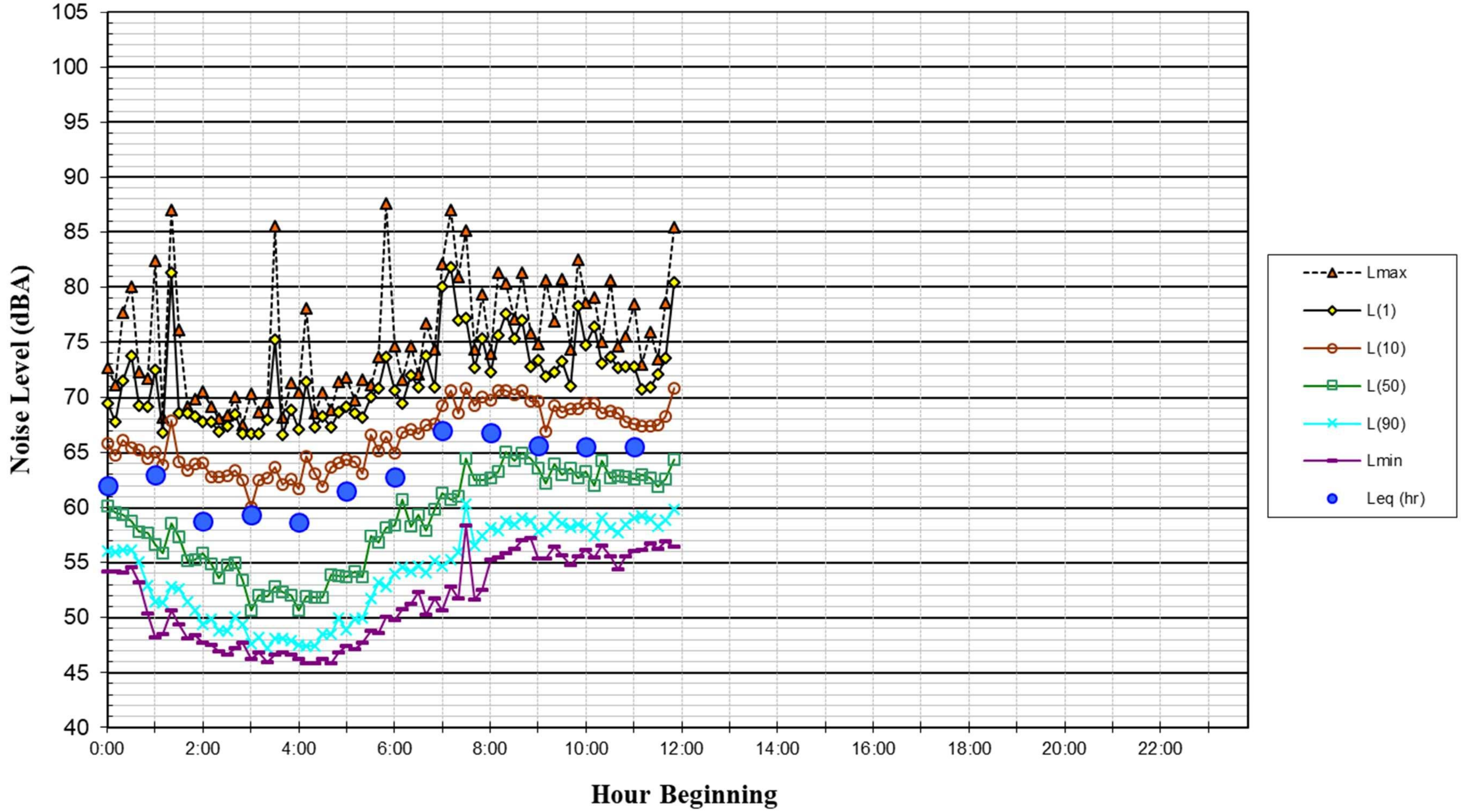
Noise Levels at Noise Measurement Site LT-1
550 O'Farrell (At Center Edge of Rooftop)
Wednesday, May 22, 2019



Noise Levels at Noise Measurement Site LT-1
550 O'Farrell (At Center Edge of Rooftop)
Thursday, May 23, 2019



Noise Levels at Noise Measurement Site LT-1
550 O'Farrell (At Center Edge of Rooftop)
Friday, May 24, 2019



ILLINGWORTH & RODKIN, INC.
Acoustics • Air Quality

429 E Cotati Ave   Cotati, CA 94931   (707) 794-0400

ENVIRONMENTAL NOISE DATA SHEET

LOCATION: 550' O'Farrell, SF
North side of roof, at center edge

37° 47' 10.22" N 122° 24' 50.40" W

JOB NO. 19-094
SITE NO. ST-1
TECHNICIAN MPR
SLM IR-2 CAL 114

DATE 5/22/19 DAY OF WEEK Wed TIME BEGIN 10:50 DURATION 10 min

WEATHER CONDITIONS SKY: Clear WIND: 0-3 mph TEMP: 62

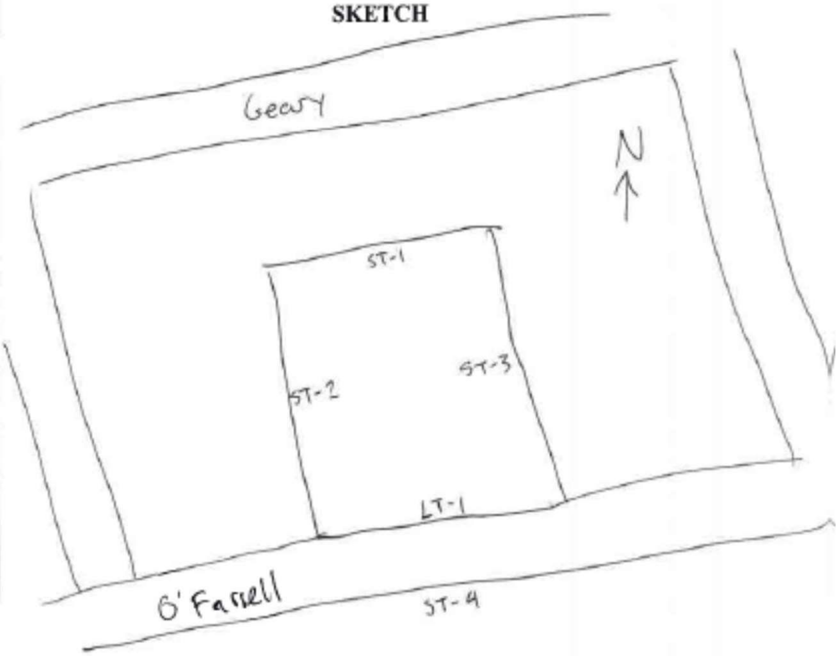
Maj.	Min.	Noise Source	Typical Noise Levels	5 min.	10 min.	15 min.
☐	X ☐	Trucks	61 - 64			
☐	☒	Cars				
☐	X ☐	Buses	60			
☐	☐	Motorcycles				
☐	☐	Emerg. Veh.				
☐	☐	Jets				
☐	☐	Gen. Av.				
☐	☐	Trains				
☐	☐	Constr.				
☐	☐	Industrial				
☐	☐	Other				

COMMENTS

62 10:51 Truck on Geary
61 10:54 Truck on Geary
60 10:55 Bus on Geary
60 10:58 Bus on Geary
64 10:59 Truck on Geary

MEASUREMENT	1	2
L_{max}	64.7	
L_{min}	51.9	
$L_{(1)}$	61	
$L_{(10)}$	58	
$L_{(50)}$	55.1	
$L_{(90)}$	53.2	
L_{eq} (5)	~	~
L_{eq} (10)	55.8	
L_{eq} (15)	~	~

SKETCH



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429 E Cotati Ave Cotati, CA 94931 (707) 794-0400

ENVIRONMENTAL NOISE DATA SHEET

LOCATION: 550 O'Farrell, SF
West side of roof, at center edge
37° 47' 9.64" N 122° 24' 50.80" W

JOB NO. 19-094
SITE NO. ST-2
TECHNICIAN MPB
SLM IR 2 CAL 114

DATE 5/22/19 DAY OF WEEK Wed TIME BEGIN 11:00 am DURATION 10 min

WEATHER CONDITIONS SKY: Clear WIND: 0-3 mph TEMP: 62°F

Maj.	Min.	Noise Source	Typical Noise Levels	5 min.	10 min.	15 min.
☐	X ☐	Trucks	58 - 62			
☐	X ☐	Cars	↓			
☐	X ☐	Buses	↓			
☐	☐	Motorcycles				
☐	☒	Emerg. Veh.	58			
☐	☐	Jets				
☐	☐	Gen. Av.				
☐	☐	Trains				
☐	☐	Constr.				
☐	☐	Industrial				
☐	☒	Other Helicopter	65			

COMMENTS

65 11:01 Helicopter
58 11:03 Vehicle on Geary
62 11:05 Truck on O'Farrell
67 11:06 Helicopter
58 11:06 Siren

SKETCH

See ST-1 sketch

MEASUREMENT	1	2
L_{max}	67.3	
L_{min}	51.3	
$L_{(1)}$	65	
$L_{(10)}$	58.8	
$L_{(50)}$	55.4	
$L_{(90)}$	53.4	
L_{eq} (5)	~	~
L_{eq} (10)	56.7	
L_{eq} (15)	~	~

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429 E Cotati Ave Cotati, CA 94931 (707) 794-0400

ENVIRONMENTAL NOISE DATA SHEET

LOCATION: 550 O'Farrell, SF
East side of roof, 5' From wall, center
37° 47' 9.76" N 122° 24' 49.86" W

JOB NO. 19-094
SITE NO. ST-3
TECHNICIAN MPB
SLM IR2 CAL 114

DATE 5/22/19 DAY OF WEEK Wed TIME BEGIN 11:10 am DURATION 10 min

WEATHER CONDITIONS SKY: Clear WIND: 0 - 5 mph TEMP: 62 °F

Maj.	Min.	Noise Source	Typical Noise Levels	5 min.	10 min.	15 min.
☐	☒	Trucks	60 - 63			
☐	☒	Cars	↓			
☐	☒	Buses	↓			
☐	☒	Motorcycles	63			
☐	☐	Emerg. Veh.				
☐	☐	Jets				
☐	☐	Gen. Av.				
☐	☐	Trains				
☐	☐	Constr.				
☐	☐	Industrial				
☐	☐	Other				

COMMENTS

61 11:12 Vehicle on Geary
63 11:13 Motorcycle on O'Farrell
62 11:16 Vehicle on O'Farrell
60 11:18 Vehicle on Geary
61 11:18 Honking on Geary
61 11:18 Vehicle on O'Farrell
60 11:19 Vehicle on O'Farrell

SKETCH

See ST-1 Sketch

MEASUREMENT	1	2
L_{max}	63.2	
L_{min}	52.7	
$L_{(1)}$	61.3	
$L_{(10)}$	58.9	
$L_{(50)}$	57.1	
$L_{(90)}$	55.4	
L_{eq} (5)	~	~
L_{eq} (10)	57.4	
L_{eq} (15)	~	~

Appendix C – Regulatory Criteria

Regulatory Criteria

The project would be subject to noise-related regulations, plans and policies established by the United States federal government, State of California and the City of San Francisco. Applicable regulations, codes, and plans include Appendix G of the CEQA Guidelines, the California Building Code, the City of San Francisco General Plan, the City of San Francisco Police Code, the Federal Transit Administration's *Transit Noise and Vibration Impact Assessment Manual* and the California Department of Transportation's (Caltrans) *Transportation and Construction Vibration Guidance Manual*. Regulations, plans, and policies presented within these documents form the basis of the significance criteria used to assess project impacts. Policies that apply to future users of the site are discussed for informational purposes only.

State CEQA Guidelines. CEQA contains guidelines to evaluate the significance of effects of environmental noise attributable to a proposed project. Under CEQA, noise impacts would be considered significant if the project would result in:

(a) Generation of a 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 applicable standards of other agencies;

(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, if the project would expose people residing or working in the project area to excessive noise levels.

2016 California Building Code, Title 24, Part 2 (for informational purposes only). The current version of the California Building Code (CBC) requires interior noise levels attributable to exterior environmental noise sources to be limited to a level not exceeding 45 dBA L_{dn}/CNEL in any habitable room.

2016 California Green Building Standards Code (Cal Green Code) (for informational purposes only). The State of California established exterior sound transmission control standards for new nonresidential buildings as set forth in the 2016 California Green Building Standards Code (Section 5.507.4.1 and 5.507.4.2). Section 5.507 states that either the prescriptive (Section 5.507.4.1) or the performance method (Section 5.507.4.2) shall be used to determine environmental control at indoor areas. The prescriptive method is very conservative and not practical in most cases; however, the performance method can be quantitatively verified using exterior-to-interior calculations. For the purposes of this report, the performance method is utilized to determine consistency with the Cal Green Code. The sections that pertain to this project are as follows:

> **5.507.4.1 Exterior noise transmission, prescriptive method.** Wall and roof-ceiling assemblies exposed to the noise source making up the building envelope shall meet a composite STC rating of at least 50 or a composite OITC rating of no less than 40, with exterior windows of a minimum STC of 40 or OITC of 30 when the building falls within

the 65 dBA L_{dn} noise contour of a freeway or expressway, railroad, industrial source or fixed-guideway noise source, as determined by the local general plan noise element.

5.507.4.2 Performance method. Wall and roof-ceiling assemblies exposed to the noise source making up the building envelope shall be constructed to provide an interior noise environment attributable to exterior sources that does not exceed an hourly equivalent noise level ($L_{eq\ (1\text{-}hr)}$) of 50 dBA in occupied areas during any hour of operation.

The performance method, which establishes the acceptable interior noise level, is the method typically used when applying these standards.

City of San Francisco General Plan* (*For informational purposes only). Policy 11.1 of the Environmental Protection Element of the City of San Francisco's General Plan identifies noise and land use compatibility standards for various land uses. The City's "satisfactory" noise level objective for residential land uses is 60 dBA L_{dn}. Additional policies in the Environmental Protection Element that apply to the proposed project include:

Policy 10.1: Promote site planning, building orientation and design, and interior layout that will lessen noise intrusion. Because sound levels drop as distance from the source increases, building setbacks can play an important role in reducing noise for the building occupants. (Of course, if provision of the setback eliminates livable rear yard space, the value of the setback must be weighed against the loss of the rear yard.) Buildings sited with their narrower dimensions facing the noise source and sited to shield or be shielded by other buildings also help reduce noise intrusion.

Although walls with no windows or small windows cut down on noise from exterior sources, in most cases it would not be feasible or desirable to eliminate wall openings. However, interior layouts can achieve similar results by locating rooms whose use require more quiet, such as bedrooms, away from the street noise. In its role of reviewing project plans and informally offering professional advice on site development, the planning department can suggest ways to help protect the occupants from outside noise, consistent with the nature of the project and size and shape of the building site.

Policy 10.2: Promote the incorporation of noise insulation materials in new construction. State-imposed noise insulation standards apply to all new residential structures except detached single-family dwellings. Protection against exterior noise and noise within a building is also important in many nonresidential structures. Builders should be encouraged to take into account prevailing noise levels and to include noise insulation materials as needed to provide adequate insulation.

Article 29 of the City of San Francisco Police Code (noise ordinance). Section 2907 states that "it shall be unlawful for any person to operate any powered construction equipment if the operation of such equipment emits noise at a level in excess of 80 dBA when measured at a distance of 100 feet from such equipment, or an equivalent sound level at some other convenient distance." Section 2907 does not apply to impact tools and equipment when properly muffled or pavement breakers and jackhammers when equipped with acoustical shields or shrouds.

The full text of Section 2907 reads as follows:

> *(a) Except as provided for in Subsections (b), (c), and (d) hereof, it shall be unlawful for any person to operate any powered construction equipment if the operation of such equipment emits noise at a level in excess of 80 dBA when measured at a distance of 100 feet from such equipment, or an equivalent sound level at some other convenient distance.*
>
> *(b) The provisions of Subsections (a) of this Section shall not be applicable to impact tools and equipment, provided that such impact tools and equipment shall have intake and exhaust mufflers recommended by the manufacturers thereof and approved by the Director of Public Works or the Director of Building Inspection as best accomplishing maximum noise attenuation, and that pavement breakers and jackhammers shall also be equipped with acoustically attenuating shields or shrouds recommended by the manufacturers thereof and approved by the Director of Public Works or the Director of Building Inspection as best accomplishing maximum noise attenuation.*
>
> *(c) The provisions of Subsection (a) of this Section shall not be applicable to construction equipment used in connection with emergency work.*
>
> *(d) Helicopters shall not be used for construction purposes for more than two hours in any single day or more than four hours in any single week.*

Section 2908 addresses construction work at night. Section 2908 states that "it shall be unlawful for any person, between the hours of 8:00 p.m. of any day and 7:00 a.m. of the following day to erect, construct, demolish, excavate for, alter or repair any building or structure if the noise level created thereby is in excess of the ambient noise level by 5 dBA at the nearest property plane, unless a special permit therefore has been applied for and granted by the Director of Public Works or the Director of Building Inspection."

Section 2909 establishes noise limits from mechanical sources for various land uses throughout the community. For noise generated by residential uses, the limit is 5 dBA in excess of the ambient noise; for noise generated by commercial and industrial uses, the limit is 8 dBA in excess of the ambient noise; and for noise on public property, including streets, the limit is 10 dBA in excess of ambient noise. The noise ordinance also provides an interior noise limit for fixed noise sources, such as mechanical equipment. Fixed noise sources may not exceed 45 dBA between the hours of 10:00 p.m. to 7:00 a.m. or 55 dBA between the hours of 7:00 a.m. to 10:00 p.m. with windows open except where building ventilation is achieved through mechanical systems that allow windows to remain closed.

United States Department of Transportation. The Federal Transit Administration has developed general assessment criteria for analyzing construction noise. This assessment is based on the simultaneous operation of the two noisiest pieces of equipment. The general assessment criteria set construction noise limits, which are summarized in Table C1 below.

TABLE C1 Federal Transit Administration Criteria for Construction Noise

Land Use	One-Hour Leq (dBA)	
	Day	Night
Residential	90	80
Commercial	100	100
Industrial	100	100
Federal Transit Administration, Transit Noise and Vibration Impact Assessment Manual, FTA Report No. 0123, Table 7-2, September 2018, Office of Planning and Environment, https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/research-innovation/118131/transit-noise-and-vibration-impact-assessment-manual-fta-report-no-0123_0.pdf, accessed July 17, 2019.		

To address the issue of combined noise levels (including noise from impact equipment), a reasonable worst-case scenario combining noise levels from the two loudest pieces of equipment operating simultaneously at the same location is evaluated.[6]

California Department of Transportation. The California Department of Transportation (Caltrans) provides guidelines regarding the vibration associated with construction and operation of transportation infrastructure. Table C2 provides Caltrans' vibration guidelines for potential damage to different types of structures.

TABLE C2 Caltrans Vibration Guidelines for Potential Damage to Structures

Structure Type and Condition	Maximum Peak Particle Velocity (PPV, in/sec)	
	Transient sources	Continuous/Frequent Intermittent sources
Extremely fragile historic buildings	0.12	0.08
Fragile buildings	0.2	0.1
Historic and some old buildings	0.5	0.25
Older residential structures	0.5	0.3
New residential structures	1.0	0.5
Modern industrial/commercial buildings	2.0	0.5
Note: Transient sources create a single, isolated vibration event (e.g., blasting or drop balls). Continuous/frequent intermittent sources include impact pile drivers, pogo-stick compactors, crack-and-seat equipment, vibratory pile drivers, and vibratory compaction equipment.		
Source: California Department of Transportation, Transportation and Construction Vibration Guidance Manual, Table 19, September 2013, http://www.dot.ca.gov/hq/env/noise/pub/TCVGM_Sep13_FINAL.pdf, accessed July 17, 2019.		

[6] Although it may be unlikely that the two loudest pieces of equipment operate simultaneously, the evaluation provides a reasonable worst-case scenario for construction noise.

Appendix D –
Manufacturer's Noise Data and Roof Plan

REYMSA
REYMSA COOLING TOWERS, INC.®

RT Series
Engineering Data

Date: August 15th, 2019

Project Name	Model	Quantity	HP Total
555 O'Farrell San Francisco	RTU-810105-A	1	5

Performance Data	
EWT (F)	87
LWT (F)	77
WBT (F)	63
Total Required Flow Rate (gpm)	600.0
Total Nominal Flow Rate (gpm)	602.8
Nominal Flow Rate per Unit (gpm)	602.8
Total Required Heat Load (Btu/h)	3,002,400

Water Data Per Unit	
Evaporated Water Rate (gpm)	4.01

Unit Data	
Quantity of Motors	1
Motor HP	5.0
Quantity of Fans	1
Air Flow (cfm)	40,200
Basin Capacity (gal)	452
Shipping Weight (lb)	4,211
Operating Weight (lb)	9,254
Tower Configuration	SINGLE FAN
Free-field S.P.L. at 5 ft(dBA)	77
Free-field S.P.L. at 30 ft(dBA)	62
Free-field S.P.L. at 50 ft(dBA)	57
Dimensions	
Length (in)	128.00
Width (in)	98.00
Height (in)	156.50
Connection Diameters	
Hot Water Inlet (in)	6
Cold Water Outlet (in)	6
Overflow (in)	2
Water make-up (in)	1
Drain (in)	2
Purge (in)	3/4

Notes:
- (3)Ft Fill Type CF-1200
- Standard Fan Selection
- Motor 5.0 HP, 230/460 V, 15.0/7.50 Amp, 3ph, 60Hz, 850 RPM
- No Noise Neither Space Restrictions
- **Sound data is calculated under Free field conditions, not taking into account any reflections. This sound data should be used as guide line only**
- **Approximate dimensions and weights. Refer to Factory for more information.**
- **Exceed the Energy Efficiency per ASHRAE Standard 90.1-2016**

Performance	
Quantity	1
Volume (CFM)	10,420
Total External SP (in. wg)	2
Operating Power (hp)	4.61
Required Power (hp)	4.61
Fan RPM	755
Max Fan RPM	1163
Oper. Frequency (Hz)	60
Elevation (ft)	433
Start-up Temp.(F)	70
Operating Temp.(F)	70

Fan Configuration	
Construction Type	PermaLock
Size	33
Arrangement	10
Rotation	CW
Discharge Position	UB
Spark Resistance	None
Scroll Material	Steel
Wheel Material	Steel
Inlet Cone Material	Steel
Pedestal Material	Steel

Equipment Weights	
Fan (LMD)(lb)	777
Motor/Drive (lb)	98
Accessories (lb)	130

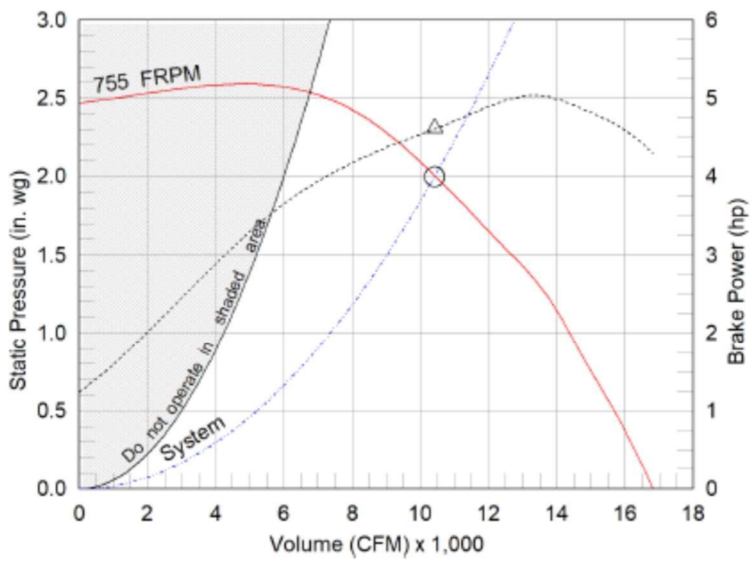
Misc Fan Data	
FEG	85
Outlet Velocity (ft/min)	1,665
Static Efficiency (%)	74
Tip Speed (ft/min)	6,525

Motor and Drives	
Motor	Included
Size (hp)	5
RPM	1725
Enclosure	ODP
V/C/P	460/60/3
Frame Size	184T
Max Frame Size	256
Location	Centered
Pulley Type	Constant
Drive Loss (%)	4.0
Drives	Multiple
Drive Service Factor	1.5
NEC FLA* (Amps)	7.6

Model: USF-333-BI

Centrifugal Utility Fan - Backward Inclined Wheel

Operating Performance

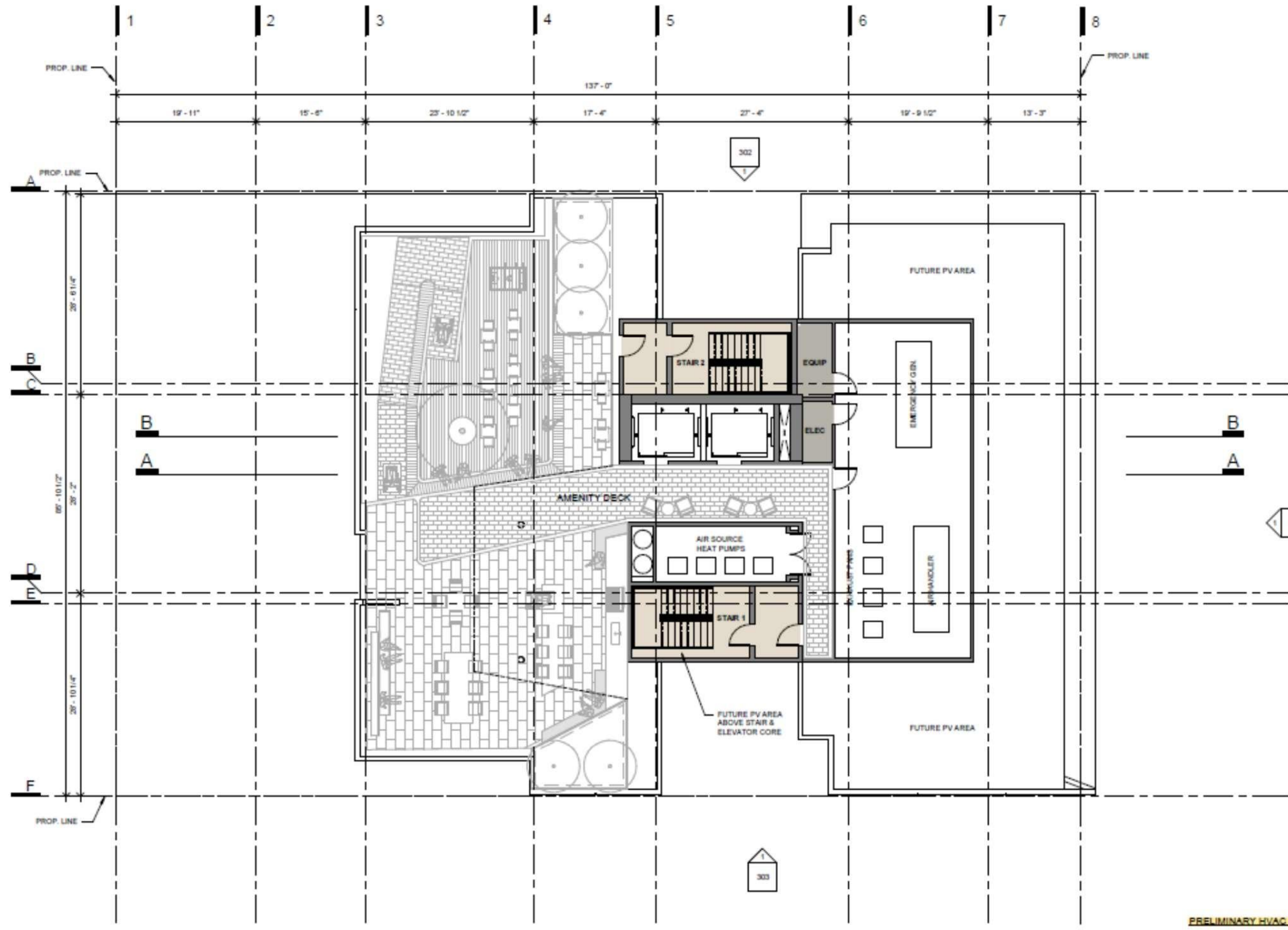


△ Operating Bhp point
○ Operating point at Total External SP
Fan curve
System curve
Brake horsepower curve

Sound Power by Octave Band

Sound Data	62.5	125	250	500	1000	2000	4000	8000	LwA	dBA	Sones
Inlet	84	86	81	76	76	73	66	60	81	69	18.0
Outlet	91	91	82	80	78	74	69	62	84	72	23

*FLA - based on tables 150 or 148 of National Electrical Code 2002. Actual motor FLA may vary, for sizing thermal overload, consult factory.
LwA - A weighted sound power level, based on ANSI S1.4
dBA - A weighted sound pressure level, based on 11.5 dB attenuation per octave band at 5 ft- dBA levels are not licensed by AMCA International
Sones - calculated using AMCA 301 at 5 ft



PRELIMINARY HVAC SYSTEM EQUIPMENT LIST AT ROOF:

(2) STAIR PRESSURIZATION FANS
(4) GENERAL EXHAUST FANS
(1) AIR HANDLER UNIT
(1) EMERGENCY GENERATOR

1/8" = 1'-0"

brick.

550 o'farrell
san francisco, ca

roof plan
11.05.18
conditional use submittal
www.brick-inc.com