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NOISE IMPACT OF NIGHTTIME CONSTRUCTION ON 29TH STREET, BETWEEN L STREET & CAPITAL AVE. & RECOMMENDATIONS TO MEET LIMITS CITY OF SACRAMENTO

Prepared for

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1.0 SUMMARY

This report documents the noise impact of night time construction activity at Sutter Health facilities at 29th Street between L Street and Capital Avenue on nearby residences. Traffic on State Route 51 (Business 80) is a major sound source for most of the homes around the site, with local traffic another important source. Other existing sound sources include activity at the Regional Transit bus maintenance facility and human activity at the restaurants. Secondary sound sources include general aviation overflights and other transient events. Road traffic, bus maintenance work and human activity are expected to remain the dominant source during the proposed project. However, evening and nighttime construction will add several new sources to the environment. This could include air compressors, jack hammers, loaders, excavators, hammering, steel movement and other sources associated with demolition and reconstruction.

The project site includes an existing parking lot, driveways, energy centers and other facilities along 29th Street from L Street to Capitol Avenue. The work is being done as part of a relocation of an energy center and the construction of a new Women and Children's Center at Sutter Health. Part of the construction expected to have to be done during hours that are not exempt from the City's Noise Control Ordinance [1]*. This was identified as a potentially significant noise impact during the preparation of the environmental impact study for the project based on the requirements of the City of Sacramento Noise Element [2]. Residences exist northwest, west, southwest and south of the project site. Residences east of the Capital City Freeway (State Route 51) were not considered because of the intervening roadway, distance and background sound levels. After hours construction work is required because of the Radiological Center that lies below the parking lot east of the Buhler Building.

Existing background sound levels vary by location, but are relatively high between 10:00 p.m. and 1:00 a.m. based on field measurements. Sound levels between 6:00 p.m. and 10:00 p.m. were assumed to be at least as high as measured before 12:00 a.m. These tests showed L_{50} sound level, the level exceeded 50 percent of the time, to be 64 to 66 dB(A) at the nearest residential area at the southwest corner of 28th Street and Capitol Avenue. Along 29th Street near O Street, the L_{50} sound level was 59 to 62 dB(A). Near 28th and K Streets, L_{50} sound level of 56 dB(A) was measured before midnight and 52 dB(A) after midnight. An L_{50} sound level of 53 dB(A) was measured before and after midnight in the alley next to The Chateau Senior Housing at 27th Street and Capitol Avenue. The City's sound limits are raised in 5 dB(A) increments until they encompass these levels. Thus, the L_{50} sound level limit at the apartments at the southwest corner of 28th Street and Capitol Avenue would be 70 dB(A) as an example.

Construction activity and staging information provided by the contractor were used to evaluate sound levels at the receiver positions. An assumption was made that only two pieces of high noise generating equipment would and could be operated concurrently. This information along with published and measured sound levels for different construction equipment were used to predict the sound levels at the receiver positions. The sources were placed at these two positions, the north or south ends of construction site. Equipment at the south or north ends of the project have the greatest potential for impacting residences because of direct line of sight to the receiver and the limited shielding at road intersections. Based on these assumptions, the L_{50} sound level at the apartments at the southwest corner of 28th Street and Capitol Avenue is 70 dB(A). This just meets the City's limits. The predicted L_{50}

* - Number(s) in brackets refer to references listed at the end of this report.



sound level at all other positions for all construction activity was less than the City's limit. To insure this, the hours of construction were limited to 6:00 p.m. until midnight for all activity. Specific activity such as steel erection was limited to 6:00 p.m. to 10:00 p.m. Requirements were set for the construction equipment regarding engine exhaust silencer and enclosures. Details are provided later in this report.

2.0 ACOUSTIC STANDARDS

Sounds generated by a project or impacts to a project fall under the jurisdiction of two sets of City of Sacramento acoustical criteria. The first criterion is given in the City's Noise Element [2]. A second standard is contained in the Noise Control Ordinance [1]. For this project, the EIR required a separate sound study if night construction was used because the City's Noise Control Ordinance only exempts construction sound when generated from 7:00 a.m. to 7:00 p.m. Typically, the sound generated by the activity would be compared with limits of the noise ordinance, but the levels could be compared to Noise Element standards also. The various City sound limits are explained in the following sections.

2.1 Noise Element Standards

Acoustic criteria contained in the Noise Element are based on the day-night average, L_{dn} , sound level. The L_{dn} sound level is an average over 24-hours and is directed mainly at transportation sources. An acoustical study is needed when noise-sensitive land uses, such as a residence, will be subjected to L_{dn} sound levels greater than 60 dB. The day-night noise descriptor averages measured or predicted sound levels over 24-hours after applying a 10 dB penalty to nighttime sounds. Hourly average sound levels, L_{eq} , are measured or predicted for each hour of the day or for each hour during which a sound source is present. A 10 dB penalty is added to each hourly average sound level measured or predicted from 10:00 p.m. to 7:00 a.m. The penalty is applied because people trying to sleep during these hours are more sensitive to external sounds. Excluding or including certain sources is possible. For example, the sounds of aircraft flyovers at the project site are included only during those hours when they occur. If no events happen during the nighttime, no penalty would be applied. When some sources are excluded from the analysis, it is called the Background L_{dn} sound level.

In the Noise Element [2], exterior L_{dn} noise levels up to 60 dB are "Normally Acceptable" for residential property. For L_{dn} sound levels of 60 to 70 dB, land use compatibility for a residence would be classified "Conditionally Acceptable". An exterior L_{dn} sound level of 70 to 75 dB is classified "Normally Unacceptable". Table 1 of the Noise Element of the General Plan requires the exterior L_{dn} sound level to be less than 60 dB in the outdoor activity areas. Interior L_{dn} sound level must be less than or equal to 45 dB. The impact of sound from street traffic must be evaluated using the requirements of the Noise Element. Commonly, the City has allowed activity area L_{dn} sound levels up to 65 dB when it is not aesthetically or economically feasible to meet the lower limit. Interior L_{dn} sound levels are not to exceed 45 dB in habitable rooms if impacts are to be less than significant.

2.2 City Noise Control Ordinance

The second criteria, the Noise Control Ordinance [1], looks at the sound produced during shorter times by sources not related to transportation equipment. The one exception is that sound produced by transportation equipment while on private property may be regulated by the Noise Control Ordinance. This Ordinance limits the amplitude and duration of sound produced over any given 1-hour period.



Sound limits are based on the type of source, the duration of the sound, the time of day of occurrence, background sound levels and the tonal content of sound. This is a City code and is enforceable with limited exceptions. Mechanical equipment used for air-conditioning is allowed to make a maximum of 55 dB(A) over the full 24-hours. The Noise Control Ordinance applies a 5 dB penalty to the limits when the sound comprises mainly speech or music or if it contains pure tones or impact sounds. When background sound levels equal the limits given in Table I for the individual categories, the limit of that category is raised in 5 dB increments to encompass the background sound level with one exception. The maximum background sound level is the exception to this rule. If the maximum background sound level exceeds the limit given in Table I, the measured values become the new limit. This process for handling background sound levels and changes in the noise limits creates conflicts. For example, if the measured background L_{50} sound level was 56 dB and the background L_{25} sound level was 58 dB, the revised limit for each would be 60 dB. However, the ordinance would then say 60 dB(A) could not be exceeded more than 15 minutes and for more than 30 minutes in an hour. Both requirements cannot be met simultaneously. Background sound is defined by the American National Standards Institute, ANSI, standards [3] as the sound measured when the source or sources of interest are absent. For this project, the lowest background sound level measured over an hour is of interest. This is expected to occur during the hours with the lowest local traffic volume.

The Noise Control Ordinance exempts construction activity from meeting noise limits from 7:00 a.m. to 6:00 p.m. Monday through Saturday and Sunday, 9:00 a.m. to 5:00 p.m. During other hours, an assumption was made that the limits summarized in Table I. This table gives limits and without a penalty but without regard to the background. Sound generated at the project site by people or equipment will be required to meet limits of the Noise Control Ordinance at all residential property. This includes the nighttime limits if work extends beyond 10:00 p.m.

TABLE I. Noise Ordinance Limits for the City of Sacramento for Residential Property Affected by Non-Transportation Sources.

| Category | Cumulative Number of Minutes in any 1-hour period | Exterior Sound Level Limits, dB(A) | | | |
|----------|---|------------------------------------|--------------------------------|------------------------------|--------------------------------|
| | | Without Penalty* | | With Penalty* | |
| | | Daytime 7 a.m. to 10 p.m. | Nighttime 10 p.m. to 7 a.m. | Daytime 7 a.m. to 10 p.m. | Nighttime 10 p.m. to 7 a.m. |
| 1 | 30 (L_{50}) | 55 | 50 | 50 | 45 |
| 2 | 15 (L_{25}) | 60 | 55 | 55 | 50 |
| 3 | 5 (L_{08}) | 65 | 60 | 60 | 55 |
| 4 | 1 (L_{02}) | 70 | 65 | 65 | 60 |
| 5 | 0 (L_{MAX}) | 75 | 70 | 70 | 65 |

* - Penalty applies when sound is composed primarily of speech or music, contains pure tones or results from impacts or impulsive sources.

3.0 SITE & PROJECT DESCRIPTION

Sutter Medical is in the process of expanding their facilities near the Buhler Building also known as the Sutter Cancer Center at 29th and L Streets. A new building is under construction west and south of the Buhler Building to house the Sutter Medical Foundation and Energy Center. A Women’s & Children’s Center is in the early stages of construction also. The infrastructure work for the energy



center and Women's & Children's Center Sutter center must be done. To limit disruptions, this work is proposed to be done at night. The work will occur only along 29th Street between L Street and Capitol Avenue.

Construction equipment that could be used at the site includes loaders, backhoes, sand blasting equipment, hammer drill, concrete vibrators, fork lifts and tower cranes. Other equipment includes saws, excavators, jack hammers, hammer drills, backhoe, screw guns, chop saws, and air compressor. Activity creating sound would include hammering, heavy truck movements, talking and working the equipment described above. The time required for each activity was provided by the contractor. Construction equipment sound data was based on in-house sound tests and a library of results from other tests. Construction work is not expected to extend beyond 1:30 a.m. each morning.

Land near the hospital is mainly used for commercial, business professional and institutional purposes. Sutter General Hospital is north of the project site while the Buhler Building is west. Capitol City Freeway is east of the site with the Old Tavern including Biba's restaurant to the west. Regional Transit's bus repair facility is south of the project site. The Monkey Bar is southwest of the south the site. Sutter's Fort is northwest of the site.

Few dwellings exist close to the site. The Monkey Bar and Café Bernardo at the southwest corner of 28th Street and Capitol Avenue are in a mixed used building. The restaurants are on the first floor and apartments are on the second level. These are the closest dwellings. Single & multi-family homes exist along K Street, directly north of Sutter's Fort and west of 28th Street. Sound generated at the northwest corner of this site would reach these homes. Multi- and single-family homes are found south of the site, including The Chateau senior housing south of the Energy Center that is under construction. Single family homes line the west side of 27th Street between L Street and Capitol Avenue. Sound would have to travel between the Old Tavern Building and the Buhler Building and through the energy Center to reach these homes. Finally, residences exist near the corner of 29th and O Streets. Other residences exist in the neighborhood, but these are the closest to the project site.

4.0 TEST EQUIPMENT AND PROCEDURES

Standard sound measuring equipment was used during the tests. Field sound measurements were made using two CEL 593 (s/n 2/0881414 & s/n 3/0201692) Sound Analyzers and two CEL 480, (s/n 129858 and s/n 2/112179), Sound Level Meters. These meters employ ½ inch random incidence condenser microphones. A CEL Type 284/2 calibrator was used to calibrate the meters and the microphones to 114 dB at 1000 Hz before beginning measurements. These meters conform to the requirements of a Type I meter per American National Standards Institute, ANSI [4]. A windscreen covered each microphone during all sound measurements. All meters can measure statistical sound levels such as the L_{10} , L_{25} , L_{50} and L_{90} . These are, respectively, the sound levels exceeded 10 percent, 25 percent, 50 percent and 90 percent of the time. The sound level meters also capture the maximum sound level, L_{MAX} , and the average sound level, L_{eq} . The CEL 593 meters were used to collect representative sound level tones in one-third octave bands.

Field sound measurements were made on May 20, 2008 between 10:15 p.m. and 1:00 a.m. at six residential locations near the project site. Average, L_{eq} , maximum, L_{MAX} , and other statistical descriptors of the sound, labeled L_x , were measured. Here, L_x represents values such as the L_{50} or L_{25} . These sound descriptors give additional information about how sound varied over the test period. That is, it



can tell you whether it was a source that was near the site for only a short time or a source that continued over substantial time. The L_{90} sound level is often considered the “background sound level.”

Measurements were made at five positions near the project site with microphones and meters mounted on tripods 5.5 to 6 feet above ground level. For each position, sound levels were measured during consecutive five minute intervals to identify sources and variations in sound with time. Two sets of measurements were made at each positions. Tonal measurements were made at each position during each set. Figure 1 gives an aerial view of the project site and surround land uses and shows the test measurement positions and receiver locations. The test positions were used at receiver locations also. A summary description of each test position follows:

- a. Position #1: SE corner of the 28th Street and Capitol Avenue, Approximately 15 feet east of near lane of 28th Street and 18 feet south of near lane of Capitol Avenue.
- b. Position #2: SW corner of 28th and K Streets, 63 feet south of near lane of K Street and 66 feet west of near lane of 28th Street.
- c. Position #3: NW corner of 29th and O Streets, 15 feet west of near lane of 29th Street and 48 feet north of near lane of O Street.
- d. Position #4: In alley 156 feet east of near lane of 27th Street and 12 feet south of rear of Church of Christ building.
- e. Position #6: In driveway, 6 feet south of house at 1214 27th Street and 36 feet west of near lane of 27th Street.

5.0 SOUND SOURCES

5.1 Existing

Residential areas are scattered around the project site. Traffic on Capital City Freeway (SR51) is the major source influencing the sound at all locations. Local street traffic is another major contributor to the acoustic environment at each residential location. This includes traffic on K Street, Capitol Avenue, N Street, O Street, 29th Street, 28th Street and 27th Street. Activity at the Monkey Bar and Café Bernardo is another source of sound influencing primarily the apartments above these restaurants. General human activity in the area is another source of sound.

The sound sources were not quantified because the number of sources is expected to increase over time. As a result, existing conditions represent the lowest background sound levels at the residences. Any increase in road traffic or the addition of either entertainment, restaurant, commercial or medical facilities would likely increase sound for the residences.

5.2 Cumulative Plus Project

Traffic on the Capital City Freeway (SR51) is expected to continue as a dominant sound source for all residences around the project site. Local traffic will vary in its importance to less than, equal to or greater than SR51, depending on the location. For the residences closest to SR51, the noise from traffic on this road will dominate because of the high volume and proximity. Homes along 29th Street and 30th Street fit this description. On streets farther away from SR51 with low local volume, SR 51 will probably still be the dominant source. This is the case for homes along 27th Street between L Street and Capitol Avenue. Local traffic will be a major sound source where residences are separated



from SR 51 and local traffic is relatively heavy such as on K Street. The actual volumes are not important because the volumes will not decrease over current conditions.

6.0 EXTERIOR ACOUSTIC ENVIRONMENT

6.1 Existing

Field sound measurements were used to evaluate the existing acoustic environment. Because each position was measured over two intervals, the averages of the 5-minute samples were computed over the length of each test. These averages of the short interval sound levels and other statistical descriptors are given in Table II.

TABLE II. Sound Levels Measured at Five Positions at Residences Near the Sutter Medical Project Site along 29th Street from L Street to Capitol Avenue in Sacramento.

| Test Position # | Test Interval | Measured Sound Level, dB(A) | | | | | | |
|-----------------|---------------|-----------------------------|----------|----------|----------|----------|----------|----------|
| | | L_{MAX} | L_{17} | L_{83} | L_{25} | L_{50} | L_{90} | L_{eq} |
| 1 | 22:25-23:00 | 90 | 78 | 71 | 68 | 66 | 63 | 69 |
| | 23:45-00:00 | 82 | 73 | 70 | 67 | 64 | 60 | 67 |
| 2 | 10:15-10:35 | 69 | 63 | 60 | 58 | 56 | 53 | 57 |
| | 11:35-00:00 | 74 | 61 | 57 | 54 | 52 | 51 | 55 |
| 3 | 11:10-11:35 | 84 | 74 | 71 | 66 | 62 | 59 | 66 |
| | 00:25-00:55 | 78 | 72 | 66 | 61 | 59 | 57 | 63 |
| 4 | 10:45-11:05 | 78 | 62 | 55 | 54 | 53 | 53 | 56 |
| | 00:05-00:30 | 58 | 55 | 54 | 53 | 53 | 52 | 53 |
| 6 | 11:15-11:30 | 57 | 54 | 51 | 49 | 48 | 47 | 49 |
| | 00:35-00:55 | 61 | 54 | 49 | 47 | 46 | 45 | 47 |

Position #1 was near the closest residences, the apartments above the restaurants at 28th Street and Capitol Avenue. Table I shows the highest background sound levels exist at this location. The sound is generated by local traffic and activity at the Regional Transit Bus shed. Buses are serviced and washed near this corner. The L_{90} sound level was 61 dB(A) while the L_{50} was 61 dB when measured up to midnight. The L_{50} sound level would not be expected to drop below 60 dB(A) for the remainder of the time construction would occur, assumed to be 1:30 a.m. Thus, the noise limit for the L_{50} sound level would probably be 65 dB and no less than 60 dB(A). Similarly the L_{25} sound limit would be 65 dB(A).

Figure 2 shows how the sound varied over time during the two measurements sessions at Position #1. The L_{90} sound level was low during the first 15-minutes of testing, then increased for the next 20 minutes. After a 45 minute break, the L_{90} sound level was about the same, and then dropped to its lowest level during the last 10-minutes of testing. The average, L_{eq} , sound level followed the L_{25} sound level during almost every 5-minute interval as seen in this figure. If the source were continuous, the L_{eq} sound level would follow the L_{50} sound level. Thus, the source is not continuous and is due to discontinuous sound sources like random traffic passage and random bus activity.



Table I shows similar results for the L_{50} and L_{90} sound levels at Positions #2 and #4. This is unexpected because sources near the two positions differ significantly. Position #2 was on the corner of K and 28th Street, both busy streets. However, the measurement position was more than 60 feet from either road. Position #4 was in an alley between Pioneer Church on the north and The Chateau senior living facility to the south. The site was just west of the Sutter Energy Center under construction. Table II shows larger differences between the L_{50} and the $L_{1.7}$ sound levels for Position #2 than for Position #4 as expected because the former position was subjected to much higher street traffic. A comparison of the variation in sound metrics measured at Position #2 is presented in Figure 3. The spread between the L_{90} and $L_{1.7}$ sound levels is the same for both test intervals, but the sound levels decreased 3 to 4 dB(A) between intervals. The measured L_{50} sound level was greater than the nighttime limit during both test intervals. For tests before midnight, the City's L_{50} noise limit would be raised to 60 dB. After midnight, the L_{50} sound level limit would increase to 55 dB.

Position #3 was near a home close to the Capital City Freeway and near 29th Street. Road traffic was the main source of sound. The background L_{50} sound level was well above the nighttime limit of 50 dB(A) during both test intervals. This was true up to 1:00 a.m. when the background L_{50} sound level was still 59 dB(A). The L_{50} sound level limit would be increased from 50 to 60 dB(A) per the City's Noise Control Ordinance after midnight and to 65 dB(A) before 12:00 a.m. Figure 4 shows how the sound metrics varied during each 5-minute interval of the two test periods. The spread between the $L_{1.7}$ and the L_{90} sound level remained the same during the two intervals, but the values were about 3 dB(A) lower during the tests done after midnight. During the first test interval from 11:10 p.m. to 11:35 p.m., the L_{eq} sound level followed the L_{25} sound level very closely. Again, this implies the noise source was not constant, whether local traffic or traffic on the Capital City Freeway. During the tests from 12:25 a.m. to 12:55 a.m., the L_{eq} sound level was greater than the L_{25} sound level. This means the sound sources were transient events that had a short duration. This could describe low volume traffic on any of the roads, but would not represent typical mechanical equipment sources, for example.

Sound measurements done at Position #4 were expected to be low because of shielding by the church to the north, the senior apartments to the south and the partially built Sutter Energy Center to the east. Low L_{90} sound levels were measured at this position, but the L_{eq} sound levels were only slightly lower than at Position #2 as noted. Thus, transient events significantly influenced the results. A comparison of the variation of the sound levels for all metrics measured during the two test intervals are presented in Figure 5. This figure shows that except for isolated events, the sound was constant with only a small drop in sound level between the first and second test periods. The City's L_{50} sound level limit would 55 dB(A) before and after midnight according to field tests.

Position #6 was directly west of Position #4, but next to a single family home at 27th Street. This position was farther from State Route 51, but next to a local street. However, the lowest sound levels were measure at this position. The L_{50} sound level was less than 50 dB(A) during both test intervals so the City's limits would apply as shown in Table I. Figure 6 displays the variation in the sound metrics measured during the two test periods. The difference between the $L_{8.3}$ and the L_{90} sound level is greater than for this position than Position #4, even though the levels are lower. Because of the low levels and small influence from traffic on the Capital City Freeway, transient events had a greater influence.

6.2 Existing Plus Project

Nighttime construction will introduce several new sound sources to the acoustic environment near the project site. The project will not increase general traffic on local streets or the Capital City



Freeway except for construction related vehicle movements. This would include heavy trucks, primarily, dump trucks moving through the project area. While these trucks are on public roads, the sound they emit is preempted by federal regulations if all original equipment remains in good working order or has been replaced with acoustically equivalent parts. The State or others can test this equipment to insure compliance with the State's regulations.

The remainder of the equipment on the project site and the heavy trucks while on private property are treated as non-transportation sound sources. Table III provides the sound sources identified by the contractor and the hours of operations and number of days. These are considered approximations of the actual work activity and are adequate for evaluating sound impacts. Two types of activity are identified also. One group will be done during after norm exempt hours while the other group will be done only after hours if the sound or vibration of the activity causes problems with uses at the project site.

TABLE III. Description of Construction Activity That Could Be Done After Normal Hours at Sutter Medical's Women & Children's Center, Along with the Duration of the Activity.

| Activity | Equipment or Task | Hours per Day | No. of Days |
|-----------------------------------|--|---------------|-------------|
| <i>After Hours Work</i> | | | |
| Excavation | Loader & backhoes | 8 | 5 |
| Sand Blasting | Sand/Bead Blasting, Air Compressor | 8 | 7 |
| Imbedding | Hammer Drill, Air Compressor | 8 | 10 |
| Steel Erection | Crane, Hammers, Forklift, Impact Wrenches, Material Handling, Air Compressor | 8 | Unknown |
| Demo Tunnel | Saws, Excavator, Jack Hammer, Air Compressor | 8 | Unknown |
| Build Exit | Saws, Jack Hammers, Hammer Drills, Backhoe, Trucks, Screw Guns, Chop Saws, Hammering, Air Compressor | 9 | 20 |
| <i>Potential After Hours Work</i> | | | |
| Concrete Work | Drills, Hammers & Concrete Trucks | 8 | 12 |
| Remove Forms | Pry Bars, Material Handling & Hammering | 8 | 4 |

The information in Table III and sound levels from published data and from in-house tests were used to predict the sound levels at all receivers. The sources were assumed to be either at the north or south end of the project site. This represents the worse case situation because the nearest residential sites are visible from these areas. The predictions assume that certain events can not occur concurrently such as excavating and jack hammering. That is, the excavator will be used to remove a structure or the soil above a structure and then a jack hammer will be used when the excavator can not be used. Similarly, when the excavator is moving around the site, only limited work can be done on other places.

Table IV provides the A-weighted sound levels used in the calculations. These were obtained from publications by the U.S. Environmental Protection Agency and the Federal transit Administration. The values are average sound levels measured at 50 feet. They do not represent the variation in sound with time except for stationary equipment that runs continuously such as a compressor. For excavators and loaders that move and vary the load on the engine, the sound levels would vary and the



numbers given represent the worse case. The data in this table that all equipment has an original equipment muffler or equal and that all enclosures for the equipment are kept closed. This is true of the compressor.

TABLE IV. Typical Published Average A-weighted Sound Levels for Construction Equipment Measured at 50 feet and Used for Prediction of Evening and Nighttime Construction at Sutter Women and Children's Center in Sacramento.

| Equipment Description | A-Weighted Sound level at 50 feet, dB |
|-----------------------|---------------------------------------|
| Jack Hammer | 88 |
| Air Compressor | 81 |
| Excavator | 80 |
| Truck | 83 |
| Back Hoe | 75 |
| Loader | 75 |
| Saw | 76 |
| Sand Blasting | 80 |
| Impact Wrench | 85 |
| Hammer Drill | 80 |

The closest receivers are in the apartments above the restaurant at the southwest corner of 28th Street and Capitol Avenue. Construction in the southeast corner of the project site would place sources at the closest distance and least shielded position to these receivers. Measurements between 10:00 p.m. and 11:00 p.m. showed L_{50} sound levels of 66 dB(A). Thus, the City's noise limit for the L_{50} sound level would be increased to 70 dB(A). However, the L_{25} sound level was 68 dB(A), raising the limit to 70 dB(A) also. The City's code would say that the sound could last for 15 minutes or for 30 minutes. Both conditions can not exist concurrently and the regulation has no provision for dealing with this anomaly. An assumption was made that the L_{50} sound level limit would prevail.

The distance from the construction site to the receivers is about 425 feet. The predicted sound level for the jack hammer and air compressor running at the apartments on the 2nd floor of the building at the southwest corner of L street and Capitol Avenue is 70 and 59 dB(A), respectively. This would be a total of 70 dB(A) and would just meet the limit. This does not include any excess sound reduction due to shielding or ground effects. If another source was active near the same location, the limit would be exceeded and more sound reduction would be required. Temporary and portable sound walls could be installed near the sources that are stationary such as the compressor.

Table V gives the predicted results at the five receiver locations, four of which were field measurement positions also. These results are compared with the City's lowest limit based on background sound levels.



TABLE V. Predicted Sound Level at Five Receiver Positions Near Sutter Health Project Site for a Compressor and Jack Hammer Operating in the Southeast Corner of the Project.

| Receiver/Test Location | Predicted L_{50}/L_{25} Sound level, dB(A) | | | Lowest L_{50}/L_{25} Sound Level Limit, dB(A) |
|-------------------------------|--|-------------|-------|---|
| | Compressor | Jack Hammer | Total | |
| Apt. above Monkey Bar | 59 | 70 | 70 | 70 |
| #2, K & 28 th St | 44 | 51 | 52 | 60 |
| #3, O & 29 th St. | 42 | 49 | 50 | 65 |
| #4, The Chateau, NW | 29 | 36 | 37 | 55 |
| #6, 1214 27 th St. | 29 | 33 | 34 | 50 |

The predicted L_{50}/L_{25} sound levels equal or are less than the City's limit at each location. Only the apartments above the restaurants at Capitol Avenue and 28th Street will be subjected to sound levels close to the limit. These venues remain open until midnight or later almost every night. Most of the sound is generated by activity at the restaurants.

A compressor and a wheeled loader were assumed to be working in the northwest corner of the project as a worse case scenario for residences to the northwest. The predicted results are presented in Table VI.

TABLE VI. Predicted Sound Level at Five Receiver Positions Near Sutter Health Project Site for a Compressor and Excavator Hammer Operating in the Northwest Corner of the Project.

| Receiver/Test Location | Predicted L_{50}/L_{25} Sound level, dB(A) | | | Lowest L_{50}/L_{25} Sound Level Limit, dB(A) |
|-------------------------------|--|--------|-------|---|
| | Compressor | Loader | Total | |
| Apt. above Monkey Bar | 37 | 43 | 44 | 70 |
| #2, K & 28 th St | 39 | 43 | 44 | 60 |
| #3, O & 29 th St. | 40 | 48 | 49 | 65 |
| #4, The Chateau, NW | 31 | 40 | 41 | 55 |
| #6, 1214 27 th St. | 30 | 36 | 37 | 50 |

The predicted L_{50}/L_{25} sound levels are less than the City's limit at each location. All of the positions receive benefit from shielding by buildings between the source and the receiver. The straightest line to a receiver would be slightly west of Position #2. The highest predicted L_{50}/L_{25} sound level is 60 dB(A). This is still less than the background sound.

6.3 Cumulative Plus Project

Road traffic on all streets is expected to remain the same or to increase over the length of this project. Thus, background sound levels will remain the same or increase. Predicted sound levels and their comparison with background sound levels for existing conditions will apply to cumulative plus project conditions.



7.0 NOISE IMPACTS

The change in exterior L_{50}/L_{25} sound levels from existing to existing plus project is expected to be insignificant because of background sound levels. However, background sound levels decrease as the night progresses. Thus, this conclusion assumes that hours of operation are limited. Similarly, the sound generated by each piece of equipment assumes that the standard enclosures are in use and all acoustical equipment such as mufflers are identical to that provided by the original equipment manufacturer or is equal to it. The prediction also assumed only limited concurrent work would and could be done by the noisier equipment.

8.0 MITIGATION MEASURES

Sound reduction is not required based on the assumptions used in this analysis. However, several requirements must be met before for the assumptions are correct. Because of the difficulty of predicting all construction activities and their locations, sound monitoring should occur randomly to ensure compliance with the City's Noise control Ordinance. The following outline provides the conditions and assumptions that must be met to comply with the assumptions used to predict no significant noise impacts. Following that are measures that could be taken to provide additional sound reduction if needed for conditions that are outside those described in this study. These requirements apply only between 6:00 p.m. and 7:00 a.m. except where designated otherwise.

I. General Requirements

A. Enclosures and Housing

1. All equipment provided with housings and enclosures shall only be operated with the housings or enclosures in place and set to provide the lowest sound radiation and equivalent to that for a new piece of equipment.
2. Equipment modified to remove any housing or enclosures shall not be used or temporary enclosures equivalent to the original system shall be constructed and approved by the City or an acoustical engineer.
3. Written approval shall be provided for any modifications in the housing or enclosure for all equipment. This approval shall be available for inspection at the job site.

B. Internal Combustion Engines

1. All internal combustion engines shall be fitted with an exhaust muffler provided by the original equipment manufacturer to meet all applicable state and federal noise regulations or a replacement equal to the original.
2. No internal combustion engine shall be allowed to operate without such silencers.

C. Location

1. The noisiest stationary equipment shown in Table IV shall be placed at the farthest distance from the nearest receivers shown in Figure 1.
2. Where possible, equipment shall be placed with intervening structures or other equipment separating the noisiest stationary equipment from other equipment.



D. Operations

1. Time

- a. All after hours weekday construction activity shall commence after 6:00 p.m.
- b. Weekend after hours construction activity shall commence after 5:00 p.m.
- c. No after hours construction activity shall be allowed on Sunday.
- d. After hours construction shall cease at 12:00 a.m.

2. Specific Activity

- a. Excavation shall be completed by no later than 10:00 p.m.
- b. Sand blasting shall be completed by no later than 10:00 p.m.
- c. Hammer drilling for placing imbeds shall be completed by no later than 10:00 p.m.
- d. The stripping of form work shall be completed by no later than 10:00 p.m.
- e. The placement of structural steel and decking shall be completed by no later than 10:00 p.m.
- f. The placing of forms and pouring of concrete shall occur only during weekday and weekend hours where construction work is exempted by the City's Noise Control Ordinance.
- g. Waterproofing shall occur only during weekday and weekend hours where construction work is exempted by the City's Noise Control Ordinance.
- h. The placement and pouring of the final slab shall occur only during weekday and weekend hours where construction work is exempted by the City's Noise Control Ordinance.
- i. The demolition of the exiting tunnel shall occur only during weekday and weekend hours where construction work is exempted by the City's Noise Control Ordinance.
- j. The construction of the emergency exit in the northeast corner of the ROC shall occur only during weekday and weekend hours where construction work is exempted by the City's Noise Control Ordinance.

The following work shall be undertaken only if field sound monitoring shows that evening and nighttime construction operating conditions differ from those assumed, resulting in excess sound at a residential location. Only a single option is provided, but other options specific to the source could be implemented.

II. Optional sound Reduction

A. Sound Barrier

1. Temporary barriers shall be erected around area where noise the source of concern is operating.
2. The barrier shall typically be placed as close as possible to the sources.
3. The height of the barrier shall be a minimum 2 feet taller than the height of the source. For internal combustion engines with vertical exhausts, the source height shall be the top of the exhaust outlet.



4. All sound barrier walls must have a minimum surface weight of 3 to 3.5 lbs./sq.ft. or they shall have been tested and achieved a Sound Transmission Class, STC, rating of at least 35.
5. The barrier must be continuous along its width and height with no gaps including at the ground.

9.0 REFERENCES

1. Noise Control Ordinance of the City of Sacramento, Ordinance No. 3872, approved by the City Council, May 31, 1977 and as revised. See Sacramento City Code, Chapter 66.
2. Sacramento City Planning Commission, "Noise Element" from Chapter 8, "Health and Safety Element" from the *City of Sacramento General Plan Updated*, Adopted January 19, 1988.
3. American National Standard, **Quantities and Procedures for Description and Measurement of Environmental Sound. Part 3: Short-Term Measurement with an Observer Present**, ANSI S12.9-1993/Part 3, reaffirmed by ANSI on September 15, 1998, New York.
4. American National Standards Institute, ANSI, *Standard Specification for Sound Level Meters, SI.4-1983 (Precision)*

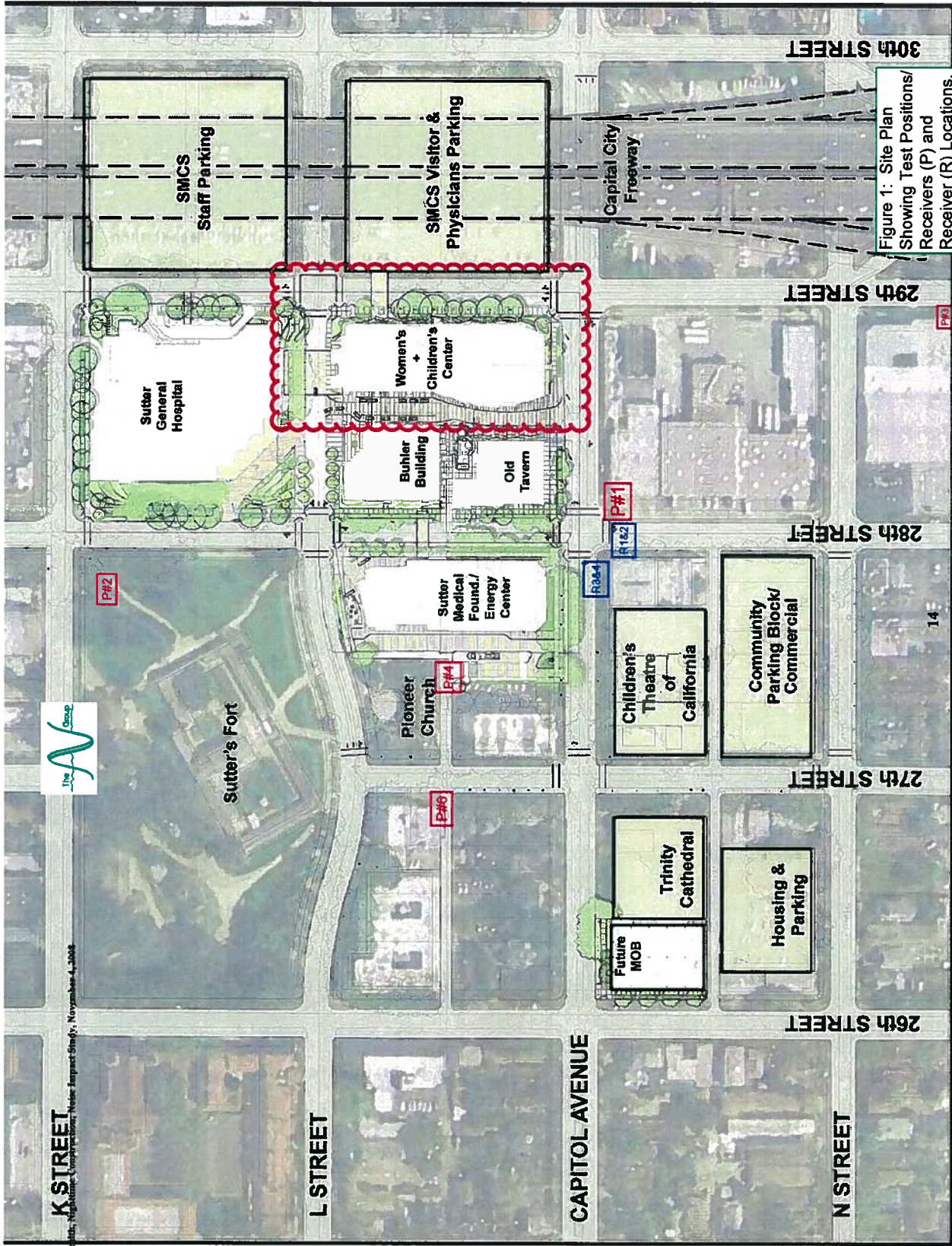


Figure 1: Site Plan Showing Test Positions/Receivers (P) and Receiver (R) Locations.



Sutter Health, W&C Cntr Nighttime Construction Site #1, 15 ft E of 28th St & 18 ft S of Capitol Avenue

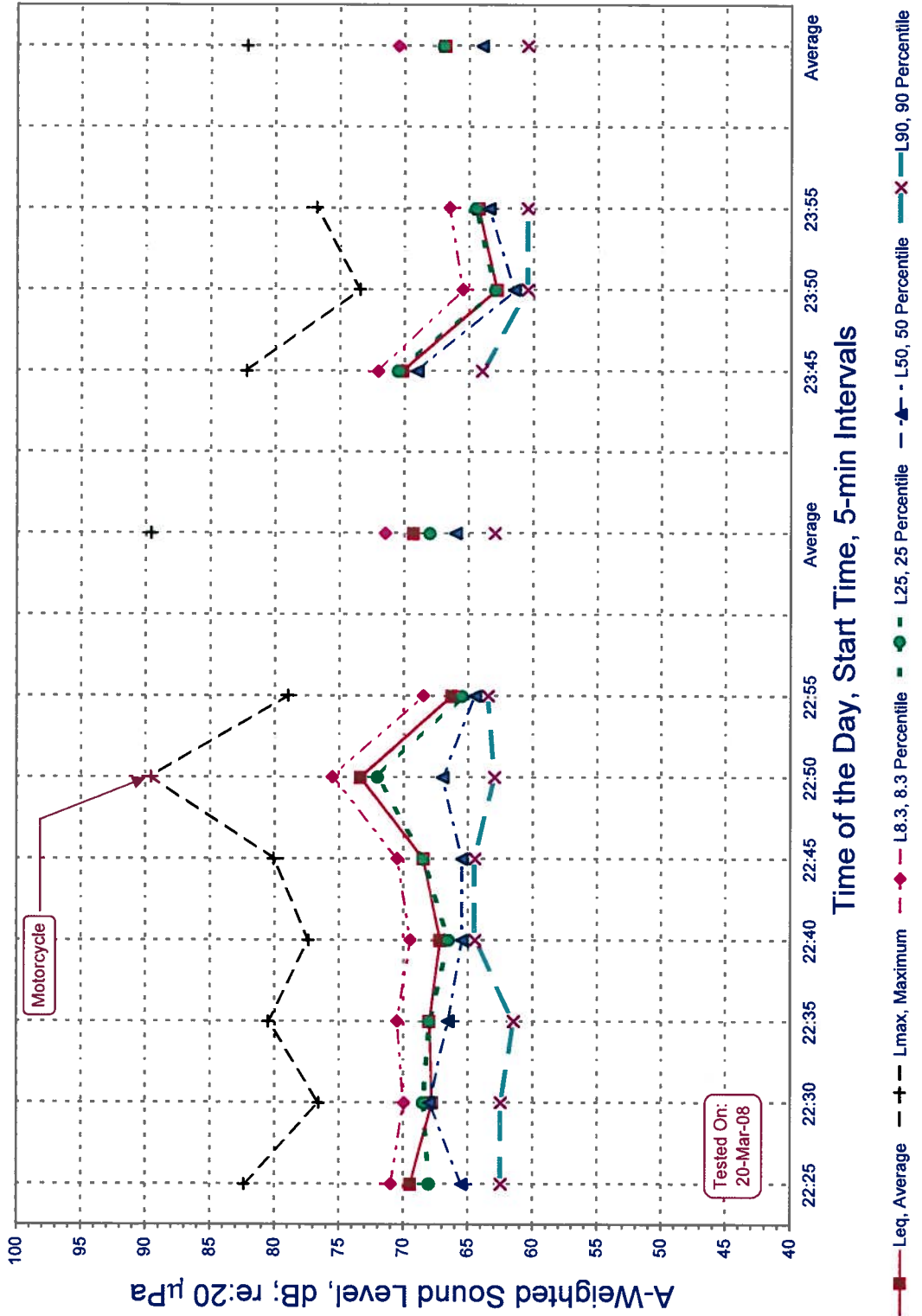


Figure 2. Variation in Sound Metrics Measured at Position #1 at Southeast Corner of Capitol Avenue and 28th Street.



Sutter Health, W&C Cntr Nighttime Construction Site #2, 63 ft South of K St & 66 ft West of 28th St

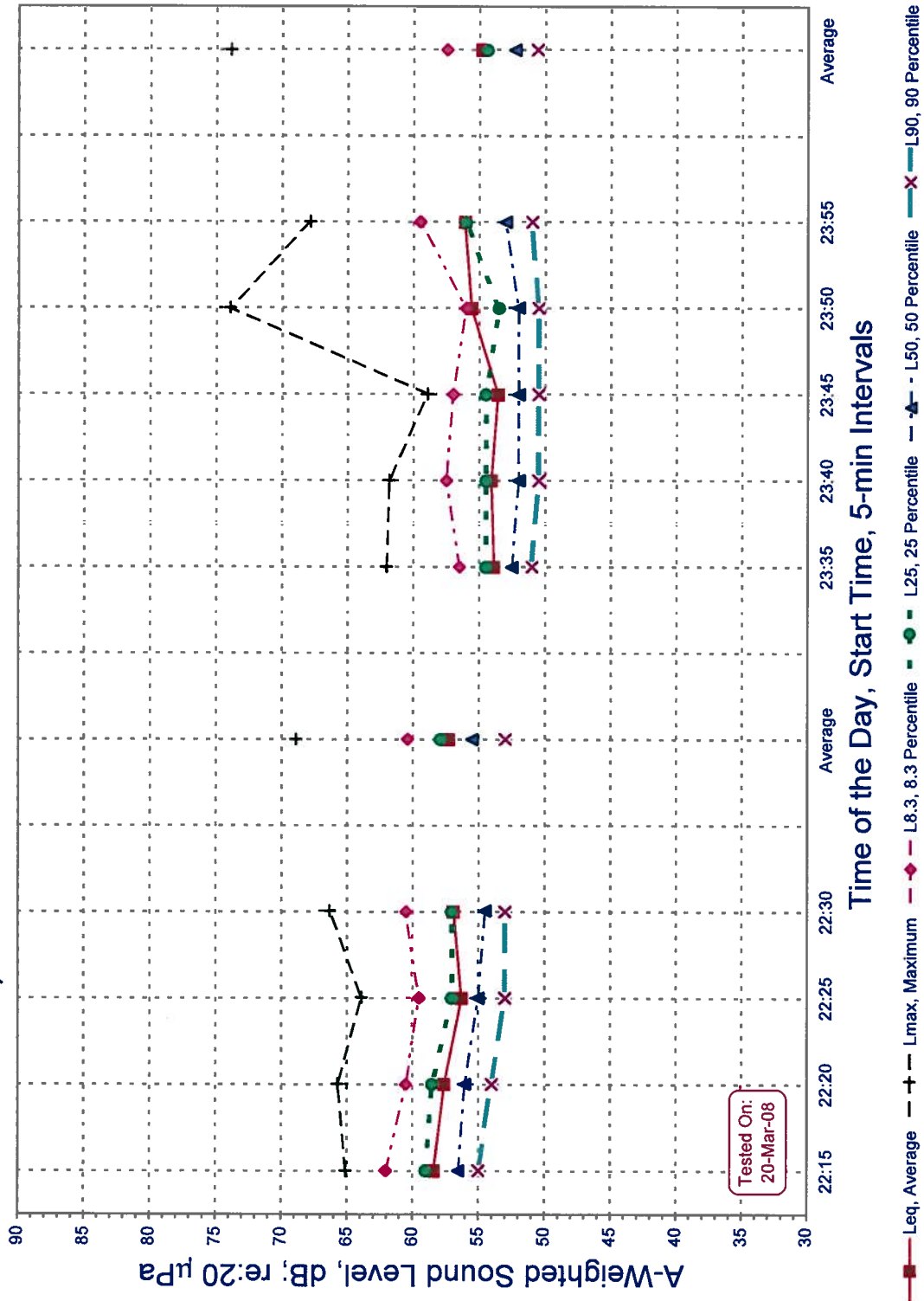


Figure 3. Measured Sound Levels During 5-Minute Intervals at Position #2 at Sutter Fort Near K and 28th Streets.



Sutter Health, W&C Cntr Nighttime Construction Site #3, 15 ft West of 29th St & 48 ft North of O St

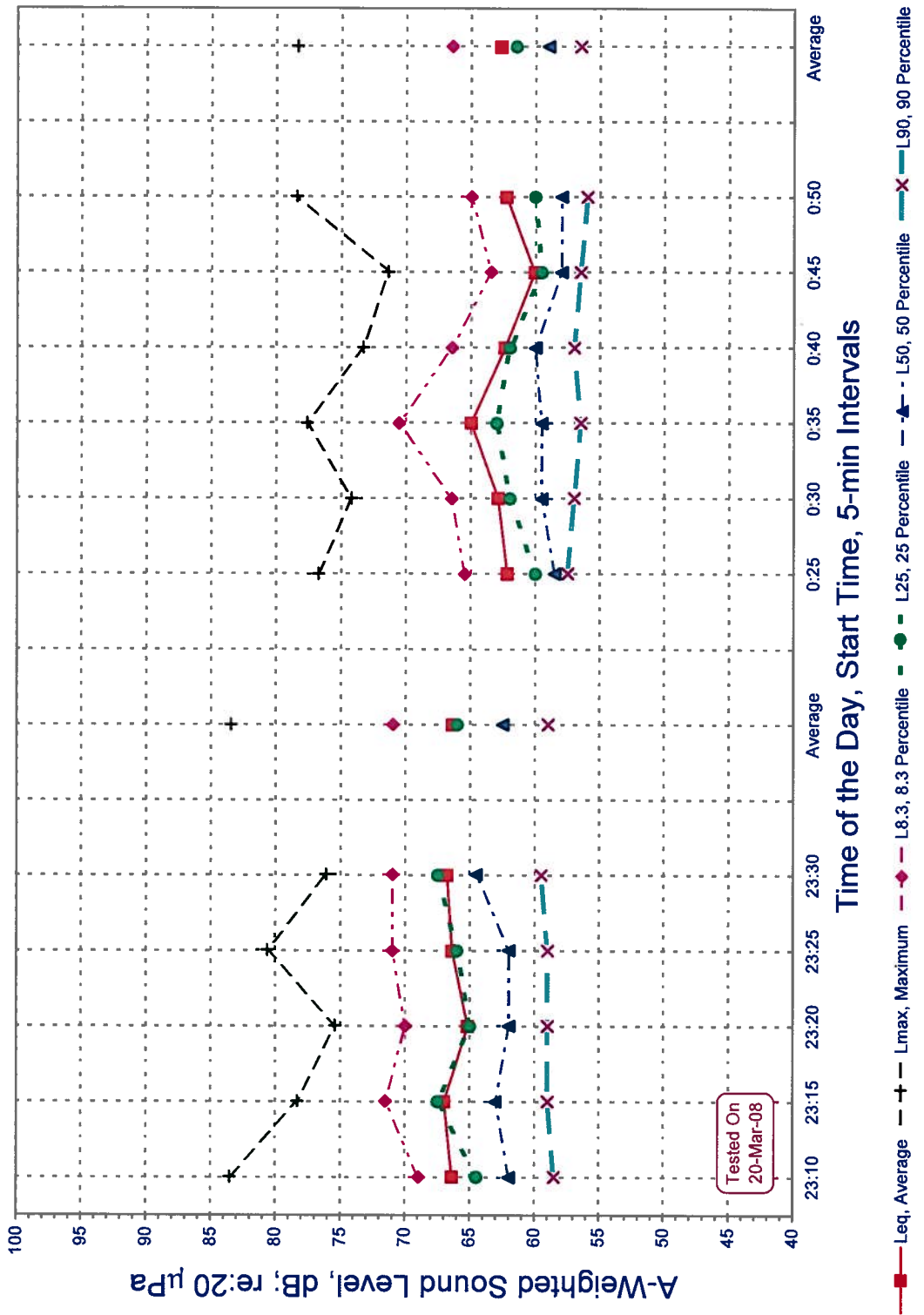


Figure 4. Variation in Sound Metrics Measured at Position #3 near the Southeast Corner of 28th and O Streets.



Sutter Health, W&C Cntr Nighttime Construction Site #4, 156 ft E of 27th St & 9 ft N of Playground

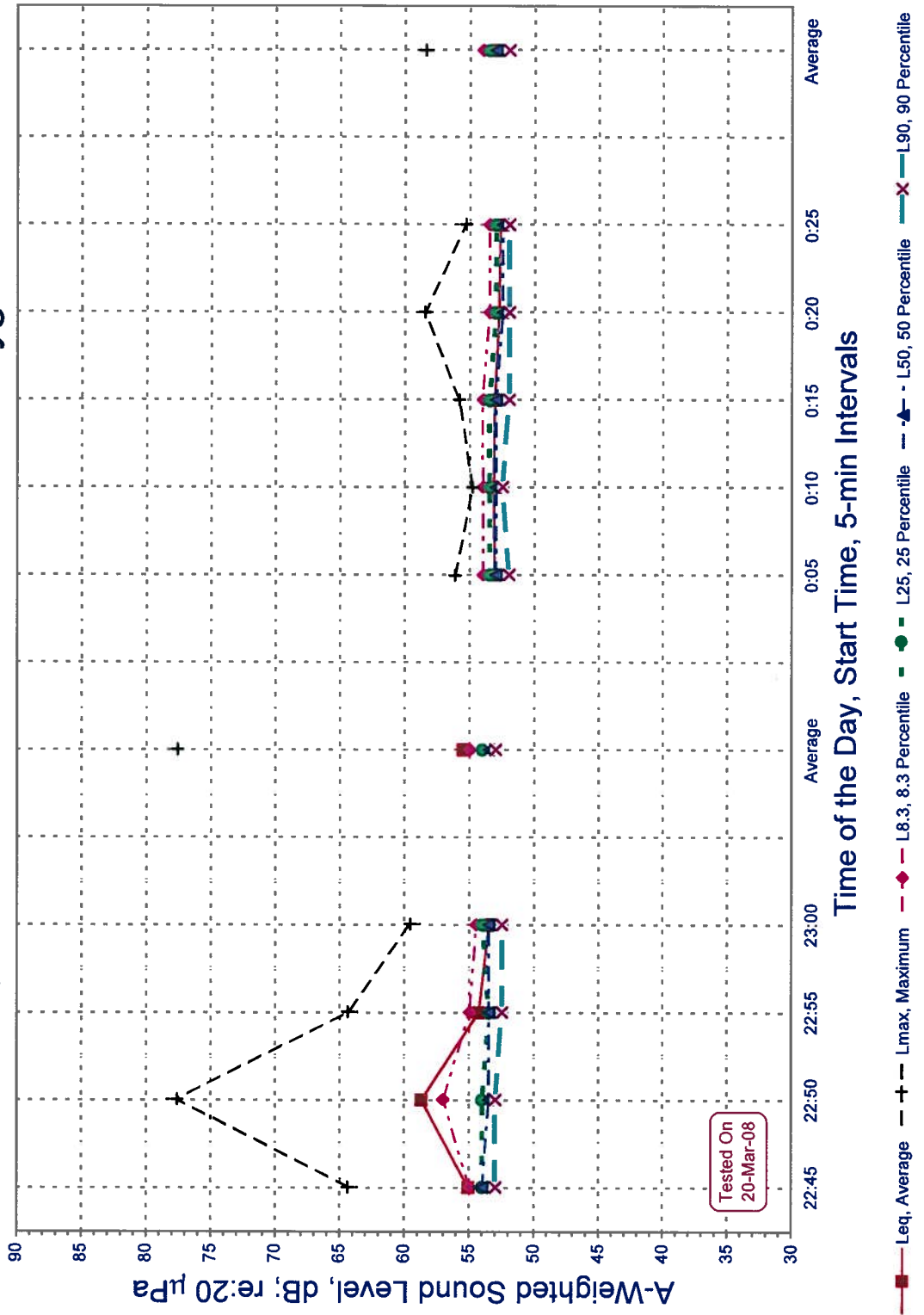


Figure 5. Measured Sound Levels During 5-Minute Intervals at Position #4 in Alley Northwest The Chateau Housing.



Sutter Health, W&C Cntr Nighttime Construction Site #4, 156 ft E of 27th St & 9 ft N of Playground

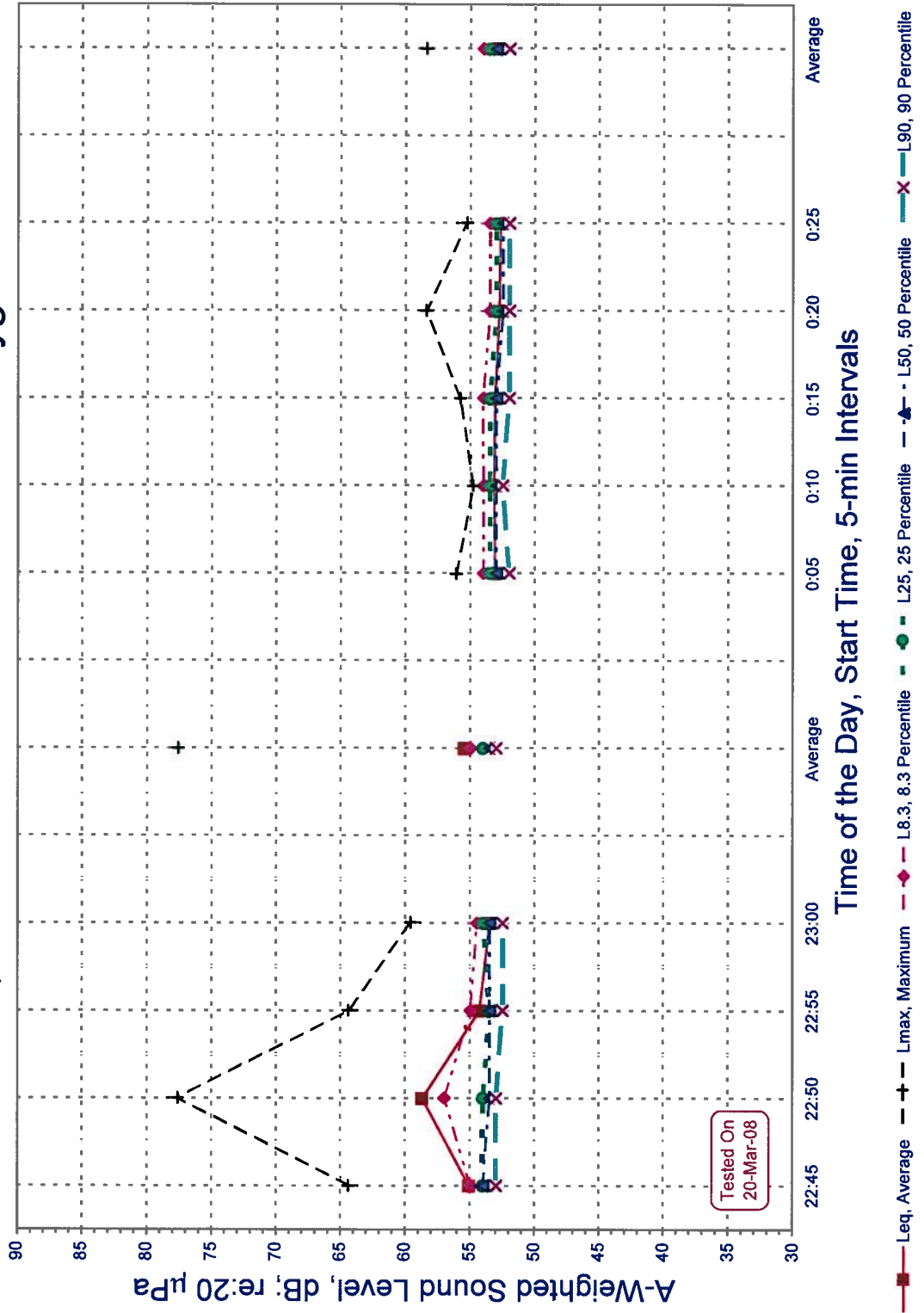


Figure 6. Measured Sound Levels During 5-Minute Intervals at Position #6 at South Side of Home at 1214 27th Street.