

*San Francisco–Oakland Bay Bridge
East Span Seismic Safety Project*



**Pier Retention Pile Driving and Pier Removal
Marine Mammal Monitoring Report**

EA 04-013574

EFIS#: 0416000287

04-SF-80 KP 12.2/KP 14.3

04-ALA-80 KP 0.0/KP 2.1

January 2019

California Department of Transportation



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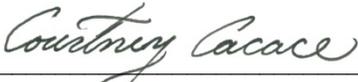
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04-ALA-80 KP 0.0/KP 2.1

January 2019

California Department of Transportation

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The environmental review, consultation, and any other actions required by applicable Federal environmental laws for this project are being, or have been, carried out by Caltrans pursuant to 23 U.S.C. 327 and the Memorandum of Understanding dated December 23, 2016 and executed by FHWA and Caltrans.

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LIST OF ABBREVIATED TERMS

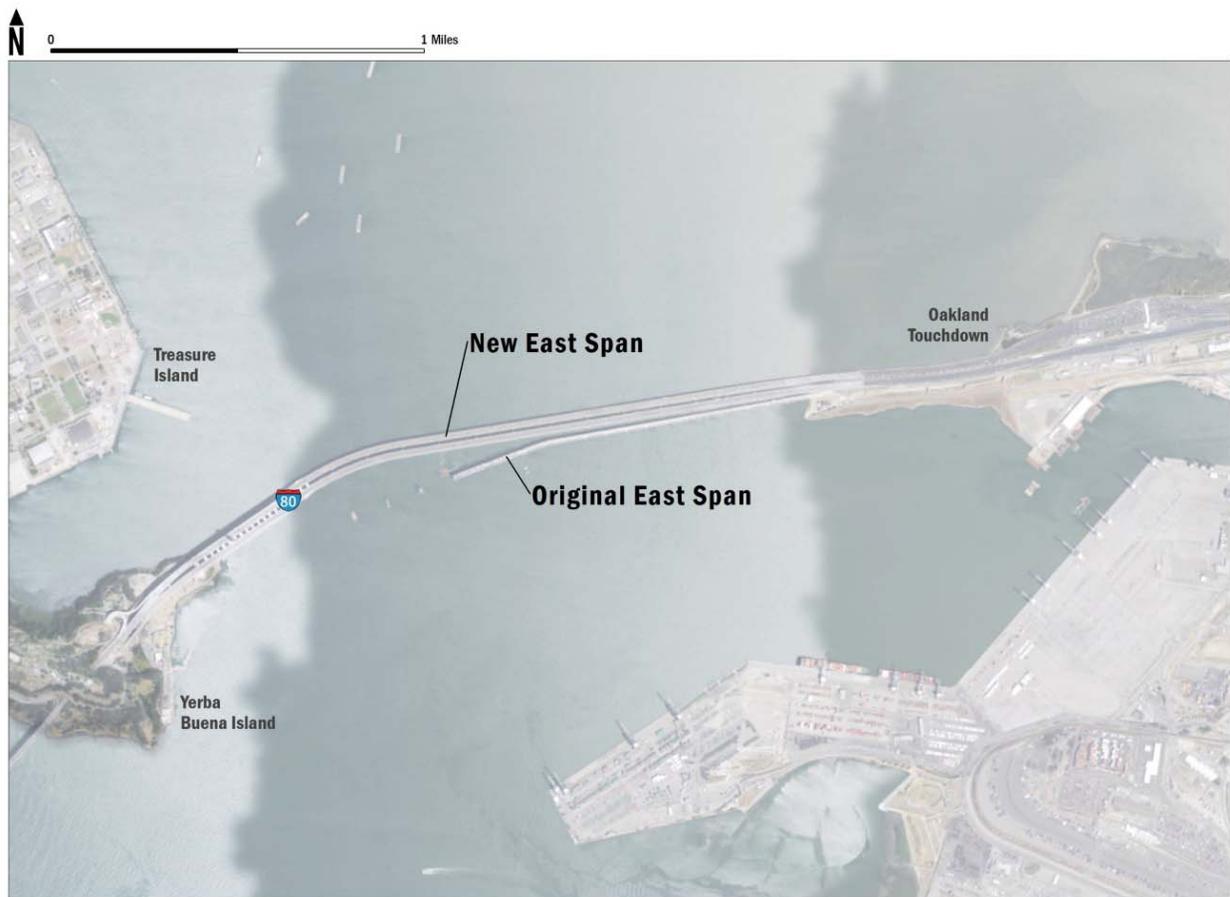
BAS	blast attenuation system
Bay	San Francisco Bay
dB	Decibel
Department	California Department of Transportation
IHA	Incidental Harassment Authorization
kg	kilograms
MMEZ	marine mammal exclusion zone
MMO	marine mammal observer
MMPA	Marine Mammal Protection Act
μPa	micro pascal
NMFS	National Marine Fisheries Service
OTD	Oakland Touchdown
Pa-sec	pascal-second
PTS	permanent threshold shift
RMS	root mean square
SEL	sound exposure level
SEL _{cum}	cumulative sound exposure level
SFOBB	San Francisco–Oakland Bay Bridge
SFOBB Project	East Span Seismic Safety Project
SPL	sound pressure level
TMMC	The Marine Mammal Center
TTS	temporary threshold shift
WDOT	Washington Department of Transportation
YBI	Yerba Buena Island
ZOI	zone of influence

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Chapter 1. Introduction

The California Department of Transportation (Department), as part of the San Francisco–Oakland Bay Bridge (SFOBB) East Span Seismic Safety Project (SFOBB Project), has replaced the original east span of the SFOBB with a new bridge north of the former bridge (Figure 1-1). The SFOBB Project included both constructing the new east span bridge and dismantling the original east span bridge. This report discusses the marine mammal monitoring associated with the removal or repurposing of marine foundations, Piers E19 to E23, completed in 2018.

Figure 1-1. SFOBB New East Span and Original East Span



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**SAN FRANCISCO BAY BRIDGE:
EAST SPAN**

Source: ESRI 2015 (imagery); compiled by AECOM in 2017

Chapter 2. Project Description

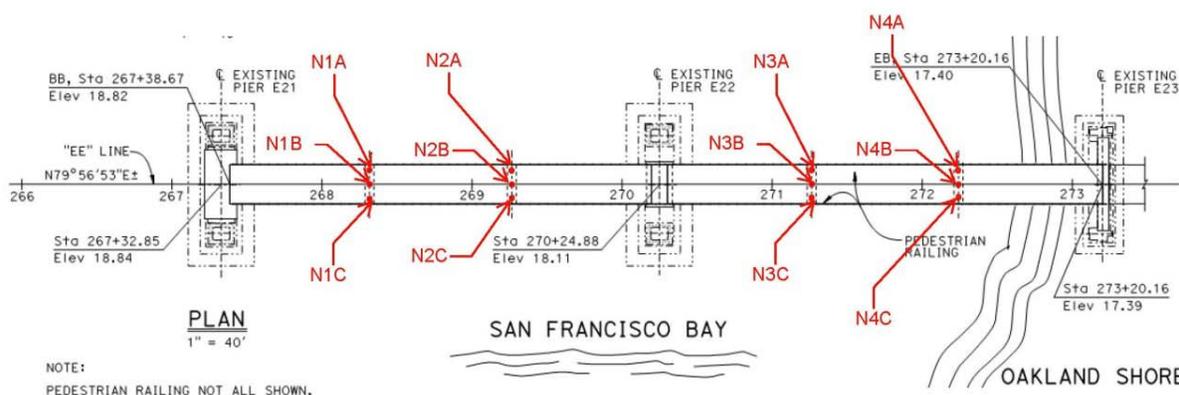
During 2018, the last of the remaining marine foundations (Piers E2 and E19 through E23) were removed or repurposed, completing the dismantling of the original east span bridge. Construction activities performed during 2018 that had the potential to affect marine mammals included pile-driving activities for construction of a Public Access Pier and temporary access trestle at Piers E21 through E23, as well as the use of highly controlled explosives to demolish Piers E19 and E20. The repurposing of Pier E2 was similar to that of Piers E21 to E23, but no in-water piles were necessary for construction; therefore, no monitoring occurred during Pier E2 construction activities, and this pier will not be discussed further.

2.1 Pile-Driving Activities

2.1.1 OTD Public Access Pier

The Oakland Touchdown (OTD) Public Access Pier extends from Pier E23 on the Oakland shoreline to Pier E21 in San Francisco Bay (Bay), and is supported by Piers E23, E22, and E21. The Public Access Pier includes observation platforms at Piers E22 and E21, situated atop reinforced concrete slabs. The existing pier foundations are spaced 88 meters (288 feet) apart. New intermediate piers have been constructed between the existing pier foundations to support the Public Access Pier. These permanent intermediate piers are pile-supported. Pile driving for the permanent Public Access Pier started on July 23, 2018, and was completed on July 31, 2018; out-of-water construction of the pier is ongoing.

Twelve 36-inch-diameter steel pipe piles with a 1-inch wall thickness were required for the Public Access Pier. Two sets of three piles were driven between existing Piers E22 and E23 using a crane positioned on the temporary access trestle, described below. Two additional sets of three piles were driven between existing Piers E21 and E22 using a crane positioned on a barge. Figure 2-1 shows the pile layout for the OTD Public Access Pier.

Figure 2-1. OTD Public Access Pier Pile Layout

The six piles installed from the temporary trestle were driven to the greatest extent practicable with a vibratory hammer and then driven with a diesel impact hammer to seat. The six piles installed from the barge were driven with only a diesel impact hammer. A marine pile-driving attenuator (bubble curtain) was used to minimize sound pressures and impacts to fish and marine mammals during impact driving.

2.1.2 Temporary Access Trestle

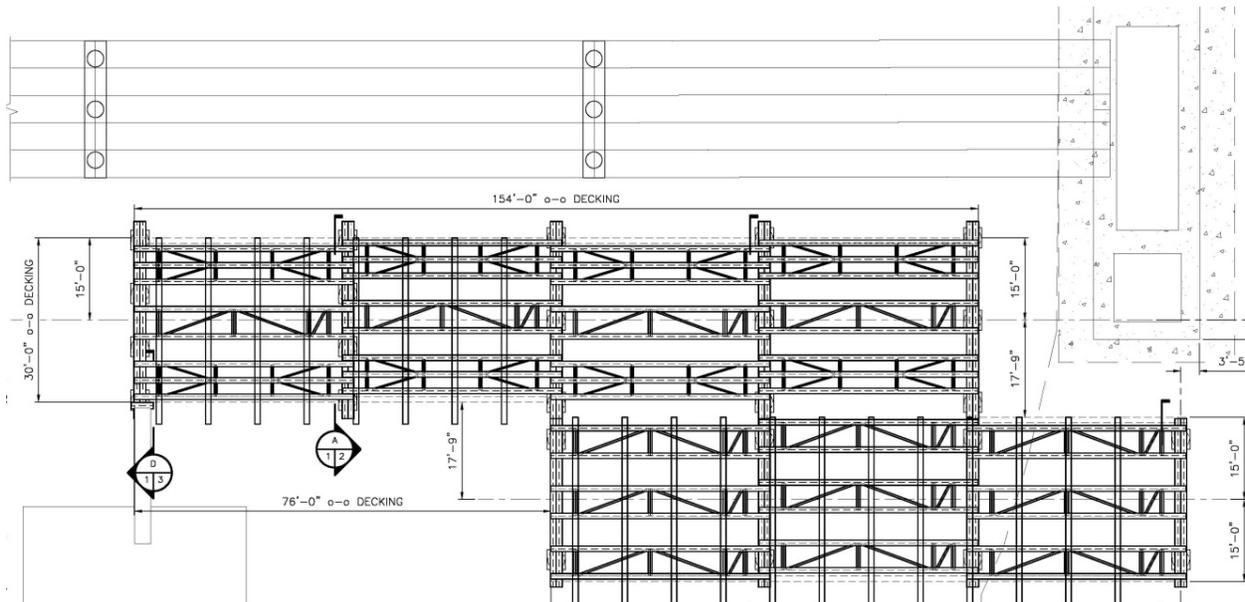
A temporary access trestle was needed to facilitate construction of the permanent OTD Public Access Pier (Figure 2-2). The trestle was required to support a crane that was used to drive six of the permanent piles that would support the OTD Public Access Pier, as stated above. The trestle itself was pile-supported; it was situated at the western end of the OTD, extending approximately 58.5 meters (192 feet) into the Bay from the shore south of Pier E23. Construction of the approximately 836-square-meter (9,000-square-foot) trestle started June 1, 2018, and was completed by July 20, 2018.

As part of the temporary trestle construction, twenty-five 36-inch-diameter steel pipe piles were included in the original pile-driving plans (Figure 2-2). However, hard ground conditions were encountered making installation of one of the piles difficult. That pile was cut short, and two additional piles (one to the east and one to the west) were installed to support a beam that passed over the planned pile. Additionally, three 36-inch steel pipe piles were driven near the terminal end of the trestle and are not shown in the plans. These fender piles were installed to support landing of marine barges. The total number of piles, therefore, was thirty 36-inch-diameter steel pipe piles.

The piles were installed with a vibratory hammer to the greatest extent practicable and then driven with a diesel impact hammer to seat, if necessary. The piles were driven to depths of

approximately 25.9 to 32 meters (85 to 105 feet) below the mudline. A marine pile-driving attenuator (bubble curtain) was used to minimize sound pressures and impacts to fish and marine mammals during impact driving. The air bubble curtain was not used during installation of the piles at the shoreline, because they were out of water during low tide and use of a bubble curtain would be ineffective. Efforts were made to install other piles at low tides. In shallow water, less sound would be transmitted into the water column. The water depth ranged from exposed Bay floor (no water depth) to less than 0.6 meter (2 feet) during low tide.

Figure 2-2. Temporary Access Trestle Pile Layout



2.2 Pier Implosion Activities

On September 8, 2018, the Department successfully executed the controlled implosion of Piers E19 and E20.

Before the blast event, controlled charges were loaded into the boreholes of Piers E19 and E20. The boreholes varied in diameter and depth, and were designed to provide optimal efficiency in transferring the energy created by the controlled charges to dismantle the piers. Charges were arranged in different levels (decks) and were separated in the boreholes by stemming. Stemming is the insertion of inert materials, such as sand or gravel, to insulate and retain charges in an enclosed space. Stemming allowed more efficient transfer of energy into the structural concrete for fracturing, and further reduced the release of potential energy into the adjacent water column. Individual cartridge charges, using electronic blasting caps, were selected to provide greater control and accuracy in determining the individual and total charge weights. Use of individual

cartridges allowed a refined blast plan that efficiently broke the concrete, while minimizing the amount of charges needed. Maximum individual charge weights used at each pier ranged from approximately 20 to 35 pounds.

To minimize impacts on biological resources, the controlled blasting event to remove Piers E19 and E20 was conducted during high slack tide in September (outside of the marine mammal pupping season), using a blast attenuation system (BAS). As shown during the Pier E3 Demonstration Project and the subsequent implosions of Piers E4 through E18, the BAS decreased noise and pressure waves generated during each controlled blast, and minimized potentially adverse effects on nearby biological resources. The BAS is a modular system of pipe manifold frames placed around each pier and fed by air compressors to create a curtain of air bubbles. Pier E19 and E20 were each encircled by their own BAS, similar to the operations used for Piers E3 through E18.

The blast event lasted approximately 2.4 seconds. The timing between the last charge on Pier E19 and the first charge on Pier E20 was approximately one-half of a second, providing enough time between blasts to avoid accumulating peak sound pressure waves. The location of former Piers E19 and E20 is shown on Figure 2-3.

Figure 2-3. Location of Piers E19 to E23



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PIER E19 - E23

Chapter 3. Background

3.1 Marine Mammal Regulations

Under the Marine Mammal Protection Act (MMPA), “take” is defined as to “harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill” marine mammals. Under the 1994 Amendment to the MMPA, harassment is statutorily defined as “any act of pursuit, torment, or annoyance which has the potential to injure or disturb a marine mammal or marine mammal stock in the wild.” Harassment which has the potential to injure a marine mammal is further defined as Level A Harassment. Level B Harassment is defined as any act that has the potential to disturb, but not injure, a marine mammal by disrupting behavioral patterns, including but not limited to migration, breathing, nursing, breeding, feeding, or sheltering.

3.2 Incidental Harassment Authorization

Pursuant to the MMPA, the Department requested and received an Incidental Harassment Authorization (IHA) from National Marine Fisheries Service (NMFS) for incidental take, by harassment, of marine mammals resulting from activities associated with both reuse and demolition of the remaining bridge pier foundations (NMFS 2018). These activities included: (1) pile driving associated with the reuse of marine foundations to construct public access improvements; and (2) the use of highly controlled charges to dismantle marine foundations.

Although numerous species of marine mammals exist along the central and northern California coasts, only seven species regularly inhabit or seasonally enter the Bay. None of these species are listed as endangered or threatened under the Federal Endangered Species Act, or as a depleted or strategic stock under the MMPA. The May 24, 2018, IHA authorizes the Department to incidentally take, by harassment, Pacific harbor seals (*Phoca vitulina richardii*), Northern elephant seals (*Mirounga angustirostris*), California sea lions (*Zalophus californianus*), Northern fur seals (*Callorhinus ursinus*), harbor porpoises (*Phocoena phocoena*), common bottlenose dolphins (*Tursiops truncatus*), and gray whales (*Eschrichtius robustus*) incidental to pile-driving and pier-implosion activities associated with the SFOBB Project.

Chapter 4. Potential Impacts on Marine Mammals

4.1 Potential Impacts on Marine Mammals from Pile-Driving Activities

Pile-driving activities associated with construction of the OTD Public Access Pier and temporary access trestle had the potential to result in the incidental take of marine mammals. Piles were driven into the substrate using a vibratory hammer, an impact hammer, or both.

Vibratory pile driving produces nonimpulse (continuous) sounds that can cause behavioral disturbance to marine mammals and a temporary threshold shift (TTS) in an animal's hearing. Both behavioral disturbance and TTS are considered to be Level B Harassment. These nonimpulse sounds from vibratory pile driving can also cause slight injury in the form of a permanent threshold shift (PTS) in an animal's hearing, which would be considered Level A Harassment.

Impact pile driving produces impulse sounds that can have similar effects on marine mammals: behavioral disturbance and TTS (Level B Harassment), and slight injury in the form of PTS in an animal's hearing (Level A Harassment).

NMFS has established sound threshold criteria for Level A and B Harassment to marine mammals from pile driving and other similar activities (Table 4-1) (NMFS 2016). These sound threshold criteria do not apply to explosives. The underwater sound pressure threshold for behavioral disturbance (Level B Harassment) is 120 decibels (dB) root mean square (RMS) for nonimpulse sound (e.g., vibratory pile driving) and 160 dB RMS for impulse sound (e.g., impact pile driving) for both cetaceans and pinnipeds (Table 4-1). The underwater sound pressure threshold for slight injury due to PTS (Level A Harassment) is a dual metric criterion, including both a peak pressure and cumulative sound exposure level (SEL_{cum}) threshold that is specific to the hearing group (i.e., low-frequency cetaceans, mid-frequency cetaceans, high-frequency cetaceans, phocids, and otariids) (NMFS 2016). Underwater sound pressure thresholds for Level B and Level A Harassment for each marine mammal taxa from nonimpulse and impulse sounds are shown in Table 4-1.

Table 4-1. Underwater Sound Threshold Criteria for Pile Driving

Hearing Group	Nonimpulse Sound (Vibratory Pile Driving)		Impulse Sound (Impact Pile Driving)		
	Level B Harassment	Level A Harassment	Level B Harassment	Level A Harassment	Level A Harassment
	Behavioral	Slight Injury (PTS)	Behavioral	Slight Injury (PTS) Peak Criteria	Slight Injury (PTS) SEL _{cum} Criteria
Low-frequency cetaceans	120 dB RMS	199 dB SEL _{cum}	160 dB RMS	219 dB Peak	183 dB SEL _{cum}
Mid-frequency cetaceans	120 dB RMS	198 dB SEL _{cum}	160 dB RMS	230 dB Peak	185 dB SEL _{cum}
High-frequency cetaceans	120 dB RMS	173 dB SEL _{cum}	160 dB RMS	202 dB Peak	155 dB SEL _{cum}
Phocids	120 dB RMS	201 dB SEL _{cum}	160 dB RMS	218 dB Peak	185 dB SEL _{cum}
Otariids	120 dB RMS	219 dB SEL _{cum}	160 dB RMS	232 dB Peak	203 dB SEL _{cum}

Notes:

All dB referenced to 1 micro pascal (re: 1 μPa).

dB = decibel

PTS = permanent threshold shift

RMS = root mean square

SEL_{cum} = cumulative sound exposure level

Source: NMFS 2016

4.2 Potential Impacts on Marine Mammals from Pier Implosion Activities

Underwater blasting can cause behavioral disturbance (Level B Harassment), slight or serious injury (Level A Harassment), and mortality to marine mammals. NMFS has established sound threshold criteria for take of marine mammals from underwater blasting (Table 4-2). The specific acoustic thresholds depend on the functional hearing group (i.e., low-frequency cetaceans, mid-frequency cetaceans, high-frequency cetaceans, phocids, and otariids). As shown in Table 4-2, different designations for the SEL_{cum} criteria exist for each hearing group, and refer to group-specific filter shapes that are to be applied to the pressure signal. For peak and RMS sound pressure levels (SPLs), no filters are specified.

Table 4-2. Sound Threshold Criteria for Take of Marine Mammals from Underwater Blasting

Hearing Group	Level B Harassment		Level A Harassment			Mortality
	Behavioral (for ≥2 pulses/ 24 hours)	TTS	PTS	Gastro Intestinal Tract	Lung	
Low-frequency cetaceans	163 dB SEL _{cum} (LF _{II})	168 dB SEL _{cum} (LF _{II}) or 213 dB peak SPL	183 dB SEL _{cum} (LF _{II}) or 219 dB peak SPL	237 dB SPL or 104 psi	39.1 M ^{1/3} (1+[D _{Rm} /10.1]) ^{1/2} Pa-sec Where: M = mass of the animal in kg D _{Rm} = depth of the receiver (animal) in meters	91.4 M ^{1/3} (1+[D _{Rm} /10.1]) ^{1/2} Pa-sec Where: M = mass of the animal in kg D _{Rm} = depth of the receiver (animal) in meters
Mid-frequency cetaceans	165 dB SEL _{cum} (MF _{II})	170 dB SEL _{cum} (MF _{II}) or 224 dB peak SPL	185 dB SEL _{cum} (MF _{II}) or 230 dB peak SPL			
High-frequency cetaceans	135 dB SEL _{cum} (HF _{II})	140 dB SEL _{cum} (HF _{II}) or 196 dB peak SPL	155 dB SEL _{cum} (HF _{II}) or 202 dB peak SPL			
Phocids	165 dB SEL _{cum} (P _{WI})	170 dB SEL _{cum} (P _{WI}) or 212 dB peak SPL	185 dB SEL _{cum} (P _{WI}) or 218 dB peak SPL			
Otariids	183 dB SEL _{cum} (O _{WI})	188 dB SEL _{cum} (O _{WI}) or 226 dB peak SPL	203 dB SEL _{cum} (O _{WI}) or 232 dB peak SPL			

Notes:

dB = decibel

kg =kilograms

SEL_{cum} = cumulative sound exposure level

Pa-sec = pascal-second

PTS = permanent threshold shift

RMS = root mean square

SPL = sound pressure level

TTS = temporary threshold shift

All decibels are referenced to 1 micro pascal (re: 1 μPa).

Groups associated with sound exposure level thresholds indicate the designated marine animal auditory weighting function.

Source: Finneran and Jenkins 2012; NMFS 2016

Chapter 5. Take Authorization

5.1 Take Authorization for Pile-Driving Activities

Based on a combination of species density; past observations of species in the Bay and in the project area; size of estimated threshold distances for Level A and Level B Harassment (or zones of influence [ZOIs]); duration of pile-driving activities; and recommendations from the Marine Mammal Commission, the Department and NMFS agreed on the quantity of incidental take that would be authorized for 2018 pile-driving activities. The 2018 IHA authorized the incidental take of Pacific harbor seals, California sea lions, Northern elephant seals, Northern fur seals, harbor porpoises, bottlenose dolphins, and gray whales by Level B Harassment, as shown in Table 5-1. The 2018 IHA also authorized the incidental take of Pacific harbor seals and Northern elephant seals by Level A Harassment (Table 5-1).

Table 5-1. Authorized Take Numbers for Pile Driving Activities

Species	Level B Harassment Take Authorization	Level A Harassment Take Authorization
Pacific harbor seal	2,161	120
California sea lion	88	0
Northern elephant seal	12	2
Northern fur seal	6	0
Harbor porpoise	91	0
Bottlenose dolphin	30	0
Gray whale	4	0

Source: NMFS 2018

5.2 Take Authorization for Pier Implosion Activities

The 2018 IHA allowed incidental take of Pacific harbor seals, California sea lions, Northern elephant seals, Northern fur seals, harbor porpoises, and bottlenose dolphins by behavioral or TTS Level B Harassment at the quantities shown in Table 5-2. Authorized take of marine mammals was calculated based on distance to the threshold criteria, duration of the activity, and the estimated density of each species in the ZOI. Take of marine mammals by Level A Harassment—PTS, other injury, or mortality—was prohibited.

Table 5-2. Authorized Take Numbers for Pier Implosion

Species	Level B Harassment Take Authorization	
	Behavioral	Temporary Threshold Shift
Pacific harbor seal	20	10
California sea lion	4	3
Northern elephant seal	2	1
Northern fur seal	2	1
Harbor porpoise	10	8
Bottlenose dolphin	4	2

Source: NMFS 2018; 83 Federal Register 15795, April 12, 2018

Chapter 6. Marine Mammal Monitoring Methods

In compliance with requirements of the 2018 IHA, the Department prepared a Marine Mammal Monitoring Plan for pier retention pile-driving activities that describes marine mammal monitoring requirements to be implemented before, during, and after pile driving (Department 2018b). The Department also prepared comprehensive Biological Monitoring Programs for the 2018 Marine Foundation Removal Project that address all of the biological monitoring requirements for the pier implosion activities, including those required under the 2018 IHA (Department 2018c). The goals of monitoring were to avoid unauthorized Level A take of marine mammals; document Level A and Level B take within authorized take limits; and document any disturbance, harassment, or injury of marine mammals. Requirements of the 2018 IHA and these monitoring plans are described in this chapter.

6.1 Briefings

Prior to the start of both pile driving and the pier implosion, briefings were held among the construction supervisors and crews, the marine mammal monitoring team, the acoustical monitoring team, and Department staff. The purpose of the briefings was to establish responsibilities of each party, define chains of command, discuss communication procedures, provide an overview of monitoring protocol, and review operational procedures. New personnel were briefed before they joined the work in progress.

6.2 Establishment of Exclusion and Behavioral Monitoring Zones

As discussed in Section 4.1 above, NMFS has established sound threshold criteria for behavioral disturbance and TTS (Level B Harassment) and PTS (Level A Harassment) to species hearing groups of marine mammals from pile driving, underwater explosions, and other similar activities (NMFS 2016; Finneran and Jenkins 2012). Based on the requirements in the 2018 IHA, the sound thresholds for each hearing group were used to calculate marine mammal exclusion zones (MMEZs) and monitoring zones for pile driving related to construction of the Public Access Pier and the implosion of Piers E19 and E20. For pier implosion, the MMEZs were intended to include all areas where the underwater SPLs were anticipated to equal or exceed thresholds for slight injury (Level A Harassment). For pile driving, the MMEZ were intended to include all areas where underwater SPLs were anticipated to equal or exceed thresholds for slight injury (Level A Harassment) to cetaceans and otariids. Phocid pinnipeds in the Level A zone during pile driving were to be monitored and documented to ensure that authorized take was not exceeded. For both pier implosion and pile driving, the Level B monitoring zones included all

areas where the underwater SPLs equaled or exceeded thresholds for behavioral disturbance or TTS.

6.2.1 Exclusion and Monitoring Zones for Pile-Driving Activities

Before impact or vibratory pile driving (with the exception of pile proof testing¹), initial MMEZs and monitoring zones were established at the radial distances shown in Table 6-1. The distances to these marine mammal threshold criteria were calculated based on hydroacoustic measurements collected during previous pile-driving activities for the SFOBB Project and other projects involving similar activities under similar conditions. Measured SPLs from other projects came from the Department's *Compendium of Pile Driving Sound Data* (Department 2007), which provides information on sound pressures resulting from pile driving measured throughout Northern California, and the 2006 Washington Department of Transportation Mukilteo Ferry Terminal Project (WDOT 2007). Distances were calculated using the NMFS-provided *User Spreadsheet Tool* (<https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-acoustic-technical-guidance>). Hydroacoustic measurements were collected during vibratory or impact pile driving to verify distances to marine mammal threshold criteria.

6.2.2 Exclusion and Monitoring Zones for Pier Implosion Activities

The hydroacoustic monitoring results from the implosions of Piers E3 in 2015, Piers E4 and E5 in 2016, and Piers E6 through E18 in 2017 were used to estimate distances to the Level A and Level B hearing group thresholds for the implosion of Piers E19 and E20 (Department 2016, 2017). Based on the estimated distances and in coordination with NMFS, the Department established specific MMEZs and monitoring zones for each hearing group or combined groups. Level A MMEZs and Level B TTS and behavioral response monitoring zones were designed to be larger than the furthest estimated ZOI appropriate to specific marine mammal functional hearing groups, to create more conservative monitoring zones. These MMEZ and monitoring zone distances are shown in Table 6-2.

¹ The Department did not perform marine mammal monitoring during the unattenuated pile proof testing, because the proofing of a pipe pile required less than 1 minute of impact driving and a maximum of 20 blows per pile, with a maximum of two piles per day. This logistic was agreed upon with NMFS in the Department's 2018 IHA.

Table 6-1. Marine Mammal Exclusion, Shutdown, and Monitoring Zones for Pile-Driving Activities

Pile Type	Installation Method	Attenuation System	Pinniped and Dolphin Shutdown Initiation Distance	Pinniped and Dolphin Exclusion Zone	Pinniped and Dolphin Level A Monitoring Zone	Porpoise and Whale Level A Exclusion Zone	Level B Monitoring Zone All Species
36-inch steel pipe pile	Vibratory	None	50 meters (164 feet)	20 meters (66 feet)	N/A	49 meters (161 feet)	2,000 meters (6,562 feet)
36-inch steel pipe pile	Impact	Bubble curtain	50 meters (164 feet)	25 meters (82 feet)	206 meters (676 feet)	459 meters (1,506 feet)	858 meters (2,815 feet)

Note:

N/A = Not Applicable

Source: NMFS 2018 and Department 2018a

Table 6-2. Level A MMEZs and Level B TTS and Behavioral Response Monitoring Zones for Implosion of Piers E19 and E20

Species/Hearing Group	Level B Harassment Monitoring Zones		Level A Harassment MMEZ
	Behavioral	TTS	PTS
Pinnipeds (Phocids and Otariids) and Bottlenose Dolphins	290 meters (951 feet)	200 meters (656 feet)	70 meters (230 feet)
Harbor Porpoise	1,220 meters (4,003 feet)	830 meters (2,723 feet)	290 meters (951 feet)

Note:

MMEZ = marine mammal exclusion zone

PTS = permanent threshold shift

TTS = temporary threshold shift

Source: NMFS 2018

6.3 Marine Mammal Monitoring

Marine mammal monitoring was conducted during both pile driving and pier implosion activities, as described below.

6.3.1 Marine Mammal Monitoring for Pile-Driving Activities

Monitoring during pile-driving activities was conducted by qualified NMFS-approved marine mammal observers (MMOs). A minimum of two MMOs and a maximum of three MMOs were on site during all pile-driving activities. One MMO was designated as the Lead MMO, and received updates from other MMOs on the presence or absence of marine mammals in the MMEZ and monitoring zones. The Lead MMO was stationed at the active pile-driving rig or nearby at the best vantage point practicable to monitor the MMEZ for marine mammals; and to implement shutdown and delay procedures, when applicable, through communication with the Resident Engineer or his designated representative. The other MMOs were stationed on the new SFOBB bicycle path, the best vantage point to observe the monitoring zones. Observations were made using binoculars during daylight hours. Each member of the monitoring team had a radio (and a mobile phone for backup) for contact with other observers.

Before the start of pile-driving activities, the MMEZs were established as discussed above. The MMOs surveyed the MMEZs for at least 30 minutes before pile-driving activities started, and for at least 30 minutes after completion. If marine mammals were in the MMEZ during the pre-driving period, pile driving was delayed until the animal had moved out of the exclusion zone, either verified visually by an observer or by waiting until enough time had elapsed without seeing the animal to assume it had moved outside the MMEZ: 15 minutes for pinnipeds and small cetaceans (harbor porpoise and bottlenose dolphin), and 30 minutes for gray whales.

If a pinniped or dolphin was sighted within 50 meters (164 feet) of the pile-driving activity after it had begun, it was considered to be approaching the MMEZ, and pile-driving shutdown procedures were initiated. The Lead MMO notified the Resident Engineer or his designated representative that the activity needed to be temporarily shut down, and the Resident Engineer or his designated representative directed the equipment operator to stop the pile-driving activity. Pile driving resumed after the animal had moved out of and was moving away from the MMEZ, or the allotted time of 15 or 30 minutes had passed since the animal was last seen. If a species for which take was not authorized, or a species for which authorization had been granted but the authorized takes were reached was sighted in or approaching the monitoring zone, activities would have been shut down immediately.

Each MMO recorded his/her observation position, start and end times of observations, and weather conditions (e.g., sunny/cloudy, wind speed, fog, and visibility). For each marine mammal sighting, the following items were recorded, if possible:

- species, numbers, and, if possible, sex and age class of marine mammals;
- description of any observable marine mammal behavior patterns, including bearing and direction of travel and distance from pile-driving activity;
- location and distance from pile-driving activities to marine mammals and distance from the marine mammals to the observation point;
- estimated amount of time that the animals remained in the Level A or Level B zone;
- description of implementation of mitigation measures in each monitoring period (e.g., shut down or delay); and
- other human activity in the area in each monitoring period.

Mitigation requirements specific to impact driving required a soft start at the start of each day's impact driving and at any time following a break in impact driving of more than 30 minutes or longer. The soft start consisted of an initial set of strikes of the impact hammer at reduced energy, followed by a 30-second waiting period, then two subsequent reduced-energy strike sets. A marine pile-driving attenuator (bubble curtain) was required to be in place around the base of the pipe pile for all soft starts and impact driving in the water.

Additionally, the 2018 IHA required a 10-meter (23.8-foot) shut-down zone for all marine mammals around all in-water heavy machinery work, which stipulated a temporary cessation of operations and a reduction in speed of all vessels to the minimum required to maintain steerage and safe working conditions.

6.3.2 Marine Mammal Monitoring for Pier Implosion Activities

Although a minimum of eight NMFS-approved MMOs were required (NMFS 2018), eleven MMOs conducted monitoring before, during, and after the blast event for the implosion of Piers E19 and E20. MMO positions were designated ahead of time, near the edge of each MMEZ and in monitoring zones. Monitoring stations included boats, the new SFOBB, and the OTD. Monitoring began a minimum of 30 minutes before the anticipated blast time and continued for 60 minutes after the implosion.

Each MMO recorded his/her observation position, start and end times of observations, and weather conditions (e.g., sunny/cloudy, wind speed, fog, and visibility). For each marine mammal sighting, the following items were recorded, if possible:

- species, number of animals, sex of animals;
- age class (i.e., pup/calf, juvenile, or adult);
- identifying marks or color (e.g., scars, red pelage, or damaged dorsal fin);
- position relative to pier implosion (i.e., distance and direction);
- movement (i.e., direction and relative speed);
- behavior (e.g., logging [resting at the surface], swimming, spy-hopping [raising above the water surface to view the area], or foraging);
- signs of injury, stress, or other unusual behavior; and
- duration of sighting or times of multiple sightings of the same individual.

All MMOs were equipped with radios using a dedicated marine mammal monitoring channel, and with mobile phones as a backup. One MMO, designated as the Lead MMO, was in constant contact with the Department Environmental Compliance Manager, who was with the Department Resident Engineer and Blaster-in-Charge. The Lead MMO coordinated marine mammal sightings with the other MMOs. Each MMO contacted the other MMOs when a sighting was made in or near the MMEZs, so that the MMOs with overlapping areas of responsibility could continue to track the animal and the Lead MMO was aware of the animal's position.

If a sighting was within 30 minutes of the scheduled blast and an animal had entered an MMEZ or was near it, the Lead MMO was to notify the Department Environmental Compliance Manager, and a delay protocol was to be implemented. If an animal was identified in the MMEZ or approaching the MMEZ, the animal was tracked until it left the zone. If it dove in the MMEZ and was not seen again, a 15-minute delay was to be implemented. The Lead MMO kept everyone informed of the location and disposition of the animal and notified the Department Environmental Compliance Manager when the MMEZs were clear before the implosion.

6.3.3 Stranding Surveys for Pier Implosion Activities

A stranding plan was prepared in cooperation with the NMFS-designated marine mammal stranding, rescue, and rehabilitation center for central California, The Marine Mammal Center

(TMMC). Although avoidance and minimization measures were anticipated to prevent any injuries from the implosion, preparations were made in the unlikely event that a marine mammal was injured. Because sick, injured, or dead marine mammals strand in the Bay for various reasons unrelated to the implosion activities, it was necessary to determine the cause of stranding for any marine mammals that appeared within 3 days after the implosion. Therefore, plans were made to examine sick or injured individuals that were observed after the implosion, to determine the cause of the stranding.

A stranding team member and a veterinarian for TMMC were staged near the project site at the time of the implosion to quickly recover any injured marine mammals, provide emergency veterinary care, and transport individuals to the stranding facility, had it been necessary. In accordance with the 2018 IHA, NMFS (both the regional office and headquarters) was to be notified within the required timelines if any injured or dead animal was found, even if the animal appeared to be sick or injured from a cause other than the implosion (NMFS 2018).

A pre-implosion survey was conducted the day before the blast to identify any stranded animals that were not related to the implosion. Post-implosion stranding surveys were conducted immediately after the pier implosion event and over the following 3 days to identify any injured or deceased marine mammals. The five surveys were conducted by the Lead MMO and took between 4 and 7.5 hours to complete. TMMC's stranding team was present only during the first post-implosion survey, and was staged on the survey boat with nets, an animal carrier, and a medical kit. The first post-implosion survey began within 90 minutes after the implosion event.

Stranding surveys were conducted by boat and by car along the shoreline in the vicinity of the SFOBB eastern span (Figure 6-1). Boat surveys were conducted from Oakland Outer Harbor Berth 9 to Clipper Cove on the southeastern side of Treasure Island, counter-clockwise around Treasure Island and Yerba Buena Island (YBI). From YBI, the boat surveys continued east through the moored barges on the northern side of the new span, along the Emeryville breakwater, into the Emeryville Crescent, and returned to Berth 9. Each survey path varied slightly depending on field and tide conditions. Land surveys were conducted along the shoreline at the OTD, at the Emeryville Crescent, and along the shoreline north of the Oakland toll plaza and SFOBB approaches. This shoreline includes two stretches of sandy beach, riprap, and portions of Radio Road, which runs parallel to the northern side of Highway 80 westbound.

Figure 6-1. Stranding Survey Area



Chapter 7. Monitoring Results

7.1 Monitoring Results for Pile Driving Activities

Pile driving began on the 30 temporary 36-inch steel pipe piles for the temporary trestle on June 1, 2018, and continued intermittently through July 2, 2018. Installation of the 12 permanent piles for the Public Access Pier began July 23, 2018, and continued intermittently through July 31, 2018. A total of 24 Pacific harbor seals and two California sea lions were seen during the 21 days of observing (Appendix A). Only two animals were observed to have a reaction to the pile driving: one California sea lion in the Level B monitoring zone reacted strongly to the soft start before impact driving, and one harbor seal reacted to the start of vibratory driving while in the Level B monitoring zone.

The large male California sea lion was first observed on June 11 at 9:45 a.m., about 200 meters (656 feet) west-northwest of the work area, under the new SFOBB. To be conservative, the Lead MMO asked the Resident Engineer to delay the impact hammer soft start; this caused the only delay to construction due to the presence of marine mammals, which lasted approximately 10 minutes. The soft start was conducted from 9:53 a.m. to 9:55 a.m. while the animal was 300 meters (984 feet) away from the pile driving. Immediately after the soft start, the animal swam toward the work area with its head out of the water, looking at the construction activities and barking continuously. It did a high dive out of the water and circled about 150 meters (492 feet) from the work area, and then left the area by 10:00 a.m. From 10:02 a.m. to 10:03 a.m., the construction crew impacted the pile with 54 blows. The animal was not seen again.

A round of vibratory driving started at 10:18 a.m. on July 23. At 10:20 a.m., a Pacific harbor seal was first seen traveling east-northeast fairly quickly about 100 meters (328 feet) north of the work area, and about 100 meters (328 feet) north of the Lead MMO, who was observing from the temporary trestle. The harbor seal surfaced actively twice, heading east toward the eelgrass beds to the north of the OTD, and did a high dive out of the water before the MMO lost sight of it. The MMO resighted the harbor seal at 10:26 a.m. in the eelgrass beds, about 400 meters (1,312 feet) away, with its head lifted out of the water. At 11:10 a.m., the harbor seal resurfaced about 100 meters (328 feet) north-northeast of the Lead MMO's position, near its original location, traveling slowly southwest. Vibratory driving was ongoing at this point and the animal did not seem disturbed. The harbor seal was not seen after 11:10 a.m., but it was assumed to still be within 2,000 meters (6,562 feet) of the work, and therefore exposed to the full length of Level B vibratory driving on that particular pile (65 minutes).

There were only two Level A takes of harbor seals, both during impact driving, for an average of 25.5 minutes of intermittent impact driving each (Appendix B). There were 13 total Level B takes of harbor seals, eight during vibratory driving and five during impact driving (Table 7-1). These animals were exposed to an average of 51.5 minutes of vibratory driving (range of 1 to 100 minutes), or 26.4 average minutes of impact driving (range of 21 to 30 minutes) (Appendix B). There was one Level B take of a sea lion for 3 minutes of impact driving (Table 7-1). Overall, the project averaged less than one Level B take per day. There was one 10-minute delay to impact driving due to the sea lion mentioned above. No shutdowns were necessary due to the presence of marine mammals.

Hydroacoustic measurements were recorded during pile driving, and if measured SPLs did not correspond to estimated values, exclusion and monitoring zone distances could have been adjusted as appropriate. All measured distances for impact driving of the temporary access trestle piles and Public Access Pier were equal to or far below estimated distances as shown in Tables 7-2 and 7-3. In both cases, to be conservative, the original threshold distances were maintained throughout the Project.

Table 7-1. Summary of Marine Mammal Take for Pile Driving

Species	Level B Harassment		Level A Harassment	
	Vibratory Pile Driving	Impact Pile Driving	Vibratory Pile Driving	Impact Pile Driving
Pacific harbor seal	8	5	0	2
California sea lion	0	1	0	0

Table 7-2. Measured Distances to Marine Mammal Threshold Criteria During Pile Driving for the Temporary Access Trestle

Threshold	Level B Behavioral	Level A PTS				
	160 dB RMS	Low-Frequency Cetacean 183 dB SEL _{cum}	Mid-Frequency Cetacean 185 dB SEL _{cum}	High-Frequency Cetacean 155 dB SEL _{cum}	Phocid Pinniped 185 dB SEL _{cum}	Otariid Pinniped 203 dB SEL _{cum}
Estimated distances	541 meters (1,774 feet)	386 meters (1,266 feet)	14 meters (55 feet)	459 meters (1,506 feet)	206 meters (676 feet)	15 meters (49 feet)
Implemented exclusion and monitoring zone distances	858 meters (2,815 feet)	459 meters (1,506 feet)	25 meters (82 feet)	459 meters (1,506 feet)	25 meters (82 feet)	25 meters (82 feet)
Date	Measured Distances to Threshold Criteria					
June 1, 2018	77 meters (253 feet)	45 meters (148 feet)	4 meters (13 feet)	35 meters (115 feet)	17 meters (56 feet)	2 meters (7 feet)
June 2, 2018	93 meters (305 feet)	9 meters (30 feet)	0 meters (0 feet)	1 meters (3 feet)	0 meters (0 feet)	1 meters (3 feet)
June 7, 2018	239 meters (784 feet)	54 meters (177 feet)	1 meters (3 feet)	18 meters (59 feet)	16 meters (52 feet)	2 meters (7 feet)
June 11, 2018	40 meters (131 feet)	35 meters (115 feet)	14 meters (50 feet)	33 meters (108 feet)	24 meters (79 feet)	12 meters (39 feet)
SEL Levels Were Insufficient to Accumulate – Following are Measured SEL Levels at 34 meters (112 feet)						
June 12, 2018	45 meters (148 feet)	168.5 dB SEL _{cum}	142.4 dB SEL _{cum}	139.5 dB SEL _{cum}	159.9 dB SEL _{cum}	160.0 dB SEL _{cum}
June 13, 2018	No Data	181.6 dB SEL _{cum}	156.5 dB SEL _{cum}	153.6 dB SEL _{cum}	172.7 dB SEL _{cum}	172.6 dB SEL _{cum}
June 22, 2018	63 meters (207 feet)	185.6 dB SEL _{cum}	160.5 dB SEL _{cum}	155.8 dB SEL _{cum}	177.7 dB SEL _{cum}	177.9 dB SEL _{cum}
June 27, 2018	13 meters (43 feet)	145.6 dB SEL _{cum}	133.4 dB SEL _{cum}	131.6 dB SEL _{cum}	140.0 dB SEL _{cum}	140.3 dB SEL _{cum}

Notes:

- dB = decibel
- PTS = permanent threshold shift
- RMS = root mean square
- SEL = sound exposure level
- SEL_{cum} = cumulative sound exposure level

Table 7-3. Measured Distances to Marine Mammal Threshold Criteria During Pile Driving for the Public Access Pier

Threshold	Level B Behavioral	Level A PTS				
	160 dB RMS	Low-Frequency Cetacean 183 dB SEL _{cum}	Mid-Frequency Cetacean 185 dB SEL _{cum}	High-Frequency Cetacean 155 dB SEL _{cum}	Phocid Pinniped 185 dB SEL _{cum}	Otariid Pinniped 203 dB SEL _{cum}
Estimated distances	541 meters (1,775 feet)	386 meters (1,266 feet)	14 meters (46 feet)	459 meters (1,506 feet)	206 meters (676 feet)	15 meters (49 feet)
Implemented exclusion and monitoring zone distances	858 meters (2,815 feet)	459 meters (1,506 feet)	25 meters (82 feet)	459 meters (1,506 feet)	25 meters (82 feet)	25 meters (82 feet)
Date	Measured Distances to Threshold Criteria					
July 24, 2018	373 meters (1,224 feet)	68 meters (223 feet)	0 meters (0 feet)	102 meters (335 feet)	33 meters (108 feet)	11 meters (36 feet)
July 25, 2018	359 meters (1,178 feet)	67 meters (220 feet)	0 meters (0 feet)	136 meters (446 feet)	28 meters (92 feet)	8 meters (26 feet)
July 27, 2018	607 meters (1,991 feet)	128 meters (420 feet)	13 meters (43 feet)	86 meters (282 feet)	62 meters (203 feet)	16 meters (52 feet)
July 30, 2018	1,828 meters (5,997 feet)	178 meters (584 feet)	13 meters (43 feet)	99 meters (325 feet)	67 meters (220 feet)	20 meters (66 feet)
July 31, 2018	767 meters (2,516 feet)	160 meters (525 feet)	17 meters (56 feet)	99 meters (325 feet)	79 meters (259 feet)	12 meters (39 feet)

Note:

- dB = decibel
- PTS = permanent threshold shift
- RMS = root mean square
- SEL_{cum} = cumulative sound exposure level

7.2 Monitoring Results for Pier Implosion

The implosion of Piers E19 and E20 occurred at 11:20 a.m. on September 8, 2018. Marine mammal monitoring was conducted from 10:00 a.m. to 12:20 p.m. Twenty harbor seals were observed during the monitoring period on September 8. There were no sea lions, elephant seals, fur seals, harbor porpoises, or bottlenose dolphins observed. The estimated threshold distances were slightly smaller than the measured distances for harbor seals, as shown in Table 7-4; therefore, the number of take in the Behavioral, TTS, and PTS zones was calculated using the measured distances. MMOs were positioned both close to and far beyond all the measured distances, and monitored in all directions. Therefore, no marine mammals were excluded from monitoring due to the minor differences in threshold distances between the estimated distances and the measured distances. There were no differences between take numbers based on the measured versus estimated exclusion and monitoring zone distances. There was one harbor seal observed in the Pinniped Level B Measured TTS monitoring zone 4 minutes prior to the blast, and immediately following the blast in the zone. This animal was presumed to be present during the blast and was counted as a Level B take. Three additional harbor seals were observed during the blast, but were far outside of the 290-meter (975-foot) Level B Behavioral Zone, and therefore were not included as take. A summary of marine mammal take is shown in Table 7-5. A complete table showing all marine mammal sightings during the monitoring period for the September 8, 2018, implosion of Piers E19 and E20 is provided in Appendix C.

Table 7-4: Measured Distances to Underwater Blasting Threshold Criteria Compared to Implemented Exclusion and Monitoring Zones for Implosion of Piers E19 and E20

Species Group		Behavioral	TTS		PTS	
Mid-frequency cetaceans (dolphins)	Threshold	165 dB cSEL	224 dB Peak	170 dB cSEL	230 dB Peak	185 dB cSEL
	Exclusion and monitoring zones distances	951 feet	656 feet		230 feet	
	Piers E19 – E20 measured distances	548 feet	101 feet	385 feet	67 feet	134 feet
High-frequency cetaceans (porpoises)	Threshold	135 dB cSEL	196 dB Peak	140 dB cSEL	202 dB Peak	155 dB cSEL
	Exclusion and monitoring zones distances	4,003 feet	2,723 feet		951 feet	
	Piers E19 – E20 measured distances	3,993 feet	691 feet	<u>2,805 feet</u>	458 feet	<u>973 feet</u>
Phocid pinnipeds (seals)	Threshold	165 dB cSEL	212 dB Peak	170 dB cSEL	218 dB Peak	185 dB cSEL
	Exclusion and monitoring zones distances	951 feet	656 feet		230 feet	
	Piers E19 – E20 measured distances	<u>975 feet</u>	230 feet	<u>683 feet</u>	153 feet	<u>236 feet</u>
Otariid pinnipeds (sea lions)	Threshold	183 dB cSEL	226 dB Peak	188 dB cSEL	232 dB Peak	203 dB cSEL
	Exclusion and monitoring zones distances	951 feet	656 feet		230 feet	
	Piers E19 – E20 measured distances	267 feet	88 feet	187 feet	58 feet	64 feet

Notes:

For instances where measured distances exceeded implemented exclusion and monitoring zone distances, values are shown in **bold and underlined**.

dB = decibel

PTS = permanent threshold shift

TTS = temporary threshold shift

Source: Compiled by AECOM in 2018

Table 7-5. Summary of Marine Mammal Take for the September 8, 2018 Implosion of Piers E19 and E20

Species	Level B Harassment		Level A Harassment
	Temporary Threshold Shift	Behavioral	Permanent Threshold Shift
Pacific harbor seal	1	0	0

7.3 Monitoring Results for Pier Implosion Stranding Surveys

A pre-blast land survey was conducted by the Lead MMO on September 7, 2018. The Emeryville Crescent west of Interstate 580, the shoreline at the end of Radio Road, the shoreline north of the SFOBB toll plaza, and the shoreline under the OTD were surveyed (Figure 6-1). No injured or dead animals were observed.

The stranding surveys for the implosion of Piers E19 and E20 were conducted with TMMC immediately following the blast event on September 8, 2018, and then subsequently from September 9 through 11 by the Lead MMO only.

On September 8, 2018, the team observed 38 harbor seals in the water during the boat survey. Eight of the harbor seals were near OTD, the remaining 30 near YBI, and an additional four were at the YBI haul-out site. None of the observed harbor seals exhibited abnormal behavior. Harbor seal behavior included logging, diving, and socializing. No stranded marine mammals were discovered along any of the shorelines.

On September 9, the Lead MMO observed 33 harbor seals in the water. Three of the harbor seals were near OTD, one was in the water near the middle of the new SFOBB span, and the remaining 29 were near YBI. All harbor seals observed exhibited normal behavior, including logging, socializing, and diving. No animals were hauled out at the YBI site. At 9:55 a.m., one dead harbor seal was observed on the rocks at the northwestern corner of Treasure Island. The Lead MMO did not observe this seal on September 8; therefore, it is likely that the dead seal had washed up during the night of September 8. The Lead MMO observed that the animal was bloated, burnt red by the sun, and its skin was sloughing. The animal appeared to be moderately decomposed and was assumed to have been dead for several days. This harbor seal mortality is not attributed to the implosion event. Both NMFS regional office and headquarters were notified of the dead harbor seal in accordance with the conditions of the 2018 IHA.

On September 10, the Lead MMO observed 28 harbor seals in the water. Six of the harbor seals were near OTD, the remaining 22 near YBI. All harbor seals displayed normal behavior,

including diving and swimming. No animals were hauled out at the YBI site. Additionally, two harbor porpoises were observed in the tidal convergence on the northeastern corner of Treasure Island. No marine mammals were observed during the land survey.

On September 11, 39 harbor seals were observed in the water during the boat survey: two near the YBI haul-out site, 12 between the haul-out site and Coast Guard Cove, two on the western side of Treasure Island, one near the eelgrass beds north of the OTD, and 22 in Clipper Cove. Nineteen harbor seals were hauled out at the YBI site. All harbor seals exhibited normal behavior. No new marine mammals were observed during the land survey, but the dead harbor seal originally observed on September 9 was seen in the same location. TMMC did not receive any reports of other injured or dead marine mammals in the Bay during this time (TMMC, pers. comm., 2018).

Chapter 8. Conclusions

8.1 Conclusions for Pile-Driving Activities

MMOs were present for all pile driving associated with construction of the temporary access trestle and Public Access Pier extending from Pier E23 on the OTD shoreline to Pier E21 in the Bay. Over 21 days of monitoring, only two animals were observed to react to Project activities. No animals were found dead or injured, or were reported to be stranded due to pile driving. There were only two Level A takes during impact driving, six Level B takes during impact driving, and eight Level B takes during vibratory driving (Table 7-1). There was one 10-minute delay and no shut downs due to the presence of marine mammals. Measured hydroacoustic SPLs were lower than estimated values, indicating that the implemented exclusion and monitoring zone distances were conservative.

Monitoring methods defined in the Marine Mammal Monitoring Plan and discussed here were sufficient to ensure that marine mammals were fully protected during pile-driving activities associated with repurposing Piers E21 through E23.

8.2 Conclusions for Pier Implosion Activities

MMOs were present during the implosion of Piers E19 and E20 to carefully monitor marine mammal species before, during, and after the blast. Monitoring began 80 minutes before, and ended 60 minutes after the event. No animals were found dead, injured, or were reported to be stranded due to the implosion. The estimated threshold distances were slightly smaller than the measured hydroacoustic distances for harbor seals, but there were no differences between take numbers based on the measured versus estimated exclusion and monitoring zone distances. There was only one Level B TTS take of a harbor seal during the implosion. There was no Level A PTS take or Level B behavioral harassment take.

Monitoring methods defined in the Biological Monitoring Programs for the 2018 Marine Foundation Removal Project and discussed here were sufficient to ensure that marine mammals were fully protected during the implosion of the remaining original SFOBB marine foundations.

Chapter 9. References

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Appendix A. Summary of Marine Mammal Sightings During Pile Driving

Appendix A. Summary of Marine Mammal Sightings During Pile Driving

Date	Observing Start Time	Observing End Time	Sighting Summary	Take/Delay?	Summary of Construction	Pile Driving Detail	Weather and Tides
1-Jun	6:45	16:00	1 Pacific Harbor Seal	Level B for 2 min during vibratory pile driving	Vibed 2 piles, impacted 1	Vibed 2A and 2B, impacted 2A	BF 2 SW, waves <0.5', clear; becoming BF 4 W, waves 0.5'
2-Jun	7:20	9:52	none	N/A	Impacted 2 piles	Impacted 2A and 2B	BF 2 SW, waves <0.5', clear; becoming BF 4 W, waves 0.5'
3-Jun			No work (Sunday)				
4-Jun	6:20	12:55	1 Pacific Harbor Seal	Level B for 1 min (56 min max possibly), during vibratory on land	Vibed 2 piles, impacted 4	Vibed 1B and 1A; impacted 1A, 1B, 2A, 2B	BF 1-2 SW, no waves, clear/sunny, high 71 degrees. Low tide 10:44, 0.2'
5-Jun			No pile driving				
6-Jun	10:10	14:30	none	N/A	Vibed 1 pile	Vibed 2A-A	BF 2 SW, waves <0.5', clear; becoming BF 4 W, waves 0.5'. Low tide 12:25, 0.7'
7-Jun	6:50	17:00	1 Pacific Harbor Seal	No	Vibed 3 piles, impacted 1	Vibed 2A-B, 3B, 3A; impacted 3A	BF 3 W, 95% cloud cover, waves <1'; becoming BF 5+ W, waves 1-2'. Low tide 13:17, 0.9'
8-Jun	6:10	16:30	none	N/A	Vibed 4 piles	Vibed 3A, 2A-C, 3A-B, 3A-A	BF 2 SSE, no waves, clear; becoming BF 4, waves 1'. Low tide 14:08, 1.2'
9-Jun			weekend				
10-Jun			weekend				
11-Jun	6:15	11:30	1 California Sea Lion	10-min delay; Level B take of sea lion during impact for 3 min (SS and impact)	Impacted 8 piles	Impacted 3B, 3A, 2A-B, 3A-A, 3A-B, 3A-C, 2A-C, 2A-A	BF 1 SSE, no waves, clear; becoming BF 1 W, no waves. Low tide 04:53, -0.4'
12-Jun	6:15	8:30	none	N/A	Impacted 2 piles	Impacted 3A, 3B	BF 0-1, no waves, clear. Low tide 05:35, -1.0'

Appendix A. Summary of Marine Mammal Sightings During Pile Driving

Date	Observing Start Time	Observing End Time	Sighting Summary	Take/Delay?	Summary of Construction	Pile Driving Detail	Weather and Tides
13-Jun	6:10	11:45	1 Pacific Harbor Seal	No	Vibed 2 piles, impacted 2	Vibed 3A-A, 3A-A(east); impacted 3A-A(west), 3A-A(east)	BF 2 WSW, no waves, clear; becoming BF 1-2 W. Low tide 06:19, -1.4'
14-Jun			No pile driving				
15-Jun			No pile driving				
16-Jun			weekend				
17-Jun			weekend				
18-Jun	6:20	15:00	none	N/A	Vibed 5 piles	Vibed 4A-C, 4A-B, 4A-A, 4B, 4A	BF 2-3 W, waves ~0.5', 100% overcast; becoming BF 3 W. Low tide 10:29, -0.8'
19-Jun			No pile driving				
20-Jun			No pile driving				
21-Jun	8:55	17:15	1 Pacific Harbor Seal	No	Vibed 4 piles	Vibed 5A-A, 5A-B, 5A-C, 5A-D	Bf 2 SW, no waves, 100% overcast; becoming BF 3 W, waves <1'. Low tide 13:21, 0.8'
22-Jun	6:00	9:00	none	N/A	Impacted 2 piles	Impacted 5A-D, 5A-A	BF 2 SW, waves <0.5', clear. Low tide 14:17, 1.3'; high tide 08:47, 4.1'
23-Jun			weekend				
24-Jun			weekend				
25-Jun			No pile driving				
26-Jun	8:40	15:45	1 Pacific Harbor Seal	No	Vibed 4 piles	Vibed 6A-A, 6A-B, 6A-C, 6A-D	BF 0-1, no waves, clear, haze; becoming BF 4, waves 1-2'. Low tide 5:52, -0.5'; high tide 13:02, 4.5'; low tide 17:34, 2.7'
27-Jun	6:00	8:35	none	N/A	Impacted 2 piles	Impacted 6A-A, 6A-B	BF 3-4 SW, waves 1', 60% cloud/high fog. Low tide 06:28, -0.6'
28-Jun			No pile driving				
29-Jun			No pile driving				

Appendix A. Summary of Marine Mammal Sightings During Pile Driving

Date	Observing Start Time	Observing End Time	Sighting Summary	Take/Delay?	Summary of Construction	Pile Driving Detail	Weather and Tides
30-Jun			weekend				
1-Jul			weekend				
2-Jul	6:00	13:40	none	N/A	Vibed 3 fender piles	Vibed Fender 1, 2, 3	BF 2-3 W, 100% cloud/low fog/smoke from fires, waves <1'; becoming BF 4 W, waves 1', fog burning off. Low tide 09:24, 0.0'
3-Jul to 22-Jul			No pile driving				
23-Jul	6:00	14:30	4 Pacific Harbor Seals in 3 sightings	Level B take of 4 harbor seals during vibratory for 100, 100, 65, and 60 min.	Start of permanent piles. Vibed 3 piles, N4 row.	Vibed N4A, N4B, N4C	BF 2 W, waves <0.5', 100% overcast/low fog; becoming BF 4 W, waves <0.5'. High tide 11:14, 4.4'; low tide 15:43, 2.7'
24-Jul	6:00	16:40	3 Pacific Harbor Seals	Level B take of 2 harbor seals during vibratory for 56 and 28 min.	Impacted 3 piles in N4 row and vibed 3 piles in N3 row.	Impacted N4A, N4B, N4C; vibed N3A, N3B, N3C	BF 1 SW, waves <0.5', 100% overcast/high fog; becoming BF 4 W, waves <0.5'. High tide 12:04, 4.6'; low tide 1`6:33, 2.8'
25-Jul	6:05	9:15	1 Pacific Harbor Seal	No	Impacted 3 piles in N3 row. Done with trestle perm. piles.	Impacted N3A, N3B, N3C	BF 1 SW, waves <0.5', 100% overcast/high fog . Low tide 05:31, -0.2'; high tide 12:46, 4.7'
26-Jul			No pile driving		7/25-7/26: Impacted H-piles on land on YBI		

Appendix A. Summary of Marine Mammal Sightings During Pile Driving

Date	Observing Start Time	Observing End Time	Sighting Summary	Take/Delay?	Summary of Construction	Pile Driving Detail	Weather and Tides
27-Jul	9:40	16:30	3-4 Pacific Harbor Seals	Level A take of 1 harbor seal during 21 min of intermittent impact driving. Level B take of 3 harbor seals during impact for 30, 21, and 21 min (intermittent).	Start of permanent piles from Hagar barge. Impacted (impact-only) 2 piles in N2 row.	Impacted N2A, N2B	BF 2 SW, waves <0.5', 99% overcast/high fog; becoming BF 3 W, waves <0.5', clear. Low tide 06:42, -0.4', high tide 13:53, 4.8'
28-Jul			weekend				
29-Jul			weekend				
30-Jul	6:05	12:00	2 Pacific Harbor Seals, 1 California Sea Lion	No	Impacted 1.8 piles (one full one and almost all of the next before reaching sound limits).	Impacted N2C, N1A	BF 1 SW, no waves, 100% overcast/high fog; becoming BF 2 W, waves <0.5', 95% clear. Low tide 08:18, 0.0'; high tide 15:17, 4.9'
31-Jul	6:05	12:20	5 Pacific Harbor Seals	Level A take of 1 harbor seal during 30 min of intermittent impact driving. Level B take of 2 harbor seals during 30 min of intermittent impact driving.	Finished 1 pile from yesterday and impacted remaining 2 permanent piles in N1 row. Done with pile driving.	Impacted N1A, N1B, N1C	BF 2 SW, waves <0.5', 100% overcast/high fog; becoming BF 1 W, waves <0.5', thin high fog. Low tide 08:50, 0.2'; high tide 15:48, 5.0'

Appendix B. Summary of Marine Mammal Observations During Pile Driving

Appendix B. Summary of Marine Mammal Observations During Pile Driving

Date	Sighting #	Species	# of Animals	Take/Delay?	Time Observed	Location and Behavior
1-Jun	1	Pacific Harbor Seal	1	Yes. Level B for 2 min during vibing	1058 - 1104	Animal first seen at 1058 traveling south calmly ~300 m from pile driving, ~250 m from mole, ~150 m south of new bridge. Dove at 1100 approximately 700 m SW of pile driving. Popped up at 1103 over 1500 m away and was lost sight of at 1104. No reaction to pile driving was
4-Jun	1	Pacific Harbor Seal	1	Yes. Level B for 1 min (56 min max possibly) during vibing on land	0804 for 30 seconds	Animal seen traveling west at the surface ~100 m from mole and from pile driving. Only seen for ~30 seconds and then it dove. No reaction to pile driving was observed.
11-Jun	1	California Sea Lion	1	10-min delay, then probable 3-min Level B take during impact soft start (2 min) and impact (1 min)	0945 - 1000	Large male first seen about 200 m from pile driving, WNW of the work area, under the new bridge. Did soft start for impact from 0953 to 0955 while the animal was about 300 m away. Soft start was necessary because more than 30 min had elapsed since the last impacting. KM would have been able to start with no SS if there hadn't been a delay for the sea lion. After the soft start, animal swam toward the work area with its head out of the water, barking continuously, looking at work area. It did a high out-of-the-water dive and circled about 150 m from the work area, and then left the area by 1000. From 1002 to 1003 KM impacted the pile with 54 blows. The animal was not seen again. The 10-min delay is a rough estimate of the additional time due to the SS, plus the delay to full-power impacting while we waited for the animal to leave the area.
23-Jul	1	Pacific Harbor Seal	2	Yes. Two Level B takes during vibratory on 2 piles, for a total of 100 min (intermittently) each	0848 - 1121	Two seals about 400 m ENE of me (on the trestle) and the pile driving, in the shallow eelgrass beds NE of the new bridge. Saw them there intermittently during entire sighting time. Probable feeding, as there were diving pelicans in the area too.

Appendix B. Summary of Marine Mammal Observations During Pile Driving

Date	Sighting #	Species	# of Animals	Take/Delay?	Time Observed	Location and Behavior
23-Jul	2	Pacific Harbor Seal	1	Yes. Level B during vibratory for 65 min (int.).	1020 - 1110	First seen traveling ENE pretty quickly (for a harbor seal), about 100 m north of me (on the trestle) and the pile driving, north of the new bridge. It surfaced actively twice, heading toward the same eelgrass beds as the others, and did a high dive out of the water before I lost sight of it for a while. Vibing started at 1018, so the increased (relative to seals) activity could have been in response to the noise. Resighted it at 1026 in the eelgrass beds about 400 m away with its head out of the water. At 1110, it resurfaced ~100 m NNE of my location and of pile driving, near its original location, traveling slowly SW. Vibing was ongoing at this point and it did not seem disturbed. It was not seen after 1110, but it was assumed it was still within 2000 m of the work, and therefore exposed to the full length of vibing on that particular pile (65 min).
23-Jul	3	Pacific Harbor Seal	1	Yes. Level B during vibratory for 60 min (int.).	1243 - 1430	First seen ~100 m north of me and pile driving, just north of new bridge. Seen repeatedly in that same place until the end of the observing day. Possibly one of the same animals as earlier in the day, but unsure, so calling it a new sighting.
24-Jul	1	Pacific Harbor Seal	1	No	0916 - 0916	Mark Oates saw it transiting 30 m south of the second wood pilings off the mole, ~150 m south of him and the work (no pile driving at the time). It surfaced for 20 seconds, dove, and was not seen again.
24-Jul	2	Pacific Harbor Seal	1	Yes. Level B during vibratory for 56 min (int.).	1144 - 1155	First seen ~300 m NE of me and the work in the eelgrass beds north of the bridge. It repeatedly surfaced actively, with high jumps/dives out of the water. Probable feeding. I saw no reaction to the start of vibro at 1149. Although I did not see the animal after 1155, I assumed it was still within 2000 m, and therefore exposed to the full bout of vibratory (= 56 min).
24-Jul	3	Pacific Harbor Seal	1	Yes. Level B during vibratory for 28 min (int.).	1508 - 1630	Active surfacing ~400 m NE of me and pile driving, in the eelgrass beds north of the bridge. Probably same animal as Sighting 2, but don't know for sure, so am calling it a new one. It stayed within 100 m of its original location for the entire time I could see it (until the end of the observing

Appendix B. Summary of Marine Mammal Observations During Pile Driving

Date	Sighting #	Species	# of Animals	Take/Delay?	Time Observed	Location and Behavior
27-Jul	1	Pacific Harbor Seal	3-4	Yes. Level A during impact for 21 min. Level B during impact for 30, 21, and 21 min (int).	1056 - 1630	Between 1 and 3 seals present in the eelgrass beds through the sighting times noted. Details: 1056: 1 seal ~150 m N of barge/me. Calm/still at surface; only saw for ~3 sec. 1059: 1 seal ~250 m NE of barge/me in eelgrass beds N of bridge. Still at surface again. Resighted a single animal periodically through 1330. This animal was exposed to Level B impact sound, with no observed reaction. At 1405, saw 2 animals in eelgrass beds periodically until 1457, when I saw 3 animals in the eelgrass beds: 2 ~300 m NE of barge/me, and 1 ~150 m NE of barge/me. I saw 1-2 seals periodically until 1548. At 1548, one seal transited west ~150 m NNW of the barge/me during impact driving. This was the Level A take. It probably was not in the Level A zone for the entire driving period of 21 min, but I'm saying 21 min to be conservative. The other 2 animals were exposed to Level B sound during this driving bout. It is very possible the animal exposed this morning was the same as one still there in the afternoon (and therefore was exposed a second time), but since I couldn't tell, I'm
30-Jul	1	Pacific Harbor Seal	1	No	0653 - 0715	At 0653, saw a single animal ~150 m WNW of me/the pile, near a new bridge pier. At 0655 it was ~150 m NE of me, traveling NE toward the eelgrass beds, where it was seen at 0658. At 0715 it was again ~150 m N of me, traveling W, and was not seen again.
30-Jul	2	Pacific Harbor Seal	1	No	0954 - 0959	First seen at 0954 traveling ENE ~175 m NE of me/the pile toward eelgrass beds. At 0955 it was still traveling E. AT 0959 it was again ~175 m NE of me, but now traveling W. It left the area and was not seen again.
30-Jul	3	California Sea Lion	1	No	1003 - 1028	This adult male was first seen at 1003 ~100 m NNW of me/the pile, feeding under the new bridge. He was whipping the caught fish around out of the water to break its bones for easier feeding. He fed in the same general area for about 10 min, with 4 gulls diving near him picking up the scraps. At 1018, Mark Oates saw him dive near the EBMUD shed on the mole, then mill closer to the Hagar barge. He moved north and was last seen traveling W 129 m from the pile, diving right next to I&R's anchored skiff (hence the precise distance measurement).

Appendix B. Summary of Marine Mammal Observations During Pile Driving

Date	Sighting #	Species	# of Animals	Take/Delay?	Time Observed	Location and Behavior
30-Jul	4	Pacific Harbor Seal	1	No	1023	Mark Oates saw it dive ~30 m E of the barge. It was not seen again. Pile driving didn't start until 1105 - well after the 15-min wait period.
31-Jul	1	Pacific Harbor Seal	2	Yes. Level B during 30 min of intermittent impact driving.	0950 - 1019	Christina Kelleher (bird monitor) saw 2 seals ~300 m SE of the work and observers traveling NW toward Hagar barge. At 0955 Mark Oates saw one animal ~250 m S of him/the piles, traveling W. At 0956 it was due south of the barge, still traveling W. At 1017 it was ~200 m SW of the piles. At 1019 it was last seen ~250 m SE of the piles, still traveling east. Pile driving didn't begin until 1107, but conservatively considering this a Level B take.
31-Jul	2	Pacific Harbor Seal	1	Yes. Level A during 30 min of intermittent impact driving.	0958 - 1127	I first saw this animal ~200 m NNE of me/the piles, traveling E in the eelgrass beds. It remained ~130-250 m N to NNE of the work throughout the sighting period.
31-Jul	3	Pacific Harbor Seal	1	Yes. Level B during 30 min of intermittent impact driving.	1110 - 1125	First seen ~300 m NNE of pile driving/me, in eelgrass beds. In same place at end of sighting.

Appendix C. Marine Mammal Monitoring Observations During Implosion of Piers E19 and E20

Appendix C. Marine Mammal Monitoring Observations During Implosion of Piers E19 and E20

Table A-1. Summary of Marine Mammal Sightings during Monitoring for the September 8, 2018 Blasts of Piers E19 and E20					
Times	(No.) Species¹, Age Class	Distance/Direction from Pier E19/E20²	Surface or Travel Direction	Time Pre- (last sighting) or Post- (first sighting) Implosion	Notes
09:57 Observations Began					
10:12 – 12:20	(2) HASE, adult	4,003ft northeast of E20	surface	68 minutes pre- to 60 minutes post-blast	Heads observed above water bobbing in place, outside of exclusion zone. Continued to surface until the end of monitoring period.
10:14 - 10:34	(1) HASE, adult	350ft south of E20	north	46 minutes pre-blast	Observed again at 10:34, about 650 ft southeast of pier upstream.
10:22 - 12:01	(1) HASE, unk	3,465ft west of E19	south	58 minutes pre- to 41 minutes post-blast	Floated south and dove, up at 10:38, 10:53, 11:06, and 12:01 in the same area.
10:28 - 10:28	(1) HASE, unk	2,723ft northwest of E19	south	52 minutes pre-blast	Briefly saw head before it dove.
10:32 - 11:42	(1) HASE, adult	2,723ft northeast of E20	east	48 minutes pre- to 22 minutes post-blast	Bobbing in place, head above water, then moved east. Continued to surface and dive until 11:42.
10:35 - 12:12	(1) HASE, unk	3970ft west of E19	south	45 minutes pre- to 52 minutes post-blast	Foraging, travelling east.
10:36 - 11:08	(1) HASE, unk	2,720ft west of E19	east	12 minutes pre-blast	Floated east, dove, surfaced at 11:08 moving northeast; moved to 700 ft east of MM4
10:48 - 10:48	(1) HASE, adult	4,003ft northwest of E19	surface	32 minutes pre-blast	Head bobbing at surface for a few seconds, did not see direction of travel.
11:02 - 11:07	(1) HASE, adult	4,200ft northwest of E19	south	13 minutes pre-blast	Head bobbing at surface for a few seconds facing south. Saw again further south.
11:10 - 11:20	(1) HASE, unk	450ft west of E19	east	0 minutes to blast	Swimming at 11:10, dove at 11:12 between 951 and 656 ft, moved west to 951 ft, dove at 11:16, surfaced at 450 ft right after blast.
11:10 - 11:30	(1) HASE, adult	4,0003ft northwest of E19	surface	10 minutes pre- to 10 minutes post-blast	Repeatedly sticking head out of water, following survey boat and watching surveyors
11:20 Piers E19/E20 Blast					
11:31 - 11:52	(1) HASE, adult	4,075ft northwest of E19	surface	11 minutes post-blast	Poked head out of water to watch surveyors, moved as close as 20 ft from boat.
11:37 - 11:37	(1) HASE, adult	3,950ft northwest of E19	north	17 minutes post-blast	Watched survey boat, then swam north.
11:43 - 11:44	(1) HASE, adult	910ft west of E19	west	23 minutes post-blast	Surfaced for less than 30 seconds and dove swimming west.

Appendix C. Marine Mammal Monitoring Observations During Implosion of Piers E19 and E20

Table A-1. Summary of Marine Mammal Sightings during Monitoring for the September 8, 2018 Blasts of Piers E19 and E20					
Times	(No.) Species¹, Age Class	Distance/Direction from Pier E19/E20²	Surface or Travel Direction	Time Pre- (last sighting) or Post- (first sighting) Implosion	Notes
11:53 - 11:59	(1) HASE, adult	5,900ft west, southwest of E19	west	33 minutes post-blast	Not in exclusion zone. Swimming, bobbing.
11:59 - 11:59	(1) HASE, unk	2,730ft west of E19	south	39 minutes post-blast	Floating and swimming south, flipped and dove (exhibiting normal behavior post-blast).
12:05 - 12:20	(2) HASE, unk	4,015ft west of E19	west	45 minutes post-blast	Swimming west and dove, surfaced at 12:12 moving east, surfaced at 12:18 moving west again.
12:10 - 12:26	(1) HASE, adult	3,750ft southwest of E19	north, northwest	50 minutes post-blast	Not in exclusion zone. Foraging, circling. Seen again at 12:25 foraging in same area.
12:15 - 12:25	(1) HASE, adult	3,800ft southwest of E19	east	55 minutes post-blast	Swimming due past, bottling on occasion. Reappeared at 12:24, bobbing in same area.
12:19 - 12:19	(2) HASE, unk	4,060ft west, southwest of E19	surface	59 minutes post-blast	Floating.
Summary of Take					
Total Marine Mammals Observed in the Level A PTS MMEZ: 0					
Total Marine Mammals Observed within Level B TTS Monitoring Zone: 1 HASE					
Total Marine Mammals Observed within Level B Behavioral Response Monitoring Zone: 0 HASE					
Notes					
¹ Species Codes: Pacific Harbor Seal = HASE, Age Class: unk = unknown age					
² Distances estimated using monitoring zone distances and Google Earth measuring tool, based on observation notes					
Highlighted cells indicate marine mammals that were within a monitoring zone within 15 minutes before the time of the implosion. Take numbers were considered for each blast according to measured hydro acoustic data.					