FINAL

Noise and Vibration Study

VAN NESS AVENUE
BUS RAPID TRANSIT

Prepared for the

San Francisco County Transportation Authority

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EXECUTIVE SUMMARY

The purpose of this study is to assess future project noise and vibration impacts along the proposed Van Ness Avenue corridor. This corridor is one of several routes that connect the Golden Gate Bridge and the city's downtown financial and commercial centers. The San Francisco County Transportation Authority (SFCTA), in cooperation with the Federal Transit Administration (FTA) and the San Francisco Municipal Transportation Agency (SFMTA), proposes to implement bus rapid transit (BRT) improvements along this corridor.

The proposed project contains designs for four alternatives:

- Alternative 1: No-build Baseline Alternative.
- Build Alternative 2: Single Lane BRT with street parking.
- Build Alternative 3: Center Lane BRT with right side boarding and dual medians.
- Build Alternative 4: Center Lane BRT with left side boarding and single median.

These alternatives will all operate BRT service from Van Ness Avenue at Lombard Street in the north to South Van Ness Avenue at Mission Street in the south, over an approximate distance of two miles. The proposed alignment and design of these alternatives differ, whereas the operation plan and service start and end points for these alternatives are essentially the same. For the purposes of this analysis, Alternative 1 serves as the future baseline for considering net project noise impacts.

Since the lead agency for the proposed project -- the SFCTA -- is developing the project in cooperation with the FTA, noise and vibration impact evaluation is conducted using the criteria set forth by the FTA and the City of San Francisco. Furthermore, Caltrans' noise impact criteria are implemented for impact assessment, because the proposed project corridor is on Van Ness Avenue which is part of U.S. Highway 101.

Noise levels during construction are regulated under Article 29 of the San Francisco Municipal Code. These noise restrictions are summarized as follows:

- Daytime (7 am to 8 pm): Construction activities are permitted provided that operation of any powered construction equipment, regardless of age or date of acquisition, does not emit noise at a level in excess of 80 dBA when measured at a distance of 100 feet. Impact tools and equipment are exempt from this restriction if they are equipped with intake and exhaust mufflers recommended by the manufacturers thereof, and approved by the Director of Public Works.

- Nighttime (8 pm to 7 am): Non-emergency construction activities are not permitted during nighttime hours if the resulting noise level is more than 5 dBA in excess of the ambient noise at the nearest property line unless express permission has been granted by the Director of Public Works.

Parsons personnel visited the proposed project site between August 4th and 6th, 2008 to conduct noise monitoring and identify noise sensitive land uses. The monitoring sites include noise-sensitive locations, such as residences, a concert hall, and a hotel.

Measured noise levels were typical for a dense urban environment, with short-term L_{eq} values ranging from the mid 60s to mid 70s dBA. L_{dn} values measured at the long-term site and estimated at the short-term sites were in the 70s dBA. No significant vibration sources exist along the proposed corridor. Typical automobile, truck, and bus pass-bys along local roadways would be the only perceptible vibration source along the alignment.

The nature of the BRT construction work as described in the Van Ness BRT Draft Project Construction Plan (PCP) is conventional, principally modifications to the existing street/highway surfaces, new stations and concrete/asphalt travel way, curbs and gutters, utility relocations, drainage, signs, stripes, and signals (Arup, 2010). Equipment with the highest potential to generate noise disturbance includes jackhammers and saws. For this project, vibratory rollers would be the most dominant sources of overall construction vibration. The vibration levels created by the normal movement of vehicles including graders, front loaders, and backhoes are comparable in order-of-magnitude to ground-borne vibrations created by heavy vehicles traveling on streets and highways.

Nighttime construction is expected to be necessary to avoid unacceptable disruptions to street and/or pedestrian traffic during daytime hours. The Draft PCP indicates that the following activities are most likely to be performed during nighttime hours:

- Reconfiguration of curb bulbs.
- Utility relocations that affect intersection corners.
- Mill-and-fill work for the curb-to-curb pavement rehabilitation.

Construction impacts are of a temporary nature, and construction is a necessary part of any project. However, mitigation measures may be required to minimize impacts. In addition, non-emergency construction activities are prohibited during nighttime hours if the resulting noise level is more than 5 dB in excess of the ambient noise at the nearest property line, unless express permission has been granted by the Director of Public Works . In effect, this would include most noise-generating construction activities during nighttime hours and almost any such activity occurring near the edge of right-of-way.

Operational noise impacts were evaluated along Van Ness Avenue and along parallel local streets. Along Van Ness Avenue, future BRT operations would represent a new category of noise source under the project alternatives. However, the elimination of two mixed-flow lanes as part of the project would reduce general automobile traffic capacity along the project corridor, tending to redirect some traffic to alternative routes. In addition, the total number of motor vehicle trips in the area is expected to decrease under the project alternatives due to the enhanced transit offered as an alternative mode of transportation to the automobile. Consistent with FTA guidelines, only the additional noise from BRT operations was considered in the FTA analysis; this approach produced conservative impact results. The same conservative approach was applied to the assessment of the change in noise levels along Van Ness Avenue as a result of the proposed project alternatives. No project noise impacts were identified along Van Ness Avenue relative to either FTA criteria which are based on the existing versus project noise or the Caltrans criterion which is based on changes in total noise levels.

Franklin and Gough Streets are expected to attract more of the traffic redirected from Van Ness Avenue under the project alternatives than any other alternative route. Along segments of these roadways paralleling Van Ness Avenue, future traffic noise levels under the project alternatives are predicted to be 0 to 1.5 decibels (dB) higher than future no project noise levels. Relative to existing traffic noise levels, future project traffic noise levels would increase by 0 to 2.2 dB. All of these levels are below the 5-dB threshold derived from the City Noise Ordinance. Accordingly, no mitigation is required for operational noise impacts on Franklin and Gough Streets.

Vibration impact due to BRT operation is not a concern due to the typical operational characteristics and vehicle design of the proposed BRT vehicles. However, roadway surface defects such as pot holes would elevate BRT passby noise and vibration. Thus, it is recommended that upkeep of roadway surface be maintained to avoid increases in BRT noise and vibration.

In summary, nighttime construction related to the proposed project would cause City noise ordinance limits to be exceeded from time to time. Caltrans guidelines for construction noise include compliance with local ordinances. In the absence of mitigation, there would likely be a few instances where vibratory rollers would need to operate near enough to wood-frame buildings such that FTA vibration thresholds for cosmetic damage could be briefly and slightly exceeded at those buildings. A combination of mitigation techniques for equipment noise and vibration control as well as administrative measures, when properly implemented, can be selected to provide the most effective means to minimize the effects of construction activity impacts. Application of the mitigation measures will reduce the construction impacts; however, temporary increases in noise and vibration would still occur at some locations. Operational project-generated and cumulative noise impacts along Van Ness Avenue would remain below both FTA and Caltrans impact criteria. Traffic noise increases along parallel streets would be lower than the applicable City impact threshold. Operational vibration impacts would be less than significant relative to the applicable (FTA) criteria.

1.0 INTRODUCTION

The purpose of this study is to assess future noise and vibration impacts along the proposed Van Ness Avenue Bus Rapid Transit (BRT) alignment. The Van Ness Avenue corridor is one of several routes that connect the Golden Gate Bridge and the City of San Francisco's downtown financial and commercial centers.

The San Francisco County Transportation Authority (SFCTA) proposes, in cooperation with the Federal Transit Administration (FTA) and the San Francisco Municipal Transportation Agency (SFMTA), to implement BRT improvements along the Van Ness Avenue corridor.

The proposed project contains designs for four alternatives:

- Alternative 1: No-Build Baseline Alternative.
- Build Alternative 2: Side Lane BRT with street parking.
- Build Alternative 3: Center Lane BRT with right side boarding and dual medians.
- Build Alternative 4: Center Lane BRT with left side boarding and single median.

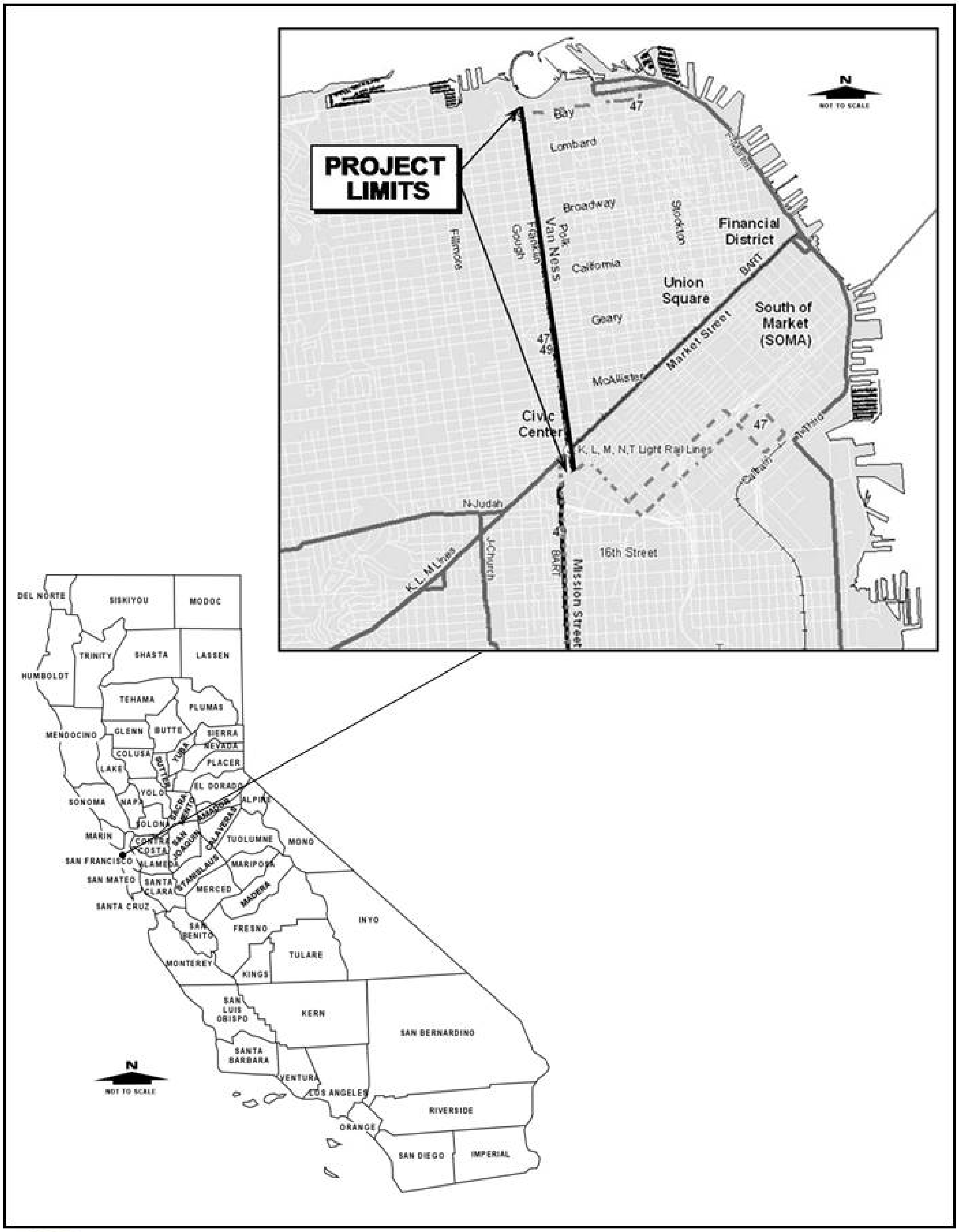
These alternatives will all operate BRT service from Van Ness Avenue at Lombard Street in the north to South Van Ness Avenue at Mission Street in the south, over an approximate distance of two miles. The proposed alignment and design of these alternatives differ, whereas the operation plan and service start and end points for these alternatives are essentially the same.

Figure 1-1 shows a regional project location map. **Figure 1-2** provides a map showing the project alignment. Project improvements would be confined largely within the right-of-way along Van Ness Avenue. The four project alternatives are described in detail in the following sections.

- **Alternative 1: No-Build (Baseline Alternative)**

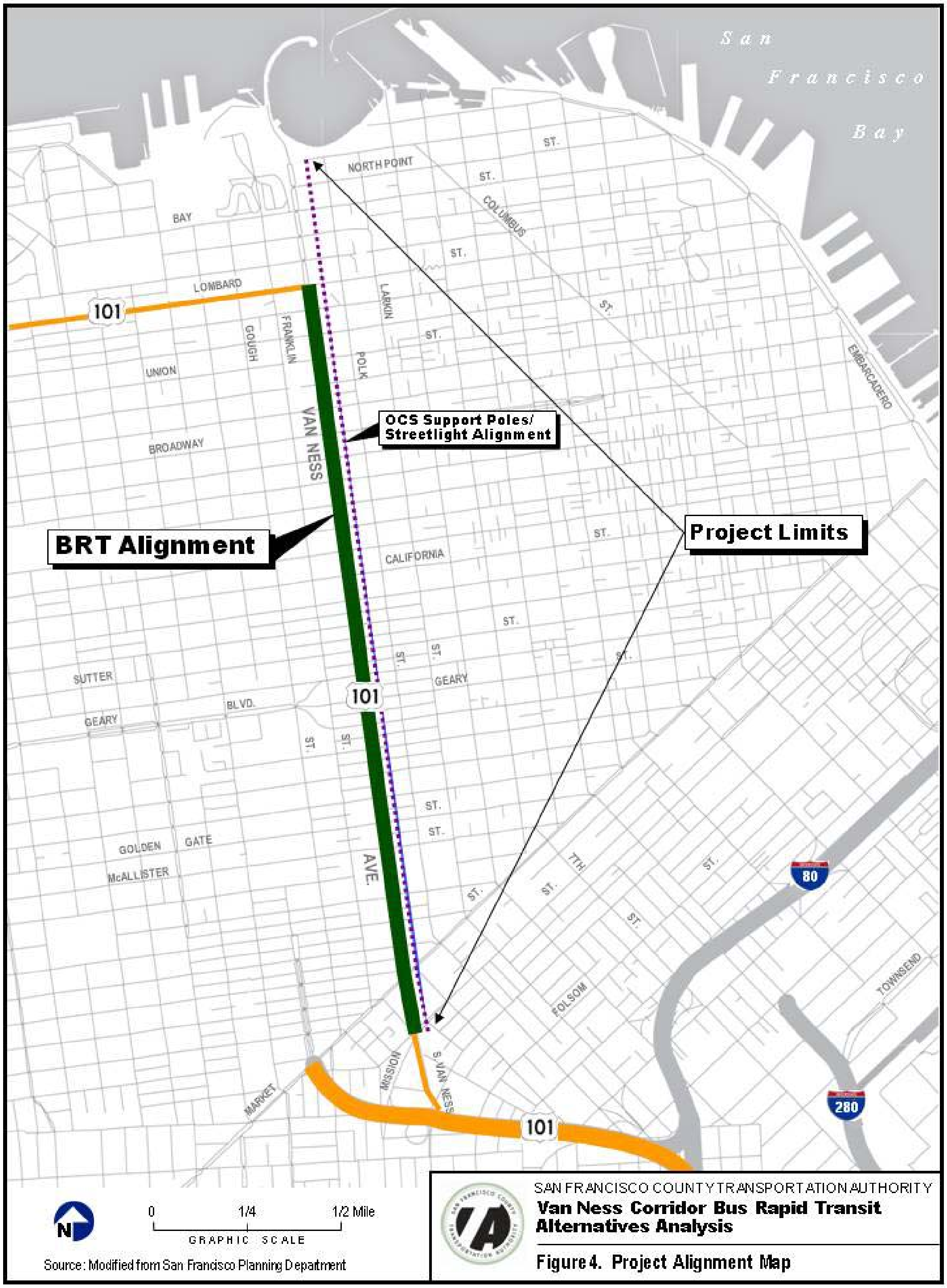
Alternative 1, the No-Build alternative, would not include a BRT service and instead assumes the existing roadway and transit services in the 2.2 mile Van Ness Avenue corridor would continue and be supplemented by funded improvement projects planned to occur within the near-term horizon year of 2015. These transportation system and infrastructure improvements are planned to occur regardless of implementation of any proposed BRT build alternative. The following transportation system and infrastructure improvements are included in the No-Build Alternative:

- *Pavement Rehabilitation*. Caltrans prepared a draft Capital Preventative Maintenance Project Report in 2008 to address pavement rehabilitation (repair and replacement of failed areas) on Van Ness Avenue between Golden Gate Avenue and Lombard Street.



Van Ness Avenue Bus Rapid Transit Project

Figure 1-1 – Regional Project Location Map



Source: Modified from San Francisco Planning Department

Figure 1-2 – Project Alignment Map

- *OCS and support pole/streetlight replacement.* The SFMTA, together with the SFDPW and the SFPUC, plans to replace the existing overhead wire contact system and supporting poles /streetlights along Van Ness Avenue from Market Street to North Point Avenue, to address the failing structural condition of the system. Poles would be replaced in approximately the same locations on the sidewalk, within approximately three to five feet from existing poles. The replacement poles would be designed to handle modern loads as required by the BRT. These poles would also provide street and sidewalk lighting. New lighting would be energy efficient, require low maintenance, and meet current lighting requirements for safety. A new duct bank would be constructed within the sidewalk area to support the streetlights and traffic signal interconnect conduits.
- *Traffic signal infrastructure for real time traffic management.* The SFgo program led by the SFMTA is a package of technology-based transportation management system tools that is comprised of many projects that would be implemented throughout the City, including the Van Ness Avenue corridor. Some elements of the SFgo program are expected to be implemented on Van Ness Avenue by 2015 regardless of a BRT project, and are part of the No-Build Alternative. Other elements of the SFgo program intended for Van Ness Avenue would be implemented as part of the proposed BRT build alternatives. The following signal infrastructure elements of SFgo are planned for implementation in the Van Ness corridor by 2015, and are therefore included in the No-Build Alternative:
    - Traffic Signal Replacement. Existing traffic signal heads and poles will be upgraded to mast armed poles (arched to hang over traffic lanes) and new signal heads at all intersections along Van Ness Avenue.
    - Pedestrian Countdown Signals. As part of SFgo, pedestrian countdown signals would be installed on all crosswalk legs at all signalized intersections along Van Ness Avenue.
    - Accessible Pedestrian signals. APS would be installed at approximately half of signalized intersections in the project corridor as part of SFgo. APS provides audible crossing indications for visually impaired pedestrians.
    - Curb Ramp Upgrades. SFgo would install curb ramps with tactile domes that meet current City standards and Americans with Disabilities Act (ADA) requirements at all intersections along Van Ness Avenue to provide access by people in wheelchairs as well as providing easier travel for those with strollers, carts, and the like.
- High-quality Bus Vehicles with Low Floor Boarding. SFMTA is gradually converting its fleet to low-floor buses which will provide more level boarding to result in easier and quicker boarding and alighting. The replacement fleet in the Van Ness Avenue corridor is anticipated to be an even split of 60-foot articulated electric trolley coaches and diesel hybrid coaches and would be phased into operation by year 2015.
- *On Bus Proof of Payment/All-door Boarding.* SFMTA expects to implement all-door boarding on Van Ness Avenue by 2015, allowing passengers with proof of

payment, such as a Clipper Card, to board through any door and then swipe their fare cards on receptors on the bus.

- *NextMuni Real Time Passenger Information.* SFMTA is installing real-time bus arrival information displays (NextMuni) at major bus stops with shelters along Van Ness Avenue.

Implementation of the aforementioned transportation system and infrastructure improvements is assumed under the No-Build Alternative. These improvements would not result in changes to the basic sidewalk, intersection crossing, and median configurations. Therefore, under the No-Build Alternative it is assumed that Van Ness Avenue would maintain the existing physical configuration (including median widths, sidewalk widths, crosswalk dimensions, crossing distances) and provision would be the same as today.

Build Alternatives

Based on findings of the 2006 Van Ness Avenue BRT Feasibility Study and scoping process, three build alternatives were defined and recommended for NEPA/CEQA analysis in the Van Ness Avenue BRT Alternatives Screening Report.

Each build alternative proposes BRT operating along a dedicated transit lane, or transitway, for the 2.2 mile project corridor. Under each build alternative, two mixed flow traffic lanes (one southbound and one northbound) would be removed to accommodate the creation of two dedicated transit lanes (one southbound and one northbound). In other words, the existing mixed flow traffic lanes would be reduced from three to two lanes in each direction to accommodate the BRT transitway. The build alternatives would occur entirely within the existing street right-of-way and no property acquisition would be required. None of the build alternatives would require reduction in sidewalk width. Curbside parking would generally be maintained under each build alternative, although some loss of street parking would occur at locations throughout the project corridor under each of the three proposed build alternatives.

Under the build alternatives, the existing MUNI bus stops along Van Ness Avenue would be removed and replaced with BRT stations. There are currently 14 northbound and 14 southbound MUNI bus stops along Van Ness Avenue between Market and Lombard Streets, with an average of 700 feet between stops.

The three build alternatives propose differing lane configurations and associated station placement at the intersections. In summary, Build Alternative 2 proposes dedicated transit lanes along the side of the roadway, adjacent to the curbside parking area. Under Build Alternative 2 curb extensions would provide curbside BRT stations. Build Alternative 3 proposes dedicated transit lanes in the center of the roadway, with two medians separating bus lanes from mixed flow traffic. Build Alternative 3 BRT stations would be located in the center medians. Build Alternative 4 proposes dedicated transit lanes in the center of the roadway, along both sides of a single, center median. Build Alternative 4 BRT stations would be located in the single center median.

Existing left-turn pockets for mixed flow traffic would be eliminated at several intersections to reduce conflicts with the BRT operation. Also, right-turn pockets for mixed flow traffic would be introduced at certain intersections to reduce conflicts with the BRT operation.

- High-quality Bus Vehicles with Level Boarding. As described for the No-Build Alternative, the build alternatives would involve an upgrade from the existing buses to higher capacity, higher performance bus vehicles. The proposed BRT vehicles would offer increased passenger capacity over the Muni 47 line buses that presently operate in the Van Ness Avenue corridor. The proposed BRT vehicle fleet under each build alternative would be an approximate 50 percent split between 60 ft electric trolley coaches and 60 ft diesel hybrid motor coaches. The proposed BRT fleet would replace the existing Muni bus lines 47 and 49 which currently operate an approximate 50 percent split between 40 ft diesel motor coaches and 60 ft electric trolleys, respectively. The maximum number of BRT buses operating in the corridor would be equivalent to the current combined schedule of Routes 47 and 49 of approximately 15-16 buses per hour in the peak hour in both northbound and southbound directions. The design vehicle would be low floor and the bus station platform design would provide level boarding from bus to station platform, reducing dwell times and improving service reliability over the existing conditions.
- *Dedicated Bus Lanes (Transitway).* BRT buses would operate in an exclusive, dedicated bus lane on the street surface. The BRT transitway would accommodate both MTA and Golden Gate Transit vehicles which currently operate along the corridor, and would be available for use by emergency response vehicles. The bus lane would be distinguished from mixed flow traffic lanes by colored pavement or other special markings. A curb or other physical means of separation from the mixed flow traffic lanes may also be utilized in some locations, to be determined in final project design.
- *Pavement Rehabilitation and Resurfacing*. Under the Build Alternatives, Van Ness Avenue would undergo curb-to-curb rehabilitation and resurfacing.
- *High-quality Stations.* The BRT stations proposed under each build alternative would include a platform, canopy, landscaped planter, and station amenities. The station would sit upon a concrete bus pad elevated above the sidewalk curb height of 6 inches, to 10-12 inches above the street grade. Stations would be approximately 150 ft in length, with a platform length of 130 ft in order to accommodate two 60 ft articulated BRT vehicles. The platform provides the area for passenger waiting, boarding, and station amenities. The station platform would range from 10-25 ft in width, depending on the project alternative and the need for a platform to accommodate single direction travel, or both southbound and northbound travel. Stations amenities would include ticket vending machines (TVM), seating, lighting, a canopy and wind screens, garbage receptacles, and wayfinding information (maps/signage). In Alternative 2, a landscaped planter would be incorporated to beautify the stations and buffer bus patrons from adjacent pedestrian or vehicular traffic. The stations would feature active data display and audio capability to indicate bus arrival time as required by ADA.

- *Platform Proof of Payment/All-door Boarding.* As described for the No-Build alternative, the build alternatives would operate with all-door boarding BRT service, allowing passengers with proof of payment, such as a Clipper Card, to board through any door. In the build Alternative, SFMTA will have the BRT platforms function as proof-of-payment areas, and passengers would swipe their fare cards on receptors before the buses arrive, further helping to reduce dwell time.
- *NextMuni Real Time Passenger Information.* As described for the No-Build Alternative, the BRT stations under the build alternatives would be equipped with NextMuni, providing real-time bus arrival information displays.
- *Transportation System Management (TSM) Capabilities.* The proposed BRT service under each build alternative would utilize advanced traffic and transit system management technologies, like those proposed under SFgo, including:
    - Traffic signal infrastructure for real time traffic management. Traffic signal poles would be upgraded to mast armed poles. Signal controllers and interconnects would be replaced with modern controllers and a new fiber optic signal interconnect communications network that would allow for real time traffic management. Variable real-time message signs and traffic cameras would also be installed to manage traffic conditions and special events. The interconnects and controllers allow for active monitoring and adjusting of traffic signal timings.
    - GPS-based Transit Signal Priority. Under the proposed build alternatives Transit Signal Priority (TSP) hardware would be installed on the traffic signal masts. TPS provides advance and extended green light time for buses approaching signals, to reduce bus delay caused by red lights. The proposed BRT stations would be located on the far side of signalized intersections as feasible to optimize the capability of TSP. Buses would be granted a green light to travel through the intersection and then subsequently stop at a station, benefiting transit travel time and reliability.
    - Automatic Vehicle Location. Automatic Vehicle Location (AVL) would be utilized under the build alternatives to manage transit route operations in real-time.
- Median Upgrades / Nose Cones for Pedestrian Safety. Median refuges would be modified and widened where feasible to reduce the distance pedestrians must cross during one light cycle, improving pedestrian safety at those locations. Nose cones would be installed where feasible to provide a protective buffer between pedestrians and automobile traffic. All upgrades to intersections would comply with ADA standards.
- Curb Ramp Upgrades. Curb ramps would be installed at all intersections along Van Ness Avenue. Curb ramps would meet current City standards and ADA requirements to provide access by people in wheelchairs as well as providing easier travel for those with strollers, carts, and the like.
- Landscaping. Medians would be landscaped to promote a unified, visual concept for the Van Ness Corridor. BRT stations would include landscaped planters, and

landscaping would be incorporated as feasible to provide a buffer between bus patrons and adjacent auto and pedestrian traffic. Also, the discontinuation of existing MUNI bus stops and removal of bus shelters as proposed under the build alternatives would open up additional sidewalk space at these locations. This would enhance the pedestrian environment at these locations and offer opportunities for tree planting, landscaping or streetscape features.

- Curb Bulbs. Curb bulbs are proposed at most signalized intersections to improve pedestrian safety by improving visibility between motorists and pedestrians, shortening the crossing distance across Van Ness Avenue, and reducing the speed of right-turning traffic.
- Pedestrian Countdown Signals. Pedestrian countdown signals would be installed on all crosswalk legs at all signalized intersections in the project corridor as part of the proposed Build Alternatives.
- Accessible Pedestrian Signals (APS). APS would be installed at all signalized intersections in the project corridor as part of the proposed build alternatives.
- OCS support pole/streetlight replacement. Under the proposed build alternatives the OCS overhead wire and support pole system would be replaced and upgraded, as described for the No-Build Alternative, along with the associated street lighting.

BUILD ALTERNATIVE 2: SIDE LANE BRT WITH STREET PARKING

Build Alternative 2 would provide a dedicated bus lane, or transitway, in the right most lane of Van Ness Avenue located adjacent to the existing curbside street parking area. The transitway would extend from Mission Street to Lombard Street in northbound and southbound directions. The transitway would be traversable for mixed flow traffic which would enter the transitway in order to complete a right turn, or to parallel park. Under Build Alternative 2 BRT stations would be located within the curbside parking area as curb extensions, eliminating the need for buses to exit the transitway to pick up passengers. Golden Gate Transit vehicles that currently operate on Van Ness Avenue would operate in the transitway and use BRT stations exclusively, thus eliminating the existing Golden Gate Transit Turk Street station. A planter with trees and shrubs would be located along the sidewalk side of the BRT station platform to serve as a buffer between bus patrons and sidewalk pedestrians. Build Alternative 2 would involve minimal modification to the existing median and thus existing trees and landscape plantings would not require removal.

BUILD ALTERNATIVE 3: CENTER LANE BRT WITH RIGHT-SIDE BOARDING AND DUAL MEDIANS

Build Alternative 3 would provide a transitway comprised of two side-by-side, dedicated bus lanes located in the center of the roadway, inside two medians. The transitway would be separated from mixed flow traffic by a 4 ft wide median and a 9 ft wide median. Golden Gate Transit vehicles that currently operate on Van Ness Avenue would operate in the transitway and use BRT stations exclusively, thus eliminating the existing Golden Gate Transit Turk Street station. BRT stations would be located on the 9 ft median, allowing right-side boarding. Build Alternative 3 would require removal of much of the existing medians, including existing trees and landscaping, in order to construct the dual median, center lane transitway. Thus opportunities to preserve existing trees and landscape would be limited, and the most constrained among the Build Alternatives. New tree planting is proposed along the 9-ft, right-side medians, and at locations of former curbside bus stops.

Center Lane Alternative Design Option B

Both center running alternatives contain a design option referred to as the Center Lane Alternative Design Option B. This design option would eliminate all northbound left turns, and all but one southbound left turn (at Broadway Street) in the project corridor. Center Lane Alternative Design Option B would reduce conflicts at intersections with turning vehicles, and increase the green light time available to BRT buses for through movement. The removal of left-turn pockets would allow for more street parking at certain locations.

BUILD ALTERNATIVE 4: CENTER LANE BRT WITH LEFT-SIDE BOARDING AND SINGLE MEDIAN

Build Alternative 4 would provide a transitway in the center of the roadway comprised of a single, 14 ft median flanked by dedicated northbound and southbound dedicated bus lanes. Station platforms would be located on the single center median, requiring left-side passenger boarding and alighting. All stations would be of this single median design, with the exception of BRT stations proposed at Geary/O’Farrell which would utilize a dual median configuration similar to that proposed under Alternative 3, in order to accommodate Golden Gate Transit buses that are strictly right-side boarding. As with the other build alternatives, Golden Gate Transit would operate exclusively in the transitway. Outside of the Geary/O’Farrell station, all other Golden Gate Transit stops along the BRT corridor would be consolidated. Golden Gate Transit vehicles operating along the Van Ness BRT corridor would make an additional stop at the corner of Chestnut Street and Van Ness Avenue in order to provide access in the northern end of the corridor. This would require routing Golden Gate Transit buses along Chestnut Street instead of Lombard Street between Laguna Street and Van Ness Avenue.

Thus Build Alternative 4 would require BRT vehicles with left side doors to allow for left-side boarding and alighting. All stations would be of this single median design, with the exception of BRT stations proposed at Geary/O’Farrell which would utilize a dual median configuration as proposed under Alternative 3, in order to accommodate Golden Gate Transit buses that are strictly right-side boarding.

Build Alternative 4 would require some modification of the existing median landscaping, including removal of some existing trees and landscaping, in order to construct the center lane transitway. Existing trees would be retained where feasible, and new trees would be planted in the median and at former bus stops.

Center Lane Alternative Design Option B

The Center Lane Alternative Design Option B is under consideration for Build Alternative 3 and 4. The design variation would eliminate all northbound left turns, and all but one southbound left turn (at Broadway Street).

For the purposes of this analysis, Alternative 1 serves as the future baseline for considering net project noise impacts. Differences in noise impacts between Alternatives 3 and 4 are expected to be negligible. Accordingly, impacts along Van Ness Avenue are evaluated for Alternative 2, and Alternatives 3 and 4 combined. Noise impacts from traffic diverted onto adjacent streets are evaluated only for the worst-case build alternative and worst-case design variation – whichever condition would divert the most traffic to those streets.

2.0 TERMINOLOGY

This section describes the basic noise and vibration terminology to provide background for the assessment for this noise study.

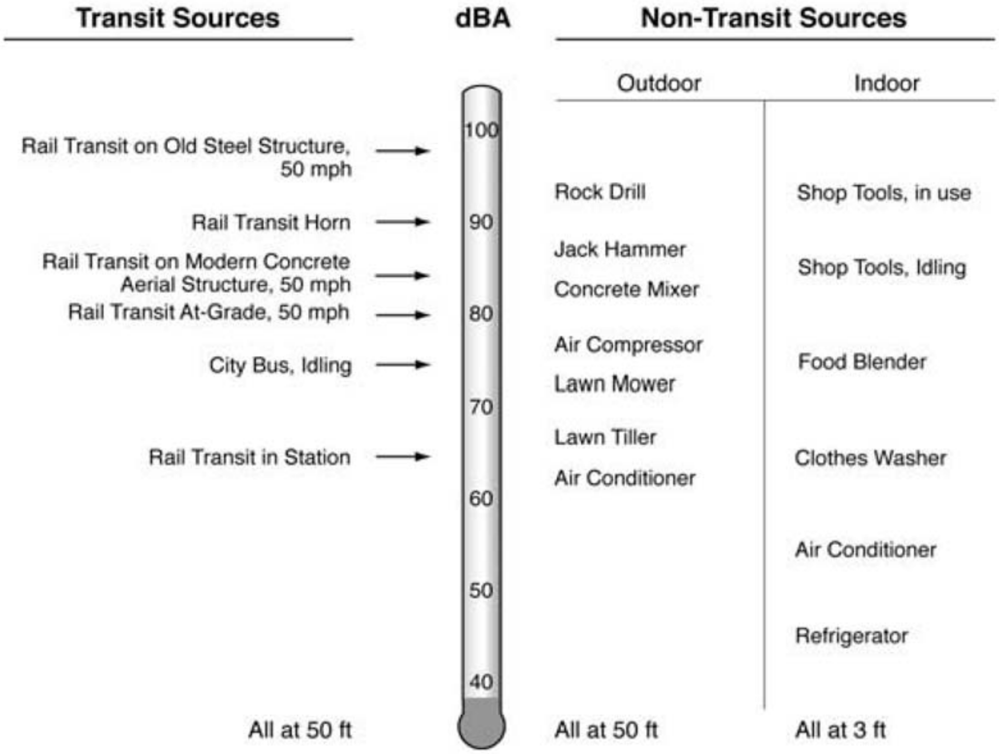
2.1 Noise Descriptors

Noise is usually defined as sound that is undesirable, because it interferes with speech communication and hearing, or is otherwise annoying (unwanted sound). Under certain conditions, noise may cause hearing loss, interfere with human activities, and in various ways may affect people's health and well being.

Sound Pressure Level (L_p) can vary over an extremely large range of amplitude. L_p describes the level of noise measured at a receiver at any moment in time and is read directly from a sound- level meter. The decibel (dB) is the accepted standard unit for measuring the amplitude of sound. When describing sound and its effect on a human population, A-weighted (dBA) sound pressure levels are typically used to account for the response of the human ear. The term "A-weighted" refers to a filtering of the noise signal in a manner corresponding to the way that the human ear perceives sound. The A-weighted noise level has been found to correlate well with people's judgments of the noisiness of different sounds, and it has been used for many years as a measure of community noise. **Figure 2-1** illustrates typical A-weighted sound pressure levels for various noise sources.

Community noise levels usually change continuously during the day. The equivalent continuous A-weighted sound pressure level (L_{eq}) is normally used to describe community noise. The L_{eq} is the equivalent steady-state A-weighted sound pressure level that would contain the same acoustical energy as the time-varying A-weighted sound pressure level during the same time interval. The maximum sound pressure level (L_{max}) is the greatest instantaneous sound pressure level observed during a single noise measurement interval. The sound exposure level (SEL) describes a receiver's cumulative noise exposure from a single noise event. It is represented by the total A-weighed sound energy during the event, normalized to a one-second interval.

Another descriptor, the day-night average sound pressure level (L_{dn}), was developed to evaluate the total daily community noise environment. The L_{dn} is a 24-hour average sound pressure level with a 10-dB time-of-day weighting added to sound pressure levels in the nine nighttime hours from 10:00 p.m. to 7:00 a.m. This nighttime 10-dB adjustment is an effort to account for the increased sensitivity to nighttime noise events. The Federal Transit Administration (FTA) uses L_{dn} and L_{eq} to evaluate BRT noise impacts at surrounding communities.



Source: FTA, 2006

Figure 2-1 – Typical A-Weighted Sound Levels

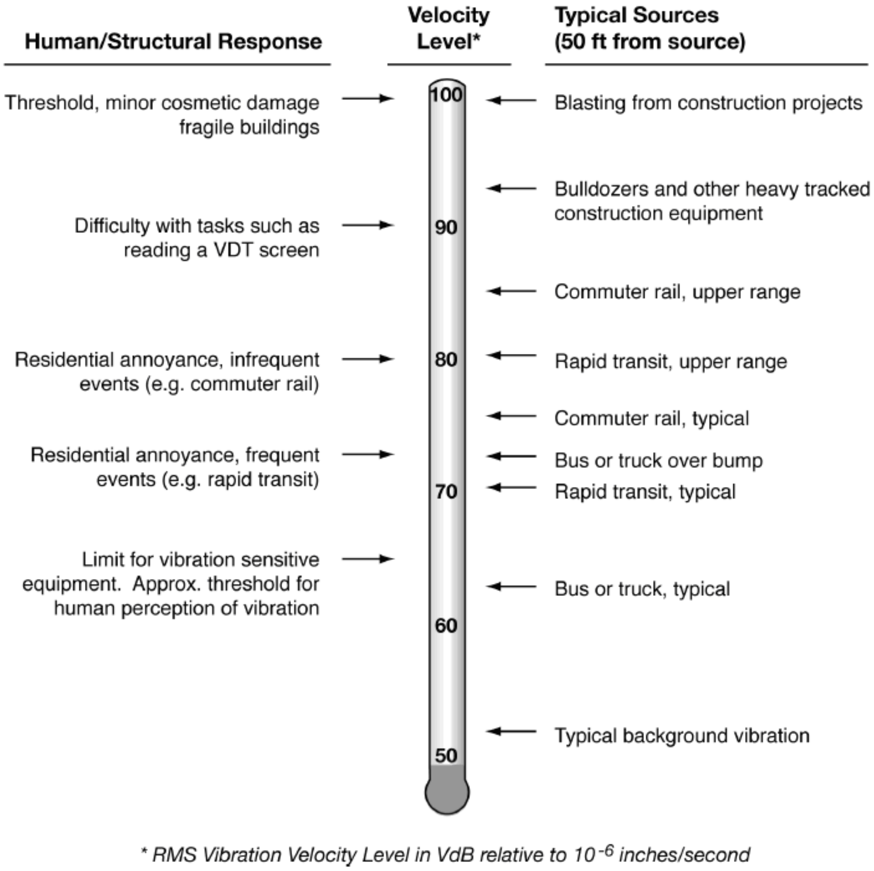
2.2 Vibration Descriptors

Vibration is an oscillatory motion, which can be described in terms of displacement, velocity, or acceleration. Displacement, in the case of a vibrating floor, is simply the distance that a point on the floor moves away from its static position. The velocity represents the instantaneous speed of the floor movement and acceleration is the rate of change of the speed. The response of humans, buildings, and equipment to vibration is normally described using velocity or acceleration. In this report, velocity will be used in describing ground-borne vibration.

Vibration amplitudes are usually expressed as either peak particle velocity (PPV) or the root mean square (RMS) velocity. The PPV is defined as the maximum instantaneous peak of the vibration signal. The RMS of a signal is the average of the squared amplitude of the signal. Although PPV is appropriate for evaluating the potential of building damage, it is not suitable for evaluating human response. Since it takes some time for the human body to respond to vibration signals, RMS amplitude is more appropriate to evaluate human response to vibration than PPV. For sources such as trucks or motor vehicles, peak vibration levels are typically 6 to 14 dB higher than RMS levels. FTA uses the abbreviation "VdB" for vibration decibels to reduce the potential for confusion with sound decibel.

The RMS vibration velocity level in decibels (VdB) is used to describe human annoyance criteria and impacts and uses a reference quantity of 1 micro-inch per second. Decibel notation acts to compress the range of numbers required in measuring vibration. **Figure 2-2** illustrates common vibration sources and the human and structural responses to ground-borne vibration. As shown in **Figure 2-2,** the threshold of perception for human response is approximately 65 VdB; however, human response to vibration is not usually significant unless the vibration exceeds 70 VdB. Vibration tolerance limits for sensitive instruments, such as MRI or electron microscopes, could be much lower than the human vibration perception threshold.

Similar to the noise descriptors, L_{eq} and L_{max} can be used to describe the average vibration and the maximum vibration level observed during a single vibration measurement interval.



Source: FTA, 2006

Figure 2-2 – Typical Levels of Ground-borne Vibration

3.0 IMPACT CRITERIA

This section presents the guidelines, criteria, and regulations used to assess noise and vibration impacts associated with the proposed project. Since the lead agency for the proposed project -- the SFCTA -- is developing the project in cooperation with the FTA, noise and vibration impact evaluation is conducted using the criteria set forth by the FTA and the City of San Francisco. Furthermore, Caltrans' noise impact criteria are implemented for impact assessment, because the proposed project alignment is on Van Ness Avenue, which is part of U.S. 101.

3.1 Noise Impact Criteria for Van Ness Avenue

3.1.1 FTA Noise Impact Criteria

The criteria in the *Transit Noise and Vibration Impact Assessment* (FTA, 2006) were used to assess existing ambient noise levels and future noise impacts from train operations. They are founded on well-documented research on community reaction to noise and are based on change in noise exposure using a sliding scale. The amount that transit projects are allowed to change the overall noise environment is reduced with increasing levels of existing noise. The noise metrics applied by the FTA to three categories of land use are summarized in **Table 3-1.**

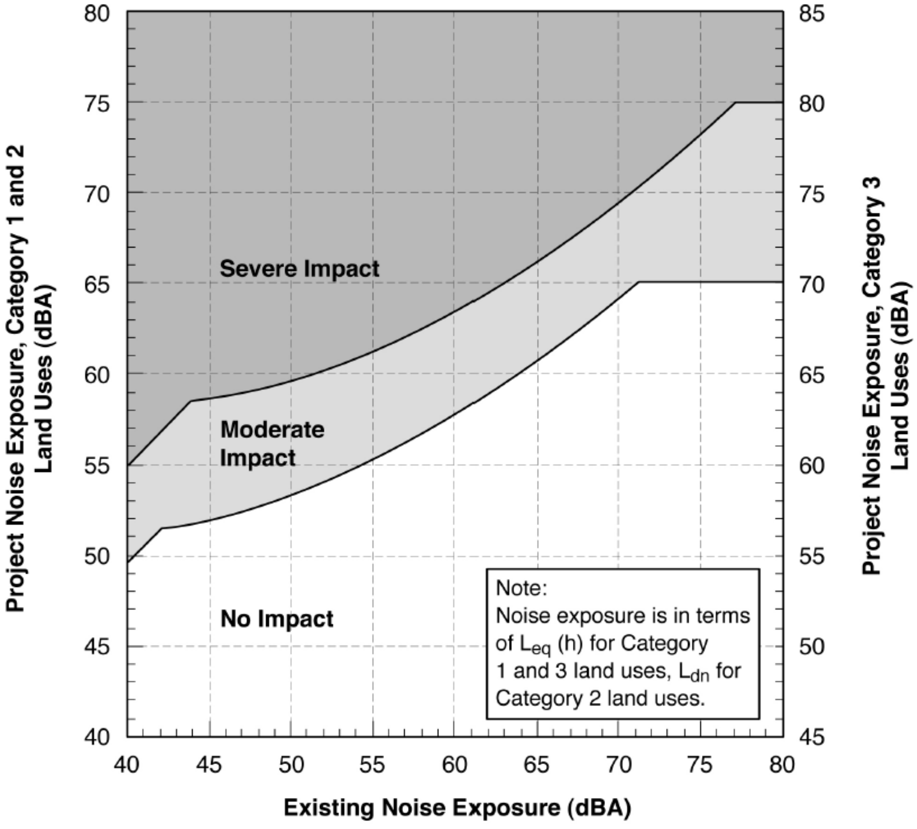
Table 3-1 – Land Use Categories and Metrics for Transit Noise Impact Criteria

Land Use Category	Noise Metric, dBA	Description of Land Use Category
1	Outdoor $L_{eq(h)}$*	Tracts of land where quiet is an essential element in their intended purpose. This category includes lands set aside for serenity and quiet, and such land uses as outdoor amphitheaters and concert pavilions, as well as National Historic Landmarks with significant outdoor use. Also included are recording studios and concert halls.
2	Outdoor L_{dn}	Residences and buildings where people normally sleep. This category includes homes, hospitals and hotels where a nighttime sensitivity to noise is assumed to be of utmost importance.
3	Outdoor $L_{eq(h)}$*	Institutional land uses with primarily daytime and evening use. This category includes schools, libraries, theaters, and churches where it is important to avoid interference with such activities as speech, meditation and concentration on reading material. Places for meditation or study associated with cemeteries, monuments, museums, campgrounds and recreational facilities can also be considered to be in this category. Certain historical sites and parks are also included.

Source: FTA, 2006
Note: * L_{eq} for the noisiest hour of transit-related activity during hours of noise sensitivity.

L_{dn} is used to characterize noise exposure for residential areas and hotels (Category 2). The maximum 1-hour L_{eq} during the period that the facility is in use is used for other noise-sensitive land uses such as school buildings and parks (Categories 1 and 3). The noise impact criteria for human annoyance are based on a comparison of the existing outdoor noise levels and the future outdoor noise levels from a proposed transit project. They incorporate activity interference caused by the transit project alone and annoyance due to the change in the noise environment caused by the project. There are two levels of impact included in the FTA criteria, as shown in **Figure 3-1.** The interpretations of these two levels of impact are summarized as follows:

- *Severe Impact*: Project noise above the upper curve is considered to cause Severe Impact since a significant percentage of people would be highly annoyed by the new noise. This curve flattens out at 80 dB for Category 1 and 2 land use, a level associated with an unacceptable living environment.
- *Moderate Impact:* The change in the cumulative noise level is noticeable to most people, but it may not be sufficient to cause strong, adverse reactions from the community. In this transitional area, other project-specific factors must be considered to determine the magnitude of the impact and the need for mitigation, such as the existing level, predicted level of increase over existing noise levels, and the types and numbers of noise-sensitive land uses affected.



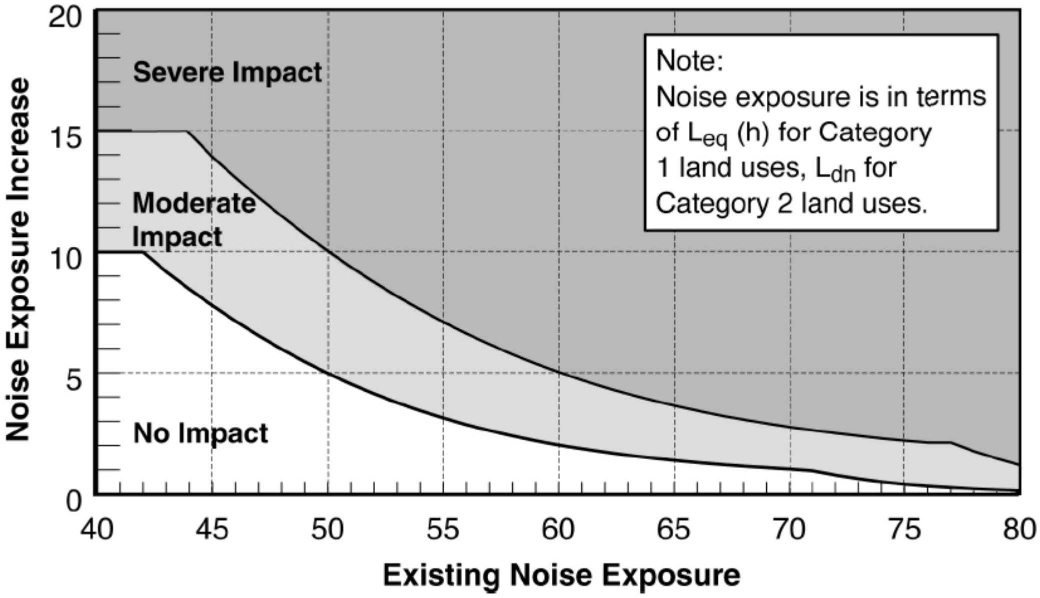
Source: FTA, 2006

Figure 3-1 – Noise Impact Criteria for Transit Projects

The horizontal axis in **Figure 3-1** is the existing L_{dn} or L_{eq} without any project-related noise. The vertical axis on the left side is the L_{dn} at residential land uses caused by a project, whereas the axis on the right side is the L_{eq} at school, park, and recreational land use. **Figure 3-1** illustrates that a project L_{dn} of 61 dBA at a Category 2 receiver would be considered as a "moderate impact" if the existing L_{dn} at a selected residence is 65 dBA. If the project noise level reaches an L_{dn} of 67 dBA, the project noise level would be considered as a "severe impact" to the Category 2 receiver.

Although the curves in **Figure 3-1** are defined in terms of the project noise exposure and the existing noise exposure, it is important to emphasize that the increase in the cumulative noise – when the project noise is added to existing noise – is the basis for the criteria. **Figure 3-2** shows the noise impact criteria for Category 1 and 2 land uses in terms of the allowable increase in the cumulative noise exposure.

Figure 3-2 shows that the criterion for moderate impact allows a noise exposure increase of 10 dB if the existing noise exposure is 42 dBA or less, but only a 1-dB increase when the existing noise exposure is 70 dBA. As the existing level of ambient noise increases, the allowable level of project noise increases, but the total allowable increase in community noise exposure is reduced. This reduction accounts for an unexpected result – project noise exposure levels that are less than the existing noise exposure can still cause moderate impact.



Source: FTA, 2006

Figure 3-2 – Increase in Cumulative Noise Levels Allowed by Criteria

For residential land use, the noise criteria are to be applied outside the building locations at noise-sensitive areas with frequent human use, including outdoor patios, decks, pools, and play areas. If no such areas exist, the criteria should be applied near building doors and windows. For parks and other significant outdoor use, the criteria are to be applied at the property lines; however, for locations where land use activities are solely indoors, noise impact may be less significant if the outdoor-to-indoor reduction is greater than for typical buildings (approximately 25 dB with windows closed). Thus, if it can be demonstrated that there will only be indoor activities, mitigation may not be needed.

3.1.2 Caltrans Noise Impact Criterion

People have different sensitivities to changes in noise levels, but it is generally known that human ears would notice a 3-dB difference in noise. As a particular noise from a source increases by more than 5 dB, a normal person would clearly respond (Yerges 1978). For the purposes of assessment under the California Environmental Quality Act (CEQA), Caltrans' noise impact criterion is based upon a quantifiable noise increase in comparison to the existing noise environment (Caltrans, 2006). When the project's predicted worst hour design-year noise level exceeds the existing worst-hour noise level by 12 dB L_{eq}(h) (1-hour equivalent sound level) or more, the noise increase is considered "substantial." Therefore, a project contributing a noise increase of 12 dB or more would cause noise impacts.

3.2 City Noise Impact Criterion

Traffic volumes on some parallel streets such as Franklin Street and Gough Street are anticipated to increase in various degrees. Since these streets are not part of a State Route, Caltrans' noise impact criterion of 12 dB L_{eq}(h) increase are not applicable for the noise impact assessment of these parallel streets. Considering the clear perception threshold of 5-dB increase and the City's municipal codes mandated in *Section 2909. Noise Limits*, a noise level increase of more than 5-dB above the ambient would be clearly perceived by receivers on these parallel streets. Therefore, a noise impact would occur if traffic volume increases on these streets result in a 5-dB or greater increase.

3.3 FTA Vibration Impact Criteria

The criteria in the *Transit Noise and Vibration Impact Assessment* (FTA, 2006) were used to evaluate vibration impacts from project construction and BRT operations. The evaluation of vibration impacts can be divided into two categories: (1) human annoyance, and (2) building damage.

Generally, human annoyance criteria are used to assess potential impacts associated with operational vibration whereas building damage criteria are used to estimate vibration impacts due to construction activities.

<u>Human Annoyance Criteria</u>

The ground-borne vibration impact criteria describe human response to vibration and potential interference related to the operation of vibration sensitive equipment. The criteria for acceptable ground-borne vibration are expressed in terms of RMS velocity levels in VdB and are based on the maximum levels for a single event (L_{max}). **Table 3-2** presents the criteria for various land use categories as well as the frequency of events.

Sensitive receivers within the project boundary include residences, hotels, and schools. These fall under Category 2, places where people normally sleep and Categories 1 and 3, performance spaces and institutional land uses with primarily daytime use. Since the number of proposed operations is 120 per weekday, the FTA classifies the proposed service under "Frequent Events." According to **Table 3-2**, the maximum vibration level cannot exceed 72 VdB for Category 2 land uses and 75 VdB for Category 3 land uses.

Building Damage Criteria

Normally, vibration resulting from a BRT vehicle pass-by would not cause building damage. However, damage to fragile historic buildings located near the right-of-way can be a concern.

Construction activities can also result in varying degrees of ground vibration, depending on the equipment and method employed. The vibration associated with typical transit construction is not likely to damage building structures, but it could cause cosmetic building damage.

Vibrations generated by surface transportation and construction activities are mainly in the form of surface or Raleigh waves. Studies have shown that the vertical component of transportation generated vibrations is the strongest, and that PPV correlates best with building damage and complaints. **Table 3-3** summarizes the construction vibration limits shown in FTA guidelines for structures located near the right-of-way of a transit project.

Table 3-2 – Ground-Borne Vibration Impact Criteria for Human Annoyance

Land Use Category	Ground-Borne Vibration Impact Levels (VdB re 1 micro-in/sec)		
	Frequent Events[1]	Occasional Events[2]	Infrequent Events[3]
Category 1: Buildings where vibration would interfere with interior operations.	65 VdB[4]	65 VdB[4]	65 VdB[4]
Category 2: Residences and buildings where people normally sleep.	72 VdB	75 VdB	80 VdB
Category 3: Institutional land uses with primarily daytime use.	75 VdB	78 VdB	83 VdB

Source: FTA, 2006.

Notes:

1. "Frequent Events" is defined as more than 70 vibration events of the same source per day. Most rapid transit projects fall into this category.
2. "Occasional Events" is defined as between 30 and 70 vibration events of the same source per day. Most commuter trunk lines have this many operations.
3. "Infrequent Events" is defined as more than 30 vibration events of the same kind per day. This category includes most commuter rail branch lines.
4. This criterion limit is based on levels that are acceptable for most moderately sensitive equipment, such as optical microscopes. Vibration-sensitive manufacturing or research will require detailed evaluation to define the acceptable vibration levels. Ensuring lower vibration levels in a building often requires special design of the HVAC systems and stiffened floors.

Table 3-3 – Construction Vibration Damage Criteria

Building Category	PPV (in/sec)	Approximate Lv*
I. Reinforced-concrete, steel, or timber (no plaster)	0.5	102
II. Engineered concrete and masonry (no plaster)	0.3	98
III. Non-engineered timber and masonry buildings	0.2	94
IV. Buildings extremely susceptible to vibration damage	0.12	90

Source: FTA, 2006.

Note:

* RMS velocity in decibels (VdB) re: 1 micro-inch per second.

3.4 Construction Noise and Vibration Ordinances

Construction impacts to sensitive neighborhoods, although temporary in nature, can affect occupants of nearby buildings and/ or compromise building structures. The City of San Francisco has jurisdiction over the construction noise and vibration of the proposed project alignment, which lies within the limits of the city. Noise levels during construction are regulated under Article 29 of the San Francisco Municipal Code (San Francisco, 2008). These noise restrictions are summarized as follows:

- Daytime (7 am to 8 pm): Construction activities are permitted provided that operation of any powered construction equipment, regardless of age or date of acquisition, does not emit noise at a level in excess of 80 dBA when measured at a distance of 100 feet. Impact tools and equipment are exempt from this restriction if they are equipped with intake and exhaust mufflers recommended by the manufacturers thereof, and approved by the Director of Public Works.
- Nighttime (8 pm to 7 am): Non-emergency construction activities are not permitted during nighttime hours if the resulting noise level is more than 5 dBA in excess of the ambient noise at the nearest property line unless express permission has been granted by the Director of Public Works.

No vibration impact criteria are included in the Code.

4.0 EXISTING SETTING

Parsons personnel visited the proposed project site between August 4th and 6th, 2008 to conduct noise monitoring and identify noise sensitive land use. The monitoring sites include noise-sensitive locations, such as residences, a concert hall, and a hotel.

This section describes the existing environment along the proposed alignment and summarizes the monitoring results in two parts. The first part will discuss the existing noise environment and the latter will discuss vibration issues.

4.1 Existing Noise Environment

The proposed BRT alignment follows Van Ness Avenue through the core of the north-of-Market-Street area. Van Ness Avenue is a principal arterial that provides interstate, interregional, and intraregional travel and goods movement, and forms part of U.S. 101. As such, it supports consistently high volumes of motor vehicular traffic throughout the typical weekday.

The proposed BRT would be implemented along an approximately 2 mile stretch of Van Ness Avenue (including a one-block portion of South Van Ness Avenue). Characteristics of neighborhoods shift from public and commercial uses in the southern portion of the proposed alignment, mixed residential-commercial in the middle portion, to multi-family residential in the northern portion. Most of these multi-family buildings have commercial uses such as office space or various stores on the ground level.

The noise environment in the vicinity of the Van Ness Avenue corridor is comprised of automobile, truck, and bus pass-by noise with intervals of motor vehicle horn noise as well as clatter from street level pedestrian and commercial activities.

Noise sensitive receivers along Van Ness Avenue that may be affected by the project include single- and multi-family residences (the latter often positioned above first-story street-side commercial uses), churches, and hotels. Along and between Franklin and Gough Streets, a larger proportion of solely residential buildings are present, along with schools, churches, hotels, two small museums. In addition, there are several parks and playfields along Gough.

Noise monitoring was conducted at various sites along Van Ness Avenue in order to assess the existing noise conditions throughout noise sensitive regions along the alignment. **Table 4-1** presents the locations and descriptions of the representative noise-sensitive sites. These locations are shown in **Figure 1** through **Figure 7** in **Appendix A**.

Noise measurements were taken at 11 locations within the project limits between August 4 and 6, 2008. The primary objectives of the measurements are to evaluate the existing noise environment and determine the appropriate impact criteria per FTA guidelines.

Short-term noise measurements were conducted at 10 sites for a duration of 20 minutes each, and a long-term measurement was conducted at one location for a total of 49 hours. At each short-term site, at least two measurements were performed, each at a different time of day. Multiple measurements were performed at each short-term site because only one suitable and available long-term measurement site was identified. Therefore, more than one set of short-term noise measurements were needed to determine the existing noise levels accurately. L_{dn} at the long-term measurement location was calculated by using hourly-measured noise levels. At short-term locations, L_{dn} levels were estimated by comparing two to three separate short-term noise level measurements to results obtained from nearby long-term measurement locations that were in progress concurrently.

Results for the long-term and short-term measurements are presented in **Table 4-1**. Also included in the table are the date, time, and duration of each measurement. **Appendix B** includes noise measurement field forms, as well as an hourly L_{eq} graph for the long-term measurement.

The following instruments were used for all of the above-mentioned noise measurements:

- Integrating Sound Level Meter – Larson Davis (LD) Model 812 and 820 integrating sound level meters with ANSI Type 1 instrumentation precision.
- Microphone System – LD Model 2559, ½-inch microphones with a wind screen attachment.
- Acoustic Field Calibrator – LD model CAL200 constant pressure microphone calibrator.

4.2 Existing Vibration Environment

No significant vibration sources exist along the proposed corridor. Typical automobile, truck, and bus pass-bys along local roadways would be the only perceptible vibration source along the alignment.

Table 4-1 – Measured Existing Noise Levels

Meas. Location/ Receiver Number	Side of Alignment	Land Use[1]	Date	Time	Duration hh:mm	Address	L_{eq}, dBA	L_{dn}[2] (Peak L_{eq}), dBA
ST1	West	MFR	08/04/08 08/05/08	18:31 11:16	00:20	140 South Van Ness Ave	72.3 69.9	76.8
ST2	East	AUD	08/04/08 08/05/08	15:48 11:43	00:20	201 Van Ness Ave Louise Davies Symphony Hall	71.4 71.0	(73.4)
ST3	East	MFR	08/04/08 08/05/08	15:21 12:09	00:20	512 Van Ness Ave	70.3 65.4	74.8
ST4	West	MFR	08/05/08	10:37 13:16	00:20	851 Van Ness Ave	73.8 71.5	76.1
ST5	West	MOT	08/04/08 08/05/08	13:48 09:51	00:20	1101 Van Ness Ave Cathedral Hill Hotel	68.9 69.0	72.4
ST6	West	MFR	08/05/08 08/06/08	15:56 14:09	00:20	1405 Van Ness Ave	67.4 75.6	77.4
ST7	East	MFR	08/05./08 08/06/08 08/06/08	16:45 08:59 12:40	00:20	1700 Van Ness Ave	74.1 73.0 72.4	76.4
ST8	East	MFR	08/05/08 08/06/08	17:37 09:46	00:20	2128 Van Ness Ave	65.9 71.8	73.9
ST9	West	MFR	08/06/08	09:58 12:06 14:41	00:20	2307 Van Ness Ave	72.5 74.2 71.5	75.5
ST10	West	MFR	08/06/08	11:29 13:03	00:20	2645 Van Ness Ave	72.9 72.4	75.7
LT1	East	MFR	08/04/08 08/05/08	12:07 13:54	23:00 26:00	750 Van Ness Ave #207	--	77.4 77.2

Notes:

STxx – short-term measurement location; LTxx – long-term measurement location.

1. SFR – single-family residence; MFR – multi-family residence; AUD – auditorium/museum; MOT: motel/hotel.
2. For all short-term measurement sites, L_{dn} levels were estimated by comparing hourly noise levels at a long-term monitoring site, LT1 and applying adjustment factors.

5.0 NOISE AND VIBRATION IMPACTS

This section analyzes the potential noise impacts associated with the construction and operation of the proposed project. The impact analysis presented in this section follows the methodologies outlined in the FTA's *Transit Noise and Vibration Impact Assessment* guidelines and Parsons' recent experience in evaluating noise impacts from other similar BRT projects.

5.1 Construction Noise

The nature of the proposed BRT construction work is conventional, principally modifications to the existing street/highway surfaces, new stations and concrete/asphalt travel way, curbs and gutters, utility relocations, drainage, signs, stripes, and signals. Construction noise varies greatly depending on the construction process, type and condition of the equipment used, and the layout of the construction site. Many of these factors are subject to the contractor's discretion. Projections of potential construction noise levels may vary from actual noise experienced during construction due to these factors.

Overall, construction noise levels are governed primarily by the noisiest pieces of equipment. The engine, which is usually diesel, is the dominant noise source for most construction equipment. The Draft PCP indicates that the following construction equipment would be used (Arup, 2009):

- 5 cy and under rubber-tired loaders
- 3 cy and under rubber-tired combination backhoe/excavator/loader
- Rubber-tired excavator
- Street-legal dump truck-style hauling units
- Motor graders similar to “CAT” 120 series sized machines
- Small “CAT” D-4 size and under dozers
- Steel drum rubber-tired self propelled compaction equipment
- Portable air compressor, light plant and generators sets
- Track-mounted asphalt milling equipment
- Track-mounted concrete and/or asphalt laydown equipment
- Rubber-tired lifting equipment (e.g., forklifts)
- Rollers
- Small pneumatically-driven hand tools such as pavement breakers and electrically-operated tools such as blowers, “skill” saw, drills, etc.
- Barrier movement machine

Preliminary construction planning was outlined in the Draft PCP. Based upon the selection of construction scheduling approaches and different alternatives, the construction duration could vary from 14 months to 69 months. Assuming a construction start date of September 2011, this would result in construction activities lasting until between November 2012 and May 2017. The Introduction chapter of this report provides additional information about proposed construction activities. **Table 5-1** presents reference noise levels for representative pieces of construction equipment.

Table 5-1 – Projected Construction Noise Emission Levels

Equipment	Typical Noise Level 50 ft from source	Typical Noise Level 100 ft from source[1]
Backhoe	80	74
Rubber-tired Excavator	85	79
Forklift	85	79
Front Loader	85	79
Jack Hammer	88	82
Saw	76	70
Asphalt Milling Machine*	84	78
Roller	74	68
Paver	77	71
Grader	85	79
Dozer	85	79
Concrete Mixers	77	71
Dump Trucks	75	69

Source: FTA, 2006; Parsons, 2010

Notes:

1. Noise levels at 100 feet are calculated using spherical spreading from a point source.

* The noise emission of an asphalt milling machine is not identified in the FTA manual; these data are from Parsons.

Brief noise disturbances could also be caused by trucks transporting equipment and supplies to and from construction staging areas. The Draft PCP proposes staging areas at Erie Street, Otis Street, and Filbert Street. Traffic noise from the U.S. 101 freeway would tend to mask noise related to construction staging at the Erie Street location. Traffic near the busy intersection of Otis and Mission Streets and Van Ness Avenue would tend to do the same for the Otis Street location. The proposed northern staging location is also near a major source of traffic noise – Van Ness Avenue. However, minor, intermittent noise disturbance could still occur at multifamily residences adjacent to the proposed staging site along Filbert Street.

5.2 Construction Vibration

Construction activity can result in varying degrees of ground vibration, depending on the equipment and methods used. The operation of construction equipment causes vibrations that spread through the ground and diminish in strength with traveled distance. Buildings in the vicinity of the construction site are affected by these vibrations, with resulting damage in the most severe cases.

Vibratory rollers would be the most dominant sources of overall construction vibration for this project. The vibration levels created by the normal movement of vehicles including graders, front loaders, and backhoes are comparable in order-of-magnitude to ground-borne vibrations created by heavy vehicles traveling on streets and highways.

Building damage can be cosmetic or structural. Fragile buildings such as some historical structures are generally more susceptible to damage from ground vibration. Normal buildings that are not particularly fragile would not experience any cosmetic damage (e.g., plaster cracks) at distances beyond 25 feet based on typical construction equipment vibration levels. This distance can vary substantially depending on the soil composition between vibration source and receiver. In addition, buildings react differently to vibrations.

The FTA has specifically addressed four different types of buildings: Category One, reinforced-concrete, steel or timber (no plaster); Category Two, engineered concrete and masonry (no plaster); Category Three, non-engineered timber and masonry buildings; Category Four, buildings extremely susceptible to vibration damage. Commercial type and multiple storied structures are generally represented by Category One and Two. Typical wood-framed residences fall under Category Three, while any structurally fragile buildings (more likely to be historical in nature) would fall under Category Four. There are buildings of historical significance along the project alignment, but none that have been identified as sufficiently sensitive to vibration impact to fall under Category Four.

The vibration levels generated by construction equipment from the FTA *Transit Noise and Vibration Impact Assessment* document are shown in **Table 5-2**. Calculations were performed to determine the distances at which vibration impacts would occur according to the FTA criteria discussed in Section 3.3. **Table 5-2** shows the results of those calculations as classified per building category. The distances shown in **Table 5-2** are the maximum distances at which short-term construction vibration impacts may occur. Mitigation would be required if construction equipment were to operate within the distances shown in **Table 5-2** from buildings located along the project alignment.

Table 5-2 – Vibration Source Levels and Building Damage Impact Distances for Construction Equipment

Equipment	PPV[1] at 25 ft, in/sec	Approximate Lv[2] at 25 ft	Impact Distance for Building Category, ft		
			I	II	III
Vibratory Roller	0.210	94	14	18	25
Loaded Trucks	0.076	86	7	10	14
Jackhammer	0.035	79	4	6	8
Small Bulldozer	0.003	58	1	1	2

Source: FTA, 2006

Notes:

1. Peak Particle Velocity
2. RMS velocity in decibels (VdB), re: 1 micro-inch per second

5.3 Operational Noise Impacts

Potential operational noise impacts associated with the proposed Van Ness BRT project are assessed in this section. The results are discussed in the following two subsections: operational noise along Van Ness Avenue and along parallel local streets.

5.3.1 Operational Noise along Van Ness Avenue

Build Alternatives 2, 3, and 4 propose construction of a dedicated bus lane whereas Alternative 1 only pertains to TSM capability improvements and replacing the current bus fleet with low-floor buses. Build Alternative 2 would provide a dedicated bus lane in the rightmost travel lane of Van Ness Avenue in both the north and southbound directions. Build Alternatives 3 and 4 would convert the existing landscaped median and portions of two inside traffic lanes for a dedicated bus lane.

The proposed service schedule for the BRT alternative is as shown in **Table 5-3**. There will be headways of 3.5 minutes during peak hours and 5 minutes during midday hours and 10 to 20 minutes during evening and nighttime hours. Service will begin at 6 am and end at midnight.

An operational noise assessment was conducted using the FTA guidelines spreadsheet. The proposed future BRT vehicle fleet is expected to include some combination of diesel hybrid and electric-powered vehicles. However, to assure a conservative analysis, noise modeling was performed using the spreadsheet model's diesel bus option, as diesel buses would be the noisiest. Project buses were assumed to operate at the posted speed limit of 25 miles per hour (mph). In practice, the operating speed would vary in the vicinity of proposed passenger stations as the bus approaches and departs from a station; however speeds would not be expected to exceed the speed limit. Also, while BRT travel between stations would be enhanced by traffic signal priority and signal optimization, travel speeds for any given bus trip would still be affected at some intersections due to red lights.

Table 5-3 – One-Way Operation Schedule for Proposed BRT Service

Operation Time	Headway, minutes	Number of Operations per Hour
6:00 AM – 9:00 AM	3.5	17
9:00 AM – 3:00 PM	5.0	12
3:00 PM – 7:00 PM	3.5	17
7:00 PM – 9:00 PM	10 to 15	4 to 6
9:00 PM – 12:00 AM	15 to 20	3 to 4
12:00 AM – 6:00 AM	Non Operational	Non Operational
Average Daytime (7:00 AM – 10:00 PM) BRT/hour: 12.7		
Average Nighttime (10:00 PM – 7:00 AM) BRT/hour: 2.8		

Note:
1. Bus headways would be the same for the No-Build Alternative, as well as Build Alternatives 2, 3 and 4, with or without incorporation of the Center B Design Variation.

BRT noise levels were calculated using the operation schedule, speed, and distance to the proposed BRT alignment. **Table 5-4** summarizes all relevant project information used in assessing future noise impacts with the FTA transit noise model.

Table 5-4 – Parameters Used in FTA Bus Noise Model

FTA Model Category	Details
Land use categories (from Table 3-1)	Category 1 (television studios and concert halls) Category 2 (residential areas, hotels, future hospital) Category 3 (public recreation areas, schools, churches, museums)
Distance to centerline of nearest BRT lane	17 to 122 feet (varies by receiver and alternative)
Bus vehicle type: Reference SEL[1]	Diesel-powered bus 82 dBA*
Speed	25 mph
Average number of daytime[2] buses per hour	12.7
Average number of nighttime[2] buses per hour	2.8
Buses per hour during peak BRT activity	17

Notes:
1. The reference SEL is at a standard distance of 50 feet and 50 mph.
2. Daytime hours are 7 am to 10 pm; nighttime hours are 10 pm to 7 am.

* The FTA's diesel-powered bus which has a higher typical reference SEL level than a diesel hybrid or electrified bus.

The calculated noise levels were then compared to the "Moderate Impact" and "Severe Impact" criteria, established according to the ambient noise conditions. **Tables 5-5** and

5-6 provide the results of the calculations at the sensitive receivers and the degree of impact. Calculations demonstrate no anticipated noise impacts along Van Ness Avenue from the proposed BRT service. **Table 5-5** summarizes the results obtained from the FTA guidelines spreadsheet for Build Alternative 2; **Table 5-6** does the same for Alternatives 3 and 4.

Predicted noise level increases were also compared with Caltrans' 12-dB substantial increase criterion. The final column of **Tables 5-5** and **5-6** show that the predicted increases remain well below that criterion.

5.3.2 Operational Noise on Parallel Streets

Some of the reduction in traffic along Van Ness Avenue under the project alternatives would be redistributed to alternative routes. Franklin and Gough Streets would bear more of the redistributed traffic than any other alternate route. **Tables 5-7** and **5-8** indicate modeled traffic volumes along various segments of these streets under the relevant analysis scenarios. In Table 5-7, some of the volumes represent level of service (LOS) C conditions. When peak hour volumes exceed LOS C volumes, LOS C traffic flow represents loudest hour conditions. As traffic volumes increase such that LOS deteriorates to levels below C, travel speeds tend to decrease sufficiently to lower traffic noise levels relative to LOS C conditions. **Table 5-9** summarizes predicted changes in traffic noise levels along these streets in terms of Ldn and peak hour Leq. These predicted changes are independent of distance from the indicated roadways, although the noise levels themselves would vary with distance from the roadways.

Along segments of Franklin and Gough Streets paralleling the project corridor, future traffic noise levels as a result of different project alternatives are predicted to be less than one decibels higher than future no project noise levels except for one low-volume segment of Gough Street, where the predicted increase is 1.5 dB. Relative to existing traffic noise levels, future project traffic noise levels would increase by 0 to 2.2 dB. Typically a noise change 3 dB or less is not noticeable (Caltrans, 2009). All of these levels are below the 5-dB threshold derived from the City Noise Ordinance. Accordingly, no mitigation is required for operational noise impacts.

5.4 Operation Vibration Impacts

Significant vibration impact from rubber tire-fitted vehicles is extremely rare. This is because rubber tire-fitted vehicles are not as massive as railway vehicles. They are additionally typically well-isolated by the vehicle suspension design and rubber tires which act as a highly effective barrier to vibration transmission from the vibration-generating carriage and the main propagation medium for vibration excitation, the ground. Potential vibration impact from rubber tire-fitted vehicles such as those used in BRT projects can be reasonably dismissed under general conditions (FTA, 2006). No further assessment is needed.

Table 5-5 – Operational Noise Levels for Alternative 2

Receiver Number	Land Use Category[1]	Distance to Bus Lane NB/SB, feet	Existing Noise Level Ldn (Leq)[2], dBA	Criteria, Moderate / Severe, dBA	Project Noise Level, Ldn (Leq)[2], dBA	Cumulative Noise, Ldn (Leq)[2], dBA	Increase in Cumulative Noise, dB	Noise Impact FTA Criteria	Noise Impact Caltrans Criterion[3]
R2	2	17 / 82	75	66-73 / >73	62	75	0	No	No
R3	1	110 / 45	(70)	65-69 / >69	(56)	(70)	0	No	No
R4	3	18 / 83	(70)	70-74 / >74	(62)	(71)	1	No	No
R5	1	154 / 88	(70)	65-69 / >69	(52)	(70)	0	No	No
R6	2	28 / 93	74	66-72 / >72	59	74	0	No	No
R7	3	102 / 34	(69)	69-74 / >74	(57)	(69)	0	No	No
R8	3	19 / 84	(69)	69-74 / >74	(61)	(70)	1	No	No
R9	2	23 / 88	77	66-74 / >74	60	77	0	No	No
R10	2	96 / 30	76	66-74 / >74	59	76	0	No	No
R11	1	89 / 33	(71)	66-70 / >70	(58)	(71)	0	No	No
R12	2	21 / 84	76	66-74 / >74	61	76	0	No	No
R13	2	113 / 50	72	66-71 / >71	56	72	0	No	No
R14	3	16 / 81	(70)	70-74 / >74	(62)	(71)	1	No	No
R15	2	94 / 29	75	66-73 / >73	59	75	0	No	No
R16	2	22 / 87	77	66-74 / >74	60	77	0	No	No
R17	2	23 / 88	77	66-74 / >74	60	77	0	No	No
R18	2	93 / 28	77	66-74 / >74	59	77	0	No	No
R19	3	24 / 90	(72)	71-76 / >76	(60)	(72)	0	No	No
R20	3	91 / 26	(72)	71-76 / >76	(59)	(72)	0	No	No
R21	2	97 / 32	72	66-71 / >71	58	72	0	No	No
R22	2	28 / 94	72	66-71 / >71	59	72	0	No	No
R23	3	96 / 30	(67)	68-72 / >72	(58)	(68)	1	No	No

Table 5-5 – Operational Noise Levels for Alternative 2 (cont'd)

Receiver Number	Land Use Category[1]	Distance to Bus Lane NB/SB, feet	Existing Noise Level L_{dn} (L_{eq})[2], dBA	Criteria, Moderate / Severe, dBA	Project Noise Level, L_{dn} (L_{eq})[2], dBA	Cumulative Noise, L_{dn} (L_{eq})[2], dBA	Increase in Cumulative Noise, dBA	Noise Impact FTA Criteria	Noise Impact Caltrans Criterion[3]
R24	2	23 / 88	76	66-74 / >74	60	76	0	No	No
R25	2	94 / 27	76	66-74 / >74	59	76	0	No	No
R26	3	103 / 39	(71)	71-75 / >75	(57)	(71)	0	No	No
R27	2	19 / 85	75	66-73 / >73	61	75	0	No	No
R28	2	90 / 24	75	66-73 / >73	60	75	0	No	No
R29	2	90 / 24	75	66-73 / >73	60	75	0	No	No

Notes:

1. Category 1 – Includes recording studios and concert halls; Category 2 – Includes residences and Hotels; Category 3 – Includes schools, theatres and churches.
2. Noise levels shown within parentheses represent one-hour L_{eq}. L_{eq} is applied rather than L_{dn} for Category 1 or Category 3 land uses. The L_{eq} values provided here represent one-hour periods corresponding to the times of future peak BRT operations.
3. The Caltrans criterion applicable to CEQA analysis is a 12-dB increase.

Table 5-6 – Operational Noise Levels for Alternatives 3 and 4

Receiver Number	Land Use Category[1]	Distance to Bus Center Lane, feet	Existing Noise Level Ldn (Leq)[2], dBA	Criteria, Moderate / Severe, dBA	Project Noise Level, Ldn (Leq)[2], dBA	Cumulative Noise, Ldn (Leq)[2], dBA	Increase in Cumulative Noise, dB	Noise Impact FTA Criteria	Noise Impact Caltrans Criterion[3]
R2	2	47	75	66-73 / >73	58	75	0	No	No
R3	1	78	(70)	65-69 / >69	(54)	(70)	0	No	No
R4	3	50	(70)	70-74 / >74	(57)	(70)	0	No	No
R5	1	122	(70)	65-69 / >69	(51)	(70)	0	No	No
R6	2	61	74	66-72 / >72	56	74	0	No	No
R7	3	60	(69)	69-74 / >74	(55)	(69)	0	No	No
R8	3	58	(69)	69-74 / >74	(56)	(69)	0	No	No
R9	2	59	77	66-74 / >74	56	77	0	No	No
R10	2	64	76	66-74 / >74	56	76	0	No	No
R11	1	63	(71)	66-70 / >70	(56)	(71)	0	No	No
R12	2	55	76	66-74 / >74	57	76	0	No	No
R13	2	79	72	66-71 / >71	55	72	0	No	No
R14	3	51	(70)	70-74 / >74	(57)	(70)	0	No	No
R15	2	59	75	66-73 / >73	56	75	0	No	No
R16	2	53	77	66-74 / >74	57	77	0	No	No
R17	2	53	77	66-74 / >74	57	77	0	No	No
R18	2	58	77	66-74 / >74	57	77	0	No	No
R19	3	56	(72)	71-76 / >76	(56)	(72)	0	No	No
R20	3	59	(72)	71-76 / >76	(56)	(72)	0	No	No
R21	2	64	72	66-71 / >71	56	72	0	No	No
R22	2	62	72	66-71 / >71	56	72	0	No	No
R23	3	62	(67)	68-72 / >72	(56)	(67)	0	No	No

Table 5-6 – Operational Noise Levels for Alternatives 3 and 4 (cont'd)

Receiver Number	Land Use Category[1]	Distance to Bus Center Lane, feet	Existing Noise Level Ldn (Leq)[2], dBA	Criteria, Moderate / Severe, dBA	Project Noise Level, Ldn (Leq)[2], dBA	Cumulative Noise, Ldn (Leq)[2], dBA	Increase in Cumulative Noise, dBA	Noise Impact FTA Criteria	Noise Impact Caltrans Criterion[3]
R24	2	56	76	66-74 / >74	57	76	0	No	No
R25	2	59	76	66-74 / >74	56	76	0	No	No
R26	3	69	(71)	71-75 / >75	(55)	(71)	0	No	No
R27	2	53	75	66-73 / >73	57	75	0	No	No
R28	2	55	75	66-73 / >73	57	75	0	No	No
R29	2	62	75	66-73 / >73	56	75	0	No	No

Notes:

1. Category 1 –Includes recording studios and concert halls; Category 2 – Includes residences and Hotels; Category 3 – Includes schools, theatres and churches.
2. Noise levels shown within parentheses represent one-hour Leq. Leq is applied rather than Ldn for Category 1 or Category 3 land uses. The Leq values provided here represent one-hour periods corresponding to the times of future peak BRT operations.
3. The Caltrans criterion applicable to CEQA analysis is a 12-dB increase.
4. Operational noise levels under Build Alternatives 3 and 4 would not change with or without incorporation of the Center B Design Variation.

Table 5-7 – Predicted Traffic Volumes along Key Parallel Routes: Loudest Hour[1]

			Van Ness (2-way)				Franklin (1-way, timed signals)[3,5]				Gough (1-way & timed signals South of Sacramento St.)[4,5]			
				Loudest Hour Volumes				Loudest Hour Volumes				Loudest Hour Volumes		
				No Project		With Project		No Project		With Project		No Project		With Project
Segment	Direction	Assumed Travel Speed (mph)	# Mixed-Flow Lanes[2]	Existing Conditions (2007)	Future (2035)	Future (2035)	# Mixed-Flow Lanes	Existing Conditions (2007)	Future (2035)	Future (2035)	# Mixed-Flow Lanes	Existing Conditions (2007)	Future (2035)	Future (2035)
North of Mission Street	SB	25	3 / 2	1,326	1,559	1,200								
	NB	25	3 / 2	1,883	1,900	1,200								
North of Market Street	SB	25	3 / 2	1,479	1,736	1,200					3	1,699	1,879	1,900
	NB	25	3 / 2	1,774	1,900	1,200	3	1,220	1,498	1,900				
North of McAllister Street	SB	25	3 / 2	1,518	1,755	1,200					3	1,900	1,900	1,900
	NB	25	3 / 2	1,623	1,900	1,200	3	1,900	1,900	1,900				
North of Geary Street	SB	25	3 / 2	1,629	1,887	1,200					3	1,900	1,900	1,900
	NB	25	3 / 2	1,490	1,900	1,200	3	1,900	1,900	1,900				
North of California Street	SB	25	3 / 2	1,554	1,816	1,200					2	1,158	1,200	1,200
	NB	25	3 / 2	1,448	1,872	1,200	3	1,900	1,900	1,900				
North of Broadway Street	SB	25	3 / 2	1,818	1,900	1,200					1	540	482	540
	NB	25	3 / 2	1,611	1,900	1,200	3	1,900	1,900	1,900	1	74	101	145
North of Lombard Street	SB	25	3 / 2	762	880	553					1	257	248	349
	NB	25	3 / 2	389	597	449	3	441	594	814	1	85	108	145

SOURCE: CHS, 2010

Notes:

1. When peak hour volumes exceed LOS C volumes, LOS C traffic flow represents loudest hour volumes, or conditions. Thus Table 5-7 shows volumes no higher than LOS C volumes.
2. The Existing Conditions scenario on Van Ness Avenue is modeled to consider three mixed flow traffic lanes (with LOS C conditions represented as 1,900 vehicles per hour); while the Future Conditions scenario considers two mixed flow traffic lanes (LOS C at 1,200 vehicles per hour) as proposed under the BRT build alternatives.
3. It is assumed that the LOS C volume for Franklin with three mixed flow traffic lanes under both existing and future conditions is 1,900 vehicles per hour.
4. It is assumed that the LOS C volumes for Gough for both existing and future conditions are as follows: 540 vehicles per hour for one lane (per direction), 1,200 vehicles per hour for two lanes (one-way), and 1,900 vehicles per hour for three lanes (one-way).
5. Franklin Street is a one-way street throughout the entire project study corridor and Gough Street is one-way throughout most of the study corridor. Thus, southbound volumes are not applicable for Franklin Street and northbound volumes are not applicable for most segments of Gough Street.

Table 5-8 – Predicted Traffic Volumes along Key Parallel Routes: Average Daily Traffic

		Van Ness			**Franklin**			**Gough**		
		No Project			**No Project**			**No Project**		
Segment		**Existing Conditions (2007)**	**Ultimate (2035)**	**With Project (2035)**	**Existing Conditions (2007)**	**Ultimate (2035)**	**With Project (2035)**	**Existing Conditions (2007)**	**Ultimate (2035)**	**With Project (2035)**
North of Mission Street	25	48,199	59,885	42,732						
North of Market Street	25	48,860	60,486	43,062	16,946	20,807	29,419	25,672	28,392	30,522
North of McAllister Street	25	47,178	57,977	43,077	34,878	39,975	45,809	31,988	36,249	38,969
North of Geary Street	25	46,847	57,376	44,880	37,114	43,337	47,823	29,646	33,015	35,599
North of California Street	25	45,090	55,394	41,590	33,961	39,600	44,434	17,497	19,356	22,861
North of Broadway Street	25	51,504	62,829	45,541	27,683	32,419	37,670	9,504	8,809	11,015
North of Lombard Street	25	17,288	22,185	15,050	6,834	9,001	11,306	5,168	5,379	7,434

SOURCE: CHS, 2010

Table 5-9 – Changes in Traffic Noise Levels along Key Parallel Routes

	Changes to Traffic Noise Levels (dB)[1]							
	Franklin				Gough			
	Ldn[2]		Peak Hour Leq		Ldn[2]		Peak Hour Leq	
Segment	Project Change[3]	Cumulative Change[4]	Project Change[3]	Cumulative Change[4]	Project Change[3]	Cumulative Change[4]	Project Change[3]	Cumulative Change[4]
North of Market Street	+0.7	+1.2	+1.0	+1.9	+0.1	+0.3	+0.0	+0.5
North of McAllister Street	+0.3	+0.5	0.0	0.0	+0.1	+0.4	0.0	0.0
North of Geary Street	+0.2	+0.5	0.0	0.0	+0.1	+0.4	0.0	0.0
North of California Street	+0.2	+0.5	0.0	0.0	+0.3	+0.5	0.0	+0.2
North of Broadway Street	+0.3	+0.6	0.0	0.0	+0.4	+0.3	+0.5	0.0
North of Lombard Street	+0.4	+1.1	+1.0	+2.2	+0.7	+0.7	+1.5	+1.3

Notes:

1 - Based on project alternative producing the greatest redistribution of traffic onto the indicated roadway segment.
2 - Assumes that all redistribution of traffic occurs during daytime hours.
3 - Year 2035 traffic noise level with project minus year 2035 traffic noise level without project.
4 - Year 2035 traffic noise level with project minus existing traffic noise level without project.

SOURCE: Parsons, 2010

5.5 Summary of Construction and Operational Impacts

Nighttime construction related to the proposed project would cause City noise ordinance limits to be exceeded from time to time. Caltrans guidelines for construction noise include compliance with local ordinances. In the absence of mitigation, there would likely be a few instances where vibratory rollers would need to operate near enough to wood-frame buildings such that FTA vibration thresholds for cosmetic damage could be briefly and slightly exceeded at those buildings.

Operational project-generated and cumulative noise impacts along Van Ness Avenue would remain below both FTA and Caltrans impact criteria. Traffic noise increases along parallel streets would be lower than the applicable City impact threshold. Operational vibration impacts would be less than significant relative to the applicable FTA criteria.

6.0 MITIGATION MEASURES

This section discusses the possible mitigation measures that can be implemented to either reduce or eliminate any impacts generated by the construction and operation of the proposed project.

6.1 Construction Mitigation Measures

Construction impacts are of a temporary nature, and construction is a necessary part of any project. However, mitigation measures may be required to minimize impacts. In addition, non-emergency construction activities are not permitted during nighttime hours if the resulting noise level is more than 5 dB in excess of the ambient noise at the nearest property line. In effect, this would include most noise-generating construction activities and almost any such activity occurring near the edge of right-of-way.

In general, construction activities conducted during daytime hours would have a lesser impact on residential land uses than nighttime construction. However, there may be locations where nighttime construction would be less obtrusive, such as between Otis and Hayes Streets at the south end of the corridor where residential uses were not identified directly along Van Ness. Nighttime construction is expected to be necessary to avoid unacceptable disruptions to street and/or pedestrian traffic during daytime hours. The PCP indicates that the following activities are most likely to be performed during nighttime hours:

- Reconfiguration of curb bulbs.
- Utility relocations that affect intersection corners to minimize impacts to pedestrian traffic.
- Mill-and-fill work for the curb-to-curb pavement rehabilitation.

There are a number of measures that can be taken to minimize intrusion without placing unreasonable constraints on the construction process or substantially increasing costs. The following are possible control measures that can be implemented in order to minimize noise and vibration disturbances at sensitive areas during construction:

1. Use newer equipment with improved noise muffling and ensure that all equipment items have the manufacturers’ recommended noise abatement measures, such as mufflers, engine covers, and engine vibration isolators intact and operational. Newer equipment will generally be quieter in operation than older equipment. All construction equipment should be inspected at periodic intervals to ensure proper maintenance and presence of noise control devices (e.g., mufflers and shrouding, etc.).
2. Perform all construction in a manner that minimizes noise and vibration. Utilize construction methods or equipment that will provide the lowest level of noise and ground vibration impact. The contractor should be required to select construction processes and techniques that create the lowest noise levels.
3. Perform independent noise and vibration monitoring to demonstrate compliance with applicable noise limits, especially in particularly sensitive areas. Require

contractors to modify and/or reschedule their construction activities if monitoring determines that maximum limits are exceeded at residential land uses.

4. Conduct truck loading, unloading and hauling operations so that noise and vibration are kept to a minimum by carefully selecting routes to avoid passing through residential neighborhoods to the greatest possible extent.
5. Turn off idling equipment.
6. Minimize construction activities during evening, nighttime, weekend, and holiday periods.
7. The construction contractor should be required by contract specification to comply with the City noise ordinances and obtain all necessary permits, particularly in relation to nighttime construction work.

It is expected that ground-borne vibration from construction activities would cause only intermittent, localized intrusion along the BRT corridor. Processes such as earth moving with bulldozers and the use of vibratory compaction rollers can create annoying vibration. There are cases where it may be necessary to use this type of equipment in close proximity to residential buildings. Following are some procedures that can be used to minimize the potential for annoyance or damage from construction vibration:

1. When possible, limit the use of construction equipment that creates high vibration levels, such as vibratory rollers and hammers. When such equipment must be used within 25 feet of any existing building, select equipment models that generate lower vibration levels.
2. Require vibration monitoring during vibration-intensive activities.
3. Restrict the hours of vibration-intensive equipment or activities such as vibratory rollers so that annoyance to residents is minimal (e.g., limit to daytime hours as defined in the noise ordinance).

A combination of the mitigation techniques for equipment noise and vibration control as well as administrative measures, when properly implemented, can be selected to provide the most effective means to minimize the effects of construction activity impacts. Application of the mitigation measures will reduce the construction impacts; however, temporary increases in noise and vibration would still occur at some locations.

6.2 Operation Mitigation Measures

No significant noise impacts from BRT operation are anticipated. Vibration impact due to BRT operation is discussed in Section 5.5 and dismissed due to the typical operational characteristics and vehicle design of BRT vehicles. However, roadway surface defects such as pot holes would elevate BRT passby noise and vibration. Thus, maintaining upkeep of roadway surface to reduce BRT noise and vibration is recommended.

7.0 REFERENCES

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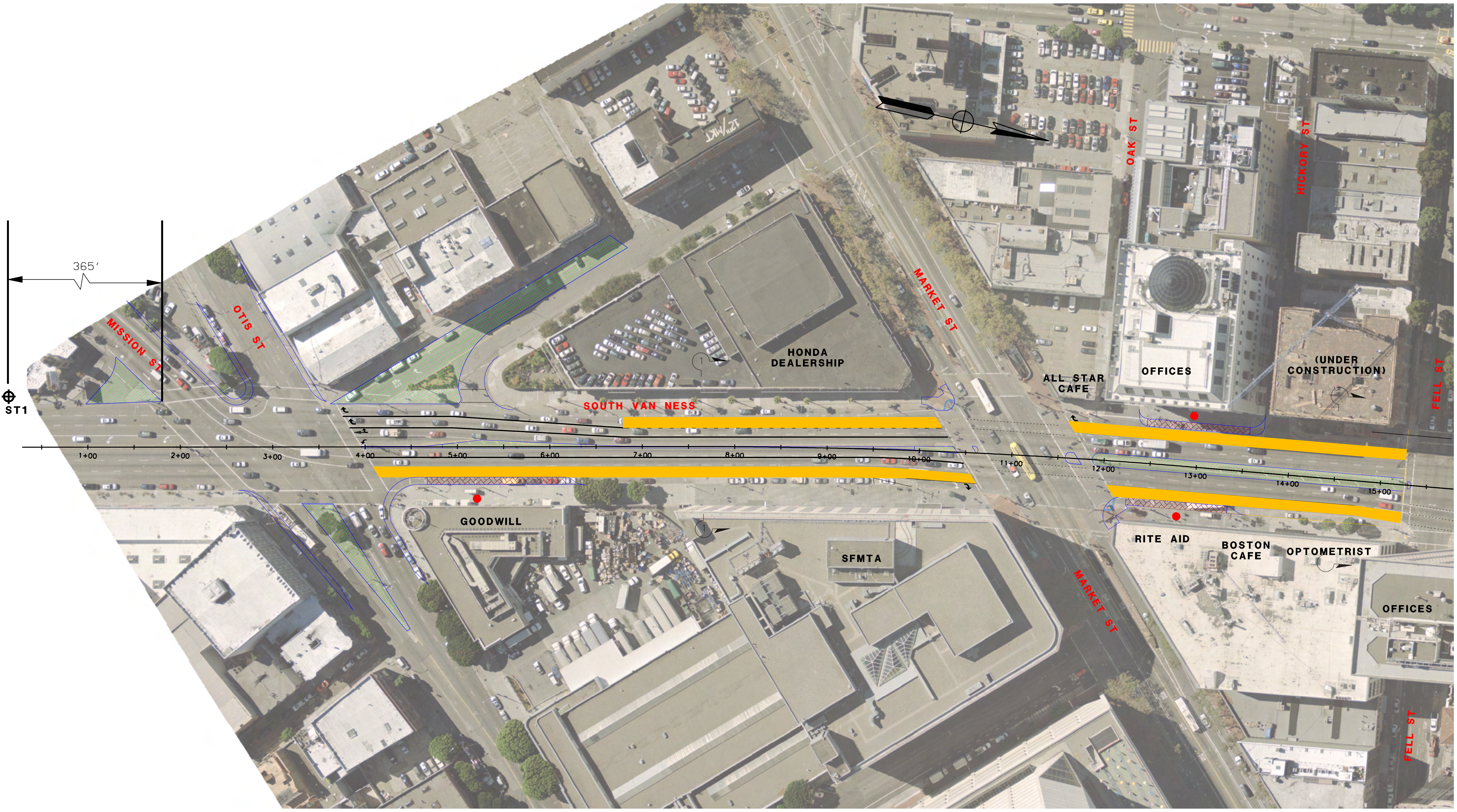
FTA, 2006. Federal Transit Administration, *Transit Noise and Vibration Impact Assessment*, Office of Planning/Federal Transportation Administration, FTA-VA-90-1003-06, May. (http://www.fta.dot.gov/documents/FTA_Noise_and_Vibration_Manual.pdf)

San Francisco, 2008. City and County of San Francisco, *Municipal Code Article 29: Regulation of Noise*, amended through November 25. (http://www.municode.com/content/4201/14140/HTML/ch029.html)

Yerges 1978. Lyle F. Yerges, *Sound, Noise, and Vibration Control*.

APPENDIX A – NOISE AND VIBRATION MODELING SITES



LEGEND

⊕R5 – SENSITIVE RECEPTOR SITE
⊕ST – SHORTERM MEASUREMENT
⊕LT – LONGTERM MEASUREMENT

SFR – SINGLE FAMILY RESIDENCE
MFR – MULTI-FAMILY RESIDENCE
COMM – COMMERCIAL
G/F – GROUND FLOOR

1in : 100ft

0 ft 50ft 100ft 150ft

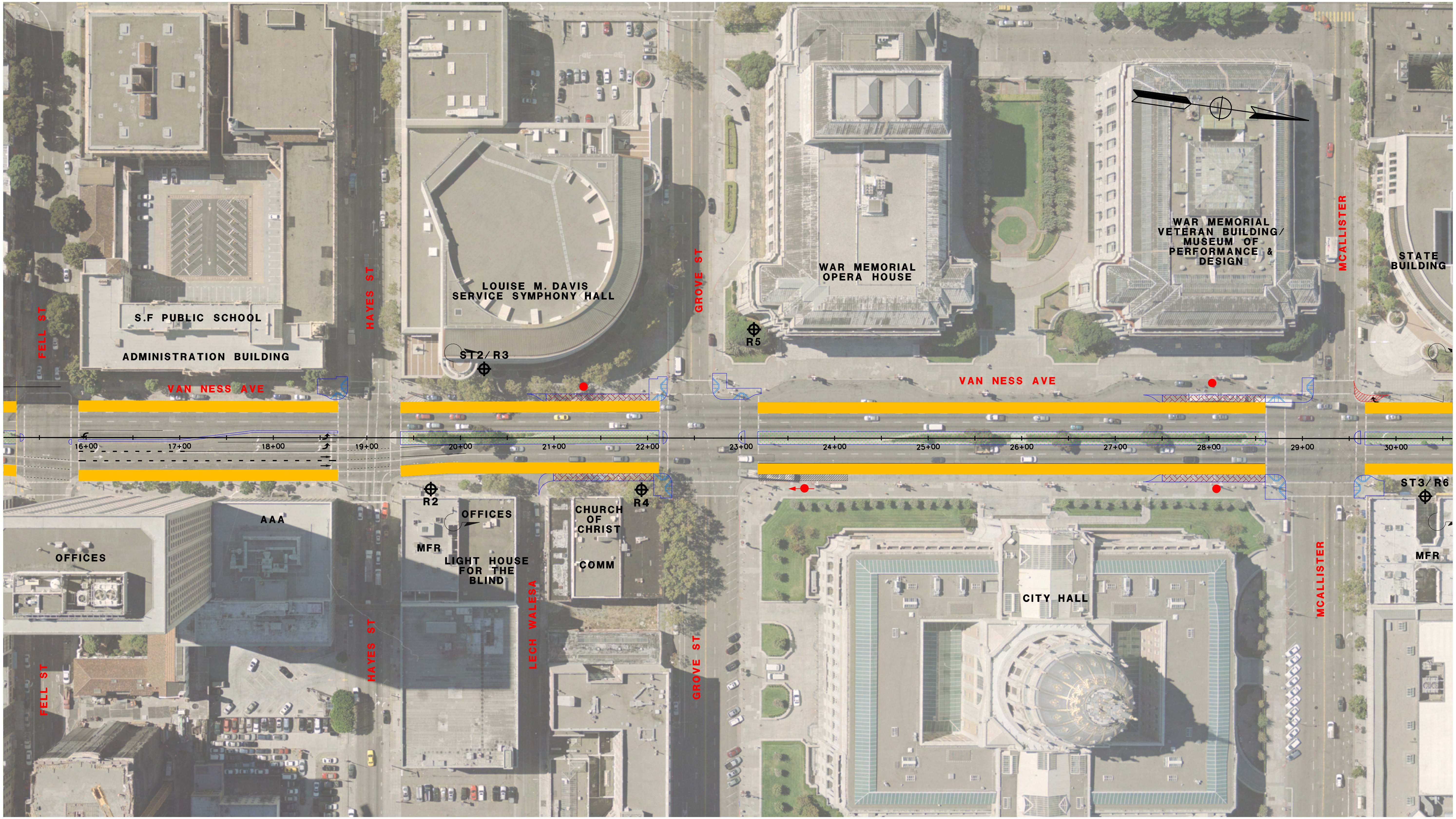
PARSONS

100 WEST WALNUT ST.
PASADENA, CA 91124
(626) 440-6100

VAN NESS AVENUE BRT SENSITIVE RECEPTOR & NOISE MEASUREMENT LOCATIONS

AUGUST 10, 2010

SHEET NO. 1 OF 7



LEGEND

R5 – SENSITIVE RECEPTOR SITE
ST – SHORTERM MEASUREMENT
LT – LONGTERM MEASUREMENT

SFR – SINGLE FAMILY RESIDENCE
MFR – MULTI-FAMILY RESIDENCE
COMM – COMMERCIAL
G/F – GROUND FLOOR

1in : 100ft

0 ft 50ft 100ft 150ft

PARSONS

100 WEST WALNUT ST.
PASADENA, CA 91124
(626) 440-6100

VAN NESS AVENUE BRT SENSITIVE RECEPTOR & NOISE MEASUREMENT LOCATIONS

AUGUST 10, 2010

SHEET NO. 2 OF 7

LEGEND

- ⊕R5 – SENSITIVE RECEPTOR SITE
- ⊕ST – SHORTERM MEASUREMENT
- ⊕LT – LONGTERM MEASUREMENT

- SFR – SINGLE FAMILY RESIDENCE
- MFR – MULTI-FAMILY RESIDENCE
- COMM – COMMERCIAL
- G/F – GROUND FLOOR

1in : 100ft

0 ft 50ft 100ft 150ft

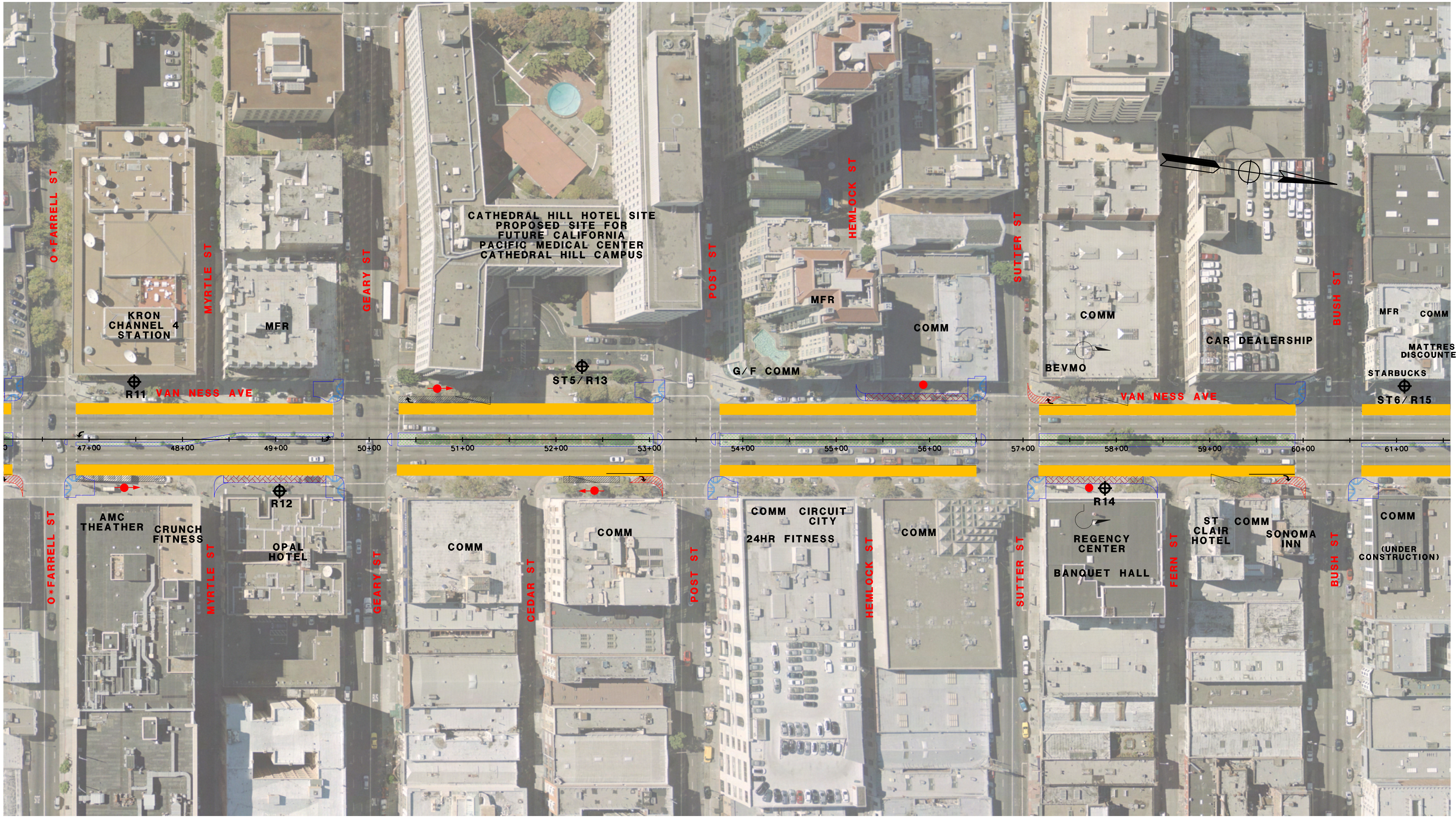
PARSONS

100 WEST WALNUT ST.
PASADENA, CA 91124
(626) 440-6100

VAN NESS AVENUE BRT
SENSITIVE RECEPTOR &
NOISE MEASUREMENT LOCATIONS

AUGUST 10, 2010

SHEET NO. 3 OF 7



LEGEND

⊕R5 – SENSITIVE RECEPTOR SITE
⊕ST – SHORTERM MEASUREMENT
⊕LT – LONGTERM MEASUREMENT

SFR – SINGLE FAMILY RESIDENCE
MFR – MULTI-FAMILY RESIDENCE
COMM – COMMERCIAL
G/F – GROUND FLOOR

1in : 100ft

0 ft 50ft 100ft 150ft

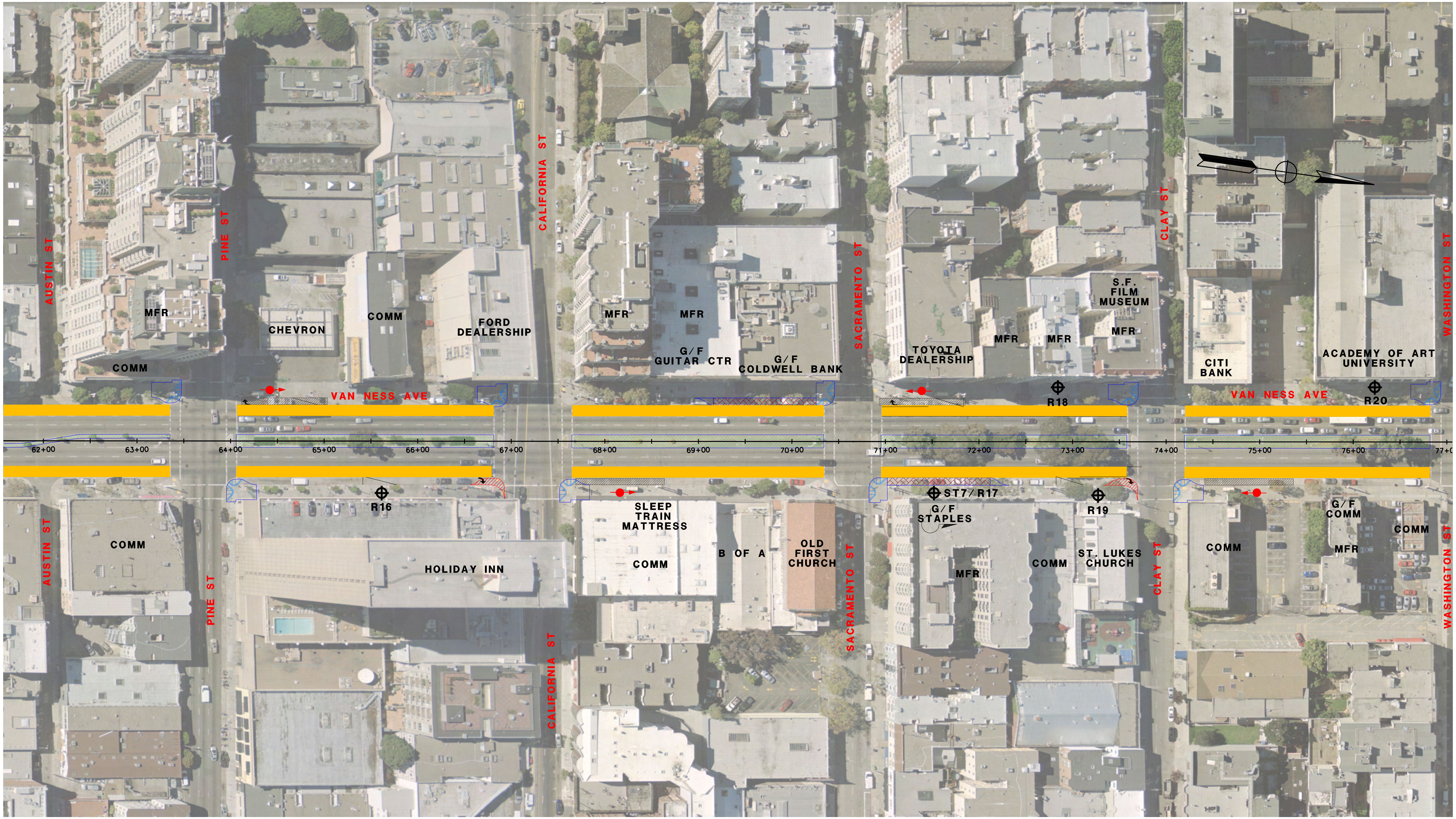
PARSONS

100 WEST WALNUT ST.
PASADENA, CA 91124
(626) 440-6100

VAN NESS AVENUE BRT
SENSITIVE RECEPTOR &
NOISE MEASUREMENT LOCATIONS

AUGUST 10, 2010

SHEET NO. 4 OF 7



LEGEND

⊕R5 – SENSITIVE RECEPTOR SITE
⊕ST – SHORTERM MEASUREMENT
⊕LT – LONGTERM MEASUREMENT

SFR – SINGLE FAMILY RESIDENCE
MFR – MULTI-FAMILY RESIDENCE
COMM – COMMERCIAL
G/F – GROUND FLOOR

1in : 100ft

0 ft 50ft 100ft 150ft

PARSONS

100 WEST WALNUT ST.
PASADENA, CA 91124
(626) 440-6100

VAN NESS AVENUE BRT SENSITIVE RECEPTOR & NOISE MEASUREMENT LOCATIONS

AUGUST 10, 2010

SHEET NO. 5 OF 7

LEGEND

⊕R5 – SENSITIVE RECEPTOR SITE
⊕ST – SHORTERM MEASUREMENT
⊕LT – LONGTERM MEASUREMENT

SFR – SINGLE FAMILY RESIDENCE
MFR – MULTI-FAMILY RESIDENCE
COMM – COMMERCIAL
G/F – GROUND FLOOR

1in : 100ft

0 ft 50ft 100ft 150ft

PARSONS

100 WEST WALNUT ST.
PASADENA, CA 91124
(626) 440-6100

VAN NESS AVENUE BRT SENSITIVE RECEPTOR & NOISE MEASUREMENT LOCATIONS

AUGUST 10, 2010

SHEET NO. 6 OF 7

LEGEND

⊕R5 – SENSITIVE RECEPTOR SITE

⊕ST – SHORTERM MEASUREMENT

⊕LT – LONGTERM MEASUREMENT

SFR – SINGLE FAMILY RESIDENCE

MFR – MULTI-FAMILY RESIDENCE

COMM – COMMERCIAL

G/F – GROUND FLOOR

1in : 100ft

0 ft 50ft 100ft 150ft

PARSONS

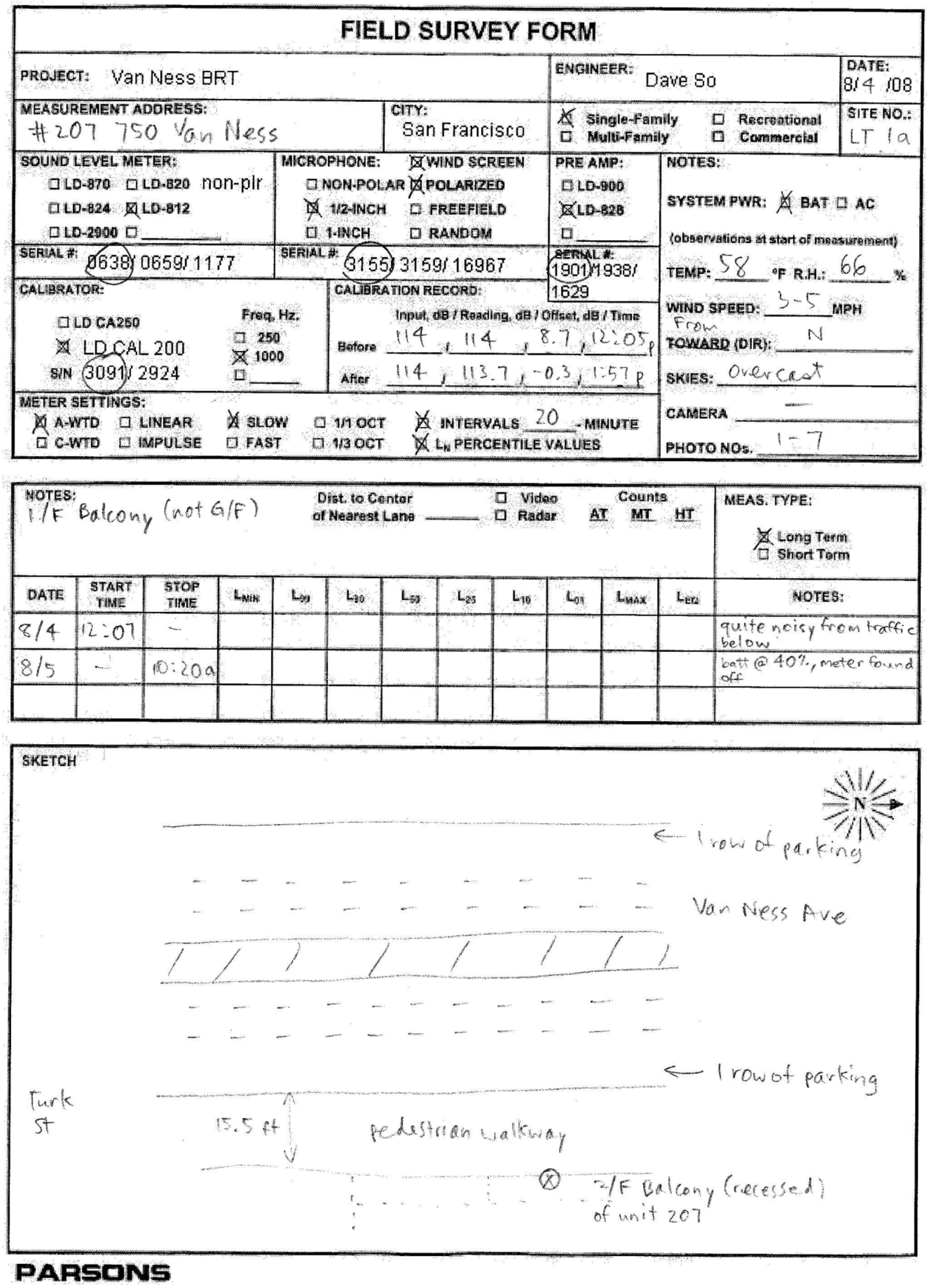
100 WEST WALNUT ST.
PASADENA, CA 91124
(626) 440-6100

VAN NESS AVENUE BRT
SENSITIVE RECEPTOR &
NOISE MEASUREMENT LOCATIONS

AUGUST 10, 2010

SHEET NO. 7 OF 7

APPENDIX B – NOISE MEASUREMENT DATA



FIELD SURVEY FORM

PROJECT: Van Ness BRT

ENGINEER: Dave So

DATE: 8/4 /08

MEASUREMENT ADDRESS: #207 750 Van Ness

CITY: San Francisco

☒ Single-Family ☐ Recreational
☐ Multi-Family ☐ Commercial

SITE NO.: LT 1a

SOUND LEVEL METER:
☐ LD-870 ☐ LD-820 non-plr
☐ LD-824 ☒ LD-812
☐ LD-2900 ☐ ________
SERIAL #: [✓ 0638]/ 0659/ 1177

MICROPHONE: ☒ WIND SCREEN
☐ NON-POLAR ☒ POLARIZED
☒ 1/2-INCH ☐ FREEFIELD
☐ 1-INCH ☐ RANDOM
SERIAL #: [✓ 3155]/ 3159/ 16967

PRE AMP:
☐ LD-900
☒ LD-828
☐ ________
SERIAL #: [✓ 1901]/1938/ 1629

CALIBRATOR:
☐ LD CA250
☒ LD CAL 200
S/N [✓ 3091]/ 2924

Freq. Hz.
☐ 250
☒ 1000
☐ ______

CALIBRATION RECORD:

	Input, dB / Reading, dB / Offset, dB / Time
Before	114 , 114 , 8.7 , 12:05p
After	114 , 113.7 , -0.3 , 1:57 p

METER SETTINGS:
☒ A-WTD ☐ LINEAR ☒ SLOW ☐ 1/1 OCT ☒ INTERVALS 20 - MINUTE
☐ C-WTD ☐ IMPULSE ☐ FAST ☐ 1/3 OCT ☒ L_N PERCENTILE VALUES

NOTES:

SYSTEM PWR: ☒ BAT ☐ AC

(observations at start of measurement)

TEMP: 58 °F R.H.: 66 %

WIND SPEED: 3-5 MPH

~~TOWARD~~ From (DIR): N

SKIES: Overcast

CAMERA —

PHOTO NOs. 1-7

NOTES: 1/F Balcony (not G/F)

Dist. to Center of Nearest Lane ______

☐ Video
☐ Radar

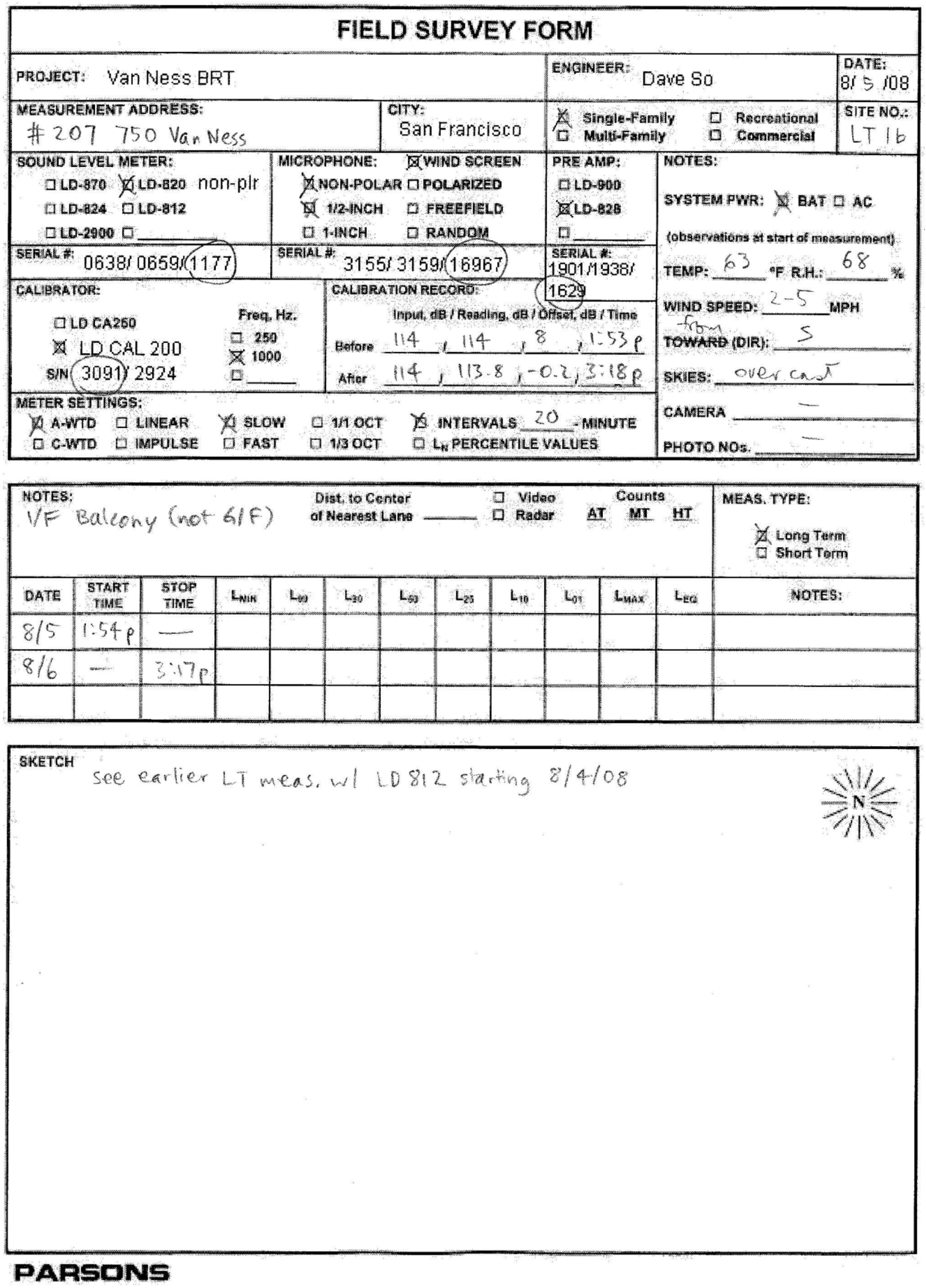
Counts
AT MT HT

MEAS. TYPE:
☒ Long Term
☐ Short Term

DATE	START TIME	STOP TIME	L_{MIN}	L_{99}	L_{90}	L_{50}	L_{25}	L_{10}	L_{01}	L_{MAX}	L_{EQ}	NOTES:
8/4	12:07	–										quite noisy from traffic below
8/5	–	10:20a										batt @ 40%, meter found off

SKETCH

PARSONS



FIELD SURVEY FORM

PROJECT: Van Ness BRT

ENGINEER: Dave So

DATE: 8/ 5 /08

MEASUREMENT ADDRESS: # 207 750 Van Ness

CITY: San Francisco

☒ Single-Family ☐ Recreational
☐ Multi-Family ☐ Commercial

SITE NO.: LT 1b

SOUND LEVEL METER:
☐ LD-870 ☒ LD-820 non-plr
☐ LD-824 ☐ LD-812
☐ LD-2900 ☐ ______

SERIAL #: 0638/ 0659/ 1177

MICROPHONE: ☒ WIND SCREEN
☒ NON-POLAR ☐ POLARIZED
☒ 1/2-INCH ☐ FREEFIELD
☐ 1-INCH ☐ RANDOM

SERIAL #: 3155/ 3159/ 16967

PRE AMP:
☐ LD-900
☒ LD-828
☐ ______

SERIAL #: 1901/1938/ 1629

CALIBRATOR:
☐ LD CA250
☒ LD CAL 200
S/N 3091/ 2924

Freq. Hz.
☐ 250
☒ 1000
☐ ______

CALIBRATION RECORD:

	Input, dB / Reading, dB / Offset, dB / Time
Before	114 , 114 , 8 , 1:53 p
After	114 , 113.8 , -0.2, 3:18 p

NOTES:

SYSTEM PWR: ☒ BAT ☐ AC

(observations at start of measurement)

TEMP: 63 °F R.H.: 68 %

WIND SPEED: 2-5 MPH

from ~~TOWARD~~ (DIR): S

SKIES: overcast

CAMERA —

PHOTO NOs. —

METER SETTINGS:
☒ A-WTD ☐ LINEAR ☒ SLOW ☐ 1/1 OCT ☒ INTERVALS 20 - MINUTE
☐ C-WTD ☐ IMPULSE ☐ FAST ☐ 1/3 OCT ☐ L_N PERCENTILE VALUES

NOTES: V/F Balcony (not 6/F)

Dist. to Center of Nearest Lane ______

☐ Video
☐ Radar

Counts: AT MT HT

MEAS. TYPE:
☒ Long Term
☐ Short Term

DATE	START TIME	STOP TIME	L_{MIN}	L_{99}	L_{90}	L_{50}	L_{25}	L_{10}	L_{01}	L_{MAX}	L_{EQ}	NOTES:
8/5	1:54 p	—										
8/6	—	3:17 p										

SKETCH

see earlier LT meas. w/ LD 812 starting 8/4/08

PARSONS

FIELD SURVEY FORM

PROJECT: Van Ness BRT
ENGINEER: Dave So
DATE: 8/4 /08

MEASUREMENT ADDRESS: 140 Van Ness (VN @ 12th St)
CITY: San Francisco
☐ Single-Family ☒ Multi-Family ☐ Recreational ☐ Commercial
SITE NO.: ST 1

SOUND LEVEL METER: ☐ LD-870 ☐ LD-820 non-plr ☐ LD-824 ☒ LD-812 ☐ LD-2900 ☐ ______
SERIAL #: 0638/ 0659/ 1177

MICROPHONE: ☒ WIND SCREEN ☐ NON-POLAR ☒ POLARIZED ☒ 1/2-INCH ☐ FREEFIELD ☐ 1-INCH ☐ RANDOM
SERIAL #: 3155/ 3159/ 16967

PRE AMP: ☐ LD-900 ☒ LD-828 ☐ ______
SERIAL #: 1901/ 1938/ 1629

CALIBRATOR: ☐ LD CA250 ☒ LD CAL 200
S/N 3091/ 2924
Freq, Hz. ☐ 250 ☒ 1000 ☐ ______

CALIBRATION RECORD: Input, dB / Reading, dB / Offset, dB / Time
Before 114 , 114 , 9.0 , 3:47 p
After ______ , ______ , ______ , ______

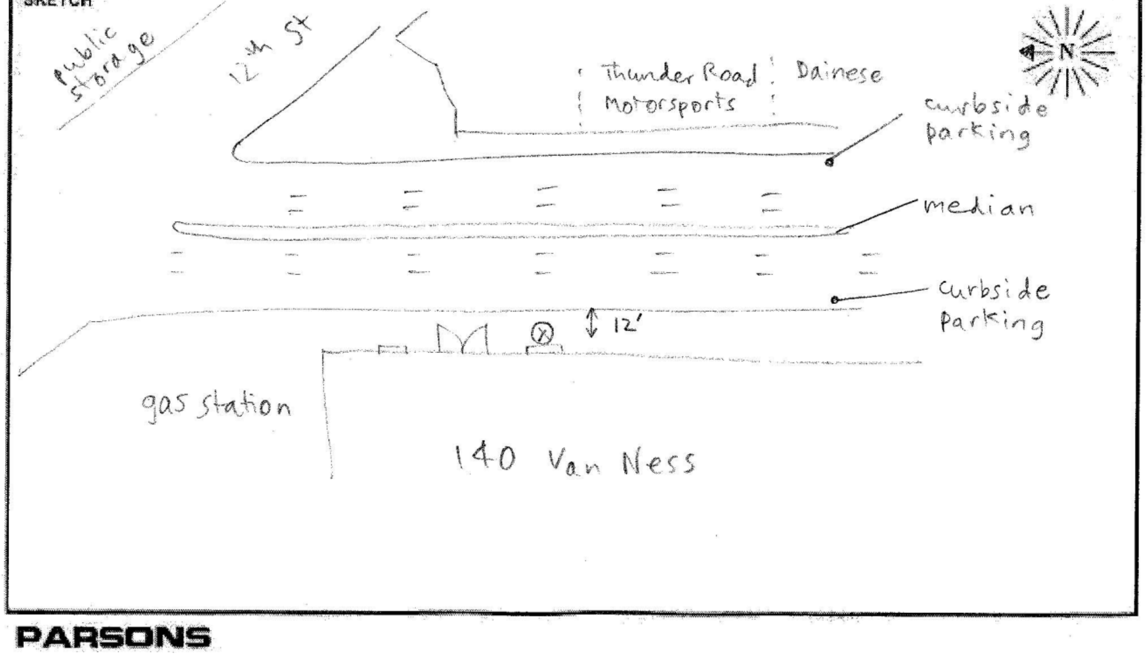
METER SETTINGS: ☒ A-WTD ☐ C-WTD ☐ LINEAR ☐ IMPULSE ☒ SLOW ☐ FAST ☐ 1/1 OCT ☐ 1/3 OCT ☒ INTERVALS 20 -MINUTE ☒ L_N PERCENTILE VALUES

NOTES:
SYSTEM PWR: ☒ BAT ☐ AC
(observations at start of measurement)
TEMP: 61 °F **R.H.:** 73 %
WIND SPEED: 1-3 MPH
from
TOWARD (DIR): SE
SKIES: clear w/ clouds
CAMERA —
PHOTO NOs. 79 - 82

NOTES: ground level meas.
Dist. to Center of Nearest Lane ______
☐ Video ☐ Radar
Counts AT MT HT
MEAS. TYPE: ☐ Long Term ☒ Short Term

DATE	START TIME	STOP TIME	L_{MIN}	L_{99}	L_{90}	L_{50}	L_{25}	L_{10}	L_{01}	L_{MAX}	L_{EQ}	NOTES:
8/4	5:31p	5:51p	58.2	—	63.1	69.4	73.8	76.2	—	84.7	72.3	checked 5:52p at 115.0
8/5	11:16a	11:31 a	54.1	—	61.3	66.9	70.8	73.8	—	82.0	69.9	polishing noise at auto detailing next door

SKETCH



PARSONS

FIELD SURVEY FORM

PROJECT: Van Ness BRT

ENGINEER: Dave So

DATE: 8/4 /08

MEASUREMENT ADDRESS: Louise M. Davies Symphony Hall

CITY: San Francisco

☐ Single-Family ☐ Multi-Family ☐ Recreational ☒ Commercial

SITE NO.: ST2

SOUND LEVEL METER:
☐ LD-870 ☐ LD-820 non-plr
☐ LD-824 ☒ LD-812
☐ LD-2900 ☐ ______

SERIAL #: 0638/ 0659/ 1177

MICROPHONE: ☒ WIND SCREEN
☐ NON-POLAR ☒ POLARIZED
☒ 1/2-INCH ☐ FREEFIELD
☐ 1-INCH ☐ RANDOM

SERIAL #: 3155/ 3159/ 16967

PRE AMP:
☐ LD-900
☒ LD-828
☐ ______

SERIAL #: 1901/ 1938/ 1629

CALIBRATOR:
☐ LD CA250
☒ LD CAL 200
S/N 3091/ 2924

Freq. Hz.
☐ 250
☒ 1000
☐ ______

CALIBRATION RECORD:
Input, dB / Reading, dB / Offset, dB / Time
Before 114 , 114 , 9.0 , 3:47p
After 114 , 113.9 , 7.4 , 11:42a

METER SETTINGS:
☒ A-WTD ☐ LINEAR ☒ SLOW ☐ 1/1 OCT ☒ INTERVALS 20 - MINUTE
☐ C-WTD ☐ IMPULSE ☐ FAST ☐ 1/3 OCT ☒ L_N PERCENTILE VALUES

NOTES:
SYSTEM PWR: ☒ BAT ☐ AC
(observations at start of measurement)
TEMP: 59 °F R.H.: 78 %
WIND SPEED: 1.3 MPH
from ~~TOWARD~~ (DIR): S
SKIES: clearing
CAMERA —
PHOTO NOs. ______

NOTES: across from apt bldg @ 200 Van Ness

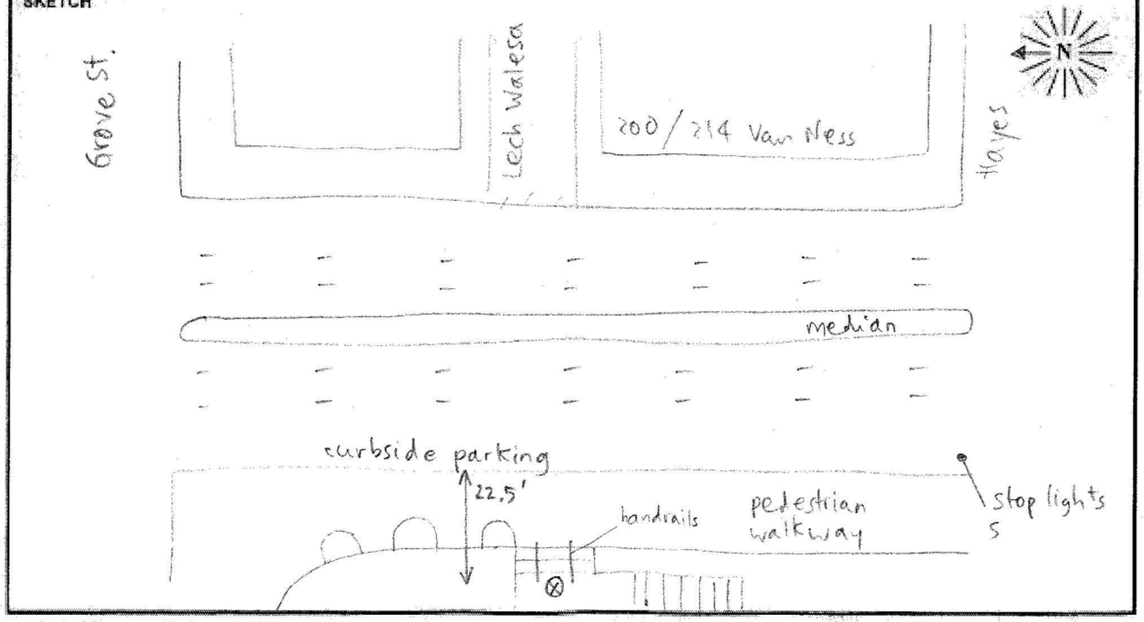
Dist. to Center of Nearest Lane ______ ☐ Video ☐ Radar

Counts AT MT HT

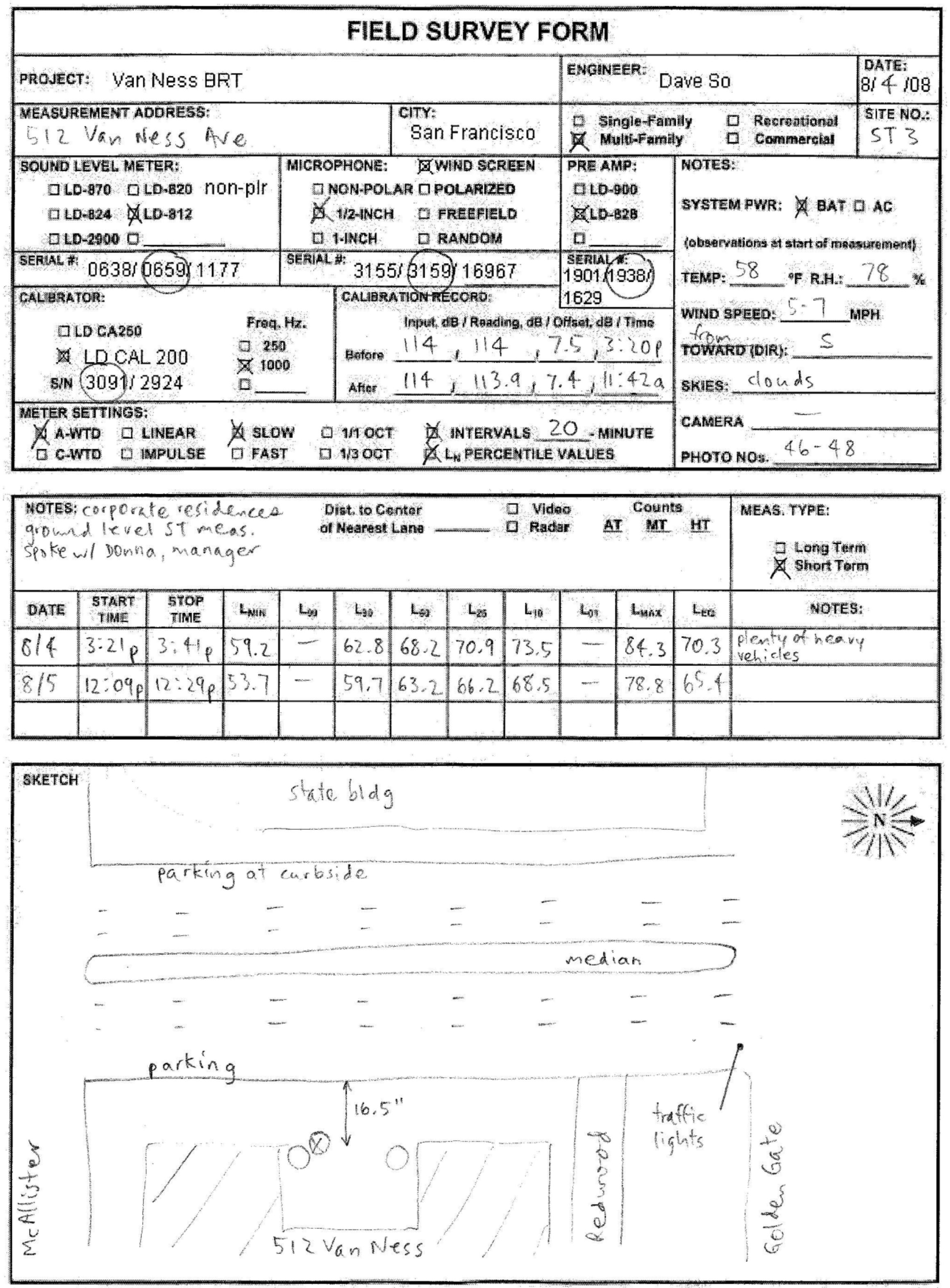
MEAS. TYPE:
☐ Long Term
☒ Short Term

DATE	START TIME	STOP TIME	L_{MIN}	L_{99}	L_{90}	L_{50}	L_{25}	L_{10}	L_{01}	L_{MAX}	L_{EQ}	NOTES:
8/4	3:48p	4:08p	61.0	–	63.8	70.3	72.7	74.4	–	83.1	71.4	
8/5	11:43a	12:03p	59.6	–	63.3	68.9	70.8	73.4	–	87.2	71.0	

SKETCH



PARSONS



FIELD SURVEY FORM

PROJECT: Van Ness BRT
ENGINEER: Dave So
DATE: 8/4/08

MEASUREMENT ADDRESS: 512 Van Ness Ave
CITY: San Francisco
☐ Single-Family ☒ Multi-Family ☐ Recreational ☐ Commercial
SITE NO.: ST 3

SOUND LEVEL METER: ☐ LD-870 ☐ LD-820 non-plr ☐ LD-824 ☒ LD-812 ☐ LD-2900 ☐ ________
SERIAL #: 0638/[✓ 0659]/1177

MICROPHONE: ☒ WIND SCREEN ☐ NON-POLAR ☐ POLARIZED ☒ 1/2-INCH ☐ FREEFIELD ☐ 1-INCH ☐ RANDOM
SERIAL #: 3155/[✓ 3159]/16967

PRE AMP: ☐ LD-900 ☒ LD-828 ☐ ________
SERIAL #: 1901/[✓ 1938]/1629

NOTES:
SYSTEM PWR: ☒ BAT ☐ AC
(observations at start of measurement)
TEMP: 58 °F R.H.: 78 %
WIND SPEED: 5-7 MPH
from TOWARD (DIR): S
SKIES: clouds
CAMERA —
PHOTO NOs. 46-48

CALIBRATOR: ☐ LD CA250 ☒ LD CAL 200
S/N [✓ 3091]/2924
Freq. Hz. ☐ 250 ☒ 1000 ☐ ______

CALIBRATION RECORD:

	Input, dB / Reading, dB / Offset, dB / Time
Before	114, 114, 7.5, 3:20p
After	114, 113.9, 7.4, 11:42a

METER SETTINGS: ☒ A-WTD ☐ C-WTD ☐ LINEAR ☐ IMPULSE ☒ SLOW ☐ FAST ☐ 1/1 OCT ☐ 1/3 OCT ☒ INTERVALS 20 - MINUTE ☒ L_N PERCENTILE VALUES

NOTES: corporate residences
ground level ST meas.
Spoke w/ Donna, manager

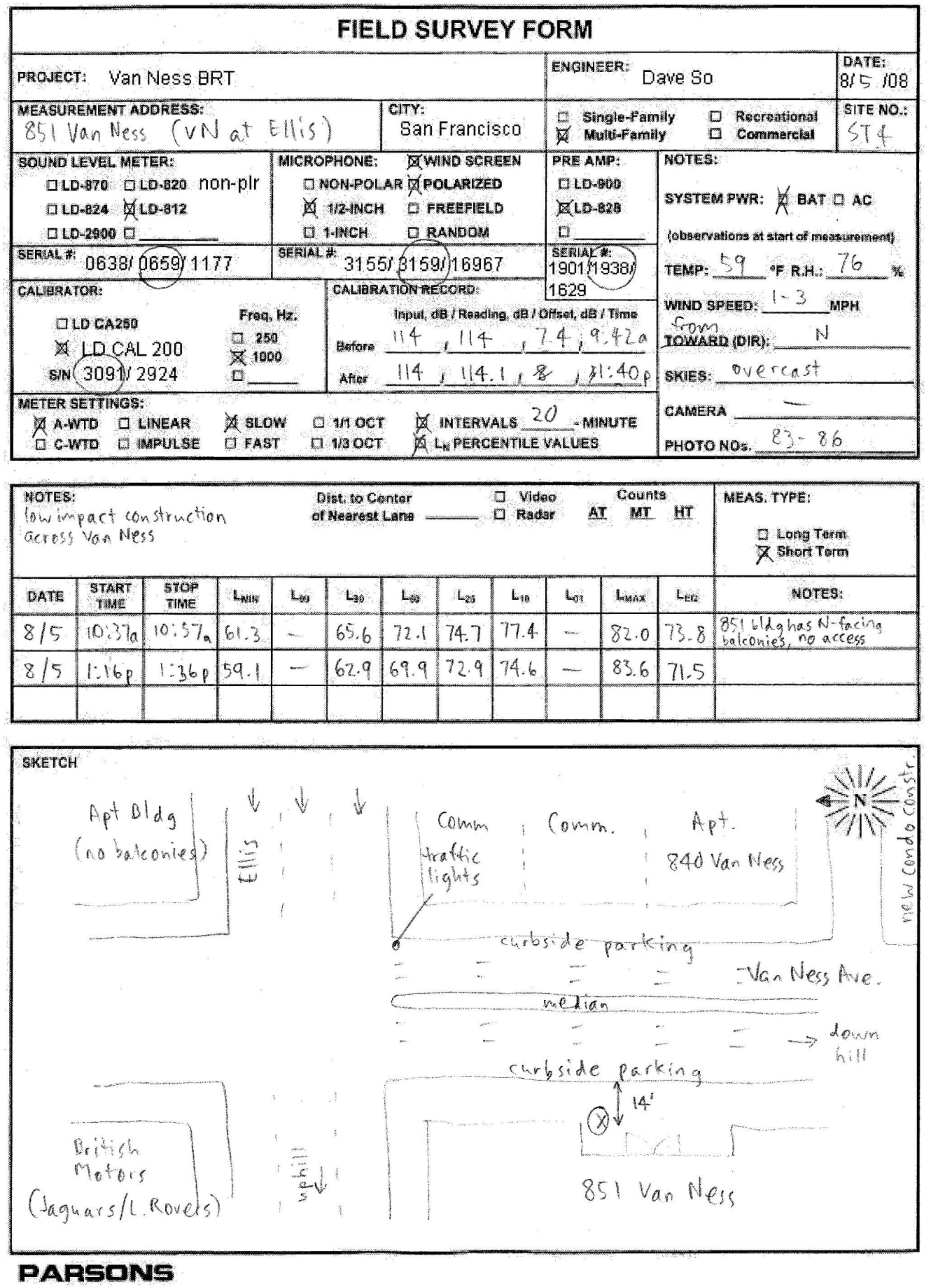
Dist. to Center of Nearest Lane ______
☐ Video ☐ Radar
Counts AT MT HT

MEAS. TYPE: ☐ Long Term ☒ Short Term

DATE	START TIME	STOP TIME	L_{MIN}	L_{99}	L_{90}	L_{50}	L_{25}	L_{10}	L_{01}	L_{MAX}	L_{EQ}	NOTES:
8/4	3:21p	3:41p	59.2	—	62.8	68.2	70.9	73.5	—	84.3	70.3	plenty of heavy vehicles
8/5	12:09p	12:29p	53.7	—	59.7	63.2	66.2	68.5	—	78.8	65.4	

SKETCH

PARSONS



FIELD SURVEY FORM

PROJECT: Van Ness BRT
ENGINEER: Dave So
DATE: 8/5/08

MEASUREMENT ADDRESS: 851 Van Ness (VN at Ellis)
CITY: San Francisco
☐ Single-Family ☐ Recreational
☒ Multi-Family ☐ Commercial
SITE NO.: ST4

SOUND LEVEL METER:
☐ LD-870 ☐ LD-820 non-plr
☐ LD-824 ☒ LD-812
☐ LD-2900 ☐ ______
SERIAL #: 0638/ 0659/ 1177

MICROPHONE: ☒ WIND SCREEN
☐ NON-POLAR ☒ POLARIZED
☒ 1/2-INCH ☐ FREEFIELD
☐ 1-INCH ☐ RANDOM
SERIAL #: 3155/ 3159/ 16967

PRE AMP:
☐ LD-900
☒ LD-828
☐ ______
SERIAL #: 1901/ 1938/ 1629

NOTES:
SYSTEM PWR: ☒ BAT ☐ AC
(observations at start of measurement)
TEMP: 59 °F **R.H.:** 76 %
WIND SPEED: 1-3 MPH
from
TOWARD (DIR): N
SKIES: overcast
CAMERA —
PHOTO NOs. 83-86

CALIBRATOR:
☐ LD CA250
☒ LD CAL 200
S/N 3091/ 2924
Freq, Hz. ☐ 250 ☒ 1000 ☐ ______

CALIBRATION RECORD:
Input, dB / Reading, dB / Offset, dB / Time
Before 114, 114, 7.4, 9:42a
After 114, 114.1, 8, 1:40p

METER SETTINGS:
☒ A-WTD ☐ LINEAR ☒ SLOW ☐ 1/1 OCT ☒ INTERVALS 20 - MINUTE
☐ C-WTD ☐ IMPULSE ☐ FAST ☐ 1/3 OCT ☒ L_N PERCENTILE VALUES

NOTES:
low impact construction across Van Ness

Dist. to Center of Nearest Lane ______
☐ Video
☐ Radar
Counts AT MT HT

MEAS. TYPE:
☐ Long Term
☒ Short Term

DATE	START TIME	STOP TIME	L_{MIN}	L_{99}	L_{90}	L_{50}	L_{25}	L_{10}	L_{01}	L_{MAX}	L_{EQ}	NOTES:
8/5	10:37a	10:57a	61.3	—	65.6	72.1	74.7	77.4	—	82.0	73.8	851 bldg has N-facing balconies, no access
8/5	1:16p	1:36p	59.1	—	62.9	69.9	72.9	74.6	—	83.6	71.5	

SKETCH

PARSONS

FIELD SURVEY FORM

PROJECT: Van Ness BRT

ENGINEER: Dave So

DATE: 8/4 /08

MEASUREMENT ADDRESS: Cathedral Hill Hotel

CITY: San Francisco

☐ Single-Family ☐ Multi-Family ☐ Recreational ☒ Commercial

SITE NO.: ST5

SOUND LEVEL METER: ☐ LD-870 ☐ LD-820 non-plr ☐ LD-824 ☒ LD-812 ☐ LD-2900 ☐ ______

SERIAL #: 0638/(0659)/1177

MICROPHONE: ☒ WIND SCREEN ☐ NON-POLAR ☐ POLARIZED ☒ 1/2-INCH ☐ FREEFIELD ☐ 1-INCH ☐ RANDOM

SERIAL #: 3155/(3159)/16967

PRE AMP: ☐ LD-900 ☒ LD-828 ☐ ______

SERIAL #: 1901/(1938)/1629

CALIBRATOR: ☐ LD CA250 ☒ LD CAL 200

S/N (3091)/2924

Freq. Hz. ☐ 250 ☒ 1000 ☐ ______

CALIBRATION RECORD:

	Input, dB / Reading, dB / Offset, dB / Time
Before	114, 114, 8-2, 1:43p
After	114, 114.1, 7.4, 9:42a

METER SETTINGS: ☒ A-WTD ☐ C-WTD ☐ LINEAR ☐ IMPULSE ☒ SLOW ☐ FAST ☐ 1/1 OCT ☐ 1/3 OCT ☒ INTERVALS 20 -MINUTE ☐ L_N PERCENTILE VALUES

NOTES:

SYSTEM PWR: ☒ BAT ☐ AC

(observations at start of measurement)

TEMP: 64 °F R.H.: 61 %

WIND SPEED: 2-3 MPH

from ~~TOWARD~~ (DIR): NE

SKIES: overcast

CAMERA —

PHOTO NOs. 9-14

NOTES: 2/F hotel platform driveway

Dist. to Center of Nearest Lane ______

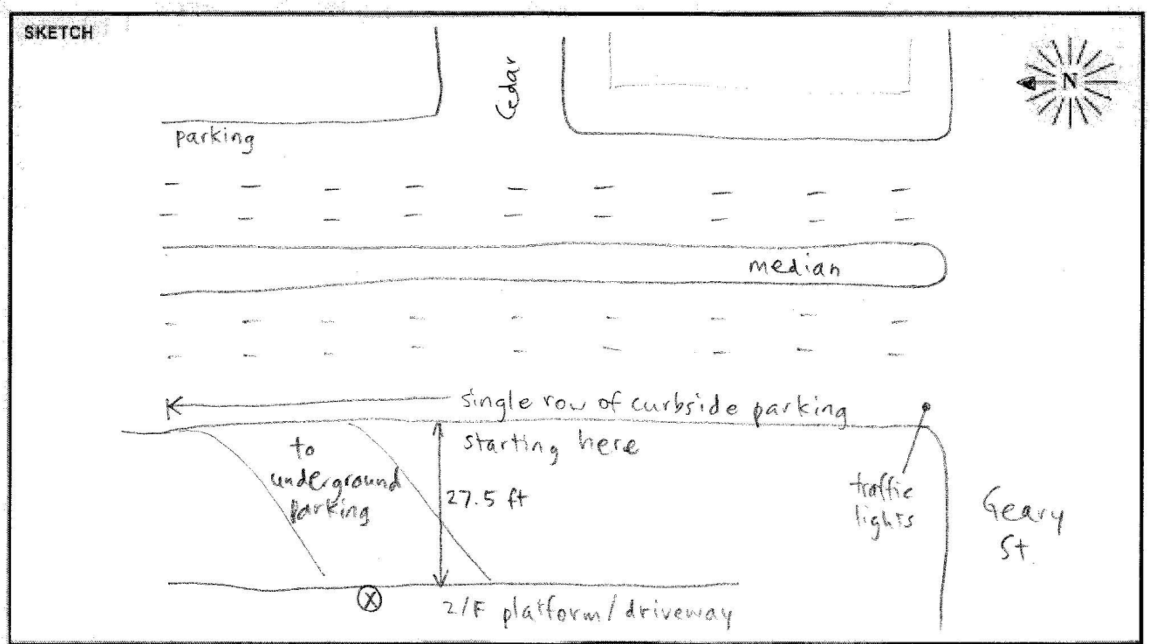
☐ Video ☐ Radar

Counts AT MT HT

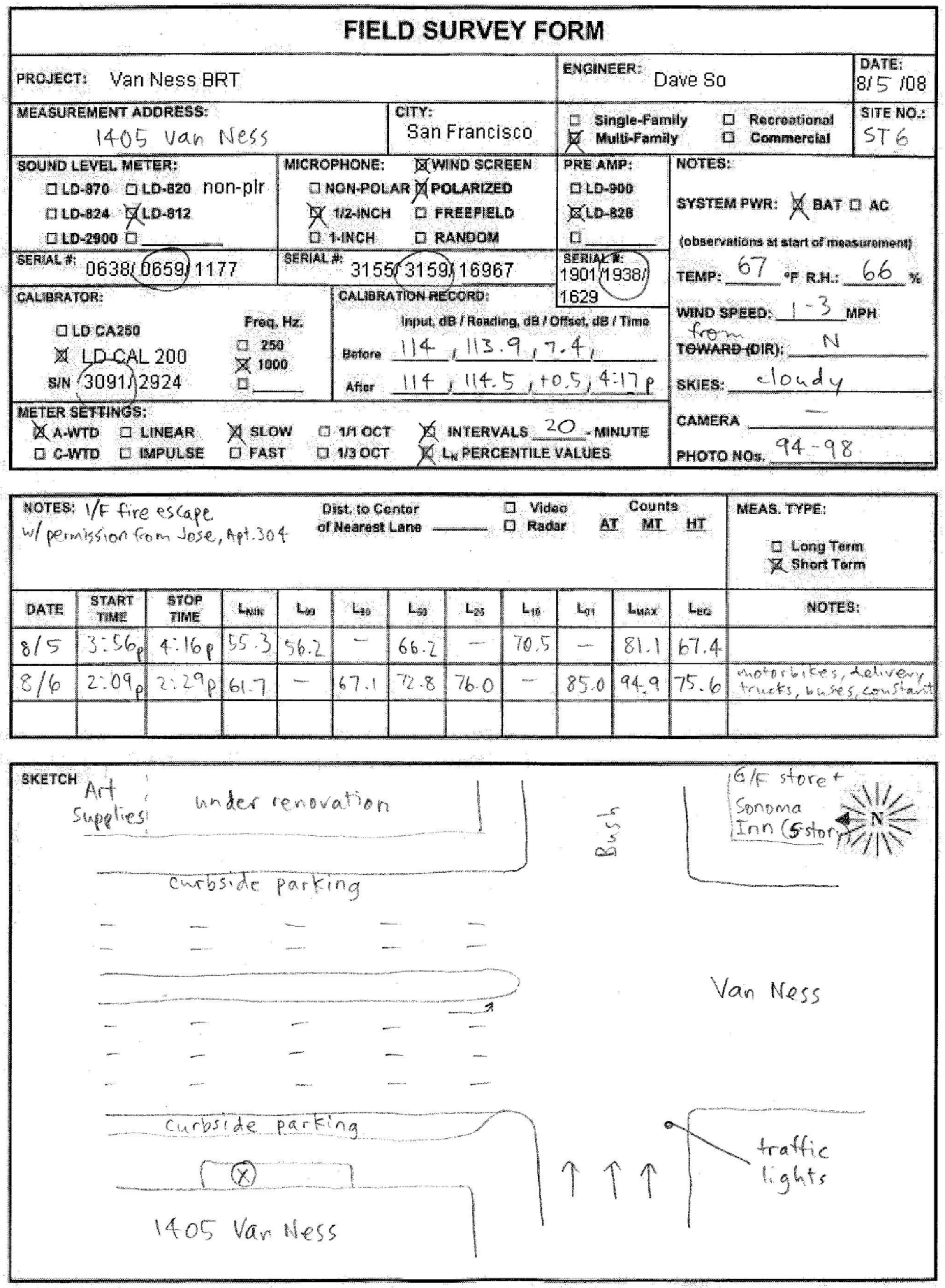
MEAS. TYPE: ☐ Long Term ☒ Short Term

DATE	START TIME	STOP TIME	L_{MIN}	L_{99}	L_{90}	L_{50}	L_{25}	L_{10}	L_{01}	L_{MAX}	L_{EQ}	NOTES:
8/4	1:48p	2:08p	58.2	80.5	–	67.5	–	71.6	–	80.5	68.9	
8/5	9:51a	10:11a	59.9	–	63.0	67.6	70.2	72.1	–	78.6	69.0	

SKETCH



PARSONS



FIELD SURVEY FORM

PROJECT: Van Ness BRT
ENGINEER: Dave So
DATE: 8/5 /08

MEASUREMENT ADDRESS: 1405 Van Ness
CITY: San Francisco
☐ Single-Family ☒ Multi-Family ☐ Recreational ☐ Commercial
SITE NO.: ST 6

SOUND LEVEL METER: ☐ LD-870 ☐ LD-820 non-plr ☐ LD-824 ☒ LD-812 ☐ LD-2900 ☐ ______
SERIAL #: 0638/ 0659/ 1177

MICROPHONE: ☒ WIND SCREEN ☐ NON-POLAR ☒ POLARIZED ☒ 1/2-INCH ☐ FREEFIELD ☐ 1-INCH ☐ RANDOM
SERIAL #: 3155/ 3159/ 16967

PRE AMP: ☐ LD-900 ☒ LD-828 ☐ ______
SERIAL #: 1901/ 1938/ 1629

NOTES:
SYSTEM PWR: ☒ BAT ☐ AC
(observations at start of measurement)
TEMP: 67 °F **R.H.:** 66 %
WIND SPEED: 1-3 MPH
from ~~TOWARD~~ (DIR): N
SKIES: cloudy
CAMERA –
PHOTO NOs. 94-98

CALIBRATOR: ☐ LD CA250 ☒ LD CAL 200
S/N 3091/ 2924
Freq. Hz. ☐ 250 ☒ 1000 ☐ ______

CALIBRATION RECORD:
Input, dB / Reading, dB / Offset, dB / Time
Before 114, 113.9, 7.4,
After 114, 114.5, +0.5, 4:17p

METER SETTINGS: ☒ A-WTD ☐ C-WTD ☐ LINEAR ☐ IMPULSE ☒ SLOW ☐ FAST ☐ 1/1 OCT ☐ 1/3 OCT ☒ INTERVALS 20 - MINUTE ☒ L_N PERCENTILE VALUES

NOTES: 1/F fire escape
w/ permission from Jose, Apt. 304

Dist. to Center of Nearest Lane ______
☐ Video ☐ Radar
Counts AT MT HT

MEAS. TYPE: ☐ Long Term ☒ Short Term

DATE	START TIME	STOP TIME	L_{MIN}	L_{99}	L_{90}	L_{50}	L_{25}	L_{10}	L_{01}	L_{MAX}	L_{EQ}	NOTES:
8/5	3:56p	4:16p	55.3	56.2	–	66.2	–	70.5	–	81.1	67.4	
8/6	2:09p	2:29p	61.7	–	67.1	72.8	76.0	–	85.0	94.9	75.6	motorbikes, delivery trucks, buses, constant

SKETCH

PARSONS

FIELD SURVEY FORM

PROJECT: Van Ness BRT

ENGINEER: Dave So

DATE: 8/5/08

MEASUREMENT ADDRESS: 1700 Van Ness (at Sacramento)

CITY: San Francisco

☐ Single-Family ☒ Multi-Family ☐ Recreational ☐ Commercial

SITE NO.: ST 7

SOUND LEVEL METER:
☐ LD-870 ☐ LD-820 non-plr
☐ LD-824 ☒ LD-812
☐ LD-2900 ☐ ______

SERIAL #: 0638/0659/1177

MICROPHONE: ☒ WIND SCREEN
☐ NON-POLAR ☒ POLARIZED
☒ 1/2-INCH ☐ FREEFIELD
☐ 1-INCH ☐ RANDOM

SERIAL #: 3155/3159/16967

PRE AMP:
☐ LD-900
☒ LD-828
☐ ______

SERIAL #: 1901/1938/1629

CALIBRATOR:
☐ LD CA250
☒ LD CAL 200
S/N 3091/2924

Freq. Hz.
☐ 250
☒ 1000
☐ ______

CALIBRATION RECORD:
Input, dB / Reading, dB / Offset, dB / Time
Before 114, 114.2, 7.6, 4:44p
After 114, 114.1, 8.4, 8:58a

NOTES:

SYSTEM PWR: ☒ BAT ☐ AC

(observations at start of measurement)

TEMP: 60 °F R.H.: 73 %

WIND SPEED: 1-3 MPH

from ~~TOWARD~~ (DIR): S

SKIES: cloudy

CAMERA —

PHOTO NOs. 101-107

METER SETTINGS:
☒ A-WTD ☐ LINEAR ☒ SLOW ☐ 1/1 OCT ☒ INTERVALS 20 -MINUTE
☐ C-WTD ☐ IMPULSE ☐ FAST ☐ 1/3 OCT ☒ L_N PERCENTILE VALUES

NOTES: NE corner of VN & Sacramento

Dist. to Center of Nearest Lane ______

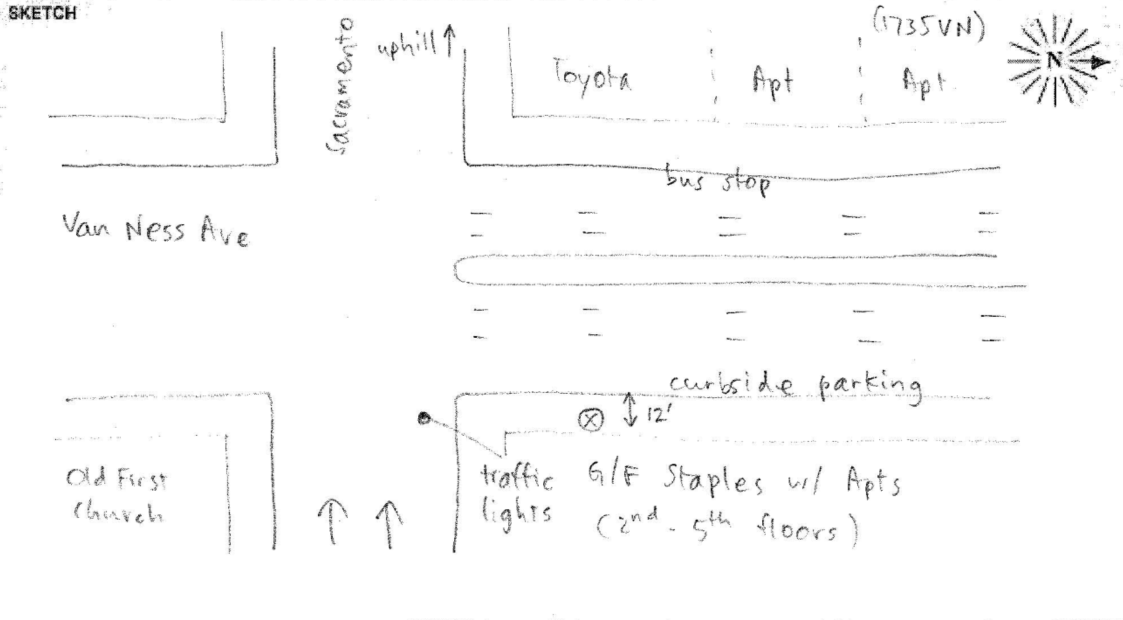
☐ Video
☐ Radar

Counts AT MT HT

MEAS. TYPE:
☐ Long Term
☒ Short Term

DATE	START TIME	STOP TIME	L_{MIN}	L_{99}	L_{90}	L_{50}	L_{25}	L_{10}	L_{01}	L_{MAX}	L_{EQ}	NOTES:
8/5	4:45p	5:05p	60.4	61.2	–	71.3	–	77.8	–	84.2	74.1	heavy traffic
8/6	8:59a	9:19a	61.4	–	64.9	71.0	74.5	~~74.5~~	80.4	84.6	73.0	rush hour
8/6	12:40p	1:00p	59.8	–	65.3	70.5	73.7	–	80.4	83.2	72.4	

SKETCH



PARSONS

FIELD SURVEY FORM

PROJECT: Van Ness BRT

ENGINEER: Dave So

DATE: 8/ 5 /08

MEASUREMENT ADDRESS: 2128 Van Ness (betw. Pacific & Broad-way)

CITY: San Francisco

☐ Single-Family ☒ Multi-Family ☐ Recreational ☐ Commercial

SITE NO.: ST 8

SOUND LEVEL METER: ☐ LD-870 ☐ LD-820 non-plr ☐ LD-824 ☒ LD-812 ☐ LD-2900 ☐ ________

SERIAL #: 0638/ [✓ 0659]/ 1177

MICROPHONE: ☒ WIND SCREEN ☐ NON-POLAR ☒ POLARIZED ☒ 1/2-INCH ☐ FREEFIELD ☐ 1-INCH ☐ RANDOM

SERIAL #: 3155/ [✓ 3159]/ 16967

PRE AMP: ☐ LD-900 ☒ LD-828 ☐ ________

SERIAL #: 1901/ [✓ 1938]/ 1629

NOTES:

SYSTEM PWR: ☒ BAT ☐ AC

(observations at start of measurement)

TEMP: 66 °F **R.H.:** 67 %

WIND SPEED: 1-3 MPH

from ~~TOWARD~~ (DIR): N

SKIES: cloudy

CAMERA ________

PHOTO NOs. 114

CALIBRATOR: ☐ LD CA250 ☒ LD CAL 200 S/N [✓ 3091]/ 2924

Freq, Hz. ☐ 250 ☒ 1000 ☐ ______

CALIBRATION RECORD:

Input, dB / Reading, dB / Offset, dB / Time

Before 114 , 114 , 7.5 , 5:37p

After 114 , 114.1 , 8.4 , 8:58a

METER SETTINGS: ☒ A-WTD ☐ C-WTD ☐ LINEAR ☐ IMPULSE ☒ SLOW ☐ FAST ☐ 1/1 OCT ☐ 1/3 OCT ☒ INTERVALS 20 - MINUTE ☒ L_N PERCENTILE VALUES

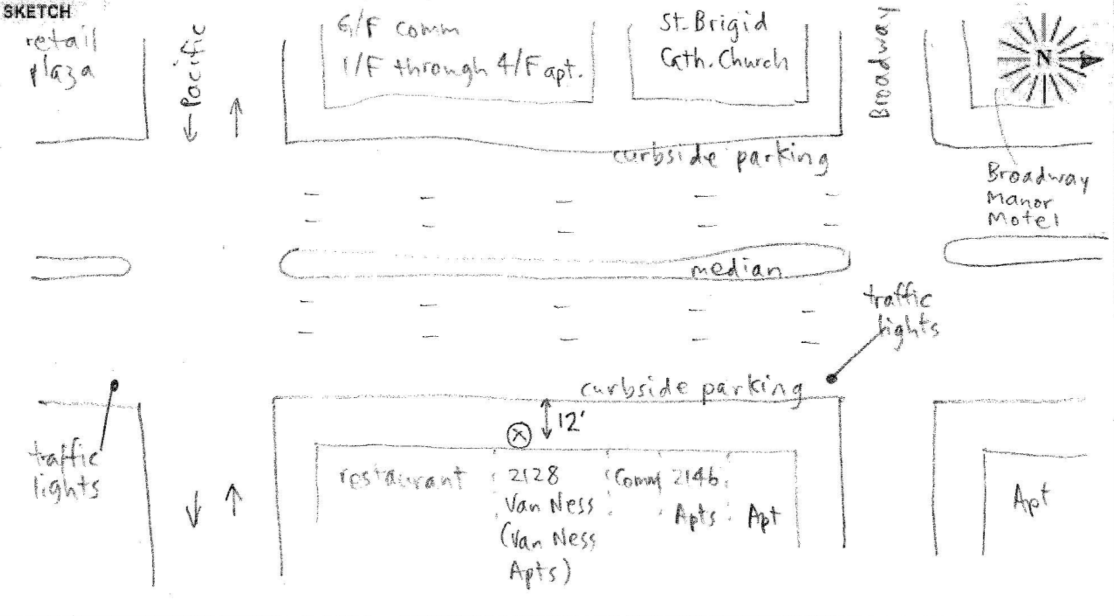
NOTES:

Dist. to Center of Nearest Lane ______ ☐ Video ☐ Radar Counts AT MT HT

MEAS. TYPE: ☐ Long Term ☒ Short Term

DATE	START TIME	STOP TIME	L_{MIN}	L_{99}	L_{90}	L_{50}	L_{25}	L_{10}	L_{01}	L_{MAX}	L_{EQ}	NOTES:
8/5	5:37p	5:57p	52.9	54.8	—	64.2		69.4	—	80.4	65.9	buses on near lane
8/6	9:26a	9:46a	60.6	—	65.6	71.0	72.9	—	77.9	88.3	71.8	rush hour traffic, buses

SKETCH



PARSONS

FIELD SURVEY FORM

PROJECT: Van Ness BRT

ENGINEER: Dave So

DATE: 8/ 6 /08

MEASUREMENT ADDRESS: 2307 Van Ness (betw. Green & Vallejo)

CITY: San Francisco

☐ Single-Family ☒ Multi-Family ☐ Recreational ☐ Commercial

SITE NO.: ST9

SOUND LEVEL METER: ☐ LD-870 ☐ LD-820 non-plr ☐ LD-824 ☒ LD-812 ☐ LD-2900 ☐ ________

SERIAL #: 0638/ 0659/ 1177

MICROPHONE: ☒ WIND SCREEN ☐ NON-POLAR ☒ POLARIZED ☒ 1/2-INCH ☐ FREEFIELD ☐ 1-INCH ☐ RANDOM

SERIAL #: 3155/ 3159/ 16967

PRE AMP: ☐ LD-900 ☒ LD-828 ☐ ________

SERIAL #: 1901/1938/ 1629

NOTES:

SYSTEM PWR: ☒ BAT ☐ AC

(observations at start of measurement)

TEMP: 58 °F **R.H.:** 78 %

WIND SPEED: 1-3 MPH

from **TOWARD (DIR):** N

SKIES: overcast

CAMERA —

PHOTO NOs. 136-139

CALIBRATOR: ☐ LD CA250 ☒ LD CAL 200

S/N 3091/ 2924

Freq. Hz. ☐ 250 ☒ 1000 ☐ ______

CALIBRATION RECORD: Input, dB / Reading, dB / Offset, dB / Time

Before 114 , 114.1 , 8.4 , 8:58a

After ____ , ____ , ____ , ____

METER SETTINGS: ☒ A-WTD ☐ C-WTD ☐ LINEAR ☐ IMPULSE ☒ SLOW ☐ FAST ☐ 1/1 OCT ☐ 1/3 OCT ☒ INTERVALS 20 - MINUTE ☒ L_N PERCENTILE VALUES

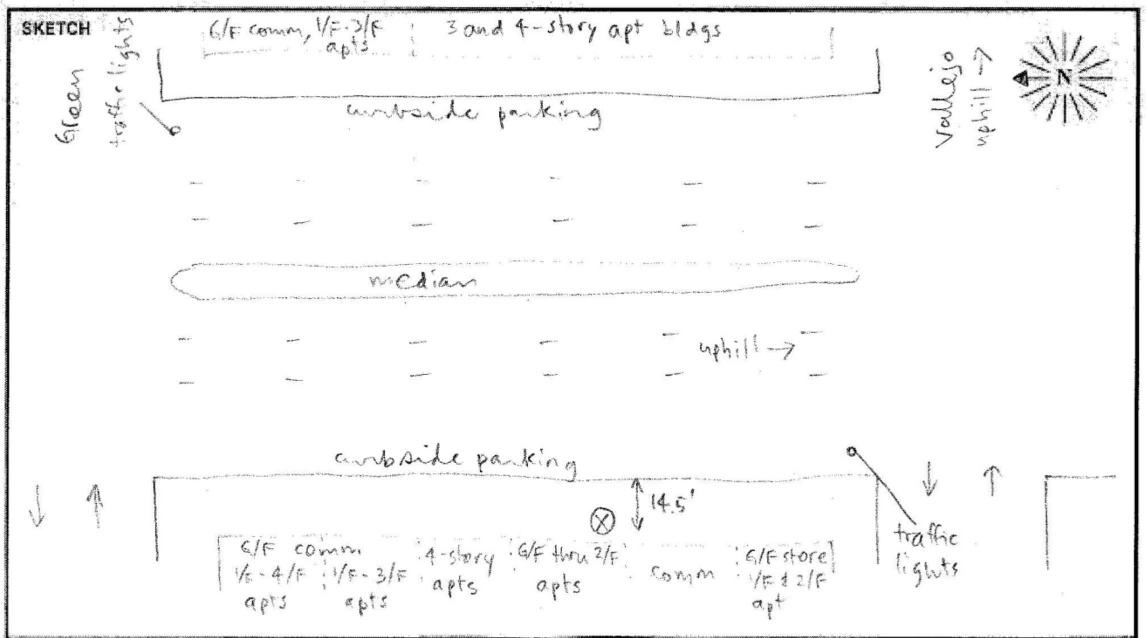
NOTES:

Dist. to Center of Nearest Lane ______ ☐ Video ☐ Radar Counts AT MT HT

MEAS. TYPE: ☐ Long Term ☒ Short Term

DATE	START TIME	STOP TIME	L_{MIN}	L_{99}	L_{90}	L_{50}	L_{25}	L_{10}	L_{01}	L_{MAX}	L_{EQ}	NOTES:
8/6	9:58a	10:18a	50.4	—	59.4	71.2	74.0	—	80.3	89.4	72.5	
8/6	12:06p	12:26p	—	—	61.8	71.7	74.7	—	84.0	95.8	74.2	
8/6	2:41p	2:58p	53.8	—	57.8	70.3	73.5	—	78.8	81.8	71.5	

SKETCH



PARSONS

FIELD SURVEY FORM

PROJECT: Van Ness BRT

ENGINEER: Dave So

DATE: 8/ 6 /08

MEASUREMENT ADDRESS: 2645 Van Ness (at Greenwich)

CITY: San Francisco

☐ Single-Family ☒ Multi-Family ☐ Recreational ☐ Commercial

SITE NO.: ST10

SOUND LEVEL METER:
☐ LD-870 ☐ LD-820 non-plr
☐ LD-824 ☒ LD-812
☐ LD-2900 ☐ ________

SERIAL #: [✓ 0638]/ 0659/ 1177

MICROPHONE: ☒ WIND SCREEN
☐ NON-POLAR ☒ POLARIZED
☒ 1/2-INCH ☐ FREEFIELD
☐ 1-INCH ☐ RANDOM

SERIAL #: [✓ 3155]/ 3159/ 16967

PRE AMP:
☐ LD-900
☒ LD-828
☐ ________

SERIAL #: [✓ 1901]/1938/ 1629

NOTES:

SYSTEM PWR: ☒ BAT ☐ AC

(observations at start of measurement)

TEMP: 53 °F **R.H.:** 69 %

WIND SPEED: 2-6 MPH

~~TOWARD~~ from (DIR): S

SKIES: overcast

CAMERA —

PHOTO NOs. 144 - 147

CALIBRATOR:
☐ LD CA250
☒ LD CAL 200
S/N [✓ 3091]/ 2924

Freq. Hz.
☐ 250
☒ 1000
☐ ______

CALIBRATION RECORD:
Input, dB / Reading, dB / Offset, dB / Time
Before 114 , 114 , — , 11:31a
After ____ , ____ , ____ , ____

METER SETTINGS:
☒ A-WTD ☐ LINEAR ☒ SLOW ☐ 1/1 OCT ☒ INTERVALS 20 - MINUTE
☐ C-WTD ☐ IMPULSE ☐ FAST ☐ 1/3 OCT ☒ L_N PERCENTILE VALUES

NOTES:

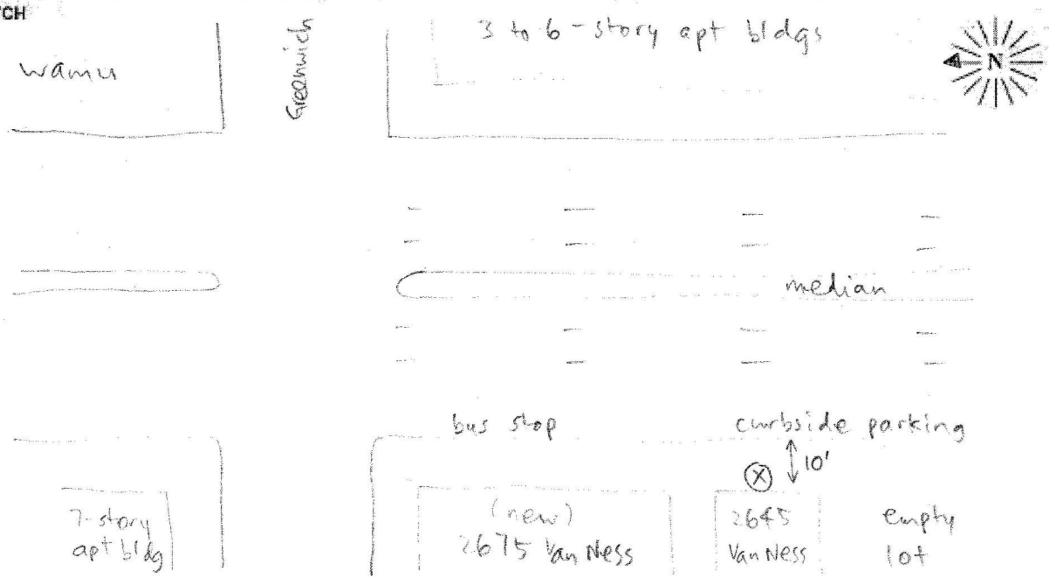
Dist. to Center of Nearest Lane ______ ☐ Video ☐ Radar

Counts AT MT HT

MEAS. TYPE:
☐ Long Term
☒ Short Term

DATE	START TIME	STOP TIME	L_{MIN}	L_{99}	L_{90}	L_{50}	L_{25}	L_{10}	L_{01}	L_{MAX}	L_{EQ}	NOTES:
8/6	11:29a	11:49a	55.7	—	62.6	69.4	73.5	—	82.8	92.0	72.9	||| buses
8/6	1:03p	1:23p	57.9	—	62.1	69.3	72.9	—	81.3	87.6	72.4	

SKETCH



PARSONS