Appendix E

Noise

BASELINE SOUND STUDY

FOR THE
UNIVERSITY OF CALIFORNIA AND LAWRENCE BERKELEY NATIONAL LABORATORY RICHMOND BAY CAMPUS PROJECT

RICHMOND, CALIFORNIA

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PREPARED FOR:
Lawrence Berkeley National Laboratory
One Cyclotron Road
Berkeley, CA 94720

PREPARED BY:
Tetra Tech, Inc.

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A NIST Laboratory Calibration Sheets

LIST OF ACRONYMS

Acronym or Abbreviation	Full Phrase
ANSI	American National Standards Institute
Caltrans	California Department of Transportation
CCR	California Code of Regulations
CEC	California Energy Commission
CEQA	California Environmental Quality Act
CNEL	Community Noise Equivalent Level
dB	decibels
dBA	A-weighted decibels
DOE	United States Department of Energy
gps	global positioning system
gsf	gross square foot
Hall	Lawrence Berkeley Hall of Science
HVAC	heating, ventilation, and air conditioning
Hz	Hertz
in	inches
in/sec	inches per second
INCE	Institute of Noise Control Engineers
kHz	kilohertz
LBNL	Lawrence Berkeley National Laboratory
L_{10}	intrusive noise level
L_{50}	median sound level
L_{90}	residual sound levlel
L_{eq}	equivalent Sound Level
L_{max}	maximum sound level
Ln	Statistical noise levels (i.e., L_{10}, L_{50}, L_{90})
MP	Monitoring Position
NAD	North American Datum
NIST	National Institute of Standards and Technology
OSHA	Occupational Safety and Health
RBC	Richmond Bay Campus
sec	seconds
UC	University of California
µPa	microPascal
UTM	Universal Transverse Mercator

Section 1 Introduction

1.1 PROJECT OVERVIEW AND PURPOSE

The University of California (UC) is proposing to establish new major research facilities at UC properties in Richmond, California. The new campus consolidates the biosciences programs of the Lawrence Berkeley National Laboratory (LBNL) and will also provide for development of additional facilities to be used by both LBNL and UC Berkeley. The campus is referred to as the Richmond Bay Campus (RBC), or the "Project" herein.

Background sound levels were monitored at several sensitive receptors such as nearby residences. Sound pressure levels reported are routinely used in the assessment of compliance with regulatory limits and in the determination of potential adverse impacts when used in conjunction with modeling results. Baseline sound measurements were collected to document the existing conditions for use in determining the expected net increase as a result of RBC construction and operation. Resultant data would be used for comparative purposes, for impact analysis under the California Environmental Quality Act (CEQA) and the National Environmental Policy Act (NEPA), and for other applicable federal, state, and local ordinances or regulations. This baseline sound report describes the RBC study area, applicable regulations, measurement methodologies, and results.

1.2 RBC STUDY AREA

The RBC project site is in the city of Richmond, California, on approximately 133 acres owned by the UC. The area is located just off Interstate 580 (I-580) and situated between the San Francisco Bay, the Richmond Annex and the Point Isabel neighborhood. The RBC site is surrounded by institutional, residential and neighborhood commercial land uses.

1.3 SOUND SURVEY DESCRIPTION

Baseline measurements were completed during daytime and nighttime periods on January 24th through the 25th to document the existing acoustic environment. Monitoring was conducted at sensitive land uses such as residences, public use areas, and a National Historical Park property (Rosie the Riveter WWII Home Front). Short-term sound level measurements were completed during daytime (i.e. 10:00 a.m. to 4:00 p.m.) and nighttime (10:00 p.m. to 4:00 a.m.) periods. To avoid high vehicular traffic time periods short-term monitoring was completed outside of peak hour traffic periods. Measurements were completed during meteorological conditions conducive to the collection of measurement data (i.e., no rain or high wind). In accordance with CEQA requirements, noise monitoring at one unattended long-term (24-hour) location on the RBC project site was included to determine diurnal variation. These sound survey locations are shown on Figure 1-1.

Figure 1-1 Proposed Project area for RBC

Section 2 Regulatory Context

The regulatory environment for the Project includes federal, state and local noise control regulations and/or guidance. LBNL, as part of a federal agency (i.e., the Department of Energy or DOE), is subject to state and/or local regulation only if there has been a waiver of federal sovereign immunity through federal law, consistent with the U.S. Constitution's supremacy clause. Federal agencies, by way of the Federal Land Policy Management Act (FLPMA), 43 USC §1701 et seq. which provides a limited waiver of federal sovereign immunity, are required to comply with state or local provisions for environmental protection for portions of the federal agency's activities that would be located on federal lands. The authors understanding is that the properties on which RBC would be constructed are owned by the UC and therefore not federal lands per say, but if these are federal lands compliance with state and/or local regulations may be required. Regardless, LBNL is committed to planning its projects to be consistent with state and local laws or regulations.

2.1 FEDERAL REGULATIONS

Federal laws, regulation and guidance establish the national framework for noise regulations. If NEPA documentation is required, LBNL, part of the U.S. Department of Energy, implements NEPA via 10 Code of Federal Regulations (CFR) Part 1021. Noise considerations are typically addressed in NEPA documentation, which incorporate U.S. Environmental Protection Agency (EPA), state and other local regulations into the analysis.

2.1.1 Occupational Safety and Health Administration, Occupational Noise Exposure; Hearing Conservation Amendment (29 CFR 1910.95)

This standard establishes mandates to protect employees from excessive noise exposure and requires a Hearing Conservation Program when employee noise exposures equal or exceed an 8-hour time-weighted average sound level (TWA) of 85 A-weighted decibels (dBA).

2.1.2 Noise Control Act of 1972, as amended (42 USC 4901 et seq.)

The Noise Control Act of 1972, as amended, requires that all Federal agencies "to the fullest extent within their authority" implement programs within their jurisdictions that promote an environment free from noise that jeopardizes health and welfare. Federal, state and local agencies enforce the requirements and standards of the Noise Control Act to regulate noise from facilities, such as those at the RBC.

2.1.3 U.S. Environmental Protection Agency in "Information of Levels on Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety." (EPA 550/9-74-004)

Published in 1974, this document identifies safe levels of environmental noise exposure and is intended to "provide State and Local governments as well as the Federal Government and the private sector with an informational point of departure for the purpose of decision making." While the EPA has no regulation governing environmental noise, the agency has conducted several extensive studies to identify the effects of sound level on public health and welfare. For outdoor residential areas, the recommended EPA guideline is a day-night average noise level (L_{dn}) of 55 dBA and an indoor L_{dn} limit of 45 dBA. These levels are identified as desirable to protect against speech interference and sleep disturbance for residential, educational, and healthcare areas. Noise-level criteria to protect against hearing damage in are identified as 24-hour L_{eq} values of 70 dBA (both outdoors and indoors), with the value of 70 dBA Leq measured at the human ear, whereas

community/environmental noise is not measured at the ear. This publication remains the authoritative study based on a large sampling of community reaction to noise. The EPA sound level guidelines do not provide an absolute measure of noise impact, but rather a consensus on potential activity interference, human health and welfare effects, and annoyance. Because these protective levels were derived without concern for technical or economic feasibility, and contain a margin of safety to ensure their protective value, they should not be viewed as standards, criteria, regulations, or goals. Rather, they should be viewed as levels below which there is no reason to suspect that the general population will be at risk from any of the identified effects of noise. The following quote from the EPA guidance provides clarification on the use of the cause and effect noise levels:

> *"Perhaps the most fundamental misuse of the Levels Document is treatment of the identified levels as regulatory goals. They are not regulatory goals; they are levels defined by a negotiated scientific consensus. These levels were developed without concern for economic and technological feasibility, are intentionally conservative to protect the most sensitive portion of the American population, and include an additional margin of safety. In short, the levels in Table VIII are neither more nor less than what Congress required."*

The EPA guideline limits are summarized in Table 2-1.

Table 2-1 Summary of EPA Cause and Effect Noise Levels

Location	Level	Effect
All public accessible areas with prolonged exposure	70 dBA $L_{eq(24)}$	Safety
Outdoor at residential structure and other noise sensitive receptors where a large amount of time is spent	55 dBA L_{dn}	Protection against annoyance and activity interference
Outdoor areas where limited amounts of time are spent, e.g., park areas, school yards, golf courses, etc.	55 dBA $L_{eq(24)}$	
Indoor residential	45 dBA L_{dn}	
Indoor non-residential	55 dBA $L_{eq(24)}$	

U.S. Environmental Protection Agency. 1974

$L_{eq(24)}$ – Equivalent sound level for a given 24-hour period.

2.2 STATE REGULATIONS

The California Environmental Quality Act (CEQA) requires that significant environmental impacts be identified and that such impacts be eliminated or mitigated to the extent feasible. The CEQA guidelines (AEP 2012) set forth characteristics that signal a potentially significant impact. Under CEQA the proposed Project would be considered to have significant noise impacts if it results in the following:

- Exposure of persons to or generation of noise levels in excess of standards established in the local general plan (see Section 2.3) or noise ordinance, or applicable standards of other agencies?
- A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project?
- A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project?
- For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?
- For a project within the vicinity of a private airstrip, would the project expose people residing or working in the project area to excessive noise levels?

For the proposed Project, the following criteria were determined to be inapplicable or to result in no impact:

- Exposure of on-site workers to noise levels that exceed occupational safety standards (90 dBA as a time-weighted 8-hour average or peak noise levels above 115 dBA).
- Exposure of residents to airport or private airstrip-related noise levels above a CNEL of 65 dBA.

Occupational noise exposure is governed by federal and state regulations. The California Division of Occupational Safety and Health (Cal/OSHA) administers industrial safety regulations in California. Cal/OSHA regulations establish a time-weighted noise exposure limit of 90 dBA averaged over 8 hours (California Code of Regulations, Title 8, Article 105). Noise source controls, administrative procedures, or worker hearing protection must be provided if worker noise exposure would exceed the 90 dBA limit. These limits are not expected to be a concern for the Project as LBNL complies with the exposure limits outlined in the American Conference of Industrial Hygienists (ACGIH) recommended Threshold Limit Values, 85 dBA with a 3 dB doubling, which is more stringent than the Cal/OSHA regulations (i.e., Cal/OSHA and OSHA are 90 dBA with a 5 dB doubling).

According to the California Energy Commission (CEC), increases in noise less than 5 dBA above background at a sensitive receptor are clearly not significant, and increases in noise greater than 10 dBA above background at a sensitive receptor are clearly significant (CEC 2002). Increases in background noise between 5 and 10 dBA may be significant, depending on the circumstances. It would be reasonable to assume that similar thresholds may be applied to the Project.

The State of California provides regulation by adopted laws and guidance regarding noise emissions through the jurisdiction of state commissions requiring local jurisdictions (California Government Code Section 65302[f]) to prepare general plans, which include Noise Elements. The purpose of the noise element is to identify goals, policies, and implementation measures that can be used to guide future land use development with regard to noise. The State of California identifies the following land uses as noise sensitive: residential areas, schools, convalescent and acute care hospitals, parks and recreational areas, and churches. The recommended noise guideline for exterior living areas (yards and patios) for new residential land uses is a 55 dBA CNEL, and must not exceed 65 dBA CNEL. In addition, for multi-family residential projects, the California Noise Insulation Standard (California Administrative Code, Title 25, Chapter 1, Subchapter 1, Article 4) requires that the indoor noise levels in multi-family residential developments do not exceed a CNEL of 45 dBA to be consistent with State of California standards.

2.3 LOCAL REGULATIONS

The City of Richmond regulates noise via its *"Code of Ordinances, Chapter 9.52 - Community Noise Ordinance"*. Maximum exterior noise levels by zoning district are listed in Table 2-2. Richmond's noise ordinance also provides noise limits applicable to stationary construction equipment.

Table 2-2 Maximum Noise Levels by Zoning District

Zoning District	Maximum Noise Level in dBA (levels not to be exceeded more than 30 minutes in any hour)		Maximum Noise Level in dBA (level not to be exceeded more than 5 minutes in any hour)
	Measured at Property Line or District Boundary	Measured at Any Boundary of a Residential Zone	Between 10 PM and 7 AM***, Measured at Any Boundary of a Residential Zone
Single-Family Residential	60	N/A	N/A
Multifamily Residential	65	N/A	N/A
Commercial	70	60	50 or ambient noise level
Lt. Industrial and Office Flex*	70	60	50 or ambient noise level
Heavy and Marine Industrial	75	65	50 or ambient noise level
Public Facilities and Community Use	65	60	50 or ambient noise level
Open Space and Recreation Districts	65	60	50 or ambient noise level

* For M-1 and M-2 the measurement will be at property line

** For M-3 and M-4 the measurement will be at the boundary of the district

*** Restricted hours may be modified through condition of an approved conditional use permit. Section subsections of Chapter 9.52 also provide for additional restricted hours and the most restrictive hours shall be controlling.

N/A Not applicable

Source: City of Richmond, May 17, 2011

Section 3 Field Methods and Results

This section includes a description of the sound terminology, survey methodologies, a description of areas surveyed, and measurement equipment used. Sound measurements were completed by a full member of the Institute of Noise Control Engineers (INCE) or under their direct supervision. The location of monitoring positions were determined by using a global positioning system (GPS) unit, and photographs were taken from the measurement points in the directions of receptors of interest and the Project site.

3.1 MONITORING LOCATIONS

Ten monitoring locations were identified for baseline sound. Figure 1-1 presents a map of these monitoring locations. Table 3-1 lists the corresponding map identifier to Figure 1-1, the Universal Transverse Mercator (UTM) coordinates, existing land uses, and a description of each location surveyed.

Table Error! No text of specified style in document.**-1 Monitoring Locations**

Map ID	Noise Sensitive Use	UTM Zone 10N X-Coordinate	UTM Zone 10N Y-Coordinate	Description
MP-1	Residential	558230	4196146	Residential Neighborhood at Point Isabel Shoreline
MP-2	Residential	558133	4196302	Eastern Residences at Bayside Court
MP-3	Residential	557948	4196398	Residences at Bayside Court
MP-4	Residential	557626	4196433	Trade Winds Sailing School
MP-5	Civic/Public	557415	4196518	Rosie the Riveter WWII Home Front
MP-6	Residential	557591	4196799	The Anchorage at Marina Bay
MP-7	Residential	557951	4197377	Neighborhood at 30th St. & Hoffman Blvd
MP-8	Residential	558899	4197114	Neighborhood at 43rd St. & Carlson Blvd
MP-9	Civic/Public	559098	4196917	Booker T. Anderson Jr. Park
LT-1	RBC	557415	4196518	Richmond Bay Campus

3.2 TERMINOLOGY AND METRICS

Airborne sound is described as the rapid fluctuation or oscillation of air pressure above and below atmospheric pressure, creating a sound wave. Sound is characterized by properties of the sound waves, which are frequency, wavelength, period, amplitude, and velocity. Sound energy travels in the form of a wave, a rapid fluctuation or oscillation of air pressure above and below atmospheric pressure. Sound levels are presented on a logarithmic scale to account for the large range of acoustic pressures that the human ear is exposed to and is expressed in decibel units or dB. A dB is defined as the ratio between a measured value and a reference value usually corresponding to the lower threshold of human hearing defined as 20 micropascals (μPa). Since the human ear does not perceive every frequency with equal loudness, spectrally varying sounds are often adjusted with a weighting filter. The A-weighted filter is applied to compensate for the frequency response of the human auditory system and sound exposure in acoustic assessments is designated in dBA. Unweighted sound levels are referred to as linear. Linear dBss are used to determine a sound's tonality and to engineer solutions to reduce or control noise as techniques are different for low and high frequency noise.

Several metrics describing the ambient conditions were measured including the time-averaged equivalent sound pressure levels, or the L_{eq}, as well as several statistical parameters including the L_{10}, L_{50}, and L_{90} which

can be used to distinguish long-term baseline sound levels from transitory events. The unit of frequency is hertz (Hz), which corresponds to the rate in cycles per second that sound pressure waves are generated., Typically, a sound frequency analysis examines 11 octave (or 33 1/3 octave) bands ranging from 16 Hz (low) to 16,000 Hz (high). This range encompasses the entire human audible frequency range. Because the human ear does not perceive every frequency with equal loudness, spectrally varying sounds are often adjusted with a weighting filter. The A-weighted filter is applied to compensate for the frequency response of the human auditory system.

Sound levels can be measured and presented in various formats. The sound metrics that were employed in the survey have the following definitions:

- **L_{eq}:** Conventionally expressed in dBA, the L_{eq} is the energy-averaged, A-weighted sound level for the complete time period. It is defined as the steady, continuous sound level over a specified time, which has the same acoustic energy as the actual varying sound levels over the specified period.
- **L_{max}:** The maximum A-weighted sound level as determined during a specified measurement period. It can also be described as the maximum instantaneous sound pressure level generated by a piece of equipment.
- **L_n:** This descriptor identifies the sound level that is exceeded "n" percent of the time over a measurement period (e.g., L_{90} = sound level exceeded 90 percent of the time). The sound level exceeded for a small percent of the time, L_{10}, closely corresponds to short-term, higher-level, intrusive noises (such as vehicle pass-by noise near a roadway). The sound level exceeded for a large percent of the time, L_{90}, closely corresponds to continuous, lower-level background noise (such as continuous noise from a distant industrial facility). L_{50} is the level exceeded 50 percent of the time and is typically referred to the median sound level over a given period.
- **CNEL:** This descriptor is another average A-weighted L_{eq} sound level measured over a 24-hour period; however, this noise scale is adjusted to account for some individuals' increased sensitivity to noise levels during the evening and nighttime hours. A CNEL noise measurement is obtained after adding 5 dB to sound levels occurring during evening hours (7:00 p.m. to 10:00 p.m.) and 10 dB to sound levels occurring during nighttime hours (10:00 p.m. to 7:00 a.m.).

An inherent property of the logarithmic decibel scale is that the sound pressure levels of two separate sources are not directly additive. For example, if a sound of 50 dBA is added to another sound of 50 dBA, the result is a 3-decibel increase (or 53 dBA), not an arithmetic doubling to 100 dBA. With respect to how the human ear perceives changes in sound pressure level relative to changes in "loudness," scientific research demonstrates that the following general relationships hold between sound level and human perception for two sound levels with the same or very similar frequency characteristics:

- **1 dBA** is the practical limit of accuracy for sound measurement systems and corresponds to an approximate 10 percent variation in the sound pressure level. A 1 dBA increase or decrease is a non-perceptible change in sound.
- **3 dBA** increase or decrease is a doubling (or halving) of acoustic energy and it corresponds to the threshold of change in loudness perceptible in a laboratory environment. The average person is generally not able to distinguish a 3 dBA difference in environmental sound outdoors.
- **5 dBA** increase or decrease is described as a perceptible change in sound level and is a readily discernible change in an outdoor environment.
- **10 dBA** increase or decrease is a tenfold increase or decrease in acoustic energy but is perceived as a doubling or halving in loudness (i.e., the average person will judge a 10 dBA change in sound level to be twice or half as loud).

3.3 SURVEY METHODS

Sound measurements were completed with Larson Davis 831 sound level meter equipped with a PCB model 377B02 ½-inch precision condenser microphone. This instrument has an operating range of 5 dB to 140 dB, and an overall frequency range of 8 to 20,000 Hz and meets or exceeds all requirements set forth in the American National Standards Institute (ANSI) standards for Type 1 sound level meters for quality and accuracy (precision). All sound analyzers were programmed to measure full-octave and 1/3-octave band frequency (Hz) levels to document and further describe the quality and character of the existing ambient soundscape. Data was collected for 1/1 and 1/3 octave band data spanning 6.3 Hz to 20 kilohertz. Short-term baseline sound monitoring data were measured and logged at 1-minute intervals for a minimum total duration of 30 minutes. The 24-hour sound monitoring station continuously monitored and logged data in one-hour intervals, consisting of ten-minute time histories.

The microphone and windscreen were tripod-mounted at an approximate height of 1.2 to 1.7 meters (4 to 5.6 feet) above grade. The 24-hour sound monitoring station was self-supporting and weather-proof and was deployed near the Project area centroid. All sound level analyzer microphones were protected from wind-induced self-noise effects by windscreen made of specially prepared open-pored polyurethane. Each sound analyzer was programmed to measure and log broadband A-weighted sound pressure levels, including a number of statistical parameters such as the L_{eq} L_{max}, and statistical L_n sound levels.

Table 3-2 provides an inventory of the measurement equipment that was used. All instrumentation components, including microphones, accelerometer(s), preamplifiers and field calibrators, had current laboratory certified calibrations traceable to the National Institute of Standards Technology (NIST). The NIST laboratory calibration certifications for the measurement instrumentation used on the Project are included in Appendix A.

Table Error! No text of specified style in document.**-2 Measurement Equipment**

Description	Manufacturer	Type
Signal Analyzer	Larson Davis	824/831
Preamplifier	Larson Davis	PRM902
Signal Conditioner	PCB	480E09
Weather Transmitter	Vaisala	WXT520
Microphone	PCB	377B02
Windscreen	ACO Pacific	7-inch
Calibrator	Larson Davis	CAL200

3.4 SURVEY RESULTS, MONITORING POSITION DESCRIPTIONS AND FIELD OBSERVATIONS

Noise measurements were completed to establish baseline conditions. The goal was to identify the regularly occurring baseline sound at monitoring positions near the RBC project site so that a comparison can be made to assess the potential for adverse impacts as a result of the Project. The following survey results and measurement data are intended to support the technical analysis required as part of the permitting process for the Project. Upon completion of the baseline sound survey, the results were tabulated into relevant time periods. The monitoring completed includes the collection and reporting of the following data:

- Sound pressure level data present during daytime and nighttime test periods.
- For each time period, the following sound measurement descriptors were compiled:
    - Spectral octave-band analysis (31.5, 63, 125, 250, 500, 1K, 2K, 4K, and 8K Hz);
    - One hour statistical values including L_{eq}, L_{10}, L_{50}, and L_{90}, in dBA;

- A narrative description of sounds audible during testing as well as a discussion of any anomalous or regularly occurring sound events identified over the course of the monitoring program; and
- Existing land uses in the vicinity of the measurement location.

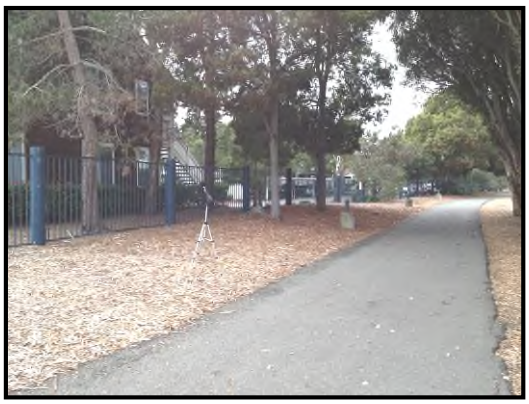
The degree of audibility of a new or modified sound source is dependent in a large part upon the relative level of the ambient noise. A wide range of noise settings occurs in and around the Project area. Variations in acoustic environment are due in part to surrounding land uses, population density, and proximity to transportation corridors. I-580 is generally audible throughout the Project site and throughout all hours of the day. The following subsection provides further details for this data analysis at each of the monitoring locations. A description of the monitoring locations with photographs, acoustic engineer's field observations and pertinent results of the sound survey are summarized in the following charts, tables and graphs. Amplitudes were found to be largely dependent on proximity of the receptor to major roadways and railway lines.

MP-1 – Meeker Slough

Monitoring position (MP) 1 is representative of multi-family residences (i.e., apartments, duplexes, etc.) along the Point Isabel shoreline neighborhood located to the south of the Project. Daytime and nighttime sound monitoring was conducted. Sound monitoring results are included in Table 3-3 and Table 3-4. Field observations included sounds from local roadway traffic, distant highway traffic, multiple aircraft flyovers, distant railroad operations (locomotives, train horns, etc.), pedestrians, bicyclists, birds and frogs.

MP-2 – Multi-Family Residences

MP-2 is representative of multi-family residences located along Bayside Court, southwest of the Project near 32nd street. Daytime and nighttime sound monitoring was conducted, and results are included in Table 3-3 and Table 3-4. Field observations included sounds from distant highway traffic, railroad operations, distant HVAC (heating, ventilation, and air conditioning) unit or units, pedestrians, bicyclists, birds, and sounds from vehicles in the nearby parking lot.



MP-3 – Multi-Family Residences

MP-3 is representative of multi-family residences located along Bayside Court, southwest of the Project but closer to Marina Bay Parkway than MP-2. Daytime and nighttime sound monitoring was conducted, and results are included in Table 3-3 and Table 3-4. Field observations included sounds from local roadway traffic, distant highway traffic, distant railroad operations, distant HVAC unit or units, walkers, bicyclists, birds, and sounds from vehicles in the nearby parking lot.

MP-4 – Trade Winds Sailing School

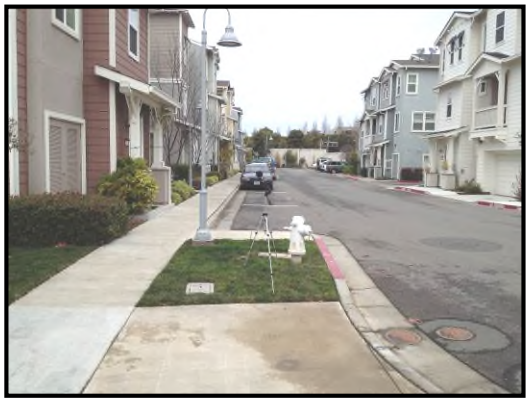
MP-4 is representative of multi-family residences located along Spinnaker Way west of the Project and adjacent to the Trade Winds Sailing School. Daytime and nighttime sound monitoring was conducted, and the results are included in Table 3-3 and Table 3-4. Field observations included sounds from local roadway traffic, distant highway traffic, aircraft overflights, and distant railroad operations.

MP-5 – Rosie the Riveter National Historic Park

MP-5 is representative of the Rosie the Riveter National Historic Park located approximately 1,500 feet west of the Project. The park is only open during the daytime, so only daytime sound monitoring was conducted. Field observations included sounds of roadway traffic, railroad operations including train horns, birds, bicyclists and pedestrians.

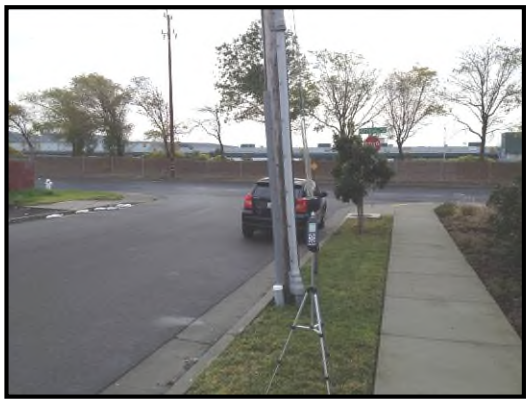
MP-6 – Anchorage Housing

MP-6 represents the Anchorage Residential area near the Marina Bay Highway. Daytime and nighttime sound monitoring was conducted, and sound monitoring results are included in Table 3-3 and Table 3-4. Field observations included sounds from highway traffic, local roadway traffic, aircraft and railroad operations



MP-7 – 30th & Hoffman

MP-7 represents a mix of single-family and multi-family residences located near the intersection of 30th Street and Hoffman Boulevard north of the Project. Only daytime monitoring was conducted at the MP-7 location due to safety concerns with equipment and staff in the area. Nevertheless, nighttime observations were made near MP-7, and sounds from the nearby I-580 dominate the acoustic environment. Daytime observations were similar to nighttime observations with the sounds from highway traffic dominating the acoustic environment mixed in with periodic sounds of local roadway traffic and railroad operations.



MP-8 – Carlson & 43rd

MP-8 represents a single-family residential neighborhood at Carlson Boulevard and 43rd Street northeast of the Project. Daytime monitoring was conducted at MP-8, and the results are included in Table 3-3 and Table 3-4. Only daytime monitoring was conducted due to safety concerns with equipment and staff in the area. Daytime observations included sounds from railroad traffic, traffic noise from I-580, local roadway traffic, periodic aircraft over flights and pedestrians. During the daytime measurement three freight trains accessing the Port of Richmond and one Caltrain passed by the MP. Observations of railroad traffic noted that rail operations reduced after the morning time period; therefore, sound levels associated with low volumes of freight rail traffic at the MP would be similar to those monitored in the afternoon at MP-9.

MP-9 – Booker T. Anderson Jr. Park

MP-9 represents Booker T. Anderson Jr. Park and multi-family residences located northeast of the Project. Daytime sound monitoring was conducted at the MP, and the results are included in Table 3-3 and Table 3-4. The park is closed to the public at night, so only daytime monitoring was conducted. Daytime observations of sound sources included I-580, local roadway traffic including transit buses with a stop near the par, periodic aircraft over flights, and pedestrians.

LT-1 Richmond Bay Campus

LT-1 represents the long term sound station set up in the middle of the Project area at the existing Richmond Field Station. The monitoring equipment was located at a central location to obtain the sound level at a location close to the acoustic centroid of the proposed campus. The acoustic centroid could be considered representative of the average sound level at the RBC project site, meaning that sound levels on the north side of the RBC site near the existing railroad tracks and I-580 are influenced by sounds from the railroad and highway more than locations south of the RBC site near the waterfront. Results of the 24-hour monitoring effort are included in Table 3-3, Table 3-4 and Table 3-5. Figure 3-1 is a chart of the time history for the monitoring period.

Table 3-3 Sound Monitoring Results (L_{eq}, L_{10}, L_{50}, L_{90} and CNEL)

Monitoring Location							Sound Level Metrics (dBA)				
Map ID	Land Use	UTM Coordinates (NAD83 Zone 10 m)		Date	Time	Time Period	L_{eq}	L_{10}	L_{50}	L_{90}	CNEL*
		Easting	Northing								
MP-1	Residential	558243	4566835	1/24/2013	12:57:20 PM	Day	53	54	51	50	58
				1/24/2013	11:25:40 PM	Night	51	53	47	46	
MP-2	Residential	558163	4567111	1/24/2013	1:34:33 PM	Day	53	53	52	51	58
				1/24/2013	10:50:59 PM	Night	51	52	49	48	
MP-3	Residential	557952	4567207	1/24/2013	1:00:59 PM	Day	53	55	51	50	56
				1/24/2013	10:15:22 PM	Night	48	50	46	45	
MP-4	Residential	557633	4567210	1/24/2013	1:41:20 PM	Day	57	61	53	50	59
				1/24/2013	10:48:48 PM	Night	50	53	48	44	
MP-5	Civic/Public	557429	4567387	1/24/2013	11:30:52 AM	Day	50	52	48	46	NA
MP-6	Residential	557591	4567695	1/24/2013	11:26:19 AM	Day	54	58	52	49	61
				1/24/2013	10:15:09 PM	Night	54	58	47	44	
MP-7	Residential	557955	4568452	1/24/2013	9:02:51 AM	Day	62	64	62	60	NA
MP-8	Residential	558866	4568091	1/24/2013	9:34:08 PM	Day	70	71	60	56	NA
MP-9	Civic/Public	559090	4567811	1/24/2013	2:28:15 PM	Day	66	67	65	63	NA
LT-1	Commercial	558561	4567503	1/24/2012 to 1/25/2012		Day	54	54	50	48	57
						Night	51	51	47	45	

*CNEL calculated for only those measurement locations with both day and nighttime monitoring results.

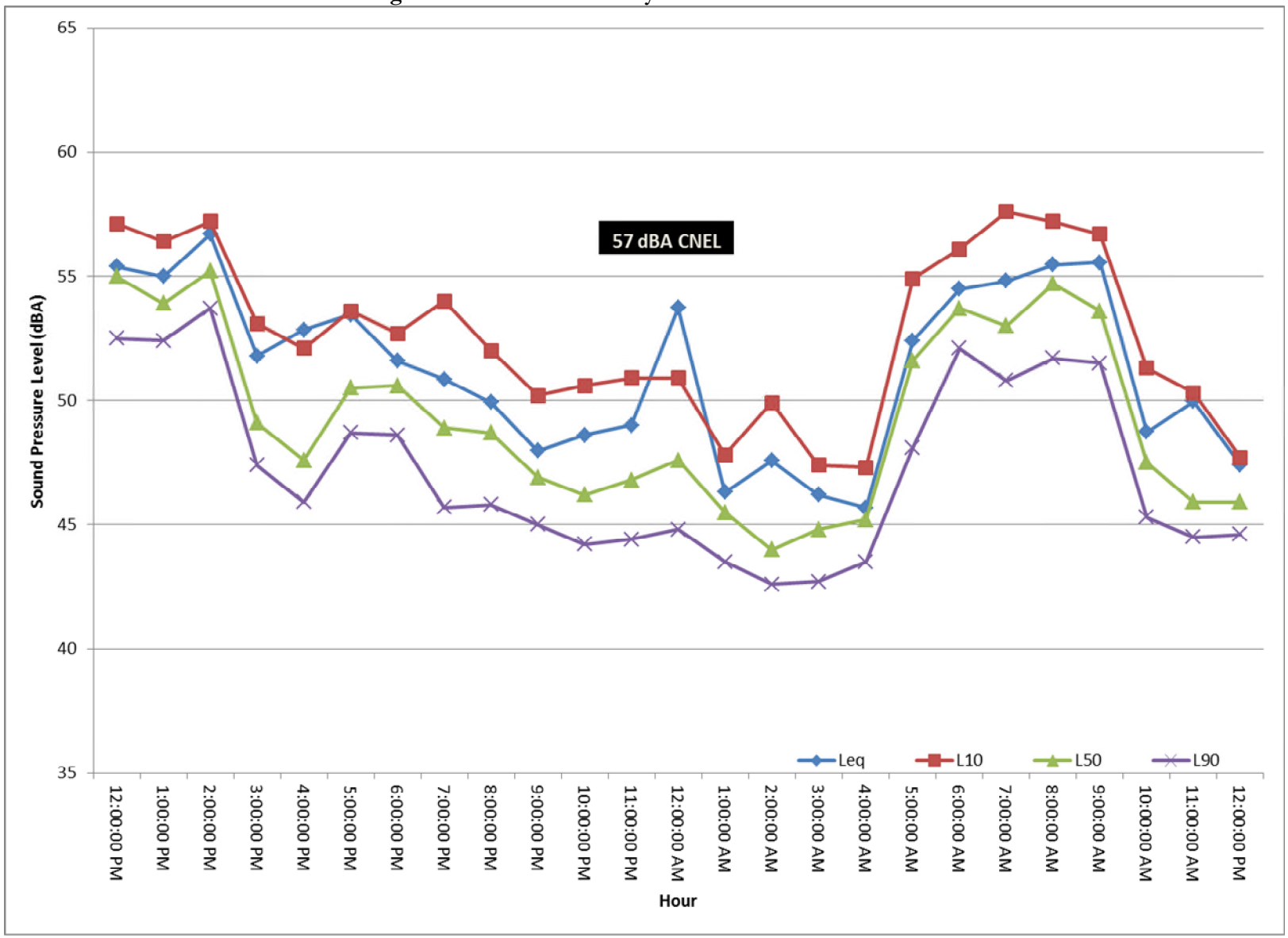
Table 3-4 Sound Monitoring Results (1/1 Octave Band Center Frequencies)

Monitoring Location			Time Period	Octave Band Sound Pressure Levels (dB)											
Map ID	UTM Coordinates (NAD83 Zone 10 m)			8 Hz	16 Hz	31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	16 kHz
	Easting	Northing													
MP-1	558243	4566835	Day	61	60	60	60	56	52	51	49	40	30	24	14
			Night	52	58	60	60	55	49	49	47	37	28	24	16
MP-2	558163	4567111	Day	59	60	61	60	52	50	50	50	44	35	29	14
			Night	53	59	61	60	55	52	49	46	38	25	16	10
MP-3	557952	4567207	Day	65	62	59	59	55	52	50	48	42	36	30	25
			Night	51	55	58	57	53	49	47	44	36	26	16	11
MP-4	557633	4567210	Day	59	58	61	63	60	53	52	54	49	41	33	21
			Night	52	56	57	57	56	51	47	45	39	29	19	10
MP-5	557429	4567387	Day	61	58	58	61	56	49	47	46	39	31	23	15
MP-6	557591	4567695	Day	58	59	60	60	58	53	51	51	45	36	26	14
			Night	50	53	57	59	57	52	49	51	46	38	30	22
MP-7	557955	4568452	Day	62	69	70	72	67	59	57	59	54	47	37	27
MP-8	558866	4568091	Day	65	74	73	74	72	66	63	61	59	55	48	38
MP-9	559090	4567811	Day	63	67	69	72	70	62	60	63	57	49	43	39
LT-1	558561	4567503	Day	58	61	61	61	57	51	51	50	39	26	17	9
			Night	54	59	59	60	55	47	49	47	36	21	11	8

Table 3-5 Long-Term (24-Hour) Sound Monitoring Results (dBA)

Date	Time	L_{eq}	L_{10}	L_{50}	L_{90}
1/24/2013	12:00 PM	55	57	55	53
	1:00 PM	55	56	54	52
	2:00 PM	57	57	55	54
	3:00 PM	52	53	49	47
	4:00 PM	53	52	48	46
	5:00 PM	53	54	51	49
	6:00 PM	52	53	51	49
	7:00 PM	51	54	49	46
	8:00 PM	50	52	49	46
	9:00 PM	48	50	47	45
	10:00 PM	49	51	46	44
	11:00 PM	49	51	47	44
1/25/2013	12:00 AM	54	51	48	45
	1:00 AM	46	48	46	44
	2:00 AM	48	50	44	43
	3:00 AM	46	47	45	43
	4:00 AM	46	47	45	44
	5:00 AM	52	55	52	48
	6:00 AM	54	56	54	52
	7:00 AM	55	58	53	51
	8:00 AM	55	57	55	52
	9:00 AM	56	57	54	52
	10:00 AM	49	51	48	45
	11:00 AM	50	50	46	45
	12:00 PM	47	48	46	45
Day Average		54	54	50	48
Night Average		51	51	47	45
CNEL		57			

Figure 3-1 Time History for 24-Hour Measurement



Section 4 References

2011 California Environmental Quality Act (CEQA) Statute and Guidelines

AEP 2012. 2012 California Environmental Quality Act (CEQA) Statute and Guidelines. Available online at http://ceres.ca.gov/ceqa/docs/CEQA_Handbook_2012_wo_covers.pdf, accessed January 28, 2013.

American National Standards Institute ANSI Standard S12.9-1996: Quantities and Procedures for Description and Measurement of Environmental Sound - Part 4: Noise Assessment and Prediction of Long-term Community Response.

American National Standards Institute ANSI/ASA Standard S1.4-2006: American National Standard Specification for Sound Level Meters.

American National Standards Institute ANSI S12.9-1993: Quantities and Procedures for Description and Measurement of Environmental Sound – Part 3: Short-Term Measurements with an Observer Present.

City of Richmond. 2011. Code of Ordinances, Chapter 9.52 – Community Noise Ordinance. Richmond, California.

US Environmental Protection Agency. 1971. Community Noise. NTID300.3 (N-96-01 IIA-231). Prepared by Wylie Laboratories.

APPENDIX A

MEASUREMENT EQUIPMENT & NIST LABORATORY CALIBRATION CERTIFICATIONS

Certificate of Calibration and Conformance

This document certifies that the instrument referenced below meets published specifications per Procedure PRD-P263; ANSI S1.4-1983 (R 2006) Type 1; S1.4A-1985; S1.43-1997 Type 1; S1.11-2004 Octave Band Class 0; S1.25-1991; IEC 61672-2002 Class 1; 60651-2001 Type 1; 60804-2000 Type 1; 61260-2001 Class 0; 61252-2002.

Manufacturer:	Larson Davis	Temperature:	75.2	°F
Model Number:	831		25	°C
Serial Number:	1009	Rel. Humidity:	33	%
Customer:		Pressure:	987	mbars
Description:	Sound Level Meter			hPa

Note: As Found / As Left: In Tolerance

Upon receipt for testing, this instrument was found to be:

Within the Stated tolerance of the manufacturer's specification

Calibration Date: 10-Oct-12 Calibration Due:

Calibration Standards Used:

Manufacturer	Model	Serial Number	Cal Due	Traceability No.
Larson Davis	LDSigGen/2239	0760/0109	4/16/2013	2012-157887

This Certificate attests that this instrument has been calibrated under the stated conditions with Measurement and Test Equipment (M&TE) Standards traceable to the National Institute of Standards and Technology (NIST). All of the Measurement Standards have been calibrated to their manufacturers' specified accuracy / uncertainty. Evidence of traceability and accuracy is on file at The Modal Shop and/or Larson Davis Corporate Headquarters. An acceptable accuracy ratio between the Standard(s) and the item calibrated has been maintained. This instrument meets or exceeds the manufacturer's published specification unless noted.

This calibration complies with ISO 17025 and ANSI Z540. The collective uncertainty of the Measurement Standard used does not exceed 25% of the applicable tolerance for each characteristic calibrated unless otherwise noted.

The results documented in this certificate relate only to the item(s) calibrated or tested. Calibration interval assignment and adjustment are the responsibility of the end user. This certificate may not be reproduced, except in full, without the written approval of The Modal Shop.

Technician: THR Signature:

THE MODAL SHOP INC.
A PCB GROUP CO.

The Modal Shop, Inc.
3149 East Kemper Road
Cincinnati, OH 45241
Phone: (513) 351-9919
(800) 860-4867
www.modalshop.com

Certificate of Calibration and Conformance

This document certifies that the instrument referenced below meets published specifications per Procedure PRD-P263; ANSI S1.4-1983 (R 2006) Type 1; S1.4A-1985; S1.43-1997 Type 1; S1.11-2004 Octave Band Class 0; S1.25-1991; IEC 61672-2002 Class 1; 60651-2001 Type 1; 60804-2000 Type 1; 61260-2001 Class 0; 61252-2002.

Manufacturer:	Larson Davis	Temperature:	75.2	°F
Model Number:	831		25	°C
Serial Number:	2546	Rel. Humidity:	33	%
Customer:		Pressure:	987	mbars
Description:	Sound Level Meter			hPa

Note: As Found / As Left: In Tolerance

Upon receipt for testing, this instrument was found to be:

Within the Stated tolerance of the manufacturer's specification

Calibration Date: 9-Oct-12 Calibration Due:

Calibration Standards Used:

Manufacturer	Model	Serial Number	Cal Due	Traceability No.
Larson Davis	LDSigGen/2239	0760/0109	4/16/2013	2012-157887

This Certificate attests that this instrument has been calibrated under the stated conditions with Measurement and Test Equipment (M&TE) Standards traceable to the National Institute of Standards and Technology (NIST). All of the Measurement Standards have been calibrated to their manufacturers' specified accuracy / uncertainty. Evidence of traceability and accuracy is on file at The Modal Shop and/or Larson Davis Corporate Headquarters. An acceptable accuracy ratio between the Standard(s) and the item calibrated has been maintained. This instrument meets or exceeds the manufacturer's published specification unless noted.

This calibration complies with ISO 17025 and ANSI Z540. The collective uncertainty of the Measurement Standard used does not exceed 25% of the applicable tolerance for each characteristic calibrated unless otherwise noted.

The results documented in this certificate relate only to the item(s) calibrated or tested. Calibration interval assignment and adjustment are the responsibility of the end user. This certificate may not be reproduced, except in full, without the written approval of The Modal Shop.

Technician: THR Signature:

THE MODAL SHOP INC.
A PCB GROUP CO.

The Modal Shop, Inc.
3149 East Kemper Road
Cincinnati, OH 45241
Phone: (513) 351-9919
(800) 860-4867
www.modalshop.com

PCB PIEZOTRONICS
A PCB GROUP COMPANY

Certificate of Calibration and Conformance

Certificate Number 2012-163960

Instrument Model 831, Serial Number 0002985, was calibrated on 19SEP2012. The instrument meets factory specifications per Procedure D0001.8310, ANSI S1.4-1983 (R 2006) Type 1; S1.4A-1985 ; S1.43-1997 Type 1; S1.11-2004 Octave Band Class 0; S1.25-1991; IEC 61672-2002 Class 1; 60651-2001 Type 1; 60804-2000 Type 1; 61260-2001 Class 0; 61252-2002.

New Instrument
Date Calibrated: 19SEP2012
Calibration due:

Calibration Standards Used

MANUFACTURER	MODEL	SERIAL NUMBER	INTERVAL	CAL. DUE	TRACEABILITY NO.
Stanford Research Systems	DS360	61889	12 Months	27JAN2013	61889-012712

Reference Standards are traceable to the National Institute of Standards and Technology (NIST)

Calibration Environmental Conditions

Temperature: 24 ° Centigrade

Relative Humidity: 28 %

Affirmations

This Certificate attests that this instrument has been calibrated under the stated conditions with Measurement and Test Equipment (M&TE) Standards traceable to the U.S. National Institute of Standards and Technology (NIST). All of the Measurement Standards have been calibrated to their manufacturers' specified accuracy / uncertainty. Evidence of traceability and accuracy is on file at Provo Engineering & Manufacturing Center. An acceptable accuracy ratio between the Standard(s) and the item calibrated has been maintained. This instrument meets or exceeds the manufacturer's published specification unless noted.

This calibration complies with the requirements of ISO 17025 and ANSI Z540. The collective uncertainty of the Measurement Standard used does not exceed 25% of the applicable tolerance for each characteristic calibrated unless otherwise noted.

The results documented in this certificate relate only to the item(s) calibrated or tested. A one year calibration is recommended, however calibration interval assignment and adjustment are the responsibility of the end user. This certificate may not be reproduced, except in full, without the written approval of the issuer.

Tested with PRM831-023767

Signed: Ron Harris
Technician: Ron Harris

Provo Engineering and Manufacturing Center, 1681 West 820 North, Provo, Utah 84601
Toll Free: 888.258.3222 Telephone: 716.926.8243 Fax: 716.926.8215
ISO 9001-2008 Certified