Alameda Marina
Shoreline Improvement Project

UNDERWATER NOISE MONITORING PLAN

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June, 2020

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INTRODUCTION

The 20.9-acre Alameda Marina Shoreline Improvement Project (Project) is located on the Oakland Estuary in the City and County of Alameda, California. The Project will make repairs for safety concerns, address seismic resistance criteria and sea level rise, update marina facilities, reconfigure the marina piers, and create a new waterfront park. Piles will be placed and/or removed in connection with seawall maintenance, wharf refurbishment, marina refurbishment, and boat hoist construction. Temporary sheet piles will also be needed to construct cofferdams to facilitate outfall refurbishment.

ACOUSTIC TERMS

Various acoustical terms are used in this report. Sound pressure is the instantaneous absolute positive or negative pressure and is presented in this report as a decibel referenced as 1 micro Pascal (dB re 1 µPa). While several noise metrics are used to describe sounds in the environment, the root-mean-square (RMS) sound pressure level is an appropriate descriptor to describe measured sounds from continuous and impulsive sounds but with different averaging time constants. The RMS sound pressure level is presented in dB re 1 µPa and is averaged over a defined time period in a stated frequency range or band. The appropriate time period to average for the RMS computation varies by the type of sound (e.g., pulsed or continuous). The average sound level during the measurement period is also computed to be the equivalent average sound pressure level measured each second over the duration of the sound (L_{eq}). Sound Exposure Level (SEL) is proportionally equivalent to the time integral of the pressure squared and is also described in this report in terms of dB re 1 μPa^2 sec over the duration of a sound event. The Peak sound pressure is the largest absolute value of the instantaneous sound pressure. Sounds are measured over the frequency range of 20 to 20,000 hertz (Hz).

PROJECT AREA

The Project is located in the San Francisco Bay USGS hydrologic 18050004. The approximately 20.9-acre Project site is entirely within the Oakland Estuary (Estuary), in the City and County of Alameda, California (Figure 1). North of the Project site, across the Oakland Inner Harbor Channel, is Coast Guard Island and Union Point Park, which is located along the Embarcadero in Oakland. Elevations at the shoreline vary in locations with seawalls, transitioning from 10 ft above mean sea level to 0 feet above mean sea level.

The Estuary is connected to the Central San Francisco Bay on the west end and San Leandro Bay on the east end. This strait runs between Alameda Island and Oakland, stretching from the Port of Oakland to the Fruitvale Bridge. Historically, the Estuary did not connect to San Leandro Bay. In 1913, the Corps dredged out the tidal canal which connects the Estuary to San Leandro Bay; this dredging project also formed Alameda Island and Coast Guard Island.

The Estuary from the Central Bay on the west end to the Project area is only approximately 492 ft (150 meters [m]) wide by 4.8 miles ([mi]; 7.7 kilometers [km]) long and relatively shallow throughout: 50 ft (15 m) for the first 2.3 mi (3.7 km) until the turning basin just west of Webster Street Tube tunnel, becoming 35 ft (11 m) deep for the next 2.3 mi (3.7 km), and only 30 ft (9 m)

deep off the Project area (BCDC 1994, 2018). The Estuary entrance through the tidal canal into San Leandro Bay on the east end is only 275 ft (114 m) wide by approximately 18 ft (6 m) deep (BCDC 1994, 2018).

Piles and sheet piles will be driven in water depths of 0 to approximately 25 ft (8 m). The substrate consists of heterogeneous fill on the top 0–5 ft (0–2 m), young Bay deposits (soft to stiff, highly compressible clay) 5–13 ft (2–4 m) deep, older Bay deposits (stiff to very stiff, moderately compressible sediment) 13–25 ft (4–8 m) deep, Merritt sand (dense to very dense, lightly cemented sand) 25–40 ft (8–12 m) deep, and San Antonio Formation clay (very stiff to hard sediment) from 40 ft (12 m) to the maximum depth surveyed.

No critical habitat for marine mammal species is present within or near the Project area[1]. Two known harbor seal haulout sites are in the vicinity: one on Yerba Buena Island approximately 6.6 mi (10.6 km) from the Project Area, and the other on the southern side of Alameda Island consisting of two haulout locations within a half mile of each other and approximately 7.8 mi (12.6 km), by water, from the Project area.

The geographic, bathymetric, and ecological characteristics of the Estuary limit its use by marine mammals. The geography of the Estuary limits tidal flushing, and the industrial history of the Estuary has led to an accumulation of toxins in the sediment: substrates in the Oakland Inner Harbor and turning basin contain contaminants that are harmful to sensitive marine organisms (Shreffler et al. 1994). Perhaps as a result, there are no eelgrass beds in the Project area within the Estuary. This lack of foraging habitat along with the compromised substrate quality limit prey resources for marine mammals. The relatively shallow and constrained channel limits physical access for large whales. These characteristics contribute to an overall low density of animals in the Estuary.

The Estuary at or near the Project area provides potential habitat for state and federal listed threatened or endangered salmonids, green sturgeon and longfin smelt. The Estuary is also designated critical habitat for green sturgeon and steelhead (Central California distinct population segment), and is located within essential fish habitat as defined under the Magnuson-Stevens Fishery Conservation and Management Act.

[1] Haase, P. Alameda Marina Shoreline Improvement Project Incidental Harassment Authorization Application For the Incidental Harassment of Marine Mammals Resulting from Activities Associated with the Maintenance and Refurbishment of the Alameda Marina Shoreline, December 31, 2019.

Figure 1- Vicinity Map of Alameda Marina Shoreline Improvement Project (taken from IHA application packet)

PILE INSTALLATION LOCATION

A summary of the piles proposed for removal and installation are shown in Tables 1-3. A total of 320 piles will be removed during the first construction year, consisting of 16-inch timber piles and 12-inch concrete piles. Piles will either be removed with a vibratory hammer or cut off at mudline and removed. Pile installation will occur over the course of two construction years. Temporary cofferdam sheet piles will be removed following outfall construction. The locations of the pile-supported structures are shown in Figures 3 and 4.

Table 1 – Summary of Piles to be Removed in Year 1

Structure	Type of Pile	Number of Piles
Seawall 1	16” timber	150
Pier 6 Stud	16” timber	20
Pier 4 Stud	16” timber	16
Boat Elevator Wharf	16” timber	7
	12” square concrete	12
Boat Lift Wharf	16” timber	25
	12” square concrete	7
Pier Outboard of Promenade Wharf	16” timber	60
Building 13 Wharf	16” timber	3
Building 14 Wharf	16” timber	20

Table 2 – Summary of Piles to be Installed in Year 1

Structure	Type of Pile	Number of Piles	Installation Method
Seawall 4	Steel sheet pile	149	Vibratory hammer
Seawall 6	Steel sheet pile	106	Vibratory hammer
Promenade Wharf	16” square concrete	39	Impact hammer (with wood block option)
Building 5 Wharf	16” square concrete	1	Impact hammer (with wood block option)
Building 13 Wharf	36” cylindrical steel	2	Vibratory hammer majority of pile; attenuated impact hammer to tip elevation
	16” square concrete	1	Impact hammer (with wood block option)
Cofferdam	Steel sheet pile	214	Vibratory hammer

Table 3 – Summary of Piles to be Installed in Year 2

Structure	Type of Pile	Number of Piles	Installation Method
Seawall 1	Steel sheet pile	233	Vibratory hammer
	Wide flange beam	117	Vibratory hammer majority of pile; attenuated impact hammer to tip elevation
Seawall 1A	Steel sheet pile	26	Vibratory hammer
	Wide flange beam	13	Vibratory hammer majority of pile; attenuated impact hammer to tip elevation
Building 14 Wharf	36” cylindrical steel	1	Vibratory hammer majority of pile; attenuated impact hammer to tip elevation
Headwalk Piles	14” square concrete	19	Impact hammer (with wood block option)
Boat Hoist	24” square concrete	8	Impact hammer (with wood block option)
	30” cylindrical steel	1	Vibratory hammer majority of pile; attenuated impact hammer to tip elevation

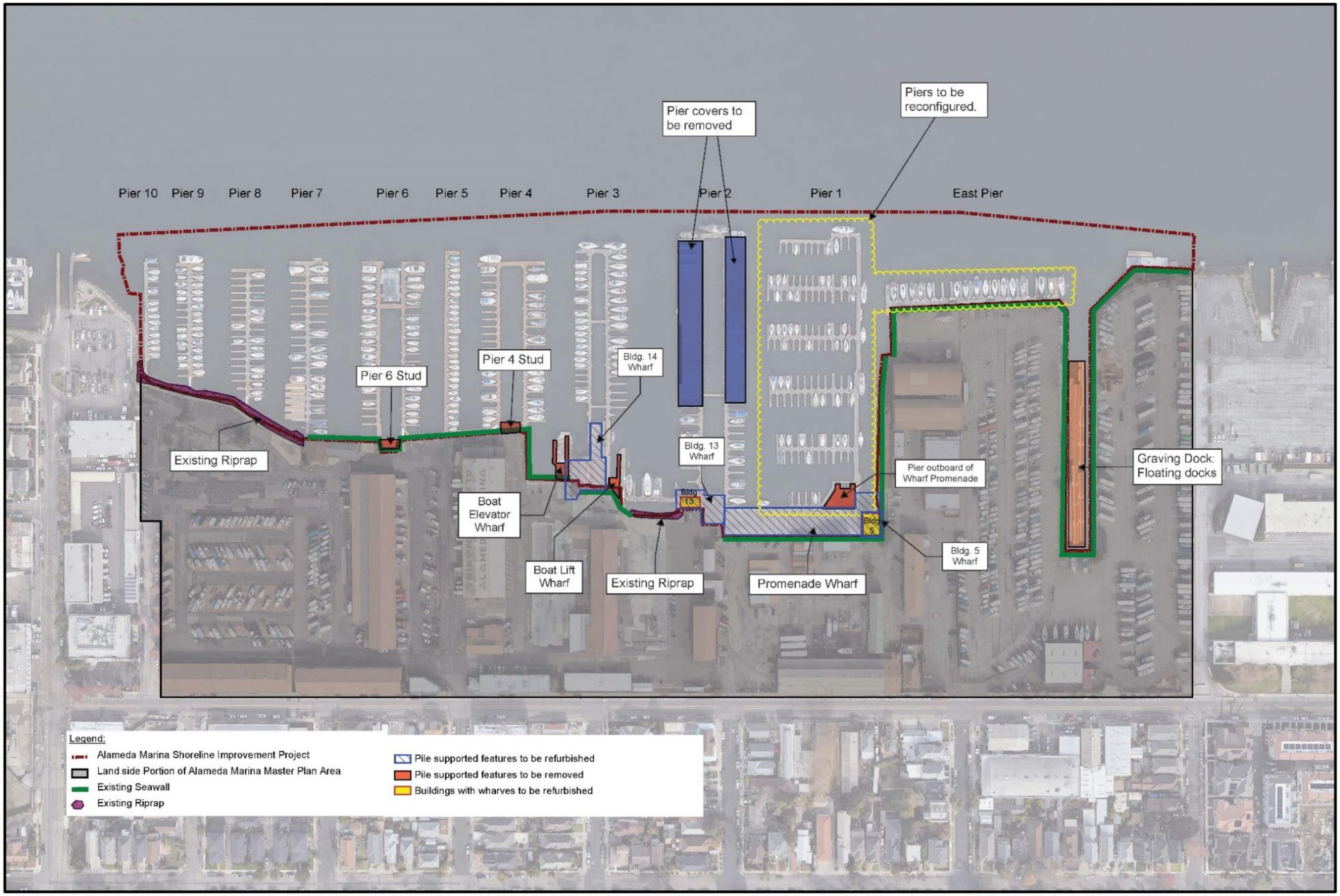

Figure 2 Existing Features Requiring Pile Installation and/or Removal (IHA application packet Figure 3)

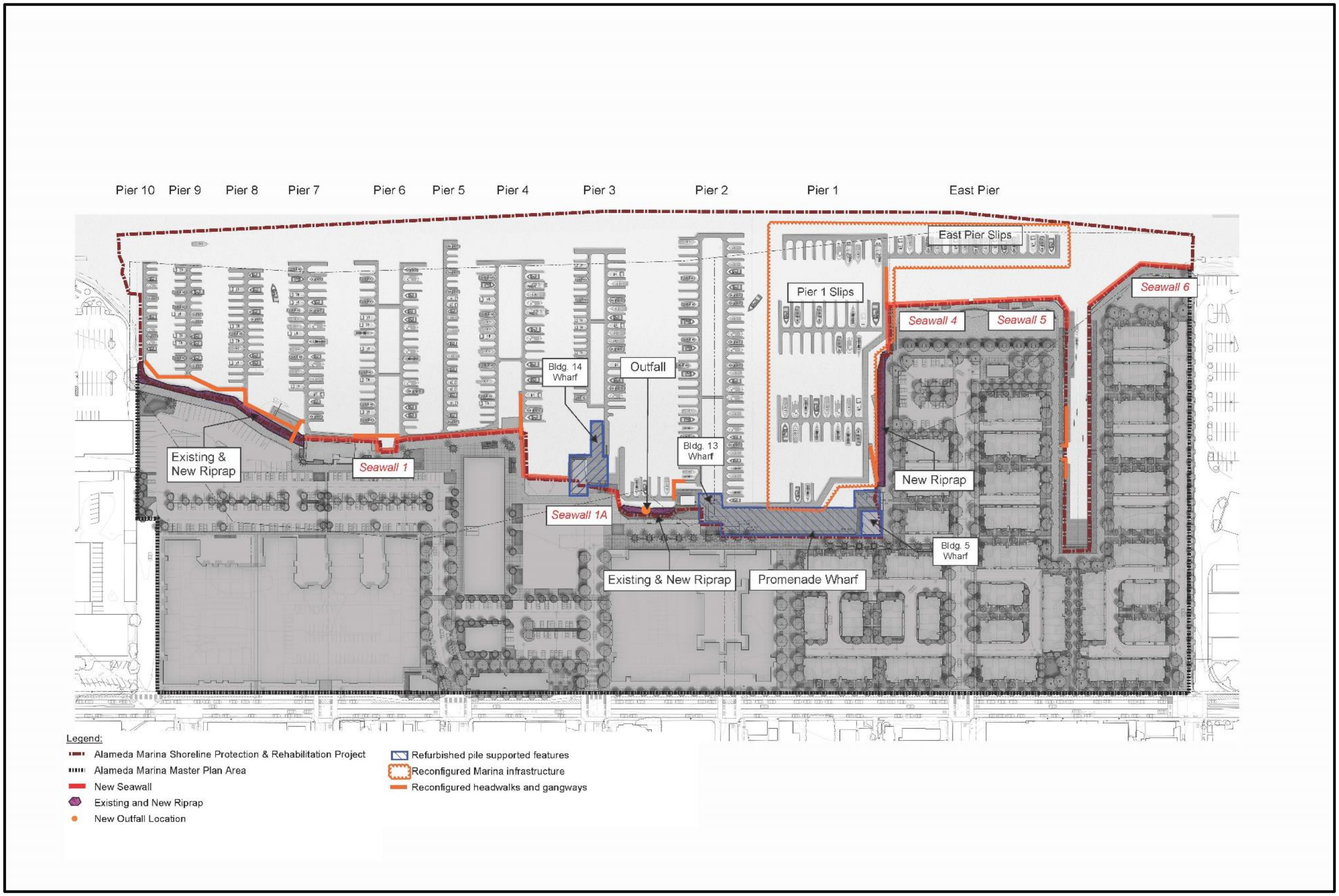

Figure 3 Proposed Features Requiring Pile Installation (IHA application packet Figure 4)

PILE INSTALLATION

Hydroacoustic monitoring will be conducted for a subset of each pile type installed or removed in at least 1.5 meters (5 feet) of water with an impact or vibratory hammer as shown in Tables 4 and 5. The entire pile driving session will be monitored for each pile.

Table 4 – Summary of Monitoring Requirement for Piles Installed with an Impact Hammer

Type of Pile	Total Number of Piles	Number of Piles to Monitor
36-inch steel pipe pile	3	1
30-inch steel pipe pile	1	0
W 40 x 199 wide flange beam	130	10
24-inch square concrete pile	8	1
16-inch square concrete pile	41	5
14-inch square concrete pile	19	2

Table 5 – Summary of Monitoring Requirement for Piles Installed or Removed with a Vibratory Hammer

Type of Pile	Total Number of Piles	Number of Piles to Monitor
36-inch steel pipe pile	3	1
30-inch steel pipe pile	1	0
W 40 x 199 wide flange beam	130	10
Steel sheet piles	728	10
16-inch timber pile removal	301	10
12-inch square concrete removal	19	2

CONTRACTOR REQUIREMENTS

The acoustical monitoring contractor shall possess a minimum of a bachelor's degree in a related field[2], with demonstratable experience in noise monitoring and analysis.

SOUND MONITORING EQUIPMENT AND MONITORING REQUIREMENTS

Monitoring equipment shall have a measurement range in terms of amplitude (in dB) referenced to one micropascal (re: 1 uPa), shall have a minimum frequency range of 20 Hz to 20 kHz, and a minimum sampling rate of 44,000 Hz. Table 1 describes the minimum requirements of the equipment to be used. In addition to the equipment selection, quality control/quality assurance

[2] This can include Institute of Noise Control Engineering of the USA (INCE/USA) certification or related fields such as acoustics, physics, oceanography, geology or other physical sciences that have required coursework in physics.

procedures should be described (e.g., how will system responses be verified and how will data be managed).

To facilitate further analysis of data full bandwidth (20 – 20,000Hz), time-series underwater signals shall be recorded as a wave file (.wav) or similar format. Data compression algorithms or technologies (e.g. MP3, compressed .wav, etc.) will not be applied to the recordings.

Table 6 – Proposed equipment for underwater sound monitoring (hydrophone, signal amplifier, and calibrator). All have current National Institute of Standards and Technology (NIST) traceable calibration.

Item	Specifications	Minimum Quantity	Usage
Hydrophone	Receiving Sensitivity- 211 dB ± 3 dB re 1 V/µPa OR 203 dB + 2 dB re 1 V/µPa	2	Capture underwater sound pressurelevels and convert to voltages that can be recorded/analyzed by other equipment.
Signal Conditioning Amplifier	Amplifier Gain- 0.1 mV/pC to 10 V/pC Transducer Sensitivity Range- 10-12 to 103 C/MU	2	Adjust signals from hydrophone to levels compatible with recording equipment.
Calibrator (pistonphone-type)	Accuracy- IEC 942 (1988) Class 1	1	Calibration check of hydrophone in the field.
Digital Signal Analyzer	Sampling Rate- 48kHz or greater	1	Analyzes and transfers digital data to laptop hard drive.
If water velocity ~> 1m/s, Flow shield	Open cell foam cover or functional equivalent	1/hydrophone	Eliminate flow noise contamination.
Laptop computer or Digital Audio Recorder	Compatible with digital signal analyzer	1	Record digital data on hard drive or digital tape.
Real Time and Post-analysis software	-	1	Monitor real-time signal and post-analysis of sound signals.

METHODOLOGY

Prior to monitoring, a standard depth sounder or a weighted line will record depth before pile driving commences. The hydrophone will be attached to a nylon cord or a steel chain if the current is swift enough to cause strumming of the line. The nylon cord or chain will be attached to an anchor that will keep the line at a set distance from the pile. The nylon cord or chain will be attached to a float or tied to a static line at the surface 10 meters from the pile. The distance will be measured by a tape measure, where possible, or a range-finder. There will be a direct line of acoustic transmission through the water column between the pile and the hydrophone in all cases.

The onsite inspector/contractor will inform the acoustics specialist when pile driving is about to start to ensure that the monitoring equipment is operational. Underwater sound levels will be

continuously monitored during the entire duration of each pile being driven with a minimum one-third octave band frequency resolution. The wideband instantaneous Peak, SEL, and RMS values of each pile should be monitored in real time during construction to ensure that the Project does not exceed its authorized take level. Peak and RMS pressures will be reported in dB (re:1 μPa). SEL will be reported in dB (re: 1 $\mu Pa^2 \cdot sec$).

Prior to, and during, the pile driving activity, environmental data will be gathered, such as water depth and tidal level, wave height, and other factors that could contribute to influencing the underwater sound levels (e.g. aircraft, boats, etc.). The start and stop time of each pile driving event will be recorded.

The contractor or agency will provide the following information, in writing, to the contractor conducting the hydroacoustic monitoring for inclusion in the final monitoring report: a description of the substrate composition, approximate depth of significant substrate layers, hammer model and size, hammer energy settings and any changes to those settings during the piles being monitored, depth pile driven.

Impact Pile Driving for Fish and Marine Mammal Consultations

Three hydrophones will be positioned as outlined below:

- Near Position. A stationary hydrophone will be positioned at a distance of 10 meters from the piles being driven to observe the measurements in real-time. If the water depth at 10 meters is not at least 1.5 meters (5 feet), the closest distance to 10 meters will be used that has a minimum water depth of 1.5 meters. The hydrophone would be placed at approximately mid-depth.
- Middle Position. A second stationary hydrophone recording system will be positioned at approximately 50 to 100 meters from the pile being driven to measure the extent of fish cSEL thresholds and marine mammal thresholds, and to calculate the site-specific transmission loss. The hydrophone would be placed at approximately mid-depth. This position will be a continuous recording of the pile being driven and the data will be further analyzed after monitoring completion.
- Distant Position (if necessary). A third stationary hydrophone recording system will be positioned at approximately 200 to 500 meters from the pile being driven to measure the extent of marine mammal thresholds and to calculate the site-specific transmission loss. This position is necessary for the impact driving of 36-inch steel pipe piles, 30-inch steel pipe piles, and wide flange beam piles, and is not necessary for the impact driving of concrete piles.

Vibratory Pile Driving for Marine Mammal Consultations

Two hydrophones will be positioned as outlined below:

- Near Position. A stationary hydrophone will be positioned at a distance of 10 meters from the piles being driven to observe the measurements in real-time. If the water depth at 10 meters is not at least 1.5 meters (5 feet), the closest distance to 10 meters will be used that

has a minimum water depth of 1.5 meters. The hydrophone would be placed at approximately mid-depth.

- Distant Position. A second stationary hydrophone recording system will be positioned at approximately 50 to 100 meters from the pile being driven to calculate the site-specific transmission loss. The hydrophone would be placed at approximately mid-depth. This position will be a continuous recording of the pile being driven and the data will be further analyzed after monitoring completion.

Flow-Induced Noise Reduction

When collecting sound measurements in an area with strong currents (such as the Project area), appropriate measures will be taken, when necessary, to ensure that the flow-induced noise at the hydrophone will not interfere with the recording and analysis of the relevant sounds (NMFS, 2012a, b, and c). As a rule, current speeds of 1.5 meters/second or greater are expected to generate significant flow-induced noise, which may interfere with the detection and analysis of low-level sounds such as the sounds from a distant pile driver.

If it becomes necessary to reduce the flow-induced noise at the hydrophone, a flow shield will be described and installed around the hydrophone to provide a barrier between the irregular, turbulent flow and the hydrophone. If no flow shield is used in these situations, the current velocity will be measured and a correlation between the levels of the pile driving sounds and current speed will be made to determine whether the data is valid and can be included in the analysis.

Calibration

Calibration of measurement systems shall be established prior to use in the field each day. An acoustical piston phone and microphone or hydrophone coupler shall be used along with manufacturer calibration certificates to calibrate the equipment. An acoustically certified piston phone and coupler that fits the hydrophone or microphone shall directly calibrate the measurement system. The volume correction of the coupler for each hydrophone or microphone shall be known so that the piston phone shall produce a known signal that shall be compared against the measurement system response. The response of the measurement system shall then be noted in the field book and applied to all subsequent measurements.

Additionally, the hydrophones are calibrated to a calibration tone prior to use in the field. The tone is then measured by the hydrophone and the results are recorded onto the beginning of the digital audio recordings. The system calibration status shall be checked by comparing the calibration tone and recorded tones. The recorded calibration tones are used for subsequent detailed analyses of recorded pile strike sounds.

SIGNAL PROCESSING

Impact Pile Driving for Fish and Marine Mammal Consultations

Post-analysis of the underwater pile driving sounds will include:

- Number of pile strikes per pile and per day.
- For each recorded strike (or each strike from a subset), determine the following:
  - The peak pressure, defined as the maximum absolute value of the instantaneous pressure (overpressure or underpressure).
  - The root mean squared sound pressure across 90% of the strike's energy ($RMS_{90\%}$).
  - The pulse duration used to compute the $RMS_{90\%}$.
  - The sound exposure level (SEL) measured across the accumulated sound energy during the pile strike.
- Maximum, mean, and median of the peak pressure, with, and if applicable, without attenuation.
- Maximum, mean, and median of the $RMS_{90\%}$, both with and if applicable, without attenuation.
- Maximum, mean, and median of the SEL, both with and if applicable, without attenuation.
- Cumulative SEL (cSEL) across all the strikes for each pile.
- One-third octave band spectrum and power spectral density plots between 20 and 20,000 Hz for up to eight successive strikes with similar sound levels.

Vibratory Pile Driving for Marine Mammal Consultations

Post-analysis of the underwater pile driving sounds will include:

- Duration in seconds of pile driving per pile and per day.
- Maximum, mean, and median of the peak pressure, with, and if applicable, without attenuation.
- Maximum, mean, and median of the RMS, both with and if applicable, without attenuation.
- Cumulative SEL (cSEL) across pile driving duration.
- One-third octave band spectrum and power spectral density plots between 20 and 20,000 Hz.

Monitoring results will include the maximum and average RMS values (calculated from 10-second RMS) for each pile monitored and a comparison of the frequency content between piles.

REPORTING

Preliminary results for the daily monitoring activities will be submitted/reported to the primary points of contact[3] within 24 hours after monitoring concludes for the day. In addition, two final reports will be submitted to the NMFS within 90 days of the completion of hydroacoustic monitoring, one for fish and one for marine mammals. A copy of the fish monitoring report also will be provided to the California Department of Fish and Wildlife. The reports will include data collected and summarized from all monitoring positions. The results will be summarized in graphical form and include summary statistics and time histories of sound values for each pile. The reports shall include:

1. Size and type of piles.
2. Whether a sound attenuation device is used, and if so, duration of its use per pile.
3. The make and model of the hammers.
4. A description of the sound monitoring equipment, including recording devices and sampling rates.
5. The distance between hydrophones and pile(s).
6. The depth of the hydrophones and depth of water at hydrophone locations.
7. The distance from the pile to the water's edge.
8. The depth of water in which the pile was driven.
9. The depth into the substrate that the pile was driven.
10. The physical characteristics of the bottom substrate into which the piles were driven.
11. The total number of strikes to drive each pile and for all piles driven during a 24-hour period.
12. The results of the hydroacoustic monitoring, as described under Signal Processing. An example table is provided in Appendix A for reporting the results of the monitoring.
13. Estimated source levels referenced to 10 meters, transmission loss coefficients, and estimated distances at which peak, cSEL, and RMS values exceed the respective threshold values, if greater than 10 meters.
14. A description of any observable fish behavior, and if possible, correlation to underwater sound levels occurring at that time will be included in the fish monitoring report. A description of any observable marine mammal behavior, and if possible, correlation to underwater sound levels occurring at that time will be included in the marine mammal monitoring report.

[3] Designated fisheries biologist and lead marine mammal observer

REFERENCES

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APPENDIX A

Date and Time	Pile ID	Hammer Type	No. of Strikes or Duration	Distance to Pile from Hydrophone (m)	Water Depth (m)		Peak (dB)			SEL (dB)				RMS (dB)			Notes
					At Pile	At H-phone	Max	Median	Mean	Max	Median	Mean	cSEL	Max	Median	Mean	