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

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List of Abbreviated Terms

Applicant	Pacific Shops, Inc.
BMPs	Best Management Practices
CAS	California Academy of Sciences
d	day
dB	decibel
ESA	Federal Endangered Species Act
ft	feet
h	hour
HF cetacean	high-frequency cetacean
Hz	hertz
I&R	Illingworth and Rodkin, Inc.
IHA	Incidental Harassment Authorization
in	inch
kHz	kilohertz
km	kilometer
LF	linear feet
LF cetacean	low-frequency cetacean
m	meter
Master Plan	Alameda Marina Master Plan
MF cetacean	mid-frequency cetacean
mi	mile
min	minute
MMEZ	marine mammal exclusion zone
MMO	marine mammal observer
MMPA	Marine Mammal Protection Act
NAVD 88	North American Vertical Datum of 1988
NMFS	National Marine Fisheries Service
NPS	National Park Service
Peak	peak pressure
Project	Alameda Marina Shoreline Improvement Project
PTS	permanent threshold shift
re 1 Pa	reference 1 micro-Pascal

RMS	root mean square
sec	second
SEL	sound exposure level
SELcum	cumulative sound exposure level
SF	San Francisco
SPL	sound pressure level
sq ft	square feet
TMMC	The Marine Mammal Center
TTS	temporary threshold shift
YBI	Yerba Buena Island
ZOI	zone of influence

1. DESCRIPTION OF SPECIFIED ACTIVITY

Pacific Shops, Inc. (Applicant) is proposing the 20.9-acre Alameda Marina Shoreline Improvement Project (Project) located on the Oakland Estuary (Estuary) in the City and County of Alameda, California (Figure 1). The proposed Project will address climate resiliency and rehabilitate existing shoreline and marina facilities so that the shoreline meets current seismic resistance criteria and addresses sea level rise from projected sea levels by 2100 for a medium-high risk aversion. The Project will update the existing marina facilities, reconfigure some of the existing marina piers, and provide the public with more aquatic recreational opportunities. The Applicant is requesting regulatory authorization for the incidental harassment of marine mammals resulting from activities associated with marina and seawall maintenance and refurbishment. These activities include pile driving and sheet pile driving to support construction activities as described in Section 1.2.

1.1 Project Background

The 44-acre Alameda Marina Master Plan (Master Plan) area consists of 27 acres of land owned by the Applicant and 17 acres of public tidelands owned by the City of Alameda and leased by the Applicant. The Master Plan area has a long maritime history and was first developed in 1914 as a shipyard which was later expanded, most significantly in the 1940s when it was used as a World War II shipyard. A remnant graving dock remains at the site from this period, as do roughly 30 land-side buildings that were constructed for the shipyard expansion. Since the 1950s, much of the wartime shipbuilding infrastructure has been removed and replaced with storage and boat-based recreation infrastructure. Currently the Master Plan area includes a marina, boat and recreational vehicle dry storage and maintenance services, and industrial/professional service-oriented small businesses. In this application we address only the shoreline portion of the Master Plan area, identified as the Alameda Marina Shoreline Improvement Project (Project, as identified above).

The proposed Project area comprises the northern portion of the larger 44-acre Master Plan area and includes an existing boat marina that covers approximately 17 acres with more than a dozen floating piers, approximately 530 boat slips, and headwalks, gangways, and wharves (Figure 1). The wharves support various types of marina infrastructure, including boat elevators and buildings. The 4,009 linear feet (LF) of shoreline are protected by approximately 835 LF of riprap and 3,174 LF of seawalls and include a remnant graving dock. Key features of the existing marina are labeled in Figure 2.

In July 2018, the City of Alameda approved the Master Plan and certified a Final Environmental Impact Report. The Master Plan includes the rehabilitation of 4,009 LF of shoreline embankments and seawalls to address three and one-half feet of anticipated sea level rise projected over the next 50–80 years, and other shoreline repairs and improvements.

Figure 1. Location of Alameda Marina Shoreline Improvement Project within the Alameda Marina Master Plan area on the Oakland Estuary in Alameda, California.

Portions of the existing shoreline infrastructure have exceeded their usable life and require significant maintenance (e.g., Figure A1, Figure A2, and Figure A3 in Appendix A). Over the past 75 years, infrastructure on the shoreline has been modified, retrofitted, and repaired using a variety of methods including riprap (e.g., Figure A4 in Appendix A), steel sheet piles with walers and tie-rods, concrete walls, walls composed of stacked square piles and lagging, and bare earth. A number of pile-supported structures along the shoreline, including wharves and pier studs, support various types of facilities and are also in need of refurbishment or removal. These structures are supported by timber piles, timber piles encased in concrete-filled fabric jackets, and concrete piles (e.g., Figure A5 in Appendix A). A portion of the wooden piles are experiencing dry-rot, warping, decay, and deterioration that cannot be repaired (e.g., Figure A6, Figure A7 in Appendix A). The structural integrity of various pile-supported structures has been compromised due to this deterioration, and one existing wharf deck along the shoreline is unstable and too dangerous for public access.

The Project also includes marina reconfiguration and installation of a new boat hoist; upgrading the marina; reconfiguring Pier 1 and the East Pier (Figure 2) to accommodate larger vessels; upgrading the existing docks, gangways, and pilings; upgrading and installing a new stormwater outfall; and constructing new headwalks to facilitate efficient access and operations on the docks. Reconfiguring the marina to reduce the number of land access points will also provide improved security and facilitate public access to the shoreline.

The Master Plan area is currently not generally accessible to the public. Reuse of the larger Master Plan area will include new open space areas within and along the shoreline edge with a San Francisco Bay Trail component and a waterlife park in the graving dock, reconnecting the community to the shoreline. The shoreline will have the capacity to accommodate future adaptive measures to provide additional protection from further extreme sea level rise.

As described in detail in Section 1.2, the Project includes the following activities:

- riprap removal and placement,
- seawall maintenance,
- wharf refurbishment,
- outfall installation,
- marina reconfiguration, including installation of a floating dock in the remnant graving dock (no piles to be driven) and removal of two large pier covers (roof structures),
- boat hoist construction, and
- pile installation and removal.

Riprap removal/placement and the addition of the floating dock in the graving dock will not result in take or harassment of marine mammals and is not discussed further in relation to mitigation.

1.2 Construction Activities with the Potential to Result in Incidental Take of Marine Mammals

Construction activities fall into two general categories: pile removal and pile installation. Piles will be removed and installed in connection with seawall maintenance, wharf refurbishment, marina refurbishment, and boat hoist construction. Permanent sheet piles will be placed to rebuild the seawalls, and temporary sheet piles will be needed to construct a cofferdam as part of outfall installation.

A map of existing features on the Project site that are proposed for removal or reconfiguration is provided in Figure 2. A map of modified/new Project features is provided in Figure 3.

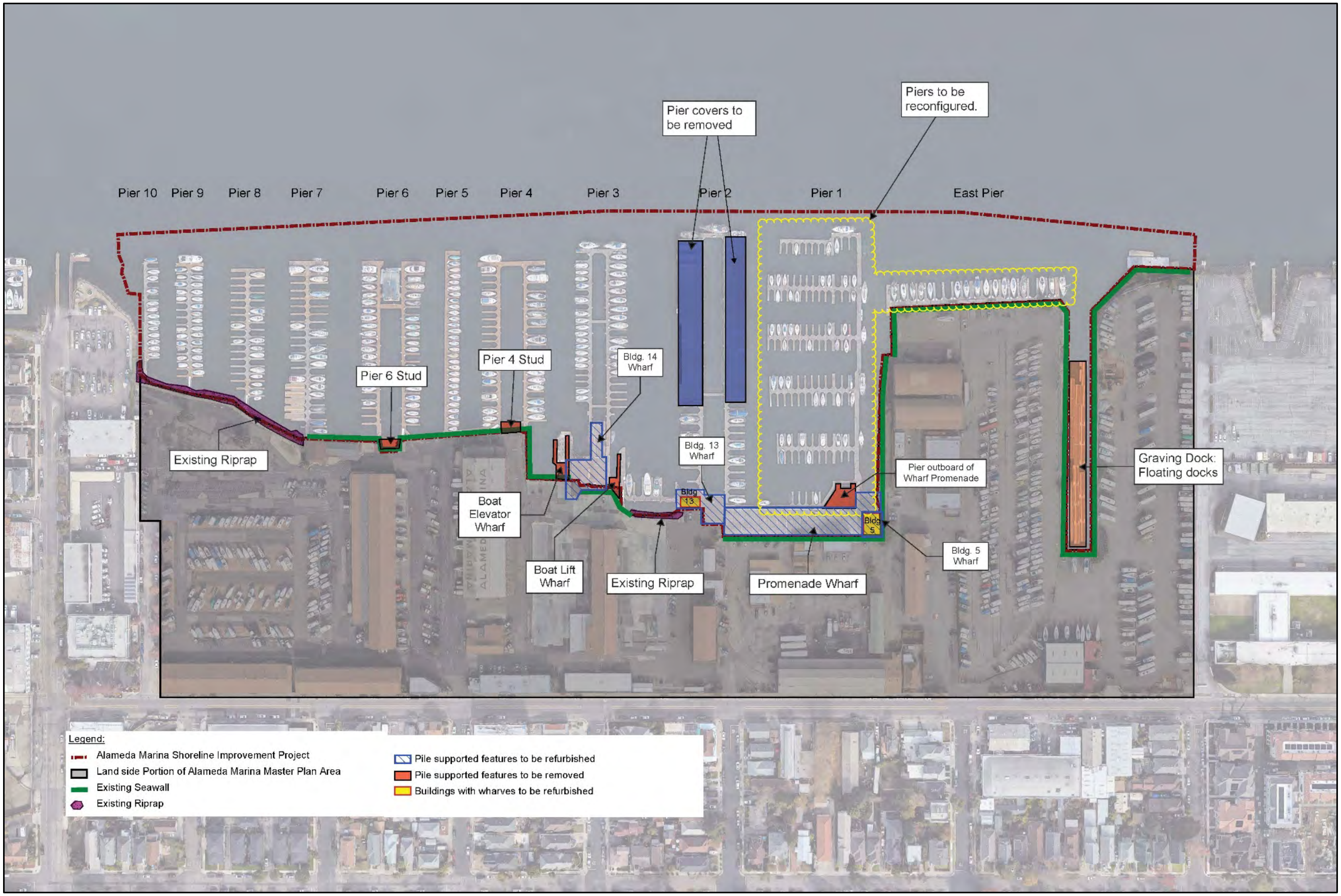

Figure 2. Existing features within the Alameda Marina Master Plan area.

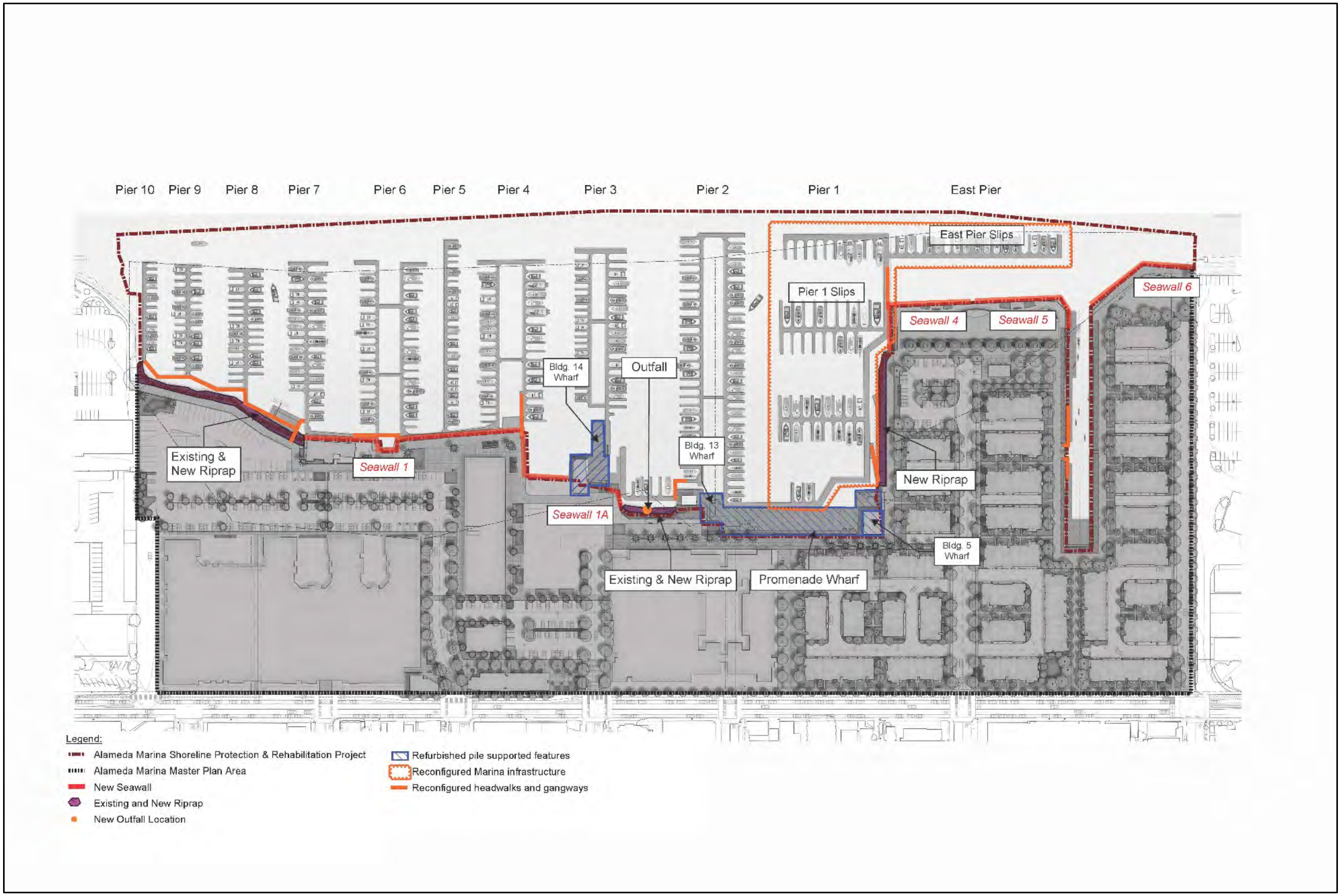

Figure 3. Proposed Project features for the Alameda Marina Shoreline Improvement Project within the Alameda Marina Master Plan area.

1.2.1 Pile Removal

The Applicant is proposing to remove several degraded wharves, piers, and pier studs (the shoreline portion of a previously removed pier), collectively referred to here as "pile-supported structures." Generally, the pile-supported structures are comprised of piles supporting a wooden platform of timber joists/girders that are covered with timber deck boards. Piles associated with Seawall 1 are also proposed for removal. All piles will be removed in Year 1. Structures proposed for removal, and the type and number of piles to be removed are presented below (Table 1; see Section 2.1 for full construction schedule). Pile-supported structure location is shown in Figure 2. Some of these pile-supported structures will also require installation of new piles, discussed in Section 1.2.2.1.

Table 1. Summary of piles to be removed in Year 1.

Structure	Type of Pile	Number of Piles
Seawall 1	16-in timber	150
Pier 6 Stud	16-in timber	20
Pier 4 Stud	16-in timber	16
Boat Elevator Wharf	16-in timber	7
	12-in square concrete	12
Boat Lift Wharf	16-in timber	25
	12-in square concrete	7
Pier Outboard of Promenade Wharf	16-in timber	60
Building 13 Wharf	16-in timber	3
Building 14 Wharf	16-in timber	20
Total		**320**

Most of the piles that will be removed are 16-inch (in) creosote-treated timber piles, plus a small number of 12-in square concrete piles. All 320 piles will be either vibrated out or cut off at mudline and removed. The Applicant will decide in-situ whether to vibrate-out or cut off the piles depending on the condition of the pile. The Applicant may first attempt to vibrate the pile out, but if it is so deteriorated that it cannot be removed, the pile will be cut it off at the mudline. The removed piles will be disposed of at an appropriate upland location.

1.2.1.1 Pile-supported Structure Removal

Pile-supported structures shown on Figure 2 proposed for removal include:

- Boat elevator wharf (3,000 sq ft),
- Boat lift wharf (1,000 sq ft),
- Pier 6 stud (1,500 sq ft),
- Pier 4 stud (1,000 sq ft), and
- a 2,288-sq ft pier outboard of the Promenade wharf.

The boat elevator wharf shown on Figure 2 is located directly west of Building 14 and is supported by (12) 12-in concrete piles and (27) 16-in timber piles. The boat lift wharf is located on the east side of the Building 14 wharf and is supported by (7) 12-in concrete piles and (25) 16-in timber piles. The Pier 6 stud is located at the base of Pier 6 and is supported by (20) 16-in timber piles. The Pier 4 stud is located at the base of Pier 4 and is supported by (16) 16-in timber piles. The pier outboard of the Promenade wharf proposed for removal is at the northeast corner of the main wharf; this portion of the wharf is supported by (60) 16-in timber piles.

The removal methods for these pile-supported structures will all be similar, and involve removal of the deck boards, followed by the timber joists/girders and shoring beams, and finally the support piles. Deck boards will be removed by hand working from the northern end of the structure back towards the shore. Once the deck is removed, the underlying timber joists/girders will be dismantled from the estuary-side toward the landside. Information regarding pile removal is provided in Section 1.2.1.

1.2.1.2 Seawall Pile Removal

Seawall 1 will require removal of 150 16-in timber piles. All piles will either be vibrated out or cut off at mudline and removed.

1.2.2 Pile Installation

All piles to be installed are permanent with the exception of the temporary cofferdam for outfall construction. The quantity and type of piles to be installed at each marina feature, as well as the installation method, is separated into Year 1 (Table 2) and Year 2 (Table 3) below (see Section 2.1 for full construction schedule). These areas, generally, are: wharf refurbishment, seawall maintenance, outfall installation, marina infrastructure removal/reconfiguration, and boat hoist construction. Piles to be installed include: 36-in and 30-in steel pipe piles; 14-, 16-, and 24-in square concrete piles; wide flange beams; and steel sheet piles. Locations of the structures requiring pile installation are shown in Figure 3 and discussed in further detail in following sections.

Sheet piles will be installed with a crane- or excavator-mounted vibratory hammer to a design depth. Sheet pile installation will be conducted from both land and water. Approximately 20 sheet piles may be installed per day, each of which will take approximately 10 minutes (min) to install. Vibratory hammering will be conducted year-round.

All steel pipe piles will be initially installed with a vibratory hammer through the top soft soils (see Section 2.2 for information on the local substrate) until the vibration cannot advance the pile further into the substrate. In some cases, the entire steel pile may be installed by vibratory means if final depths can be achieved. A crane- or excavator-mounted impact hammer will be used to complete pipe pile installation and drive to final depths. All impact driving of steel piles will be attenuated. Pipe pile installation will be conducted from both land and water.

All concrete piles will be vibrated in as far as possible and then an impact hammer will be used to drive to final depth as needed. A wood block cushion may be used for attenuation. Concrete pile installation will be conducted from both land and water.

A number of measures will be taken to attenuate the underwater sound generated from installation of steel and/or concrete piles with impact driving hammers. A bubble curtain attenuator or other marine pile driving energy attenuator (such as an isolation casing) will be used during impact pile driving. If a bubble curtain is used, the following operating standards will be met:

- The bubble curtain will distribute air bubbles around 100 percent of the piling perimeter for the full depth of the water column.
- The lowest bubble ring will be in contact with the mudline for the full circumference of the ring, and the weights attached to the bottom ring shall ensure 100 percent mudline contact. No parts of the ring or other objects will prevent full mudline contact.
- Air flow to the bubblers will be balanced around the circumference of the pile.

A wood block cushion may also be used during impact pile driving of concrete piles to reduce hydroacoustic disturbance. The anticipated pile installation rate is three to five piles per day.

A soft start will be implemented before operating impact pile driving hammers at full capacity. Pile installation with both impact and vibratory pile driving hammers will occur behind a turbidity curtain to minimize impacts to water quality. Detailed measures to minimize impacts for both vibratory and impact pile driving are provided in Section 11.

Table 2. Summary of piles to be installed in Year 1.

Structure	Type of Pile[1]	Number of Piles	Installation Method[2]
Seawall 4	Steel sheet pile (e.g., PZ35)	149	Vibratory hammer
Seawall 6	Steel sheet pile (e.g., PZ35)	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 (e.g., PZ27)	214[3]	Vibratory hammer

[1] The specific type or model of steel sheet piles are identified as examples only. The contractor will choose which sheet piles to install at the time of construction.
[2] Pile installation will be subject to the Minimization of Impacts from Pile Driving described in Section 11.1, which include the use of a bubble curtain attenuator or other marine pile driving energy attenuator during impact driving of all permanent piles.
[3] Installation and removal of 107 temporary sheet piles.

Table 3. Summary of piles to be installed in Year 2.

Structure	Type of Pile[1]	Number of Piles	Installation Method[2]
Seawall 1	Steel sheet pile (e.g., PZC13)	233	Vibratory hammer
	Wide flange beam (e.g., W40X199)	117	Vibratory hammer majority of pile; attenuated impact hammer to tip elevation
Seawall 1A	Steel sheet pile (e.g., PZC13)	26	Vibratory hammer
	Wide flange beam (e.g., W40X199)	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

[1] The specific type or model of wide flange beams and steel sheet piles are identified as examples only. The contractor will choose which wide flange beams and sheet piles to install at the time of construction.
[2] Pile installation will be subject to the Minimization of Impacts from Pile Driving described in Section 11.1, which include the use of a bubble curtain attenuator or other marine pile driving energy attenuator during impact driving of all permanent piles.

1.2.2.1 Wharf Refurbishment

The Project needs to refurbish several wharves that will be retained to ensure structural stability and public safety. A portion of the supporting piles, timber joists/girders and shoring beams, and timber deck boards of these wharves are deteriorating. The wharves proposed for refurbishment, shown in Figure 2, include:

- the Promenade wharf (14,500 square feet [sq ft]),
- the Building 5 wharf (5,040 sq ft),
- the Building 13 wharf (5,100 sq ft), and
- the Building 14 wharf (7,100 sq ft).

The Promenade wharf is located south of Pier 1 and is supported by 200 timber and concrete piles. The Building 5 wharf, located directly east of the promenade wharf, is supported by 53 timber and concrete piles. The Building 13 wharf is supported by 55 timber and concrete piles and is located at the base of Pier 2. The Building 14 wharf is supported by 144 timber piles and is located at the base of Pier 3.

These wharves will be refurbished by replacing or reinforcing a portion of the degraded support piles, as well as miscellaneous support framing, bracing, and connectors (i.e., joists/girders, blocking, and hardware). All of the Promenade wharf deck boards will be replaced, as well as the Building 5 wharf deck and Building 13 wharf deck. The type and number of piles that will be installed for each wharf are listed in Table 3 and Table 4.

In general, the wharf refurbishment will be performed in stages. The wharf deck boards will be removed first. New prestressed concrete piles will be installed adjacent to existing severely deteriorated piles.

Concrete piles will be installed with an impact hammer; concrete blocks may be used for attenuation. Timber piles with moderate deterioration will be jacketed. Pile jacketing involves encasing existing piles in a circular plastic case and filling the space between the pile and plastic case with cement grout. Subsequently, deteriorated beams will be replaced with new beams of the same size and new piles will be added to the wharves for lateral restraint (steel pipe piles and wide flange beams). Structural connections between the new piles and the deck beam frame will be constructed. Finally, the wharf deck boards will be placed over the frame.

The only in-water work anticipated in connection with the wharf refurbishment will be pile driving and pile jacketing; the remaining work activities will be conducted above-water. No marine mammal mitigation is proposed for over-water work. Some limited falsework likely will be required for access, which will span between the existing beams and piles. Falsework will likely consist of hanging a temporary scaffold system under the existing wharf to prevent debris generated during the refurbishment of the wharf from falling into the water.

Pile jacketing will not result in take or harassment of marine mammals and is not discussed further. In-water pile driving to refurbish wharves, piers, and pier studs may result in the incidental harassment of marine mammals.

1.2.2.2 Seawall Maintenance

To maintain approximately 1,260 ft of existing seawalls within the Project area that are in varying states of disrepair (see Appendix A), the Applicant is proposing repairs that will strengthen the walls and address projected sea level rise. The proposed repairs will raise the elevation of the seawalls to 13.5 North American Vertical Datum of 1988 (NAVD 88). The seawall repairs are anticipated to be completed prior to the removal of some existing seawall materials. The seawall maintenance shown in Figure 3 has been broken up into four segments:

- Seawall 1 spans Pier 7 to Pier 3 (700 LF),
- Seawall 1A is directly east of Pier 3 (80 LF),
- Seawall 4 is south of East Pier (280 LF), and
- Seawall 6 is east of the graving dock (200 LF).

Seawall 1 and Seawall 1A will consist of new steel sheet piles or combi-wall with a reinforced concrete cap at its top (Table 4). Seawall 4 and Seawall 6 will consist of new steel sheet piles with reinforced concrete caps and tie-rods (Table 3). A brief description of the existing condition of each seawall and further information about the proposed repairs is provided below.

The new sheet piles (steel sheet piles) or combi-wall (combination of steel wide flange beams and steel sheet piles) at Seawalls 1 and 1A will be driven to the design tip elevation seaward of the existing timber seawall. Wide flange beams and sheet piles will typically tip in a dense sand layer approximately 25 to 35 ft below mudline. Sheet piles will be installed using a vibratory hammer. If wide flange beams are used, they will be initially installed with a vibratory hammer; an impact hammer will be used to complete beam installation and drive to final depths. The reinforced concrete cap will be cast in place along the top of the piles of the new seawall. Seawall 1 will be built of 233 steel sheet piles (e.g., PZC13) combined with 117

wide flange beams (e.g., W40X199), or entirely with steel sheet piles (e.g., PZC13). Seawall 1A will be built of 26 steel sheet piles (e.g., PZC13) combined with 13 wide flange beams (e.g., W40X199), or entirely with steel sheet piles (e.g., PZC13; Table 4).

To repair Seawalls 4 and 6, new wall segments consisting of steel sheet piles with a concrete cap beam will be constructed on the outside face of the existing seawall. The steel sheet piles and concrete cap will be installed in a manner similar to that described for Seawalls 1 and 1A. Following the installation of the steel sheet pile wall, soil behind the wall will be excavated to the depth of the existing tie-rod for inspection of the steel and concrete deadman anchor components. Deteriorated components of the deadman anchor and the associated connection components will be replaced as needed. The existing deadman anchor will be tied to the new concrete cap beam above the sheet pile wall using a steel tie-rod. Excavation and replacement of deadmen anchor components as needed will occur completely out of water. Seawall 4 will require 149 steel sheet piles (e.g., PZ35) and Seawall 6 will require 106 steel sheet piles (e.g., PZ35; Table 3).

In-water pile driving for seawall maintenance may result in the incidental harassment of marine mammals.

1.2.2.3 Outfall Installation

The Master Plan stormwater management system will include outfall repair and installation with new inlets and pipelines of appropriate size to convey runoff and run-on. This stormwater management system will continue to discharge directly to the Estuary through six outfalls located either in revetments or seawalls that range in size from 18-in to 36-in-diameter pipelines. The Project includes the installation of one new outfall in the Estuary.[1] The Project outfall is shown in Figure 3 and is located in the shoreline between Pier 3 and Pier 2.

The outfall is located along revetment and will be a cast-in-place concrete structure consisting of a headwall, wingwalls, and riprap. The outfall will include a tide valve to prevent backwater into the storm drain system. The Master Plan area storm drain system includes stormwater management facilities to provide water quality treatment and trash capture in accordance with state and local Best Management Practices (BMPs) for post-construction controls.

The construction methods for this outfall involve installation of a cofferdam around the outfall location, excavation of riprap and soil for the new headwall, installation of the new headwall and wingwalls, removal of the cofferdam, stabilization of the shoreline with riprap, and installation of additional riprap and the tidal flap gate.

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[1] The Alameda Marina Master Plan includes the installation of one new outfall, repairing five existing outfalls, and removing four existing outfalls. Of these, only the new outfall involves improvements below the high tide line. The new outfall is shown on Figure 3.

A sheet pile cofferdam will be installed to facilitate outfall repair and installation. Information regarding the number of temporary steel sheet piles associated with the cofferdam and installation methodology is provided in Section 1.2.2. The sheet pile cofferdam wall will be embedded in shoreline substrate immediately downstream from the outfall. Some riprap and sediment will be removed from the cofferdam footprint prior to cofferdam installation. It will take several days to install the cofferdam, but the sheet piles will only be installed using methods that generate minimal noise, i.e., with a vibratory pile driving hammer.

Once the cofferdam is installed, soil and riprap will be excavated from the location of the new outfall using a land-side excavator. Once the existing materials have been excavated and cleared, forms for the new headwall and wingwalls will be constructed and concrete poured into the forms. After the headwall and wingwalls have cured enough to hold the slope, riprap will be placed in upland areas and within the Estuary. The forms and sheet pile cofferdam will be removed after the concrete has reached design strength, allowing the headwall and wingwalls to cure. The sheet piles will be removed at low tide.

In-water sheet pile driving for temporary outfall cofferdam construction may result in the incidental harassment of marine mammals.

1.2.2.4 Marina Infrastructure Removal/Reconfiguration

The existing 529-slip marina will be reconfigured to reduce points of land access as a measure of safety, facilitate improved access and operation of the docks, and create a new waterlife park in the remnant graving dock. To accomplish this, the Applicant will remove or reconfigure existing marina infrastructure, including removing Pier 2 slip covers, installing floating docks in the existing graving dock, and reconfiguring gangways and headwalks.

Gangways provide pedestrian access from land to the floating docks and headwalks are pile-supported floating portions of a dock that provide pedestrian access to slips. Pictures of some of the existing gangways and headwalks within the Project area are provided in Appendix A. Only headwalk reconfiguration involves pile driving; all other construction activities mentioned in this section related to marina infrastructure removal and reconfiguration will occur out of the water. No piles will be removed for marina reconfiguration.

Figure 2 shows the existing marina conditions with these features labeled and Figure 3 shows the proposed marina reconfiguration. The existing marina uses will remain unchanged and no additional slips will be added. Existing support piles for marina infrastructure will be reused to the greatest extent possible; however, some existing piles will be removed for dock reconfiguration via the methods described in Section 1.2.1. The Project will reconfigure Pier 1 slips to accommodate larger vessels and the East Pier slips will be moved toward the channel to accommodate the new waterfront park (Figure 3). New support piles will be installed for the new headwalks. A summary of the number and type of piles that will be installed and the proposed installation methodology is provided in Section 1.2.2.

The bulk of marina reconfiguration work will be completed from land. New sections of headwalks, gangways, and docks will be built in an upland location, hoisted onto the water and floated into place.

Existing features that require demolition will be disconnected from the current fixed dock, floated to the edge of the marina, hoisted onto land, and demolished in an upland location.

New headwalks will be supported by nineteen new 14-in square prestressed concrete piles (Table 4). The 14-in prestressed concrete piles will be installed with an impact hammer. Information regarding the number of concrete piles associated with the headwalks and installation methodology is provided in Section 1.2.2.

In-water pile driving to reconfigure headwalks may result in the incidental harassment of marine mammals.

1.2.2.5 Boat Hoist

Three existing boat hoists will be replaced with a new 3-ton boat hoist (approximately 42 ft by 50 ft in area). The new boat hoist, located on the west side of the Project site (Figure 4), will lift sailboats into and out of the Estuary. The boat hoist requires new infrastructure of a pile-supported deck. Figure 5 depicts the infrastructure associated with the new boat hoist.

The new deck will be 2,100 sq ft, with 270 sq ft over land and 1,830 sq ft over water. The new deck will be supported by eight 24-in square prestressed concrete piles and one 30-in cylindrical steel pipe pile (Table 4). The single 30-in steel pipe pile supporting the hoist platform deck will be initially installed with a vibratory hammer; an attenuated impact hammer will be used to complete pile installation and drive to final depths. The 24-in concrete piles will be impact-driven their entire length without attenuation. Further information regarding the number of piles associated with the boat hoist and installation methodology is provided in Section 1.2.2.

In-water pile driving associated with the new boat hoist construction may result in the incidental harassment of marine mammals.

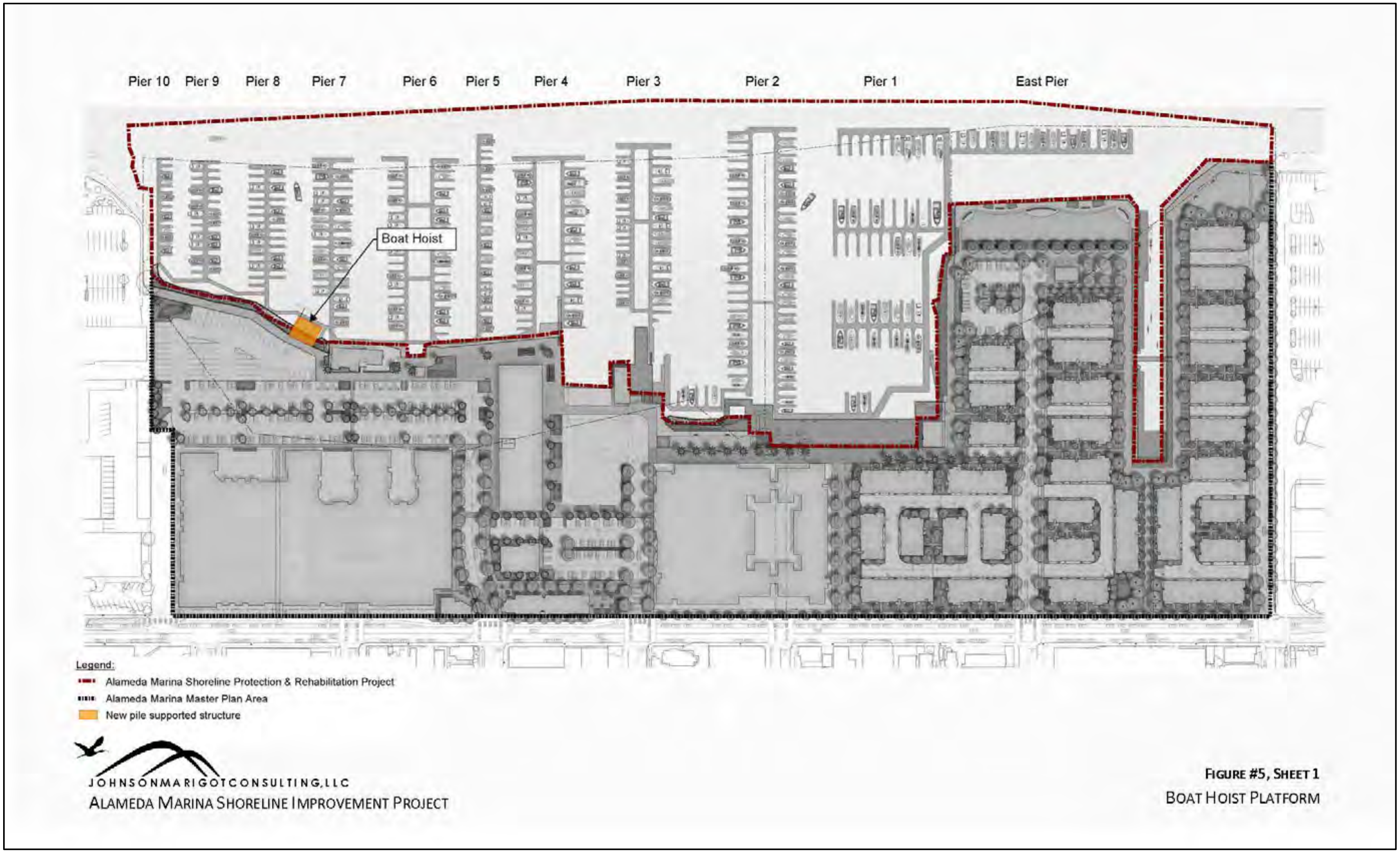

Figure 4. Location of new boat hoist in the Alameda Marina Shoreline Improvement Project.

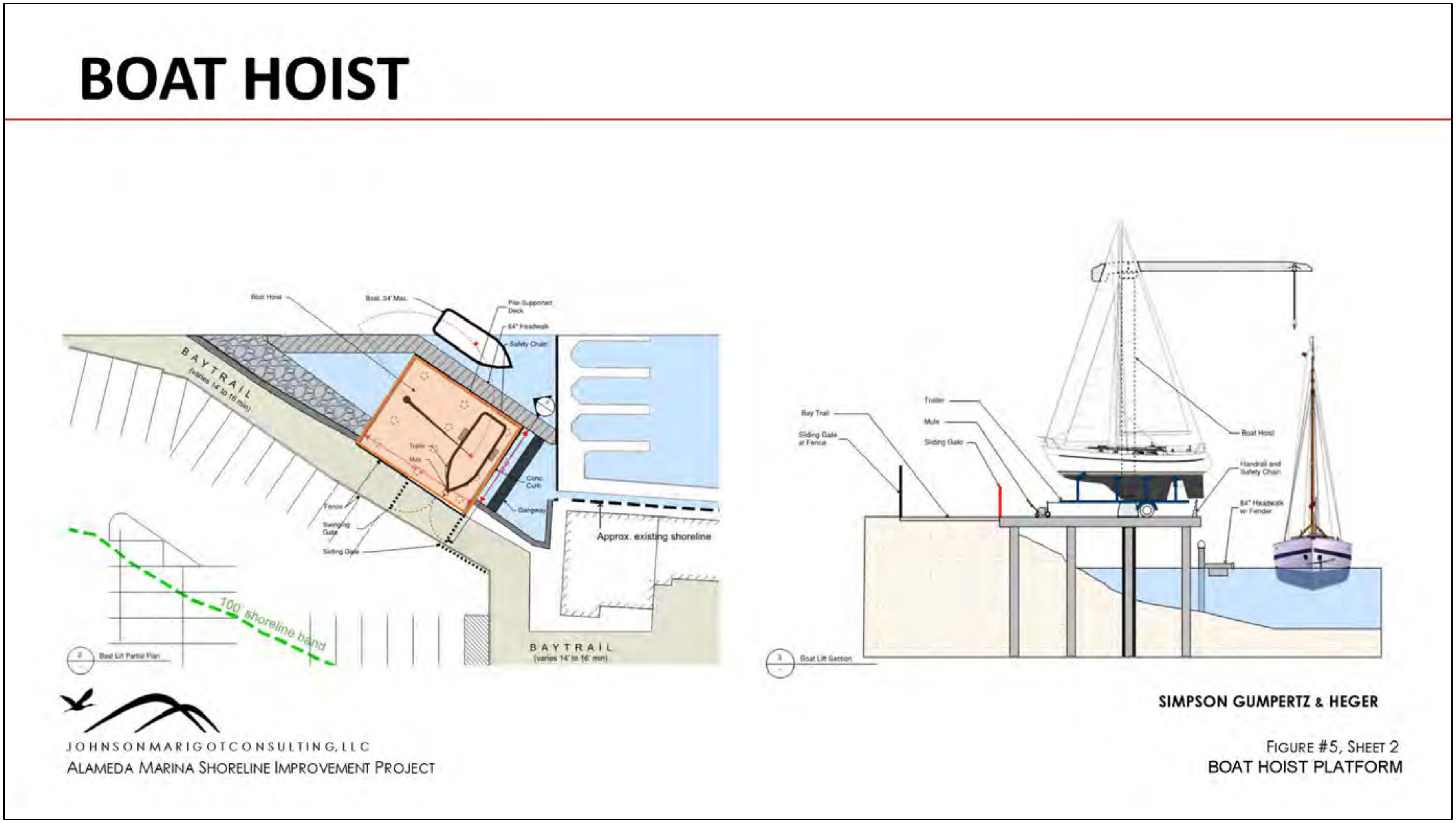

Figure 5. Infrastructure associated with the new boat hoist installation in the Alameda Marina Shoreline Improvement Project.

2. DATES, DURATION, AND SPECIFIED GEOGRAPHIC REGION

In-water work is scheduled to begin June 1 2020 (see Section 2.1). Pile driving may be done with a vibratory hammer year-round without attenuation.

The Applicant is requesting issuance of an IHA for a two-year period, or two one-year IHAs, beginning June 1 2020 and ending May 31 2022. To allow sufficient time to prepare a biological monitoring plan and coordinate resources and staff to meet the final conditions of the IHA, the Applicant is requesting issuance of this IHA no later than May 1, 2020. The Applicant is requesting the IHA be effective beginning June 1, 2020 to align with the two-year schedule below.

2.1 Construction Schedule

Construction work for the Project will be completed primarily during daylight hours from 8:30 a.m. to 6:00 p.m. Construction activities will occur in phases, with the first phase of work starting in spring 2020; it is anticipated that work will be completed in 2022. Below is a summary of the approximate in-water work schedule, divided into Year 1 and Year 2:

Year 1 (June 1 2020–May 31 2021)

- Removal of all piles: June–September 2020
- Promenade wharf: June–November 2020
- Riprap repair/replacement on eastern end of Project site (no mitigation required): July–August 2020
- Seawall 4 and Seawall 6: July–August 2020
- Building 13 wharf, Building 5 wharf: August–October 2020
- Outfall cofferdam: spring 2021–May 31 2021

Year 2 (June 1 2021–May 31 2022)

- Seawall 1, Seawall 1A: June–August 2021
- Boat hoist: August–October 2021
- Building 14 wharf: July–November 2021
- Riprap repair/replacement at western end of Project site (no mitigation required): October 2021
- Marina reconfiguration (only headwalks require mitigation): spring 2022–May 31 2022

2.2 Geographic Region

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 (Central 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 (Figure 6). 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. Two known harbor seal haulout sites are in the vicinity: one on Yerba Buena Island (YBI) 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 (Figure 6).

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, as will be discussed in Section 6.1.

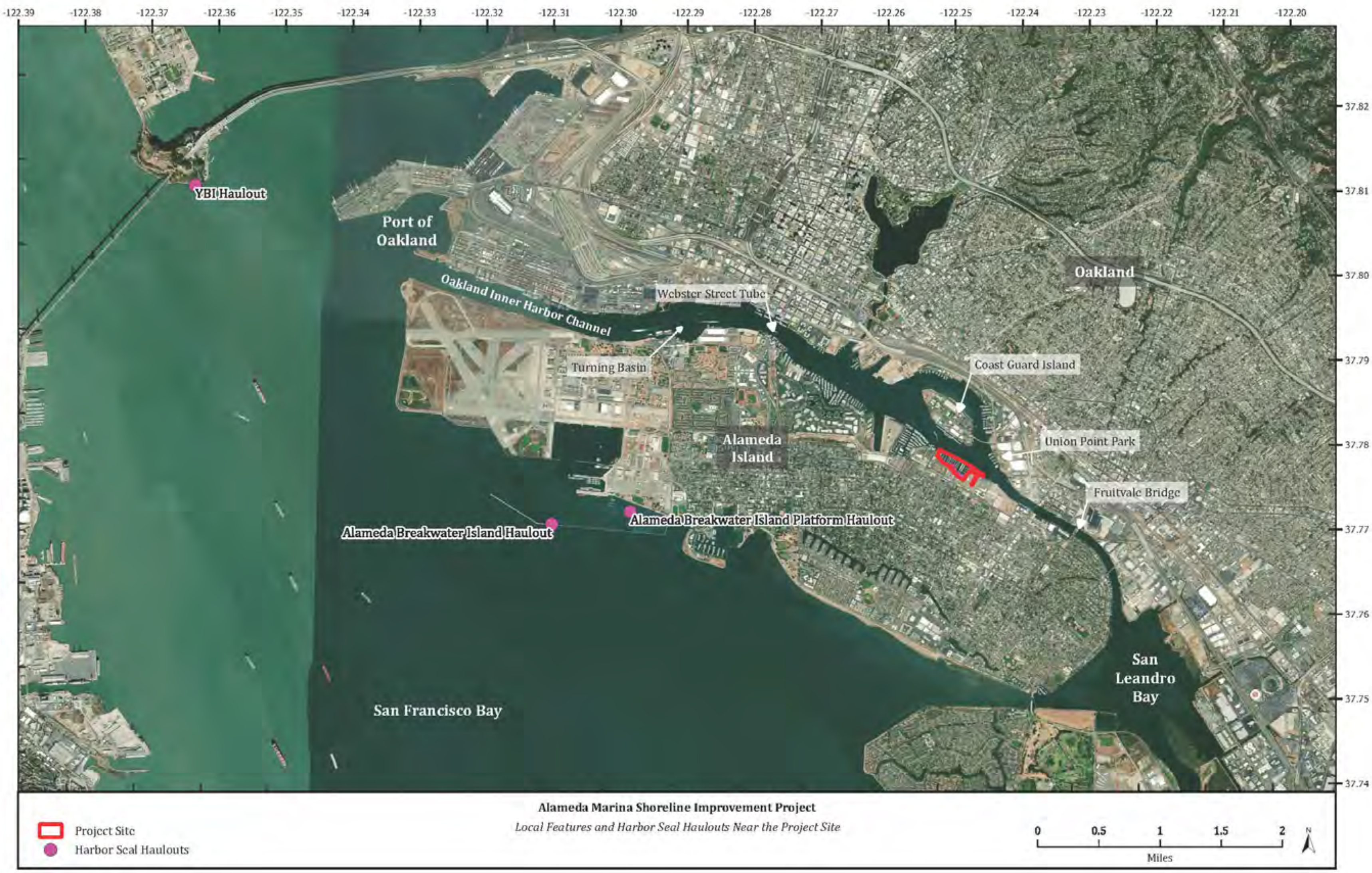

Figure 6. Local features and harbor seal haulouts near the Alameda Marina Master Plan area.

3. SPECIES AND NUMBERS OF MARINE MAMMALS

Six species of marine mammals have the potential to occur in the Estuary near the Project area (Table 4). The two most common species are the Pacific harbor seal (*Phoca vitulina richardii*) and the California sea lion (*Zalophus californianus*). Harbor porpoise (*Phocoena phocoena*) and bottlenose dolphin (*Tursiops truncatus*) are present in the Bay year-round but are rarely if ever seen in the Estuary. They are included here because of their regular observed proximity to the Estuary and potential to expand their known range into the Estuary. Northern elephant seals (*Mirounga angustirostris*) and northern fur seals (*Callorhinus ursinus*) enter the Bay seasonally in low numbers but have not been recorded in the Estuary. They are included here because of their potential to enter the Estuary seasonally.

None of these species are listed as endangered or threatened under the Federal Endangered Species Act (ESA), or as a depleted or strategic stock under the Marine Mammal Protection Act (MMPA). Two additional species of marine mammals seasonally enter the Bay in low numbers but have not been recorded in the Estuary and are considered extralimital to the Project area in the Estuary (Table 4): gray whales (*Eschrichtius robustus*) and humpback whales (*Megaptera novaengliae*).

Quantitative information on the estimated densities of harbor seals, northern elephant seals, sea lions, northern fur seals, harbor porpoise, and bottlenose dolphins in the vicinity of the Project area was estimated from marine mammal monitoring conducted in June of 2019 and from stranding and opportunistic sighting data reported by the public (National Marine Fisheries Service [NMFS] 2019a, 2019b). Qualitative information on animal densities was collected from frequent local users of the Estuary. Stock status, local densities, and local distribution are presented in Section 4 below.

Table 4. Summary of marine mammals in the Oakland Estuary.

Species	Stock	Status (EPA and MMPA)	Population Trend	Stock Abundance	Potential Biological Removal (PBR)[1]	Annual Human-caused Mortality and Serious Injury	Stock Status Factors (Unusual Mortality Events (UME)[2], spills, etc.)
Species with Potential to Occur in the Oakland Estuary near the Alameda Marina Project Area							
Phocid							
Pacific Harbor Seal (*Phoca vitulina*)	CA	Not listed	Decreasing	30,968 (CV=0.157)	1,641	42.8	Fisheries, entrainment in power plants, other human-induced mortality
Northern Elephant Seal (*Mirounga angustirostris*)	CA Breeding	Not listed	Increasing	179,000	4882	≥8.8 (n/a)	Shootings, entanglement in marine debris, fisheries
Otariid							
California Sea Lion (*Zalophus californianus*)	US	Not listed	Increasing	296,750	9200	≥389	Domoic acid blooms, fisheries, shootings, entrainment in power plants, other human-induced mortality
Northern Fur Seal (*Callorhinus ursinus*)	CA; Ern N Pacific	Not listed	Increasing; Decreasing	14,050; 637,561	451; 11,602	1.8; 436	Fisheries; subsistence, entanglement in marine debris, fisheries
Odontocetes							
Bottlenose Dolphin (*Tursiops truncatus*)	Coastal CA	Not listed	Stable, possibly increasing	453 (CV=0.06)	2.7	≥1.6 (CV=0.46)	Pollutants (especially DDT residues) and possibly morbillivirus
Harbor Porpoise (*Phocoena phocoena*)	SFB to RR	Not listed	Stable	9,886 (CV=0.51)	66	0	None, but sensitive to disturbance by anthropogenic sound sources
Species with Regular or Seasonal Occurrence in San Francisco Bay but Extralimital to the Oakland Estuary							
Gray Whale (*Eschrichtius robustus*)	Ern N Pacific	Not listed	Stable	20,990 (CV=0.05)	624	133	Subsistence, fisheries, ship strikes

Humpback Whale (*Megaptera novaengliae*)	CA-OR-WA	Endangered (ESA); Strategic and Depleted (MMPA)	Increasing in past years, but may be variable now	1,918 (CV≈0.03)	11	9.2	Fisheries, ship strikes, anthropogenic sound

Source: Sections 4.1–4.5

[1] PBR is defined by the MMPA as the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population.

[2] An UME is defined by the MMPA as a stranding event that is unexpected, involves a significant die-off of any marine mammal population, and demands immediate response.

4. AFFECTED SPECIES' STATUS AND DISTRIBUTION

Four species may be affected by Project construction activities. The following discussion outlines their distribution and current population status. A summary of biological characteristics of these marine mammals is shown in Table 5. As knowledge of these species in the Oakland Estuary (Estuary) is very limited, this table summarizes species information in the Central Bay, adjacent to the Estuary (see Figure 2).

4.1 Pacific Harbor Seal (California Stock)

Status: The Pacific harbor seal is protected under the MMPA but is not listed as a strategic or depleted species under the MMPA (Carretta et al. 2013), or listed as endangered or threatened under the ESA. The California stock of harbor seals increased from 1972 through 2004, but declined from 2009 through 2012 (Carretta et al. 2015). The population size of the California stock during the last count in 2012 was estimated at 30,968 seals (CV=0.157; Carretta et al. 2015).

Distribution: Harbor seals are found from Baja California to the eastern Aleutian Islands of Alaska (Harvey and Goley 2011, Herder 1986). In California there are approximately 500 haulout sites along the mainland and on offshore islands, including intertidal sandbars, rocky shores, and beaches (Hanan 1996, Lowry et al. 2008). Harbor seals are the most common marine mammal species observed in the Bay. Within the Bay they primarily haul out on exposed rocky ledges and on sloughs in the southern Bay. Harbor seals are central-place foragers (Orians and Pearson 1979) and tend to exhibit strong site fidelity within season and across years, generally forage close to haulout sites, and repeatedly visit specific foraging areas (Grigg et al. 2012, Suryan and Harvey 1998, Thompson et al. 1998,). Harbor seals in the Bay forage mainly within 7 mi (10 km) of their primary haulout site (Grigg et al. 2012), and often within just 1–3 mi (1–5 km; Torok 1994). Depth, bottom relief, and prey abundance also influence foraging location (Grigg et al. 2012). Most seals tagged in the Bay remain in the Bay (Grigg et al. 2012, Harvey and Goley 2011, Manugian 2013, 2016), although some animals may travel 186–311 mi (300–500 km) to find food or to breed (Harvey and Goley 2011, Herder 1986, Thompson et al. 1998, Torok 1994), and there is recent evidence that some tagged harbor seal pups travel as far as Oregon and Mexico (Greig et al. 2018).

The molt occurs from May through June. Peak numbers of harbor seals haul out in central California during late May to early June, which coincides with the peak molt. During both pupping and molting seasons, the number of seals and the length of time hauled out per day increase, from an average of 7 hours per day to 10–12 hours during pupping and molting (Harvey and Goley 2011, Huber et al. 2001, Stewart and Yochem 1994).

Harbor seals tend to forage at night and haul out during the day with a peak in the afternoon between 1 p.m. and 4 p.m. (Grigg et al. 2002, London et al. 2001, Stewart and Yochem 1994, Yochem et al. 1987). Tide levels affect the maximum number of seals hauled out, with the largest number of seals hauled out at low tide, but time of day and season have the greatest influence on haul-out behavior (Manugian et al. 2017, Patterson and Acevedo-Gutiérrez 2008, Stewart and Yochem 1994).

Table 5. Summary of biological characteristics of marine mammals in San Francisco Bay (Bay).

Species	Population in Bay	Distribution in Bay	Seasons Present in Bay	Pupping/ Calving Season	Dive Duration (Maximum)	Audiogram (Maximum Sensitivity)	Group or Pod Size in Bay	Haulout Sites (Distance to Project Site)
Pacific Harbor Seal	Up to 2000	Throughout	Year-round	March–May (inside the Bay)	3–10 min (30 min)	1–180 kHz (0.5–40 kHz)	1	YBI (6.6 mi [10.7 km]), Alameda Breakwater (7.8 mi [12.6 km])
Northern Elephant Seal	Up to 100 (stranded juveniles)	Throughout	Spring to fall	December–March	10–15 min (45 min)	3.2–55 kHz (3.2–45 kHz)	1	Mostly stranded; rare haul out on YBI and Treasure Island (7.3 mi [11.7 km])
California Sea Lion	Up to 2000	Throughout	Year-round; more common in fall through winter	May–July (only outside the Bay)	<2.5 min (10 min)	0.1–43 kHz (15–30 kHz)	1	Pier 39 (9.3 mi [15 km])
Northern Fur Seal	Rare	Occasional stranding on YBI or Treasure Island	Fall to spring	May–October	3–7 min (10 min)	1–40 kHz (2–16 kHz)	1	Mostly stranded; rare haul out on YBI and Treasure Island (7.3 mi [11.7 km)]
Bottlenose Dolphin	1–5	Primarily western portion of Central Bay, and near former Alameda Air Station	Year-round; may be more common summer to fall	Spring; secondary peak in fall (only outside the Bay)	30 sec (15 min)	0.1–160 kHz (25–70 kHz)	1–5	N/A
Harbor Porpoise	Up to 200	Primarily western Central Bay and Northern Bay	Year-round	Spring (inside and outside the Bay)	<1 min (5 min)	0.125–150 kHz (16–140 kHz)	1–6	N/A

Source: Sections 4.1–4.7.

Project Area: Harbor seals in the Bay typically haul out in groups ranging from a few individuals to over 300 during peak molt (National Park Service [NPS] unpublished data). The closest haulout to the Project area is YBI, approximately 6.6 mi (10.7 km) to the northwest. The YBI haulout site has a daily range of zero to 109 harbor seals during fall months, with the highest numbers hauled out during afternoon low tides (California Department of Transportation [Caltrans] 2004). A second high-use haulout is located on the southwest side of Alameda Island near the Encinal Boat Ramp, 7.8 mi (12.6 km) by water. This location consists of two haulout sites approximately 0.5 mi (0.8 km) apart: one at the western end of Breakwater Island, and the other on a platform installed for the harbor seals within the harbor protected by Breakwater Island (Figure 6). More animals haul out here daily in the winter than in the summer and fall: an average of fewer than 10 animals per day haul out in the fall, while up to 75 animals per day use this haulout in January and December (M. Klein and R. Bangert, pers. comm. 2019). This trend reflects the fact that more seals are present in the Bay during the winter foraging period than during the spring breeding season. Large concentrations of spawning Pacific herring (*Clupea pallasii*) and migrating salmonids likely attract seals into the Bay during the winter months (Greig and Allen 2015) and may similarly increase harbor seal numbers in the Estuary. Harbor seals forage for Pacific herring in eelgrass beds in the winter (Schaeffer et al. 2007). There are no eelgrass beds in the Estuary to attract foraging harbor seals.

Grigg et al. (2004) analyzed historical data from 1970 through 1997, and count data from 1998 through 2002 for harbor seals within the Bay. They concluded that the population had not rebounded significantly since implementation of the MMPA in 1972, but noted that it had increased slightly (Grigg et al. 2012). Manugian et al. (2016) examined aerial survey data from 2002 to 2012 and estimated 950 harbor seals in the Bay (95% CI=715–1,184), concluding that the local population was stable, although it has not rebounded as the California Stock has. The NPS has conducted a yearly harbor seal survey since 2005 at the five primary haulout sites within the Bay: Alcatraz Island, Castro Rocks, YBI, Mowry Slough, and Newark Slough (Vanderhoof and Allen 2005). The 2018 maximum count in the Bay was the highest recorded (527 adult and immature animals counted during the breeding season [NPS unpublished data]), following high counts also in 2010, 2014, and 2016 (Codde and Allen 2018). Although this is not a comprehensive count of seals in the Bay, the trend is supportive of a stable or increasing population.

There have been no formal surveys of marine mammals in the Estuary before 2019 (W. Keener, pers. comm. 2019), and the few sightings that have been recorded have been opportunistic. Between 2006 and June 2019, only two harbor seals stranded in the Estuary (NMFS 2019a, 2019b). In August 2017 a harbor seal was seen in Lake Merritt, after transiting through the Estuary (Martichoux 2017). Grigg et al. (2012) tagged 19 harbor seals at Castro Rocks, approximately 15.2 mi (24.5 km) north-northeast of the Project area. Although some ranged as far as the South Bay, approximately 39 mi (63 km) from Castro Rocks, none were recorded in the Estuary (Grigg et al. 2012). No harbor seals were seen by the author at the Project area during 30 hours of marine mammal monitoring over four days in June 2019.

A local recreational boater who lives on his boat full-time in the existing Alameda Marina reported seeing a harbor seal (confirmed via video) approximately twice a week throughout 2019 (G. Dees [Respondent 1], pers. comm. 2019; Table 6). Another recreational boater who is occasionally on her boat in Alameda Marina reported a harbor seal in the marina on five days in August through October, 2019 (T. Drake [Respondent 2], pers. comm. 2019; Table 6). This respondent also reported that a single harbor seal

occasionally hauled out on the marina docks for several hours per day. Two staff members (Respondents 3 and 4; Table 6) of a local marina who could differentiate between a seal and sea lion reported an average of two harbor seals per month in the Estuary, or rare occurrence. Two other staff members (Respondents 5 and 6; Table 6) who could not confidently differentiate between a seal and a sea lion reported seeing one to two animals per week and approximately two seals per month.

Table 6. Summary of species sighting information by local frequent users of the Oakland Estuary near Alameda Marina. All respondents interviewed in October 2019. No respondent reported seeing bottlenose dolphins or harbor porpoises in the Estuary.

Respondent	Distance from Alameda Marina (mi)	Time at Location	Confidence Identifying Species	Harbor Seal Sightings	Sea Lion Sightings
Alameda Marina–Respondent 1 (G. Dees)	0	1 year, full-time living aboard personal boat	High–video evidence	Approx. 2/wk	0
Alameda Marina–Respondent 2 (T. Drake)	0	Occasional for 6 months on personal boat	High–decades observing marine life on the CA coast and from vessels	5 times in 3 mo	0
Jack London Square Marina–Respondent 3	2	Employed for past 2 years, 50 h/wk. Harbormaster for five marinas on Oakland side of Estuary; spends most time at Central Basin in Jack London Square.	High–12 years mitigating marine pollution	rarely	1/yr
Jack London Square Marina–Respondent 4	2	Employed for 2 years, 40 h/wk. Office and dock work.	Moderate	2/mo	1 every 4–5 mo
Jack London Square Marina–Respondent 5	2	Employed for 2.5 years, 40 h/wk. Office and dock work.	Low	2/mo	0
Grand Marina–Respondent 6	0.1	Employed for 10 years, 28 h/wk. Office and dock work.	Low	≤2/wk	0

Reproduction and Breeding: Pupping occurs from March through May in central California (Codde and Allen 2018). Pups are weaned in four weeks; most pups are weaned by mid-June (Codde and Allen 2018). Harbor seals molt from June through July (Codde and Allen 2018) and breed between late March and June (Greig and Allen 2015).

Diving and Foraging: As central-place foragers, harbor seals forage mainly within 1–5 km of their primary haulout site (Grigg et al. 2009, Grigg et al. 2012, Kopec and Harvey 1995, Torok 1994), and as such, rely heavily on local prey resources (Grigg et al. 2012). Harbor seals in the Bay are opportunistic

predators (Middlemas et al. 2006, Thomas et al. 2011) with a large proportion of their foraging concentrated on benthic species (Grigg et al. 2012).

Harbor seals generally are shallow divers, with about 90 percent of dives lasting less than 7 minutes (min; Eguchi and Harvey 2005, Gjertz et al. 1991), and a maximum recorded dive time of 32 min (Eguchi and Harvey 2005). Dive behavior is significantly influenced by haulout site, season, sex, and light (Wilson et al. 2014).

Acoustics: During the breeding season, adult males use underwater low-frequency vocalizations, primarily at night, to defend their “maritories” (underwater territories) and possibly to attract mates (Greig and Allen 2015, Matthews et al. 2017, Nikolich et al. 2018). Generally, they do not vocalize while traveling or foraging. Male harbor seals produce sounds in the frequency range of 100 to 1,000 Hertz (Hz; Richardson et al. 1995). Harbor seals hear frequencies from 1 to 180 kilohertz (kHz; Møhl 1968); however, the species’ hearing is most acute below 60 kHz, with peak underwater hearing at 0.5–40 kHz (Kastelein et al. 2010, Reichmuth et al. 2013).

4.2 Northern Elephant Sea (California Breeding Stock)

Status: The northern elephant seal (*Mirounga angustirostris*) is protected under the MMPA but is not listed as a strategic or depleted species under the MMPA (Carretta et al. 2015), or listed as endangered or threatened under the ESA. The population size of the California breeding stock is estimated at 179,000 seals and is increasing (Lowry et al. 2010, 2014; Carretta et al. 2015).

Distribution: Northern elephant seals are common on California coastal mainland and island sites, where the species pups, breeds, rests, and molts. The largest rookeries are on San Nicolas and San Miguel islands in the northern Channel Islands. Near the Bay, elephant seals breed, molt, and haul out at Año Nuevo Island, the Farallon Islands, and Point Reyes National Seashore.

Northern elephant seals haul out to give birth and breed from December through March. Pups remain onshore or in adjacent shallow water through May. Both sexes make two foraging migrations each year: one after breeding and the second after molting (Stewart 1989; Stewart and DeLong 1995). Adult females migrate to the central North Pacific to forage, and males migrate to the Gulf of Alaska to forage (Robinson et al. 2012). Pup mortality is high when they make the first trip to sea in May, and this period correlates with the time of most strandings. Young-of-the-year pups return in the late summer and fall to haul out at breeding rookery and small haul-out sites, but occasionally may make brief stops in the Bay.

Project Area: Generally, only juvenile elephant seals enter the Bay seasonally and do not remain long if they are healthy. From mid-February to the end of June, The Marine Mammal Center (TMMC) reports the most strandings, primarily of malnourished juveniles (www.marinemammalcenter.org). Juvenile northern elephant seals occasionally forage in the Central Bay, and approximately 100 strandings are documented annually throughout the Bay (CalTrans 2018b). However, no elephant seals, alive or stranded, have been reported in the Estuary (NMFS 2019a, 2019b).

Diving and Foraging: Northern elephant seals have the highest diving capacity of any pinniped. Elephant seal juveniles regularly dive for 10 to 15 minutes, with a maximum reported dive time of 45.5 minutes (Thorson and Le Boeuf 1994; Le Boeuf et al. 1996).

Acoustics: The audiogram of the northern elephant seal indicates that the highest sensitivity range is between 3.2 and 45 kHz, with greatest sensitivity at 6.4 kHz and an upper frequency cutoff of approximately 55 kHz (Kastak and Schusterman 1998).

4.3 California Sea Lion (United States Stock)

Status: The California sea lion is protected under the MMPA but is not listed as a strategic or depleted species under the MMPA (Carretta et al. 2012), or listed as endangered or threatened under the ESA. The United States stock increased from 1975 through 2008, with a current estimated population of 296,750 (Carretta et al. 2015). However, it has also been shown that population growth can be dramatically decreased by increasing sea surface temperature associated with El Niño events or similar regional ocean temperature anomalies (Laake et al. 2018, Melin et al. 2010).

Distribution: California sea lions are found from Vancouver Island, British Columbia, to the southern tip of Baja California. Sea lions breed on the offshore islands of southern and central California from May through July (Heath and Perrin 2008). During the non-breeding season, adult and subadult males and juveniles migrate northward along the coast to central and northern California, Oregon, Washington, and Vancouver Island (Jefferson et al. 1993). They return south the following spring (Heath and Perrin 2008, Lowry and Forney 2005). Females and some juveniles tend to remain closer to rookeries (Antonelis et al. 1990, Melin et al. 2008).

Project Area: California sea lions have occupied docks near Pier 39 in San Francisco, about 9.2 mi (14.9 km) from the Project area, since 1987. The highest number of sea lions recorded at Pier 39 was 1,701 individuals in November 2009. Occurrence of sea lions here is typically lowest in June (during pupping and breeding seasons) and highest in August. Approximately 85 percent of the animals that haul out at this site are males, and no pupping has been observed here or at any other site in the Bay. Pier 39 is the only regularly used haulout site in the Project vicinity, but sea lions occasionally haul out on human-made structures such as bridge piers, jetties, or navigation buoys (Riedman 1990).

There have been no formal surveys of marine mammals in the Oakland Estuary before 2019 (W. Keener, pers. comm. 2019), and the few sightings that have been recorded have been opportunistic. In May 2017 a sea lion was seen in the small canal that connects Lake Merritt with the Estuary (Martichoux 2017). Between 2006 and June 2019, only three sea lions stranded in the Estuary (NMFS 2019a, 2019b). Surveys conducted by the author for 30 hours in June 2019 saw only one sea lion near the Project site, across the Estuary under the Coast Guard dock approximately 1130 ft (345 m) from the Project shoreline. Interviews with local frequent users of the Estuary confirm that sightings of sea lions are rare: two people interviewed with high confidence identifying species reported seeing one to two sea lions per year in the Estuary (Table 6). It is probable that slightly more sea lions use the Estuary in the fall and winter after pupping and breeding. California sea lions forage for Pacific herring in eelgrass beds in the winter (Schaeffer et al. 2007). There are no eelgrass beds in the Estuary to attract foraging sea lions.

Reproduction and Breeding: Pupping occurs primarily on the California Channel Islands from late May until the end of June (Peterson and Bartholomew 1967). Weaning and mating occur in late spring and summer during the peak upwelling period (Bograd et al. 2009). After the mating season, adult males migrate northward to feeding areas as far away as the Gulf of Alaska (Lowry et al. 1992), and they remain away until spring (March–May), when they migrate back to the breeding colonies. Adult females generally remain south of Monterey Bay, California throughout the year, feeding in coastal waters in the summer and offshore waters in the winter, alternating between foraging and nursing their pups on shore until the next pupping/breeding season (Melin and DeLong 2000; Melin et al. 2008).

Diving and Foraging: Adult lactating females have a range of mean dive durations from 1.6 to 8.1 min (Melin et al. 2008), with a maximum recorded dive of 9.9 min (Feldkamp et al. 1989). Most sea lions in the Bay are juveniles or subadult males, and are similar in size to adult lactating female sea lions; therefore, these dive data should approximate the diving abilities of the Bay sea lions. Additional studies confirm that over all age and sex classes, dives are primarily <2.5 min (Kuhn and Costa 2014, McHuron et al. 2018, Weise et al. 2006).

Acoustics: California sea lions produce two types of underwater sounds: clicks (or short duration sound pulses) and barks (Schusterman 1969, Schusterman et al. 1966). Most of the energy of underwater sounds is below 4 kHz (Schusterman et al. 1967). Sea lions' full underwater hearing frequency range is approximately 100 Hz to 43 kHz, with peak sensitivities from 15 to 30 kHz, and relatively acute hearing sensitivity (62–86 dB re: 1 Pa; Reichmuth and Southall 2011, Reichmuth et al. 2013, Schusterman et al. 1972).

4.4 Northern Fur Seal (California and Eastern North Pacific Stocks)

Status: Two northern fur seal (*Callorhinus ursinus*) stocks may occur near the Bay: the California and Eastern North Pacific stocks. The California northern fur seal stock is protected under the MMPA but is not listed as a strategic or depleted species under the MMPA (Carretta et al. 2012), or listed as endangered or threatened under the ESA. The California stock has an estimated population of 14,050 and is increasing (Orr et al. 2016).

The Eastern North Pacific Stock is protected under the MMPA and is listed as a strategic and depleted species (Carretta et al. 2012), but is not listed as endangered or threatened under the ESA. The Eastern North Pacific Stock has an estimated population of 637,561 but is currently in decline (Carretta et al. 2012).

Distribution: The California stock breeds and pups on the offshore islands of California, and forages off the California coast. The Eastern Pacific stock breeds and pups on islands in the North Pacific Ocean and Bering Sea, including the Aleutian Islands, Pribilof Islands, and Bogoslof Island, but females and juveniles move south to California waters to forage in the fall and winter months (Gelatt and Gentry 2018).

Project Area: Both the California and Eastern North Pacific stocks forage in the offshore waters of California, but usually only sick or emaciated juvenile fur seals seasonally enter the Bay. TMMC

occasionally picks up stranded fur seals around YBI and Treasure Island, but they have not been reported in the Estuary (NMFS 2019b).

Reproduction and Breeding: Breeding and pupping occur from mid- to late-May into July. Pups are weaned in September and move south to feed offshore California (Gentry 1998).

Diving and Foraging: The average dive time of northern fur seals is 2.6 min, with a maximum between 5 and 7 min. The majority of dives are between 66 and 460 ft (20 and 140 m; Kooyman et al. 1976; Gentry et al. 1986); the deepest recorded dive is 679 ft (207 m).

Acoustics: Northern fur seals' hearing range is 0.5 to 40 kHz (Moore and Schusterman 1987).

4.5 Common Bottlenose Dolphin (California Coastal Stock)

Status: The common bottlenose dolphin is protected under the MMPA but is not listed as a strategic or depleted species under the MMPA (Carretta et al. 2015), or listed as endangered or threatened under the ESA. The population size for the California coastal stock is estimated at 450–515 animals based on 2009–2011 surveys (Weller et al. 2016). This stock of bottlenose dolphins remained stable between 1987 and 2005 (Dudzik et al. 2006).

Distribution: The California coastal stock of common bottlenose dolphin is found within 0.6 mi (1 km) of shore (Defran and Weller 1999) and occurs from northern Baja California, Mexico to Bodega Bay, CA. Their range has extended north over the last several decades with El Niño events and increased ocean temperatures (Hansen and Defran 1990). An offshore common bottlenose dolphin stock exists, but genetic studies have shown that no mixing occurs between the two stocks (Lowther-Thieleking et al. 2015).

Project Area: As the range of bottlenose dolphins extended north, dolphins began entering San Francisco Bay in 2010 (Szczepaniak 2013). Bottlenose dolphins have primarily been observed in the western Central and South Bay, from the Golden Gate Bridge to Oyster Point and Redwood City. However, one individual has been regularly seen in the Bay since 2016 near the former Alameda Air Station (Perlman 2017; W. Keener, pers. comm. 2017), and five animals were regularly seen in the summer and fall of 2018 in the same location (W. Keener, pers. comm. 2019). This area is on the far side of Alameda Island from the Project area, approximately 6.8 mi (10.9 km) by water. There have been no formal surveys of marine mammals in the Estuary before 2019 (W. Keener, pers. comm, 2019), and no reports of bottlenose dolphins in the Estuary (NMFS 2019a, 2019b). The two closest known sightings to the Project area were of a single dolphin on one occasion and an adult and juvenile on another occasion in February 2019. Both sightings were on the edge of the Inner Harbor Entrance Channel to the northwest of the Estuary, approximately 5.8 mi (9.3 km) from the Project area (W. Keener, pers. comm., 2019). During 30 hours of monitoring by the author in June 2019 at the Project site, no bottlenose dolphins were seen. Six local frequent users of the Estuary interviewed for this Project reported never seeing a bottlenose dolphin in the Estuary. It is unlikely bottlenose dolphins will be present in the Estuary but they have been included in the Application because of their year-round residency in the Bay, regular proximity to the work area, and possibility of expanding their range into the Estuary.

Diving and Foraging: Navy bottlenose dolphins have been trained to reach maximum dive depths of about 984 ft (300 m; Ridgway et al. 1969). Reeves et al. (2002) noted that the presence of deep-sea fish in the stomachs of some individual offshore bottlenose dolphins suggests that they dive to depths of more than 1,638 ft (500 m). Dive durations up to 15 minutes have been recorded for trained individuals (Ridgway et al. 1969), but typical dives are shallower and of a much shorter duration (approximately 30 seconds [sec]; Bearzi et al. 1999, Mate et al. 1995). Bottlenose dolphins are opportunistic foragers: time of day, tidal state, and oceanographic habitat influence where they pursue prey (Hanson and Defran 1993).

Acoustics: The bottlenose dolphin has a functional high-frequency hearing limit of 160 kHz (Au 1993) and a low-frequency hearing limit near 40 to 125 Hz (Turl 1993). The audiogram of the Atlantic bottlenose dolphin shows that the lowest thresholds occurred near 50 kHz, at a level around 45 dB reference 1 micro-Pascal (re 1 µPa; Finneran and Houser 2006; Houser and Finneran 2007, Nachtigall et al. 2000). Atlantic bottlenose dolphins' range of best hearing sensitivity is between 25 and 70 kHz, with peaks in sensitivity at 25 and 50 kHz at levels of 47 and 46 dB re 1 µPa (Ljungblad et al. 1982, Nachtigall et al. 2000). Pacific bottlenose dolphins have significantly lower mean thresholds at 40 kHz and 60–115 kHz (10–20 dB) than Atlantic bottlenose dolphins, but their mean thresholds are similar for frequencies between ≤30 kHz and ≥130 kHz (Houser et al. 2008).

4.6 Harbor Porpoise (San Francisco–Russian River Stock)

Status: The harbor porpoise is protected under the MMPA but is not listed as a strategic or depleted species under the MMPA (Carretta et al. 2013), or listed as endangered or threatened under the ESA. The population size for the San Francisco–Russian River stock is estimated at 9,886 porpoises (CV=0.51) and is stable (Carretta et al. 2014, Forney et al. 2013).

Distribution: Harbor porpoise occur along the US west coast from southern California to the Bering Sea (Allen and Angliss 2013, Barlow and Hanan 1995, Carretta et al. 2009, 2012). They are seldom found in waters warmer than 62.6 degrees Fahrenheit (17 degrees Celsius; Read 1990). The San Francisco–Russian River stock is found from Pescadero, 18 mi (30 km) south of the San Francisco Bay, to 99 mi (160 km) north of the Bay at Point Arena (Carretta et al. 2012, Chivers et al. 2002). In most areas, harbor porpoise occur in small groups of just a few individuals.

Project Area: Harbor porpoise are seen frequently outside the Bay and re-entered the Bay beginning in 2008 (Stern et al. 2017). They are now commonly seen year-round within the Bay, primarily on the west and northwest side of the Central Bay near the Golden Gate Bridge, near Marin County, and near the city of San Francisco (Duffy 2015, Keener et al. 2012, Stern et al. 2017). In the summer of 2017 and 2018, mom-calf pairs and small groups (1–4 individuals) were seen to the north and west of Treasure Island, and just south of YBI (Caltrans 2018a, 2019; M. Schulze, pers. comm. 2019). No formal surveys of marine mammals have been conducted in the Estuary before 2019 (W. Keener, pers. comm. 2019). Between 2006 and June 2019, only one harbor porpoise stranded in the Estuary, in an advanced state of decomposition (NMFS 2019a), indicating that it probably died outside the Estuary and floated in. During 30 hours of surveying by the author in June 2019, no harbor porpoise were seen near the Project site. Six local frequent users of the Estuary interviewed for this Project reported never seeing a harbor porpoise in the Estuary. It is unlikely harbor porpoise will be present in the Estuary, but we include them in our

Application because of their year-round residency in the Bay, their proximity to the work area, and their expanding range.

Diving and Foraging: Harbor porpoise are generally shallow, short-duration divers. A study in Japan found that 90 percent of dives were less than 32 ft (10 m) deep and 80 percent were less than one minute in duration (Otani et al. 1998). In Canadian waters, the maximum dive depth reported was 676 ft (206 m) and maximum duration was 5.5 min (Westgate et al. 1995).

Harbor porpoise must forage nearly continuously to meet their high metabolic needs (Wisniewska et al. 2016). They consume up to 550 small fish (1.2–3.9 in [3–10 cm]; e.g. anchovies) per hour at a nearly 90 percent capture success rate (Wisniewska et al. 2016).

Acoustics: Harbor porpoise vocalizations include clicks and pulses (Ketten 1998), as well as whistle-like signals and echolocation clicks centered at 125 kHz (Kastelein et al. 2014, Verboom and Kastelein 1995). Their hearing ability extends from 0.125 to 150 kHz (Kastelein et al. 2015b). Their range of best hearing (defined as 10 dB within maximum sensitivity) is 16 to 140 kHz; sensitivity declines sharply above 125 kHz (Kastelein et al. 2002, 2017).

4.7 Extralimital or Rare Species

The following species occur only seasonally and in small numbers in the Bay, and have not been recorded in the Estuary (NMFS 2019a, 2019b). Gray and humpback whales are very unlikely to enter the Estuary because of its geography (long, narrow channel and shallow depths), as discussed in Section 2.2. They are not expected to occur in the Project area and will not be addressed further in this Application.

4.7.1 Gray Whale (Eastern North Pacific Stock)

The gray whale (*Eschrichtius robustus*) is protected under the MMPA but is not listed as a strategic or depleted species under the MMPA (Carretta et al. 2015), or listed as endangered or threatened under the ESA. The population size of the eastern north Pacific stock is estimated at 20,990 (CV=0.05; Durban et al. 2013) and has been stable since the 1990s (Carretta et al. 2015). Gray whales breed during the winter along the west coast of Baja California and the southeastern Gulf of California (Braham 1984), and summer in the northern Bering Sea, the Chukchi Sea, and the western Beaufort Sea (Rice and Wolman 1971). They may enter the Bay in late winter/early spring or in the fall during their migrations (Rice and Wolman 1971). In recent years there have been an increased number of gray whales in the Bay, but they primarily occur in the western and central Bay (W. Keener, pers. comm. 2019), and none have been reported in the Estuary (NMFS 2019a, 2019b). They are not expected to enter the Estuary because of the narrow channel width and shallow depths (see Section 2.2).

4.7.2 Humpback Whale (California/Oregon/Washington Stock)

The humpback whale (*Megaptera novaeangliae*) is protected under the MMPA and is listed as a depleted and strategic stock under the MMPA (Carretta et al. 2018). Humpback whales are listed as endangered under the ESA. The current best estimate for the California/Oregon/Washington stock is 1,918 whales

(CV≈0.03; Calambokidis et al. 2008, Calambokidis and Barlow 2013). Humpbacks have regularly been seen inside the Bay, primarily in the western Bay, from April through November since 2016 (W. Keener, pers. comm. 2019), and sometimes venture up the Delta waterway (e.g., Gulland et al. 2008), but have not been recorded in the Estuary (NMFS 2019a, 2019b). They are not expected to enter the Estuary because of the narrow channel width and shallow depths (see Section 2.2).

5. TYPE OF INCIDENTAL TAKING AUTHORIZATION REQUESTED

The Applicant requests an Incidental Harassment Authorization (IHA), pursuant to Section 101 (a)(5)(A) of the MMPA, for the harassment of marine mammals incidental to maintenance and refurbishment activities during the Alameda Marina Shoreline Improvement Project (Project). Sound and pressure levels from pile driving have the potential to result in take of marine mammals.

Under the MMPA, "take" of marine mammals is defined as to "harass, hunt, capture, kill or collect, or attempt to harass, hunt, capture, kill or collect." 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 defined further as Level A harassment. Harassment which has the potential to disturb a marine mammal by causing disturbance of behavioral patterns, including migration, breathing, nursing, breeding, feeding, or sheltering, but which does not have the potential to injure a marine mammal, is defined as Level B harassment.

5.1 Pile Driving for Maintenance and Refurbishment of Alameda Marina Shoreline

The Applicant will use vibratory and impact pile driving to rebuild seawalls and refurbish marina structures.

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

Impact pile driving produces impulse sounds that can cause behavioral disturbance and TTS to marine mammals (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 behavioral disturbance (Level B harassment) and PTS (Level A harassment) to marine mammals from pile driving and other similar activities (Table 7). The underwater sound pressure threshold for behavioral disturbance (Level B harassment) is 120 dB root-mean-square (RMS) for non-impulse sound (e.g., vibratory pile driving) and 160 dB RMS for impulse sound (e.g., impact pile driving) for both cetaceans and pinnipeds (Table 7). The underwater sound pressure threshold for slight injury, PTS (Level A harassment), is a dual metric criterion, including both a peak pressure (Peak) and cumulative sound exposure level (SELcum) threshold that is specific to the species hearing group (i.e., high-frequency cetaceans (HF), mid-frequency cetaceans (MF), low-frequency cetaceans (LF), phocids, and otariids). Underwater sound pressure thresholds for Level B and Level A harassment for each marine mammal hearing group from continuous and impulse sounds are shown in Table 7.

Table 7. Underwater sound threshold criteria for pile driving.

Species Hearing Group	Non-Impulse Sound (Vibratory Pile Driving)		Impulse Sound (Impact Pile Driving)		
	Level B (dB RMS)	Level A (dB SELcum)	Level B (dB RMS)	Level A Dual Criteria	
				(dB Peak SPL)	(dB SELcum)
High-Frequency Cetaceans (e.g., harbor porpoise)	120	173	160	202	155
Mid-Frequency Cetaceans (e.g., bottlenose dolphin)		198		230	185
Phocids (e.g., harbor seal)		201		218	185
Otariids (e.g., California sea lion)		219		232	203

Note: All decibels (dB) are referenced to 1 micro Pascal (re 1 μPa).
Source: NMFS 2018

5.2 Levels and Types of Marine Mammal Take

The following discussion provides additional information and background on the levels and types of marine mammal take for which NMFS has established threshold criteria.

5.2.1 Behavioral Responses

Generally, a louder source of sound results in a more intense behavioral response. However, other factors, such as the proximity, type, and frequency of a sound source, and the animal's experience, motivation, and conditioning are also critical factors influencing the response (Southall et al. 2007). The distance from the sound source and whether it is perceived as approaching or moving away can also affect the type and intensity of the animal's response to a sound (Nowacek et al. 2007, Southall et al. 2007, Southall et al. 2019, Wartzok et al. 2003,). Responses range from minor (e.g., changes in direction, swimming speed, dive profiles, vocalizations, and respiration rates) to strong (e.g., rapidly swimming away from the sound or abandonment of the area).

Harbor porpoise (HF cetacean hearing group) exhibited changes in respiration and avoidance behavior when exposed to pile driving sounds between 90 and 140 dB Peak re 1 μPa (Kastelein et al. 2013). Pile driving for offshore wind farm installation displaced harbor porpoise up to 1.6 mi (2.5 km) from the source of impact driving that produced a sound exposure level (SEL) of 176 dB re 1 mPa at 720 m (Brandt et al. 2012). The duration of behavioral response decreased with distance from the source, and harbor porpoise returned to the area within 70 h (Brandt et al. 2012).

Blackwell et al. (2004) observed that ringed seals (Phocid hearing group) exhibited little or no reaction to impact pile driving noise with mean underwater levels of 157 dB Peak re 1 μPa and suggested that the seals had habituated to the noise. However, captive California sea lions (Otariid hearing group) avoided

sounds from an impulsive source at levels of 165 to 170 dB RMS re 1 µPa (Finneran et al. 2003), and phocid seals showed avoidance reactions at or below 190 dB Peak re 1 µPa (Richardson et al. 1995).

Although pile driving has the potential to induce hearing loss or injury at very close range (Madsen et al. 2006), behavioral disruptions seem to be the primary reaction (Ellison et al. 2012). Long-term impacts of these behavioral responses on foraging, survival, and/or fecundity should not be overlooked (Bailey et al. 2014, Dahl et al. 2015).

5.2.2 Hearing Threshold Shift (TTS and PTS)

TTS is an increase in the hearing threshold (i.e., a reduction in sensitivity) at a specific frequency after noise exposure that returns to normal over time. PTS is also an elevation of hearing threshold at a specific frequency, but it involves irreversible tissue damage (Yost 2000). PTS has not been measured in marine mammals because of ethical concerns, but it is assumed that a noise exposure capable of inducing approximately 40 dB of TTS will cause an onset of PTS (Southall et al. 2007). This level is calculated to occur about 6 dB above the sound level that causes TTS (Southall et al. 2007).

The magnitude of TTS is dependent on sound exposure level (SEL; a measure of energy that takes into account both received level and duration of exposure): the higher the SEL, the higher the TTS induced (Kastelein et al. 2019). Recovery from TTS usually occurs within minutes to hours depending on the extent of the threshold shift and the duration of the exposure (Kastelein et al. 2018, Mooney et al. 2009).

TTS onset in harbor seals (Phocid hearing group) has been measured to occur around SELcum (a value equivalent to a single exposure for cumulative sound energy combining multiple pulses, e.g., impact hammer strikes) of 192 dB re 1 µPa2s, at 4 and 8 kHz, after 360 min of exposure to pile driving noise (Kastelein et al. 2018). Kastelein et al. (2013) induced severe 44 dB TTS in a harbor seal with 1 h of exposure to very high sound pressure levels (SPLs; 22–30 dB above levels causing TTS onset), and concluded that the critical level at which PTS-onset would be induced in phocids was between 150 and 160 dB re 1 µPa for a 60 min exposure to octave-band white noise (OBN) centered around 4 kHz.

Experiments exposing bottlenose dolphins (MF cetacean hearing group) to various frequencies and SPLs found that TTS onset and recovery are complex. TTS onset and growth in bottlenose dolphins is frequency-specific, with the maximum susceptibility between approximately 10 and 30 kHz (Finneran 2013, Nachtigall et al. 2004). Recovery to baseline hearing thresholds occurred faster after greater shifts, and recovery was longer after longer-duration exposures (Mooney et al. 2009).

A review of current harbor porpoise (HF cetacean hearing group) research found sound pressure thresholds 40–50 dB above their hearing thresholds induced avoidance reactions, and SELs about 100 dB above their hearing thresholds induced TTS (Tougaard et al. 2015). For pile driving in particular, when harbor porpoise were exposed to 60 min of playback of broadband pile driving sounds, they suffered TTS at 4 and 8 kHz, and recovered hearing within 48 min (Kastelein et al. 2015a). As with other marine mammals, response thresholds and TTS for harbor porpoise depend on the frequency (Tougaard et al. 2015) and SPL (Kastelein et al. 2014) of the stimulus.

5.2.3 Injury and Mortality

Injury from impulse sounds, including impact pile driving, usually involves air-filled cavities such as the lungs, gastrointestinal tract, and nasal sinuses, as well as the auditory system (Craig and Hearn 1998, Goertner 1982, Yelverton et al. 1973). Damage to the tissues of the brain may also occur (Knudsen and Øen 2003). Injuries from impulsive sound to the respiratory system may consist of lung contusions, collapsed lungs, air in the chest cavity between the lungs, traumatic lung cysts, and/or interstitial or subcutaneous emphysema (Phillips and Richmond 1990). The reinforced trachea, flexible thoracic cavity, and ability to deflate and re-inflate the lungs during diving (Kooyman et al. 1970, Ridgway and Howard 1979) may decrease the risk of lung injury in marine mammals when exposed to loud sounds or pressures.

Although impact pile driving of sufficient intensity (e.g., >20 dB for harbor seals) has the potential to injure or kill marine mammals at very close range (<50 m; Thompson et al. 2013), no mortality has been reported due to impact or vibratory pile driving.

6. TAKE ESTIMATES FOR MARINE MAMMALS

The distance to marine mammal threshold criteria for the particular pile driving scenarios of this Project, i.e., Level A and Level B isopleth distances, have been modeled by the acoustic engineering firm Illingworth and Rodkin, Inc. (I&R), based on underwater sound and pressure measurements from similar construction activities. The numbers of marine mammals by species that may be taken by each type of construction activity were calculated based on the estimated density of each species in the Level A or Level B zone, distance to the marine mammal threshold criteria, and duration of the activity. The full hydroacoustic report prepared by I&R is available upon request.

6.1 Estimates of Occurrence of Marine Mammals in the Project Area

Prior to 2019 there have been no marine mammal surveys in the Estuary (W. Keener, pers. comm. 2019). In June 2019, the author conducted 30 hours of marine mammal monitoring over four days in support of the Project from a barge 12.6 ft (3.8 m) above sea level located at the end of Pier 6 (see Figure 2), adjacent to the channel, at the existing Alameda Marina. Only one California sea lion was seen during this monitoring. In the absence of other systematic surveys in the Estuary, in-water densities of harbor seals, northern elephant seals, sea lions, northern fur seals, bottlenose dolphins, and harbor porpoises could not be calculated. As much opportunistic data and local knowledge as possible was collected to estimate occurrence of these animals in the Estuary. In addition to the survey in June, stranding reports to TMMC and California Academy of Sciences (CAS) from 2006 through May 2019, and informal interviews with frequent users of the Estuary were collected and reviewed.

All reports to TMMC and CAS of stranded animals that were of confirmed species and first reported with a confirmed location within the Estuary or in San Leandro Bay were included in this analysis no matter whether they were living, dead (all stages of decomposition), floating, or stranded. Twenty-seven stranded marine mammals were reported in the Estuary between 2006 and May 2019: four harbor seals, 18 sea lions, one harbor porpoise, and four fin whales (NMFS 2019a, 2019b). Despite their reported presence here, fin whales are excluded from our request for take because they are not known to actively swim into the Bay (W. Keener, pers. comm. 2019); the only reports of stranded fin whales in the Estuary were fin whale carcasses that were likely struck by commercial ships in the ocean and disengaged from the ships when they slowed to dock at the Port of Oakland.

Local knowledge was obtained through interviews with six members of the public (a harbormaster, staff, and local boaters) of three marinas (Alameda Marina, Grand Marina, and Jack London Square Marina) located within 2 mi (3.2 km) of the Alameda Marina, all of whom frequently view the Estuary (interviews conducted in October 2019; Table 6). No one interviewed reported seeing an elephant seal, fur seal, bottlenose dolphin, or harbor porpoise in the Estuary. Reported approximate rates of harbor seal and sea lion presence are given in the sections below.

All data sources indicate that animal density in the Estuary is very low, most likely due to the restricted geography, compromised substrate quality, and lack of foraging habitat (see Section 2.2). Because of the low numbers of opportunistically reported sightings and absence of extensive systematic surveys, insufficient sighting data exist to estimate densities of marine mammals in this Application. To ensure

that the Project has coverage for incidental take of these occasionally occurring species, the Applicant has estimated the frequency of occurrence of all species in the Estuary based on the best available data.

6.1.1 Pacific Harbor Seal Density Estimates

Most data on harbor seal populations are collected while the seals are hauled out as they are much easier to count out of the water. The number of harbor seals hauled out on a floating platform at the Alameda Breakwater, approximately 7.8 mi (12.6 km) from the Project area, has been recorded almost every day since March 2014 (M. Klein and R. Bangert, pers. comm. 2019). Between zero and 75 seals haul out each day; more animals are present in the winter during the herring run (see Section 4.1 for more information).

Although complete count information exists for harbor seals at Alameda Breakwater on the other side of Alameda Island, insufficient sighting data exist to estimate harbor seal density in the Estuary. In June 2019 during 30 h of monitoring, no harbor seals were seen. The seasonal increase in seals hauled out at Alameda Breakwater in the winter may explain the dearth of sightings in June, and also suggests there could be more harbor seals present in the Project area later in the year (see Section 4.1). There were only four confirmed harbor seal sightings reported in the Estuary to TMMC and CAS between 2006 and May 2019 (NMFS 2019a, 2019b), and a dead harbor seal at Pier 2 in the existing Alameda Marina on October 27, 2019 (T. Drake, pers. comms. 2019). A local boater who lives aboard his boat full-time in Alameda Marina reported seeing a harbor seal in the marina approximately twice per week. Another local boater who uses Alameda Marina occasionally reported seeing a harbor seal near or within the marina on five days in August and October. This single seal would occasionally haul out on the docks of Alameda Marina for several hours per day. Local users with low to high confidence identifying pinniped species reported seeing harbor seals rarely, two per week, or two per month (see Section 4.1). Local knowledge and the limited survey effort in June of 2019 indicate that harbor seal use of the Estuary is very limited, perhaps averaging two seals per week. To compensate for a potential increase in seals in the Estuary in the winter, we are assuming a frequency of one harbor seal per day near the Project area, i.e., up to 68 individuals in Year 1 and up to 98 individuals in Year 2.

6.1.2 Northern Elephant Seal Density Estimates

Insufficient data are available to estimate the density of northern elephant seals in the Estuary. During 30 h of monitoring in June 2019, no elephant seals were seen, and between 2006 and May 2019 there were no reports of stranded elephant seals in the Estuary (NMFS 2019a, 2019b). Interviews with frequent users of the Estuary also reported they had never seen an elephant seal in the Estuary. For the purpose of this assessment and to ensure that the Project has coverage for incidental take of this species that may occur due to their expanding range in the Bay and effects of climate change, the Applicant is requesting a total of six Level B takes of northern elephant seals throughout the Project duration.

6.1.3 California Sea Lion Density Estimates

Insufficient sighting data exist to estimate sea lion density in the Estuary. There were 18 confirmed sea lion sightings reported in the Estuary to TMMC and CAS between 2006 and May 2019 (NMFS 2019a, 2019b). In June 2019 during 30 h of monitoring over four days, only one sea lion was seen, possibly

foraging under the Coast Guard dock across the channel from the Project area. Only two staff members of the local marinas could confidently identify pinnipeds. They reported seeing one to two sea lions per year in the Estuary (Table 6). Because of the brief monitoring time, limited local knowledge, and the fact that sea lion use of the Estuary is likely to increase in winter, it is assumed that one California sea lion may occur in the Project area every 5 days (i.e., up to 15 individuals in 68 days of construction in Year 1, and up to 21 individuals in 98 days of construction in Year 2).

6.1.4 Northern Fur Seal Density Estimates

Insufficient data are available to estimate the density of northern fur seals in the Estuary. During 30 h of monitoring in June 2019, no fur seals were seen, and between 2006 and May 2019 there were no reports of stranded fur seals in the Estuary (NMFS 2019a, 2019b). Interviews with frequent users of the Estuary also reported they had never seen a fur seal in the Estuary. For the purpose of this assessment and to ensure that the Project has coverage for incidental take of this species that may occur due to their expanding range in the Bay, the Applicant is requesting a total of six Level B takes of Northern fur seals throughout the Project duration.

6.1.5 Coastal Bottlenose Dolphin Density Estimates

Insufficient sighting data exist to estimate bottlenose dolphin density in the Estuary. Historically, observations of bottlenose dolphins primarily have occurred west of Treasure Island and were concentrated along the nearshore area of San Francisco south to Redwood City. However, since 2016 one individual has been regularly seen near the former Alameda Air Station (W. Keener, pers. comm. 2017; Perlman 2017), and five animals were regularly seen in the summer and fall of 2018 in the same location (W. Keener, pers. comm. 2019). In February 2019, a single dolphin and adult and juvenile were seen on two separate occasions northwest of the Oakland Inner Harbor (W. Keener, pers. comm. 2019), only 5.8 mi (9.3 km) from the Project area. In June 2019 during 30 h of monitoring, no bottlenose dolphins were observed. There were no reports of bottlenose dolphins in the Estuary between 2006 and May 2019 (NMFS 2019a, 2019b). Interviews with frequent users of the Estuary also reported they had never seen a dolphin in the Estuary. For the purpose of this assessment and to ensure that the Project has coverage for incidental take of this species that may occur due to their increasing numbers and expanding range in the Bay, it is assumed that a group of two bottlenose dolphins may occur in the Project area every 10 days (i.e., up to 15 individuals in 68 days of construction in Year 1, and up to 21 individuals in 98 days of construction in Year 2).

6.1.6 Harbor Porpoise Density Estimates

Insufficient sighting data exist to estimate harbor porpoise density in the Estuary. Historically, harbor porpoise are primarily seen near the Golden Gate Bridge, Marin County, and the city of San Francisco on the northwest side of the Bay (Keener et al. 2012, Stern et al. 2017). However, in the summer of 2017 and 2018, mom-calf pairs and small groups (1–4 individuals) were seen to the north and west of Treasure Island, and just south of YBI (Caltrans 2018a, 2019), indicating that their range may be expanding within the Bay. During 30 h of monitoring in June 2019, no harbor porpoise were seen, and between 2006 and May 2019 there was only one report of a harbor porpoise stranded in the Estuary (NMFS 2019a, 2019b).

This animal was in an advanced state of decomposition, so probably floated into the Estuary rather than died there. Interviews with frequent users of the Estuary also reported they had never seen a porpoise in the Estuary. This opportunistic data indicate that harbor porpoise have not yet been seen in the Estuary, but they may begin to use the Estuary as their range expands. For the purpose of this assessment and to ensure that the Project has coverage for incidental take of this species that may occur due to their expanding range in the Bay, it is assumed that a group of two harbor porpoise may occur in the Project area every 10 days (i.e., up to 15 individuals in 68 days of construction in Year 1, and up to 21 individuals in 98 days of construction in Year 2).

6.2 Distances to Marine Mammal Criteria for Pile Driving

As discussed in Chapter 5, "Type of Incidental Taking Authorization Requested," NMFS has established sound threshold criteria for behavioral disturbance (Level B harassment) and PTS (Level A harassment) to marine mammals from pile driving and other similar activities (Table 7). The Applicant is proposing:

- Vibratory driving of sheet piles;
- Vibratory removal of timber and concrete piles;
- Initial vibratory driving of wide flange beams and steel pipe piles ≥30 in in diameter, followed by;
- Attenuated (i.e., bubble curtain) impact driving of steel pipe piles ≥30 in in diameter to final depth;
- Attenuated (i.e., bubble curtain) impact driving of wide flange beams to final depth; and
- Unattenuated (i.e., no bubble curtain) impact driving of square concrete piles ≤24 in.

The distances to the marine mammal threshold criteria for vibratory and impact driving were modeled by the acoustic engineering firm I&R based on hydroacoustic measurements for similar activities. Measured sound pressure levels from other projects came from the California Department of Transportation's (Caltrans) *Compendium of Pile Driving Sound Data* (2007), which provides information on sound pressures resulting from pile driving measured throughout Northern California. Distances to marine mammal threshold criteria were modeled for all pile types and installation methods outlined above and listed in Table 8. These distances were calculated by I&R using the NMFS' User Spreadsheet Tool Version 2.0 associated with the 2018 revision of the Marine Mammal Hearing Technical Guidance (NMFS 2018; spreadsheet available at http://www.nmfs.noaa.gov/pr/acoustics/guidelines.htm). A practical spreading model was used to calculate transmission loss, and it was assumed that a bubble curtain would provide 7 dB of attenuation for impact driving, as is recommended by NMFS. As described in Section 1.2.2, the Project may also use wood block cushions to attenuate for impact driving on concrete piles, but no reduction in sound levels was calculated from use of the blocks.

Unique inputs for the User Spreadsheet are provided in Table 8, and screenshots of User Spreadsheets used to calculate vibratory and impact Level A harassment isopleths are provided in Appendix B. The following inputs were used for all vibratory calculations. Five hundred strikes per pile was used to model impact driving for this application, based on input from the Project contractor; isopleth distances based on 750 and 1,000 strikes are given in Appendix C for reference.

- Spreadsheet tab A.1: "Vibratory Pile Driving (STATIONARY SOURCE: Non-impulsive, Continuous)"
- Weighting factor adjustment = 2.5 kHz,
- Duration to drive a single pile (min) = 20
- Propagation (xLogR) = 15,
- Distance of source level = 32.8 ft (10 m).

The following inputs were used for all impact calculations:

- Spreadsheet tab E.1: "Impact Pile Driving (STATIONARY SOURCE: Impulsive, Intermittent)"
- Input method E.1–2: ALTERNATIVE METHOD TO CALCULATE PK AND SELcum (SINGLE STRIKE EQUIVALENT)
- Weighting factor adjustment = 2.0 kHz,
- Number of strikes per pile = 500,
- Propagation (xLogR) = 15,
- Distance of single strike SEL measurement = 32.8 ft (10 m).

Table 8. NMFS' User Spreadsheet source level inputs. All sound values are expressed in dB re 1μPa.

Vibratory Pile Driving			
	Peak	RMS	One-second SEL
36-in Steel Pipe Pile	180	170	170
30-in Steel Pipe Pile[1]	180	170	170
W 40x199 Wide Flange Beam[2]	170	155	155
PZC13, PZ27, and PZ35 Steel Sheet Pile[3]	175	160	160
16-inTimber Pile Removal[4]	162	152	152
12-in Concrete Pile Removal[5]	171	155	155
Impact Pile Driving			
	Peak	RMS	Single-strike SEL
36-in Steel Pipe Pile	210	193	183
30-in Steel Pipe Pile	210	190	177
W 40x199 Wide Flange Beam[6]	207	194	178
24-in Concrete Pile[7]	188	176	166
16-in Concrete Pile[8]	185	166	155
14-in Concrete Pile[8]	185	166	155

[1] Source levels based on 36-in steel pipe pile
[2] Source levels based on 38-in x 18-in king piles at the Naval Station Mayport in Jacksonville, Florida
[3] RMS level based on 24-in AZ steel sheet (CalTrans 2015)
[4] Source levels based on 14-in timber piles (The Greenbusch Group, Inc. 2018)
[5] Source levels based on 12-in steel pipe pile (CalTrans 2015)
[6] Source levels based on 24-in steel pipe pile (CalTrans 2015)
[7] Source levels based on 24-in concrete piles driving in 15 m of water (CalTrans 2015)
[8] Source levels based on 18-inch square concrete piles

For calculation of SELcum threshold distances, the following assumptions were made:

- Only one type/size of pile will be installed on the same day.
- Only one pile installation method, impact or vibratory, will be performed on the same day.
- A maximum of 20 steel sheet piles will be installed (vibratory driving only) on the same day.
- A maximum of 10 timber and/or concrete piles will be removed (vibratory driving only) on the same day.
- A maximum of three 36-in steel pipe piles will be installed (attenuated impact driving or vibratory) on the same day.
- A maximum of one 30-in steel pipe pile will be installed (attenuated impact driving or vibratory) on the same day.
- A maximum of four wide flange beams will be installed (attenuated impact driving or vibratory) on the same day.
- A maximum of four 24-in, 16-in, or 14-in square concrete piles will be installed (vibratory driving only) on the same day.
- A maximum of four 24-in, 16-in, or 14-in square concrete piles will be installed (impact driving only) on the same day.

The distances to the Level A and Level B marine mammal threshold criteria for these pile driving activities are shown in Table 9 and Table 10.

The calculations of Level A/PTS threshold distances (isopleths) for impulsive sounds are based on a dual metric threshold between the higher level of the SELcum or Peak SPL calculations. Level A isopleths calculated for this Project using Peak SPLs are <10 m for for all hearing groups and all pile types, except for a 34- and 12-m isopleth for HF cetaceans for 36-in and 30-in pipe piles (unattenuated and attenuated, respectfully). Since the onset of PTS based on the distance to the SELcum threshold is further from the pile for all pile types than for the Peak SPL calculations, only Level A/PTS isopleths based on SELcum computations are included in this analysis (Table 10). Isopleth threshold distances based on Peak SPL calculations are given for reference in Appendix C.

The distance to the 120 dB RMS Level B threshold for vibratory pile driving was calculated to be 21,544 meters for 30-in steel pipe piles and 36-in steel pipe piles. However, the majority of pile driving work will be along the shoreline within the Estuary, and sound will be blocked by the channel edges and surrounding land masses (Figures 7 through 10). Additionally, due to the shallow water depths in the Project area (0–25 ft [0–8 m]; Section 2.2), underwater sound propagation of low-frequency sound (the primary frequency range of pile driving) is expected to be poor. As it is not practical to monitor the full zones for a project of this extended length, the Applicant proposes to position MMOs such that at least 20 percent of the Level B zone is covered. MMOs will fully monitor this representative area surrounding the Level A zone, and estimates of take will be scaled up proportional to the full Level B zone (see Section 13.2).

Table 9. Distances to Level A and Level B harassment threshold criteria for vibratory pile driving.

Pile Description	Number of Piles Installed per Day	Level A/PTS Isopleth Threshold (m) Based on SELcum					Level B (120 dB RMS) Behavioral Harassment Zone (m)
		Cetaceans			Pinnipeds		
		LF	MF	HF	Phocids	Otariids	
36-in Steel Pipe Pile	1	8	1	12	5	<1	21,544
	3	17	2	25	10	1	
30-in Steel Pipe Pile	1	8	1	12	5	<1	21,544
W 40x99 Wide Flange Beam	1	1	<1	1	1	<1	2,154
	4	2	<1	3	1	<1	
PZC 13, PZ 27, and PZ 35 Steel Sheet Pile	1	<1	<1	1	<1	<1	4,642
	20	2	<1	3	1	<1	
16-in Timber Pile Removal	1	<1	<1	1	<1	<1	1,359
	10	2	<1	2	1	<1	
12-in Concrete Pile Removal	1	1	<1	1	<1	<1	2,154
	10	2	<1	4	2	<1	

Table 10. Distances to Level A and Level B harassment threshold criteria for impact pile driving based on SELcum. Isopleth thresholds based on Peak SPLs were also calculated, however all isopleth distances were less than those calculated based on SELcum and therefore are not shown here; they are listed in Appendix C.

<table>
<tr><th rowspan="3">Pile Description</th><th rowspan="3">Attenuation</th><th rowspan="3">Number of Piles Installed per Day</th><th colspan="5">Level A/PTS Isopleth Threshold (m) Based on SELcum</th><th rowspan="3">Level B (160 dB RMS) Behavioral Harassment Zone (m)</th></tr>
<tr><th colspan="3">Cetaceans</th><th colspan="2">Pinnipeds</th></tr>
<tr><th>LF</th><th>MF</th><th>HF</th><th>Phocids</th><th>Otariids</th></tr>
<tr><td rowspan="4">36-in Steel Pipe Pile</td><td rowspan="2">Unattenuated</td><td>1</td><td>629</td><td>22</td><td>749</td><td>337</td><td>25</td><td rowspan="2">1,585</td></tr>
<tr><td>3</td><td>1,308</td><td>47</td><td>1,559</td><td>700</td><td>51</td></tr>
<tr><td rowspan="2">Attenuated</td><td>1</td><td>215</td><td>8</td><td>256</td><td>115</td><td>8</td><td rowspan="2">541</td></tr>
<tr><td>3</td><td>447</td><td>16</td><td>532</td><td>239</td><td>17</td></tr>
<tr><td rowspan="2">30-in Steel Pipe Pile</td><td>Unattenuated</td><td>1</td><td>250</td><td>9</td><td>298</td><td>134</td><td>10</td><td>1,000</td></tr>
<tr><td>Attenuated</td><td>1</td><td>86</td><td>3</td><td>102</td><td>46</td><td>3</td><td>341</td></tr>
<tr><td rowspan="4">W 40x99 Wide Flange Beam</td><td rowspan="2">Unattenuated</td><td>1</td><td>292</td><td>10</td><td>348</td><td>156</td><td>11</td><td rowspan="2">1,848</td></tr>
<tr><td>4</td><td>736</td><td>26</td><td>876</td><td>394</td><td>29</td></tr>
<tr><td rowspan="2">Attenuated</td><td>1</td><td>100</td><td>4</td><td>119</td><td>53</td><td>4</td><td rowspan="2">341</td></tr>
<tr><td>4</td><td>251</td><td>9</td><td>299</td><td>135</td><td>10</td></tr>
<tr><td rowspan="2">24-in Square Concrete Pile</td><td rowspan="2">Unattenuated</td><td>1</td><td>46</td><td>2</td><td>55</td><td>25</td><td>2</td><td rowspan="2">117</td></tr>
<tr><td>4</td><td>117</td><td>4</td><td>139</td><td>62</td><td>5</td></tr>
<tr><td rowspan="2">16-in Square Concrete Pile</td><td rowspan="2">Unattenuated</td><td>1</td><td>9</td><td><1</td><td>10</td><td>5</td><td><1</td><td rowspan="2">25</td></tr>
<tr><td>4</td><td>22</td><td>1</td><td>26</td><td>12</td><td>1</td></tr>
<tr><td rowspan="2">14-in Square Concrete Pile</td><td rowspan="2">Unattenuated</td><td>1</td><td>9</td><td><1</td><td>10</td><td>5</td><td><1</td><td rowspan="2">25</td></tr>
<tr><td>4</td><td>22</td><td>1</td><td>26</td><td>12</td><td>1</td></tr>
</table>

6.3 Number of Marine Mammals, by Species, that May be Taken by Pile Driving and Pile Removal Activities

The numbers of harbor seals, elephant seals, sea lions, fur seals, bottlenose dolphins, and harbor porpoises that may be taken by pile driving were calculated based on the estimated frequency of animals within the Project area and the number of days of vibratory and impact pile driving. The estimated frequency of animals was used to calculate take estimates as there was insufficient data to estimate species densities in the Estuary.

The total take estimate is the sum of estimated take for vibratory driving plus the estimated take for impact driving. The number of days of driving for each year of construction was estimated based on the Project construction assumptions in Section 6.2, and by adding a 10% buffer (Tables 11–14). Take estimates for Year 1 are based on 56 days of vibratory driving (Table 11) plus 12 days of impact driving (Table 12). Take estimates for Year 2 are based on 52 days of vibratory driving (Table 13) plus 46 days of impact driving (Table 14).

Figures 7 through 10 show the Level A and Level B zones of influence (ZOI) for vibratory and impact driving as a function of the geography in the Estuary. The Project area has been divided into western and eastern work sections. Work in the eastern section is primarily along the edge of the channel and thus ZOIs will extend further west and east down the Estuary than for all piles on the western side (Figure 7).

Take estimates assume that Project pile driving activities will occur on a maximum total of 166 days over the two-year period requested in this application, and that a single animal can only be taken once per pile/hammer type per day. Inputs used to calculate take estimates, and requested take numbers, are shown in Table 15 and Table 16.

Table 11. Total estimated number of days of vibratory pile driving and removal in Year 1.

Type of Pile	Total Number of Piles	Number of Piles Allowed per Day	Days of Vibratory Driving or Removal
36-in Steel Pipe Piles	2	3	0.7
Steel Sheet Piles	362	20	18.1
Timber and Concrete Pile Removal	320	10	32.0
Total **Total (+10% buffer)**	**684**		**50.8** **55.8**

Table 12. Total estimated number of days of impact pile driving in Year 1.

Type of Pile	Total Number of Piles	Number of Piles Allowed per Day	Days of Impact Driving
16-in Square Concrete Piles	41	4	10.3
Total **Total (+10% buffer)**	**41**		**10.3** **11.3**

Table 13. Total estimated number of days of vibratory pile driving in Year 2.

Type of Pile	Total Number of Piles	Number of Piles Allowed per Day	Days of Vibratory Driving or Removal
36-in Steel Pipe Piles	1	3	0.3
30-in Steel Pipe Pile	1	1	1.0
Wide Flange Beams	130	4	32.5
Steel Sheet Piles	259	20	13.0
Total **Total (+10% buffer)**	**391**		**46.8** **51.5**

Table 14. Total estimated number of days of impact pile driving in Year 2.

Type of Pile	Total Number of Piles	Number of Piles Allowed per Day	Days of Impact Driving
36-in Steel Pipe Piles	1	1	1.0
30-in Steel Pipe Pile	1	1	1.0
Wide Flange Beams	130	4	32.5
24-in Square Concrete Piles	8	4	2.0
14-in Square Concrete Piles	19	4	4.8
Total **Total (+10% buffer)**	**159**		**41.3** **45.4**

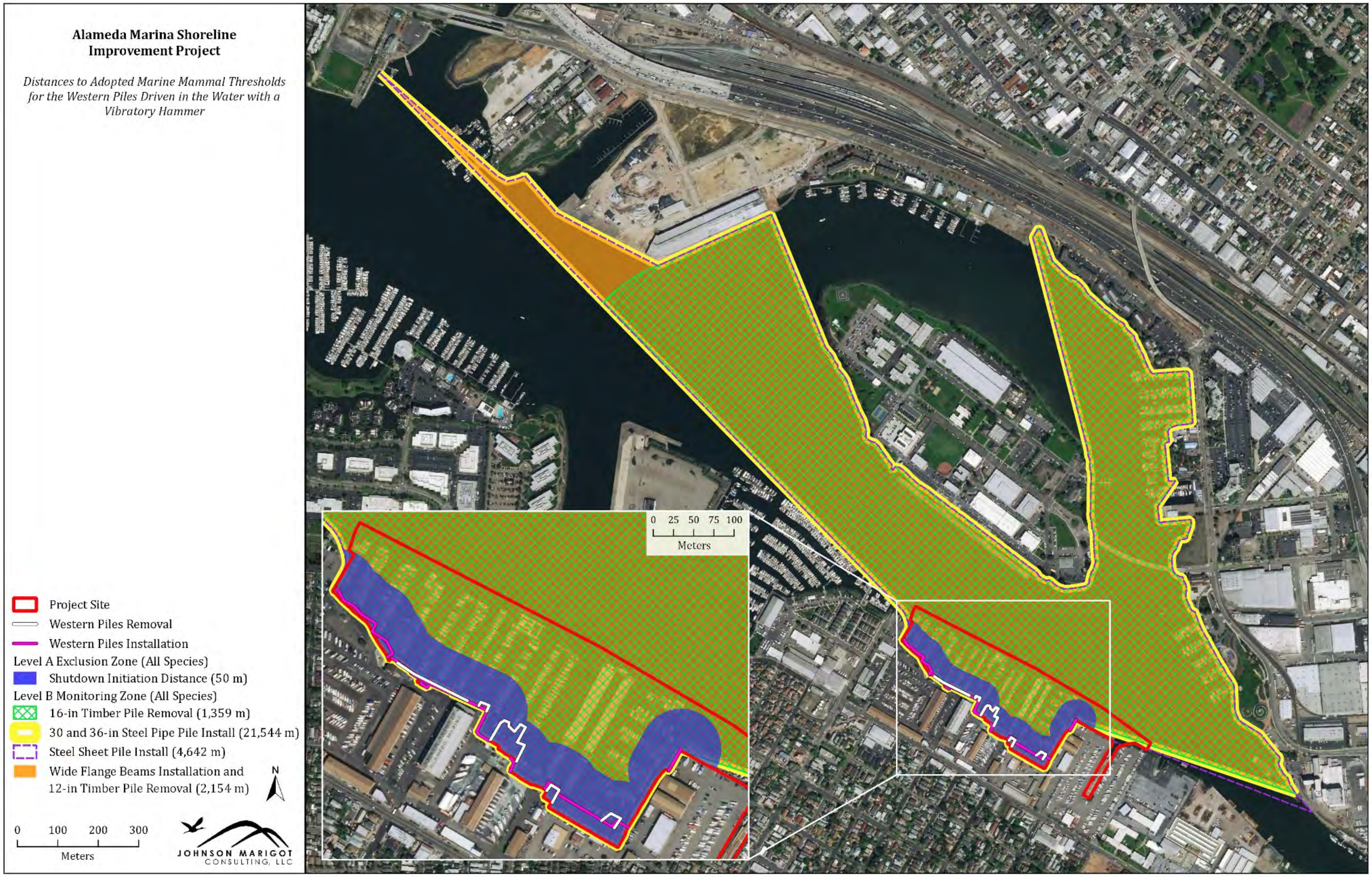

Figure 7. Level A and Level B zones of influence for piles driven or removed by vibratory hammer on the western side of the Alameda Marina.

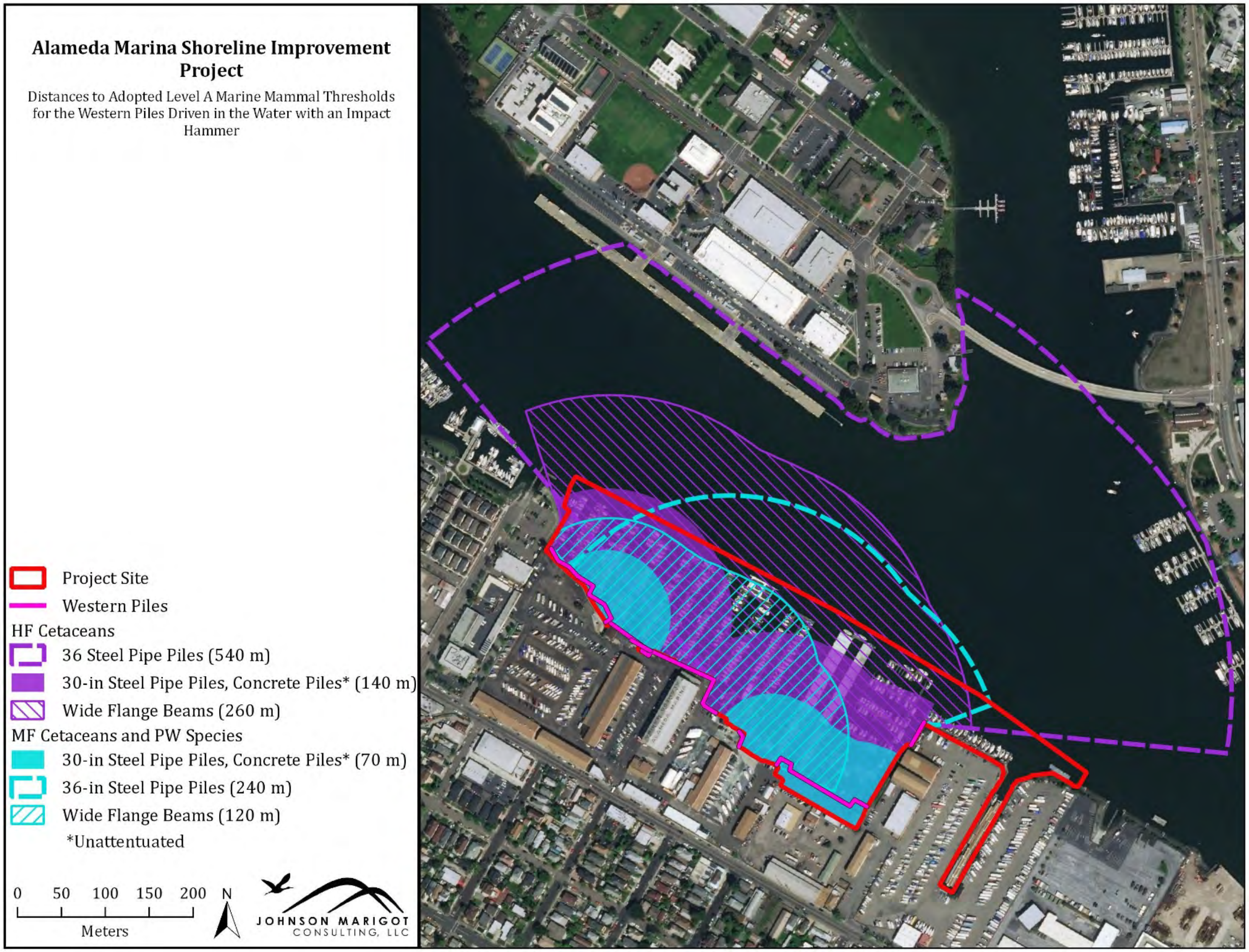

Figure 8. Level A zones of influence for piles driven by impact hammer on the western side of the Alameda Marina.

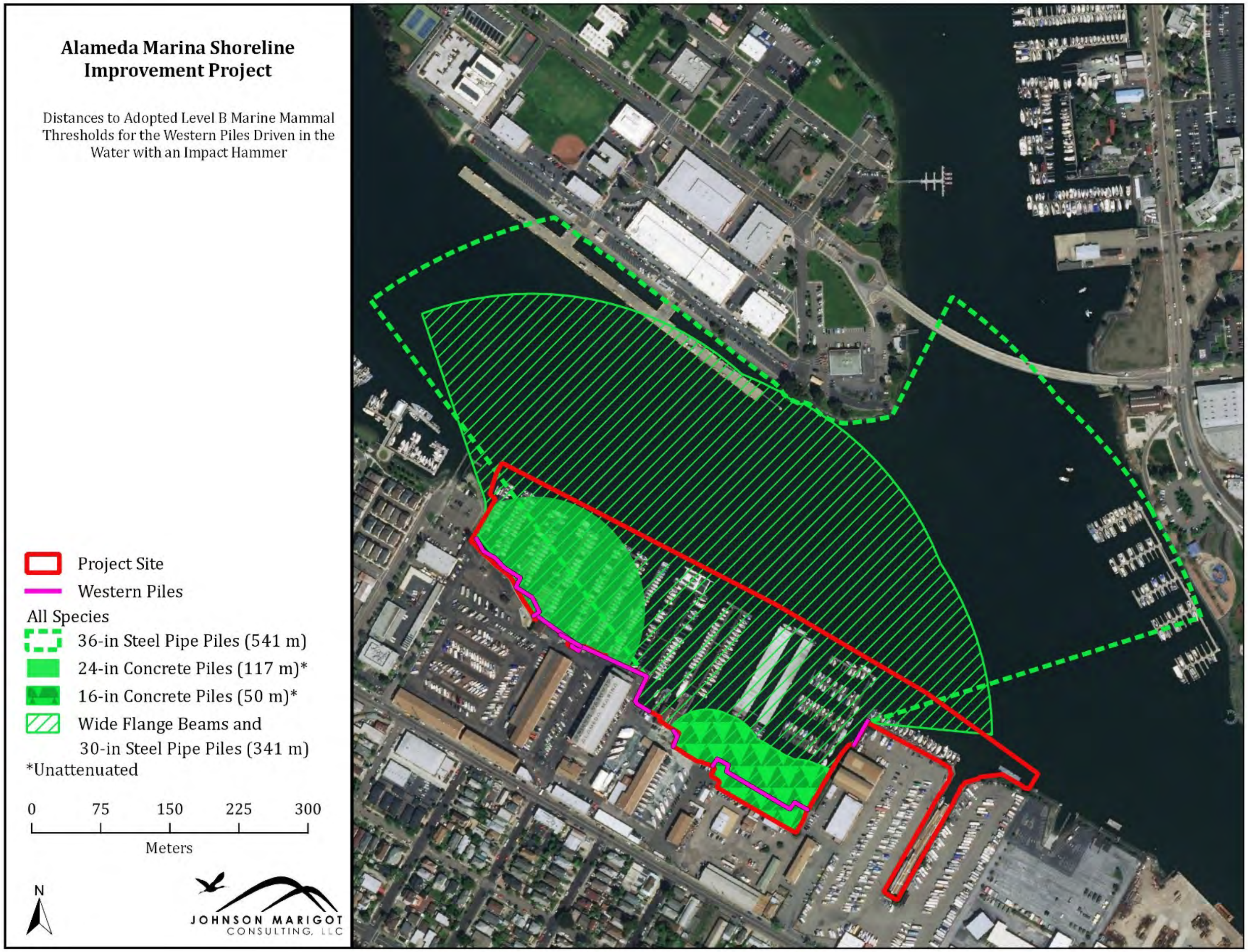

Figure 9. Level B zones of influence for piles driven by impact hammer on the western side of the Alameda Marina.

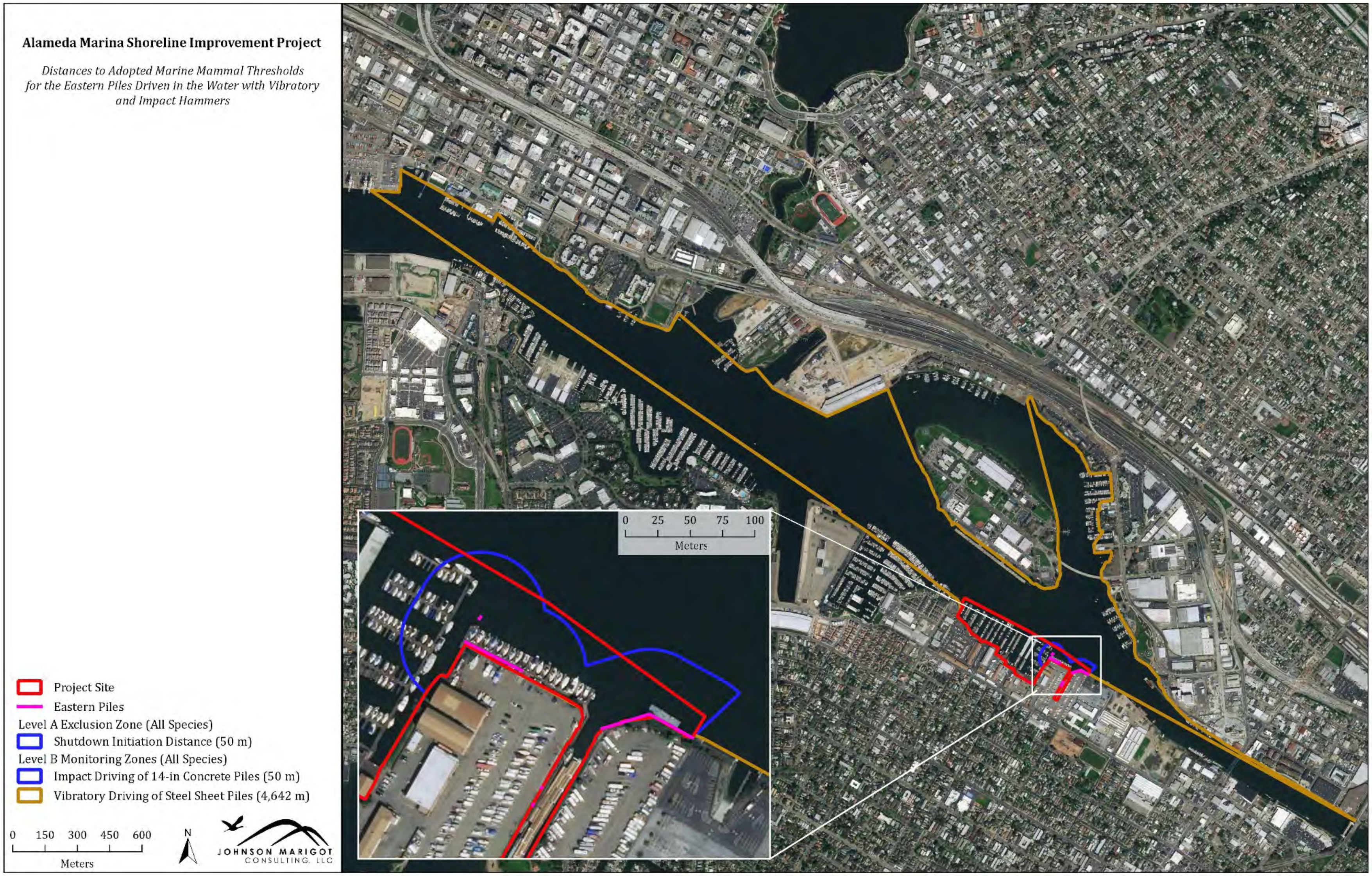

Figure 10. Level A and Level B zones of influence for piles driven by impact and vibratory hammer on the eastern side of the Alameda Marina.

Table 15. Summary of marine mammal estimated frequency in the Project area and requested Level B take for Year 1 of construction activities. Pile driving will not begin if a marine mammal is within the Level A/PTS MMEZ. Therefore, no animals will be taken by Level A harassment.

Species	Frequency in Project Area	Estimated Level B Take (68 Days of Pile Driving * Animal Frequency)	Total Requested Level B Take in Year 1
Pacific Harbor Seal	1/day	68.0	**68**
California Sea Lion	1/5 days	13.6	**14**
Bottlenose Dolphin	2/10 days	13.6	**14**
Harbor Porpoise	2/10 days	13.6	**14**
Northern Elephant Seal	6 total	N/A	**6**
Northern Fur Seal	6 total	N/A	**6**

Table 16. Summary of marine mammal estimated frequency in the Project area and requested Level B take for Year 2 of construction activities. Pile driving will not begin if a marine mammal is within the Level A/PTS MMEZ. Therefore, no animals will be taken by Level A harassment.

Species	Frequency in Project Area	Estimated Level B Take (98 Days of Pile Driving * Animal Frequency)	Total Requested Level B Take in Year 2
Pacific Harbor Seal	1/day	98.0	**98**
California Sea Lion	1/5 days	19.6	**20**
Bottlenose Dolphin	2/10 days	19.6	**20**
Harbor Porpoise	2/10 days	19.6	**20**
Northern Elephant Seal	6 total	N/A	**6**
Northern Fur Seal	6 total	N/A	**6**

The Applicant anticipates that a maximum of 122 animals may be taken by Level B harassment during pile driving activities in Year 1 (Table 15), and a maximum of 170 may be taken in Year 2 (Table 16). These animals will be exposed temporarily to continuous (vibratory pile installation and removal) sounds greater than 120 dB RMS and impulse (impact driving) sounds greater than 160 dB RMS. The majority of the animals taken by Level B harassment will be harbor seals (Table 15 and Table 16), the most numerous marine mammals in the Project area.

In the final report to NMFS, estimates of animals taken during the Project will be scaled up proportional to the number of animals observed in the portion of the Level B ZOI fully monitored by MMOs (see Section 13.2).

The Applicant does not anticipate any individuals will be taken by Level A harassment. If a marine mammal is observed in a Level A/PTS Marine Mammal Exclusion Zone (MMEZ), pile driving will be delayed until the animal has moved out of the area or has not been observed for 15 min. With proposed monitoring and establishment of MMEZs, discussed further in Chapter 11, “Mitigation Measures,” Level

A harassment of marine mammals will be avoided. The Applicant is not requesting Level A take for this Project.

6.4 Species Impacts from Pile Driving

6.4.1 Pacific Harbor Seal

Harbor seals and California sea lions are the most numerous marine mammal species in the Project area. Based on the low number of animals known to inhabit the Estuary, the Applicant anticipates a maximum of 166 harbor seals may be exposed to Level B harassment levels during pile driving over the two years of construction activity (Table 15 and Table 16): sounds greater than 120 dB RMS during vibratory driving and greater than 160 dB RMS during impact driving. With the proposed monitoring and establishment of the MMEZ, discussed in Chapter 11, slight injury, PTS Level A harassment will be avoided.

Male and female adult and juvenile harbor seals may be present in the Project area. Although harbor seals may be present in the Level B harassment monitoring zone during pile driving, their exposure to sound generally will be for a short duration, and those seals that may remain to forage are expected to be unaffected.

Based on known behavior patterns, low numbers of harbor seals present near the Project area, low anticipated sound levels, and implementation of avoidance and minimization measures (discussed further in Chapter 11), the Applicant has determined that pile driving activities will not result in Level A harassment or mortality to any harbor seals. Pile driving activities may result in Level B behavioral harassment of both juvenile and adult harbor seals transiting or foraging in the Project area.

6.4.2 Northern Elephant Seal

Northern elephant seals are not yet known to use the Estuary. Most have been observed near YBI or Treasure Island, and were discovered by TMMC to be stranded, sick, or injured juveniles. However, the Applicant wants to ensure that the Project has coverage for the incidental take of any species with the potential to be present in the Project area, and estimates a maximum of six northern elephant seals may be exposed to Level B harassment levels during pile driving over the two years of construction activity (Table 15 and Table 16). With the proposed monitoring and establishment of the MMEZ, discussed further in Chapter 11, slight injury, PTS Level A harassment will be avoided.

Based on known behavior patterns, little to no elephant seal presence in the Estuary, low anticipated sound levels, and implementation of avoidance and minimization measures (discussed further in Chapter 11), the Applicant has determined that pile driving activities will not result in Level A harassment or mortality to any northern elephant seal. Pile driving activities may result in Level B behavioral harassment of a small number of juvenile northern elephant seals transiting or foraging in the Project area, but exposure to sound generally will be for a short duration, and thus they are expected to be unaffected.

6.4.3 California Sea Lion

Based on the low number of sea lions known to inhabit the Estuary, the Applicant anticipates a maximum of 34 sea lions may be exposed to Level B harassment levels during pile driving over the two years of construction activity (Table 15 and Table 16). With the proposed monitoring and establishment of the MMEZ, discussed in Chapter 11, slight injury, PTS Level A harassment will be avoided.

Although sea lions may enter the Level B behavioral harassment monitoring zone during pile driving activities, the exposure to sound will be only for a short duration. Exposure to the pile driving sounds may cause a short-term behavioral response, such as altering their travel path through the area, but is unlikely to affect their reproductive, foraging, or hearing abilities.

Subadult and adult male sea lions can be distinguished from females by the sagittal crest on their head, but in the water, the gender of juveniles up to 3 years old is indistinguishable. Female sea lions are much less common in the Bay and, by extension, the Estuary, than males. Adult females remain near the rookeries in Southern California throughout the year, alternating between foraging and nursing their pups on shore until the next pupping/breeding season. After the breeding season, adult and subadult males migrate northward along the coast to Northern California and the Bay. Because of the gender and reproductive phase-specific distribution of animals, fewer females than males and no pups have the potential to be affected by pile driving activities.

Based on known behavior patterns, limited presence in the Estuary, low anticipated sound levels, and implementation of avoidance and minimization measures (discussed further in Chapter 11), the Applicant has determined that pile driving will not result in Level A harassment or mortality of California sea lions. Pile driving activities may result in Level B harassment of a small number of adult male, subadult male, and juvenile sea lions that are transiting or foraging in the Project area.

6.4.4 Northern Fur Seal

Northern fur seals are not yet known to use the Estuary. Most have been observed near YBI or Treasure Island, and were discovered by TMMC to be stranded, sick, or injured juveniles. However, the Applicant wants to ensure that the Project has coverage for the incidental take of any species with the potential to be present in the Project area, and estimates a maximum of six northern fur seals may be exposed to Level B harassment levels during pile driving over the two years of construction activity (Table 15 and Table 16). With the proposed monitoring and establishment of the MMEZ, discussed further in Chapter 11, slight injury, PTS Level A harassment will be avoided.

Based on known behavior patterns, little to no fur seal presence in the Estuary, low anticipated sound levels, and implementation of avoidance and minimization measures (discussed further in Chapter 11), the Applicant has determined that pile driving activities will not result in Level A harassment or mortality to any northern fur seal. Pile driving activities may result in Level B behavioral harassment of a small number of juvenile northern fur seals transiting or foraging in the Project area, but exposure to sound generally will be for a short duration, and thus they are expected to be unaffected.

6.4.5 Coastal Bottlenose Dolphin

Bottlenose dolphins have not been reported in the Project vicinity but a few individuals are commonly seen approximately 6.8 mi (10.9 km) away on the far side of Alameda Island. As discussed in Section 4.3, until 2016, most bottlenose dolphins in the Bay were observed in the western Bay, from the Golden Gate Bridge to Oyster Point and Redwood City, although one individual was observed frequently near the former Alameda Air Station (Perlman 2017). As of 2017, the same two individuals, known to be female, have been observed regularly near Alameda, and up to five individuals were seen regularly in 2018 (W. Keener, pers. comm., 2019). Bottlenose dolphins are not known to use the Estuary, but if their range expands, they could become frequent users of the Estuary. The Applicant wants to ensure that the Project has coverage for the incidental take of any species with the potential to be present in the Project area. Therefore, the Applicant is requesting authorization for the Level B take of 34 bottlenose dolphins during pile driving activities over two years of construction activity (Table 15 and Table 16).

Based on known behavior patterns, little to no dolphin presence in the Estuary, low anticipated sound levels, and implementation of avoidance and minimization measures, including the establishment and monitoring of the MMEZ (discussed further in Chapter 11), the Applicant has determined that pile driving activities will not result in Level A harassment or mortality of bottlenose dolphins. A small number of male and female bottlenose dolphins may be exposed to Level B sound exposure thresholds for a short time while they are transiting or foraging in the Project area.

6.4.6 Harbor Porpoise

Based on estimated frequency in the Estuary, the Applicant anticipates a maximum of 34 harbor porpoise may be exposed to Level B harassment levels during pile driving over the two years of construction activity (Table 15 and Table 16). With the proposed monitoring and establishment of the MMEZ, discussed further in Chapter 11, slight injury, PTS Level A harassment will be avoided.

Harbor porpoise are not yet known to use the Estuary, but the Applicant wants to ensure that the Project has coverage for the incidental take of any species with the potential to be present in the Project area, as harbor porpoise seem to be expanding their range over the past couple years. Both juvenile and adult harbor porpoise were observed near YBI and Treasure Island, approximately 6.1 mi (9.8 km) distant, in 2017 and 2018 (Caltrans 2018a, 2019). Establishing the gender of harbor porpoise in the water is difficult. However, both male and female harbor porpoise presumably will have the potential to be present.

Based on known behavior patterns, little to no porpoise presence in the Estuary, low anticipated sound levels, and implementation of avoidance and minimization measures (discussed further in Chapter 11), the Applicant has determined that pile driving activities will not result in Level A harassment or mortality to any harbor porpoise. Pile driving activities may result in Level B behavioral harassment of a small number of both juvenile and adult harbor porpoise transiting or foraging in the Project area, but exposure to sound generally will be for a short duration, and thus they are expected to be unaffected.

7. ANTICIPATED IMPACT OF THE ACTIVITY

Take estimates in Table 15 and Table 16 represent estimated exposures to pile driving harassment threshold criteria under the MMPA. Threshold zones in Table 9 and Table 10 were calculated by I&R based on measurements collected during numerous previous pile driving activities in the northwest U.S. (Caltrans 2007, CalTrans 2015, Greenbusch Group 2018).

Because of this analysis and through implementation of avoidance and minimization measures, the Applicant has determined that the proposed pile driving will result only in Level B harassment. Based on the best available science, exposures of marine mammal species and stocks from pile driving is anticipated to result in only short-term effects on individuals exposed and will not be likely to affect annual rates of recruitment or survival. Implemented mitigation measures will prevent any Level A exposures or mortality.

Implementation of the protective measures described herein will assure that no permanent injury or mortality will occur to animals, and no impacts (short- or long-term) will occur on the populations or stocks of marine mammals that regularly inhabit or occasionally enter the Bay and Estuary.

8. ANTICIPATED IMPACTS ON SUBSISTENCE USES

Not applicable; none of the species or stocks of marine mammals regularly found in the Bay or Estuary are used for subsistence purposes.

9. ANTICIPATED IMPACTS ON HABITAT

No designated critical habitat exists for marine mammals in the Bay or Estuary. The primary source of effects on marine mammal habitat will be temporary noise and pressure exposures from pile driving. The Project is not expected to have any substantial effects on marine mammal habitat. Short-term impacts on water clarity may result from minimal disturbance of sediment during pile driving.

Project activities will not affect any pinniped haulout sites or pupping sites. The YBI harbor seal haulout site is 6.6 mi (10.7 km) away from the Project site by water, and the Alameda Breakwater haulout site is 7.8 mi (12.6 km) away by water. Both are separated from the Project area by the island of Alameda. Because of the distance and the island landmass blocking the sound, underwater noise and pressure levels from the Project will not reach the haulout sites. Harbor seals on YBI and at the Alameda Breakwater commonly are subjected to high levels of disturbance, primarily from watercraft, ship wakes, and traffic noise. This is particularly true during the summer, when the numbers of small recreational watercraft in the Bay increase (Green et al. 2002). Other haulout sites for harbor seals, northern elephant seals, California sea lions, and northern fur seals are at a sufficient distance from the Project area that they also will not be affected. The closest recognized harbor seal pupping site is at Castro Rocks, approximately 15.2 mi (24.5 km) from the Project area. No sea lion, elephant seal, or fur seal rookeries are found in the Bay or Estuary.

SPLs from impact pile driving have the potential to injure or kill fish in the immediate area. These few isolated fish mortality events are not anticipated to have a substantial effect on marine mammal prey species populations or their availability as a food resource for marine mammals.

Based on the discussion in this chapter, no effects on marine mammals will occur from loss or modification of marine mammal habitat, including changes to haulout habitat or food resources.

10. ANTICIPATED EFFECTS OF HABITAT IMPACTS ON MARINE MAMMALS

Pile driving at the Project site is not likely to negatively affect the habitat of marine mammal populations because no loss of habitat will occur, and only a minor, temporary modification of habitat will occur from the hydroacoustic impacts of pile driving. The Project area is not used as a haulout site by pinnipeds, and the limited amount of impact driving will not have a long-term effect on fish prey species in the Project area. The physical effects from pressure waves that are generated by underwater impulse sounds (e.g., impact pile driving) may result in minor injury and mortality to fish but will not have a significant effect on fish populations within proximity of Project activities. The abundance and distribution of fish in the immediate vicinity of impact pile driving activities may be altered for a few hours during and immediately following the activities.

Based on the discussions above and in Chapter 9, no impacts will occur to marine mammals resulting from loss or modification of habitat. No designated critical habitat exists in the Bay. The Project is not expected to result in loss of marine mammal habitat (i.e., no destruction of haulout sites or destruction of reef areas will occur); therefore, no impacts will occur.

11. MITIGATION MEASURES TO PROTECT MARINE MAMMALS AND THEIR HABITAT

11.1 Minimization of Impacts from Pile Driving

Level A harassment of marine mammals during maintenance and refurbishment of the Alameda Marina will not occur due to implementation of avoidance and minimization measures described in Chapter 13 However, despite implementation of mitigation measures described in Chapter 13, pile driving activities have some potential to result in Level B take of harbor seals, northern elephant seals, California sea lions, northern fur seals, harbor porpoises, and bottlenose dolphins under the MMPA. Level B harassment may occur, resulting in negligible short-term effects on marine mammals transiting or foraging in the area. However, the Project will not cause long-term effects on individuals and will not result in population-level effects. The following measures will be taken to minimize the exposure of marine mammals and their habitat to the effects of sound from pile driving.

- Pipe pile sizes will be limited to 36 in in diameter or smaller.
- Pile driving may be done with a vibratory hammer year-round without attenuation. If vibratory pile-driving occurs during the peak seasonal salmonid migration period (November 1 to May 31), work will occur only during daylight hours, from 1 hour after sunrise to 1 hour before sunset. For vibratory pile driving operations occurring outside the peak seasonal salmonid migration period (June 1 to October 30), illumination will be directed away from the water when night work is required. The only time night work that may be required would be to remove the 107 temporary sheet piles for the cofferdam at low tide, if low tide falls outside daylight hours.
- Steel piles will be initially installed with a vibratory hammer. An impact hammer will be used to complete steel pile installation and drive to final depths. All impact driving of steel piles will be attenuated with a bubble curtain attenuator or other marine pile driving energy attenuator (such as an isolation casing).
- Before operating impact pile driving hammers at full capacity, the Applicant will implement a soft start. The soft start will consist of an initial set of strikes at reduced energy, followed by a 30-sec waiting period, then two subsequent reduced-energy strikes separated by the waiting period. A soft start will be implemented at the start of each day’s impact pile driving and at any time following cessation of impact pile driving for 30 min or longer.

These measures will limit the intensity of pile driving sound in the marine environment. In addition, the use of vibratory hammers to install and remove piles where feasible, and employment of a “soft start" for the impact hammer, in which pile driving intensity begins at reduced energy, is expected to encourage marine mammals to move away from disturbance areas so that they are less likely to be present within these areas during full-power pile driving activities. The use of sound attenuation devices such as bubble curtains and perhaps cushion blocks (for concrete piles only) will further reduce transmitted sound levels. Establishment of MMEZs and implementation of a monitoring plan will ensure that no marine mammals

are exposed to Level A sound thresholds, and that exposure of any animals to Level B sound thresholds is minimized and documented. Therefore, with these measures, the effects of the pile driving will be mitigated to the level of least practical adverse impact on marine mammals.

11.1.1 Marine Pile Driving Energy Attenuator Air Bubble Curtain System

Use of a marine pile driving energy attenuator (i.e., air bubble curtain system) or other equally effective sound attenuation method will be required during impact driving of all steel pipe piles and wide flange beams. Requiring the use of sound attenuation will reduce SPLs and therefore the size of the Level A and Level B harassment zones. See Section 1.2.2 for full operating standards of bubble curtains.

11.1.2 Monitoring Plan and Establishment of Marine Mammal Exclusion Zones

A Project-specific marine mammal monitoring plan for pile driving activities (discussed further in Chapter 13 and provided in Appendix D) will be employed to avoid the potential for individual exposure to Level A harassment, and to document the number and species potentially exposed to Level B harassment. The plan is similar to the previously NMFS-approved monitoring plan for SFOBB East Span Pier Retention pile driving activities (Caltrans 2018b). Before the start of impact pile driving activities, MMEZs will be established. The MMEZs are intended to include all areas where the underwater SPLs are anticipated to equal or exceed thresholds for slight injury– PTS Level A harassment thresholds for the species-specific hearing groups, shown in Table 9 and Table 10. NMFS-approved observers will survey the MMEZs for at least 30 min before pile driving activities start. If marine mammals are found within the MMEZ, pile driving will be delayed until the animal has moved out of the exclusion zone, either verified by sight by an observer or by waiting until 15 min has elapsed without a sighting, which assumes that the animal has moved beyond the MMEZ. With implementation of these avoidance and minimization measures, exposure of marine mammals to SPLs that can result in PTS Level A harassment will be avoided, and exposure of marine mammals to Level B SPLs will be minimized.

12. MITIGATION MEASURES TO PROTECT SUBSISTENCE USES

Not applicable; no activities will occur within Arctic subsistence hunting areas.

13. MONITORING AND REPORTING

A specific marine mammal monitoring plan for shoreline construction will be employed to avoid the potential Level A harassment of marine mammals and document the number of individuals by species taken by Level B harassment (Appendix D).

13.1 Monitoring Plan for Pile Driving

The monitoring plan includes Level A injury exclusion zones and Level B TTS and behavioral response harassment monitoring zones extending out to a pre-determined distance from pile driving, based on conservatively estimated distances to acoustic threshold criteria. The following are the general elements of the Marine Mammal Monitoring Plan (Plan). The complete Plan is provided in Appendix D and includes all NMFS monitoring and reporting requirements.

13.1.1 Pre-Construction Briefings

Briefings will be conducted for construction supervisors and crews, the marine mammal monitoring team, and Applicant staff prior to the start of all pile driving activity, and when new personnel join the work. Briefings will explain personnel responsibilities, communication procedures, the marine mammal monitoring protocol, and operational procedures.

13.1.2 Level A Harassment – Injury and Mortality Exclusion Zones

The MMEZs will include all areas where the underwater SPLs are anticipated to equal or exceed thresholds for Level A harassment PTS thresholds, shown in Table 7. Before impact or vibratory pile driving or pile removal, initial hearing-group-specific MMEZs will be established at a radial distance, as shown in Table 17. The MMEZs will be monitored by marine mammal observers (MMOs) for at least 30 min before pile driving begins, and if any marine mammal is observed inside the MMEZs, pile driving will be delayed until the animal leaves the area or at least 15 minutes have passed since the last observation of the animal. Some Level A zones will utilize an initial shutdown distance which is greater than the calculated threshold (Table 17). These initial shutdown distances have been added to conservatively protect marine mammals and to simplify the EZs for use in the field.

For all in-water construction using heavy machinery other than pile driving equipment (e.g., use of barge-mounted excavators, or dredging), a 10-m shutdown zone will be in effect. If a marine mammal comes within 10 m, the Applicant will cease operations and reduce vessel speed to the minimum required to maintain steerage and safe working conditions. Monitoring of this shutdown zone does not require an MMO; the contractor can implement this measure.

After impact pile driving begins, hydroacoustic measurements will be collected for the specific activity (location and size/type of pile). These hydroacoustic monitoring results will be provided to NMFS, and the radius of the exclusion zones may be adjusted based on measured SPLs. The hydroacoustic monitoring plan prepared by I&R is included in Appendix E.

13.1.3 Level B Harassment – Behavioral Response and TTS Monitoring Zones

Behavioral harassment monitoring zones will include areas where the underwater SPLs are anticipated to equal or exceed thresholds for Level B behavioral response and TTS for all species–120 dB RMS for continuous sounds (vibratory pile driving), and 160 dB RMS for impulse sounds (impact pile driving). The largest Level B zone radius for vibratory driving (of three 36-in steel pipe piles in one day) was calculated at 21,544 m (Table 9) but the ZOI is functionally only 1.43 km^2 in the Estuary due to the geography of the Estuary. The largest Level B zone for impact driving (of three 36-in steel pipe piles in one day) is 541 m (Table 10), 0.28 km^2 in the Estuary. Before impact or vibratory pile driving, initial Level B marine mammal monitoring zones will be established at the radial distance shown in Table 17. For larger zones, the Applicant will position MMOs to cover a representative area of the Level B zone surrounding the Level A zone. After pile driving activity begins, hydroacoustic measurements will be collected for the specific activity (location and size/type of pile). These hydroacoustic monitoring results will be provided to NMFS, and the radius of the Level B monitoring zone may be adjusted, based on measured SPLs. For example, if vibratory pile driving cannot be differentiated from underwater background noise at less than 2,000 m, the Applicant would confer with NMFS to decrease the Level B zone radius below 2,000 m. The hydroacoustic monitoring plan prepared by I&R is included in Appendix E.

13.1.4 Marine Mammal Observers (MMOs)

Between one and three MMOs will be required during pile driving so MMEZs will be fully monitored and a representative portion of Level B harassment zones will be fully monitored to provide an accurate sample size of animals taken by Project activities, and to ensure that animals approaching the MMEZs will be detected. One MMO will be designated as the Lead MMO, who will receive updates from other MMOs on the presence or absence of marine mammals within the monitoring zones. The Lead MMO will notify the construction foreman of a cleared MMEZ before the start of pile driving.

13.1.5 Monitoring Protocol

Pile driving will be conducted only during daylight hours and with enough time for pre- and post-construction monitoring, and with full visibility of the MMEZs. If the entire MMEZ is not visible (e.g., due to fog, heavy rain), pile driving and removal will be delayed until the MMOs are confident that marine mammals within the MMEZ could be detected. The Lead MMO will be in contact with other MMOs and the Project construction foreman. MMOs will begin monitoring at least 30 min before pile driving begins. If any marine mammal enters a MMEZ within 15 minutes of the beginning of pile driving, the Lead MMO will notify the foreman to inform that pile driving may need to be delayed. The Lead MMO will keep the foreman informed of the location of the animal. If the animal remains in the MMEZ, pile driving will be delayed until it has left the MMEZ. If the animal dives and is not seen again, pile driving will be delayed at least 15 minutes. If a species for which authorization has not been granted, or a species for which authorization has been granted but the authorized takes are met, is observed approaching or within the Level B harassment zone, pile driving and removal activities will shut down

immediately using delay and shut-down procedures. Activities will not resume until the animal has been confirmed to have left the area or the observation time period (15 minutes), has elapsed. After pile driving has ended for the day, MMOs will continue to monitor the area for at least 30 minutes.

13.1.6 Data Collection

Standardized data collection sheets will be provided to the MMOs. Each MMO will record the following information:

- Dates and times (beginning and end) of all marine mammal monitoring.
- Construction activities occurring during each daily observation period, including how many and what type of piles were driven or removed and by what method (i.e., impact or vibratory).
- Weather parameters and water conditions during each monitoring period (e.g., wind speed, percent cloud cover, visibility, Beaufort sea state).
- The number of marine mammals observed, by species, relative to the pile location and if pile driving or removal was occurring at time of sighting.
- Age and sex class, if possible, of all marine mammals observed.
- MMO locations during marine mammal monitoring.
- Distances and bearings of each marine mammal observed to the pile being driven or removed for each sighting (if pile driving or removal was occurring at time of sighting).
- Description of any marine mammal behavior patterns during observation, including direction of travel.
- Detailed information about implementation of any mitigation triggered (e.g., shutdowns and delays), a description of specific actions that ensued, and resulting behavior of the animal, if any.

13.1.7 Communication

All MMOs will be equipped with a radio and have a mobile phone as backup. One channel of the radios will be dedicated to the MMOs. The Lead MMO will be in constant contact with the construction foreman as needed. The Lead MMO will coordinate marine mammal sightings with the other MMOs. The Lead MMO will contact other MMOs when a sighting is made within the MMEZ or near the MMEZ, so that the MMOs within overlapping areas of responsibility can continue to track the animal. If an animal has entered or is near the MMEZ within 15 min of pile driving, the Lead MMO will notify the construction foreman, who will be kept informed of the location of the animal.

13.1.8 MMO Qualifications

MMOs will have the following minimum qualifications:

- Independent MMOs (i.e., not construction personnel) who have no other assigned tasks during monitoring periods will be used.

- If a team of three or more MMOs is required, a lead observer (i.e., Lead MMO) or monitoring coordinator will be designated. The Lead MMO will have prior experience working as a marine mammal observer during construction.
- Other MMOs may substitute education (degree in biological science or related field) or training for experience.
- The Applicant will submit MMO CVs for approval by NMFS prior to the onset of pile driving.
- MMOs will have the following additional qualifications:
    - Ability to conduct field observations and collect data according to assigned protocols.
    - Experience or training in the field identification of marine mammals, including the identification of behaviors.
    - Sufficient training, orientation, or experience with the construction operation to provide for personal safety during observations.
    - Writing skills sufficient to prepare a report of observations including but not limited to the number and species of marine mammals observed; dates and times when in-water construction activities were conducted; dates, times, and reason for implementation of mitigation (or why mitigation was not implemented when required); and marine mammal behavior.
    - Ability to communicate orally, by radio or in person, with project personnel to provide real-time information on marine mammals observed in the area as necessary.

13.2 Reporting

The Applicant will submit a draft report on all monitoring conducted under the IHA within 90 calendar days of the completion of marine mammal and acoustic monitoring or sixty days prior to the issuance of any subsequent IHA for this Project, whichever comes first. A final report will be prepared and submitted within 30 days following resolution of comments on the draft report from NMFS. This report will contain the informational elements described in Section 13.1.6 and in the Marine Mammal Monitoring Plan.

In addition, the report will contain the following information:

- Number of individuals of each species (differentiated by month as appropriate) detected within the monitoring zone, and estimates of number of marine mammals taken, by species.
- Description of attempts to distinguish between the number of individual animals taken and the number of incidences of take, such as ability to track groups or individuals.
- In the case where MMOs were not able to observe the entire Level B harassment zone, an extrapolation of the estimated takes by Level B harassment based on the number of observed exposures within the Level B harassment zone and the percentage of the Level B harassment zone that was not visible will be included.
- The Applicant will submit all MMO datasheets and/or raw sighting data in a separate file from the final report referenced above.

13.2.1 Take of Marine Mammal due to Project Activity

In the unanticipated event that the Project activity clearly causes the take of a marine mammal in a manner prohibited by the MMPA, such as serious injury or mortality, the Applicant will immediately cease the specified activities and report the incident to the NMFS Office of Protected Resources and West Coast Region Stranding Coordinator. The report will include the following information:

- Time and date of the incident;
- Description of the incident;
- Environmental conditions (e.g., wind speed and direction, Beaufort sea state, cloud cover, and visibility);
- Description of all marine mammal observations and active sound source use in the 24 hours preceding the incident;
- Species identification or description of the animal(s) involved;
- Fate of the animal(s); and
- Photographs or video footage of the animal(s).

Activities will not resume until NMFS is able to review the circumstances of the prohibited take. NMFS will work with the Applicant to determine what measures are necessary to minimize the likelihood of further prohibited take and ensure MMPA compliance. The Applicant may not resume their activities until notified by NMFS.

13.2.2 Discovery of Injured or Dead Marine Mammal

In the event the Applicant discovers an injured or dead marine mammal, and the Lead MMO determines that the cause of the injury or death is unknown and the death is relatively recent (e.g., in less than a moderate state of decomposition), the Applicant will immediately report the incident to the Office of Protected Resources, NMFS, and the West Coast Region Stranding Coordinator, NMFS. The report will include the same information listed in Section 13.2.1.1 above. Activities may continue while NMFS reviews the circumstances of the incident. NMFS will work with the Applicant to determine whether additional mitigation measures or modifications to the activities are appropriate.

In the event that the Applicant discovers an injured or dead marine mammal, and the Lead MMO determines that the injury or death is not associated with or related to the specified activities (e.g., previously wounded animal, carcass with moderate to advanced decomposition, or scavenger damage), the Applicant must report the incident to the Office of Protected Resources, NMFS, and the West Coast Region Stranding Coordinator, NMFS, within 24 hours of the discovery.

Table 17. Summary of marine mammal Level A exclusion zones, shutdown initiation zones, and Level B monitoring zones for pile driving activities to be implemented during construction. Some Level A zones have been rounded up for ease of use in the field.

Pile Type	Installation Method	Attenuation System	Level A Pinniped and Dolphin Exclusion Zone	Level A Porpoise Exclusion Zone	Level B Monitoring Zone for All Species
36-in Steel Pipe Pile	Vibratory	None	**10 m** (33 ft)	**25 m** (82 ft)	**21,544 m** (70,682 ft)
36-in Steel Pipe Pile	Impact	Bubble curtain	**240 m** (787 ft)	**540 m** (1,772 ft)	**541 m** (1,775 ft)
30-in Steel Pipe Pile	Vibratory	None	**5 m** (16 ft) (shutdown initiated at 10 m)	**12 m** (3 ft) (shutdown initiated at 25 m)	**21,544 m** (70,682 ft)
30-in Steel Pipe Pile	Impact	Bubble curtain	**70 m** (230 ft)	**140 m** (459 ft)	**341 m** (1,119 ft)
Wide Flange Beam	Vibratory	None	**1 m** (3 ft) (shutdown initiated at 10 m)	**3 m** (10 ft) (shutdown initiated at 10 m)	**2,154 m** (7,067 ft)
Wide Flange Beam	Impact	Bubble curtain	**140 m** (459 ft)	**300 m** (984 ft)	**341 m** (1,119 ft)
Steel Sheet Pile	Vibratory	None	**1 m** (3 ft) (shutdown initiated at 10 m)	**3 m** (10 ft) (shutdown initiated at 10 m)	**4,642 m** (15,230 ft)
16-in Timber Pile Removal	Vibratory	None	**1 m** (3 ft) (shutdown initiated at 10 m)	**2 m** (7 ft) (shutdown initiated at 10 m)	**1,359 m** (4,459 ft)
12-in Concrete Pile Removal	Vibratory	None	**2 m** (7 ft) (shutdown initiated at 10 m)	**4 m** (13 ft) (shutdown initiated at 10 m)	**2,154 m** (7,067 ft)
24-in Square Concrete Pile	Impact	None	**70 m** (230 ft)	**140 m** (459 ft)	**117 m** (384 ft)
16-in Square Concrete Pile	Impact	None	**12 m** (39 ft) (shutdown initiated at 25 m)	**26 m** (85 ft) (shutdown initiated at 30 m)	**25** m (82 ft)

14-in Square Concrete Pile	Impact	None	**12 m** (39 ft) (shutdown initiated at 25 m)	**26 m** (85 ft) (shutdown initiated at 30 m)	**25 m** (82 ft)

Source: Table 9 and Table 10

14. SUGGESTED MEANS OF COORDINATION

Members of the Project team have coordinated with and worked closely with the local marine mammal stranding, rescue, and rehabilitation center (TMMC) in the past. TMMC and CAS have provided data for this Project on marine mammal strandings in the Estuary to inform the analysis of potential takes. In particular, William Keener, Research Associate at TMMC, formerly head of Golden Gate Cetacean Research, has shared his invaluable knowledge of marine mammals in the Bay.

All Project activities will be conducted in accordance with applicable federal, state, and local regulations. The Applicant will coordinate Project activities with relevant agencies including NMFS, San Francisco Bay Conservation and Development Commission, U.S. Army Corps of Engineers, San Francisco Bay Regional Water Quality Control Board, and the California Department of Fish and Wildlife. Results of the monitoring effort described in Chapter 13 will be provided to NMFS in a final report. The IHA application for the Project will be available for a public comment period in accordance with the MMPA, and the Applicant in coordination with NMFS will respond to any public comments.

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PERSONAL COMMUNICATIONS

Dees, G., local boater at Alameda Marina. October 2019. Personal communications to Patti Haase/Alameda Marina Shoreline Improvement Project team.

Drake, T., local boater at Alameda Marina. August 2019. Personal communications to Patti Haase/Alameda Marina Shoreline Improvement Project team.

Grand Marina, Oakland, CA. October 2019. Personal communications to Patti Haase/Alameda Marina Shoreline Improvement Project team.

Jack London Square Marina, Oakland, CA, October 2019. Personal communications to Patti Haase/Alameda Marina Shoreline Improvement Project team.

Keener, W. Research Associate, The Marine Mammal Center, Sausalito, California. 2017–2019. Personal communications to Patti Haase/Alameda Marina Shoreline Improvement Project team.

Klein, M. and R. Bangert, Alameda Point Harbor Seal Monitors. Personal communications to Patti Haase/Alameda Marina Shoreline Improvement Project team.

Schulze, M, AECOM Oakland. Environmental Planner/Project Manager, 2019. Personal communications to Patti Haase/Alameda Marina Shoreline Improvement Project team.

The Marine Mammal Center (TMMC). Sausalito, California. S. Stoudt, Data Manager. June 2019. Personal communications to Patti Haase/Alameda Marina Shoreline Improvement Project team.

APPENDIX A PHOTOGRAPHS OF EXISTING INFRASTRUCTURE

Figure A1. Corroding sheet pile of Seawall 1.

Figure A2. Wide flange beams propping up existing sheet pile of Seawall 1.

Figure A3. Heavily corroded steel H-pile at the head of Pier 1.

Figure A4. Poured concrete, concrete slabs, and bare earth used as riprap to the west of Seawall 4.

Figure A5. Timber piles encased in concrete-filled fabric jackets under the Promenade wharf.

Figure A6. Eroded timber piles along Seawall 1 facing the wharf between Pier 3 and Pier 4.

Figure A7. Eroded timber piles under the Promenade wharf.

APPENDIX B NMFS USER SPREADSHEETS USED TO CALCULATE LEVEL A ISOPLETH THRESHOLDS FOR VIBRATORY AND IMPACT PILE DRIVING

E.1: IMPACT PILE DRIVING (STATIONARY SOURCE: Impulsive, Intermittent)

VERSION 2.0: 2018

KEY

	User Provided Information
	NMFS Provided Information (Technical Guidance)
	Resultant Isopleth

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	30" Steel Pipe Unattenuated
PROJECT/SOURCE INFORMATION	Alameda Marina

Please include any assumptions

PROJECT CONTACT	Cameron Heyvaert

STEP 2: WEIGHTING FACTOR ADJUSTMENT

		Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value
Weighting Factor Adjustment (kHz)[¥]	2	

[¥] Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 75), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

[¥] BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)

STEP 3: SOURCE-SPECIFIC INFORMATION

NOTE: Choose either E.1-1 OR E.1-2 method to calculate isopleths (not required to fill in sage boxes for both)

E.1-1: METHOD TO CALCULATE PK AND SEL_{cum} (USING RMS SPL SOURCE LEVEL)

SEL_{cum}

Source Level (RMS SPL)	
Number of piles per day	
Strike Duration[a] (seconds)	
Number of strikes per pile	
Duration of Sound Production (seconds)	0
10 Log (duration of sound production)	#NUM!
Propagation (xLogR)	
Distance of source level measurement (meters)[+]	

[a] Window that makes up 90% of total cumulative energy (5%-95%) based on Madsen 2005

[+] Unless otherwise specified, source levels are referenced 1 m from the source.

PK

Source Level (PK SPL)	
Distance of source level measurement (meters)[+]	
Source level at 1 meter	#NUM!

[+] Unless otherwise specified, source levels are referenced 1 m from the source.

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SEL_{cum} & PK). Metric producing largest isopleth should be used.

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!

E.1-2: ALTERNATIVE METHOD TO CALCULATE PK AND SEL_{cum} (SINGLE STRIKE EQUIVALENT)

Unweighted SEL_{cum} (at measured distance) = SEL_{ss} + 10 Log (# strikes)	210.0

SEL_{cum}

Source Level (Single Strike SEL)	183
Number of strikes per pile	500
Number of piles per day	1
Propagation (xLogR)	15
Distance of single strike SEL measurement (meters)[+]	10

[+] Unless otherwise specified, source levels are referenced 1 m from the source.

PK

Source Level (PK SPL)	210
Distance of source level measurement (meters)[+]	10
Source level at 1 meter	225.0

[+] Unless otherwise specified, source levels are referenced 1 m from the source.

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SEL_{cum} & PK). Metric producing largest isopleth should be used.

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	[illegible]	22.4	749.4	336.7	24.5
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	2.5	NA	34.1	2.9	NA

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	-0.01	-19.74	-26.87	-2.08	-1.15

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}$$

E.1: IMPACT PILE DRIVING (STATIONARY SOURCE: Impulsive, Intermittent)

VERSION 2.0: 2018

KEY

	User Provided Information
	NMFS Provided Information (Technical Guidance)
	Resultant Isopleth

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	36" Steel Pipe Attenuated
PROJECT/SOURCE INFORMATION	

Please include any assumptions

PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

		Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value
Weighting Factor Adjustment (kHz)[¥]	2	

[†] Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 75), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

¥ BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See [illegible] tab for more information on WFA applicable frequencies)

STEP 3: SOURCE-SPECIFIC INFORMATION

NOTE: Choose either E1-1 OR E.1-2 method to calculate isopleths (not required to fill in sage boxes for both)

E.1-1: METHOD TO CALCULATE PK AND SEL_{cum} (USING RMS SPL SOURCE LEVEL)

SEL_{cum}

Source Level (RMS SPL)	
Number of piles per day	
Strike Duration[a] (seconds)	
Number of strikes per pile	
Duration of Sound Production (seconds)	0
10 Log (duration of sound production)	#NUM!
Propagation (xLogR)	
Distance of source level measurement (meters)*	

[a] Window that makes up 90% of total cumulative energy (5%-95%) based on Madsen 2005

*Unless otherwise specified, source levels are referenced 1 m from the source.

PK

Source Level (PK SPL)	
Distance of source level measurement (meters)*	
Source level at 1 meter	#NUM!

*Unless otherwise specified, source levels are referenced 1 m from the source.

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SEL_{cum} & PK). Metric producing largest isopleth should be used.

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!

E.1-2: ALTERNATIVE METHOD TO CALCULATE PK AND SEL_{cum} (SINGLE STRIKE EQUIVALENT)

Unweighted SEL_{cum} (at measured distance) = SEL_{ss} + 10 Log (# strikes)	203.0

SEL_{cum}

Source Level (Single Strike SEL)	176
Number of strikes per pile	500
Number of piles per day	1
Propagation (xLogR)	15
Distance of single strike SEL measurement (meters)*	10

*Unless otherwise specified, source levels are referenced 1 m from the source.

PK

Source Level (PK SPL)	202
Distance of source level measurement (meters)*	10
Source level at 1 meter	219.0

*Unless otherwise specified, source levels are referenced 1 m from the source.

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SEL_{cum} & PK). Metric producing largest isopleth should be used.

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	214.8	7.6	255.9	115.0	8.4
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	NA	NA	11.7	NA	NA

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	-0.01	-19.74	-26.87	-2.08	-1.15

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}$$

E.1: IMPACT PILE DRIVING (STATIONARY SOURCE: Impulsive, Intermittent)

VERSION 2.0: 2018

KEY

	User Provided Information
	NMFS Provided Information (Technical Guidance)
	Resultant Isopleth

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	30-inch steel pipe pile unattenuated
PROJECT/SOURCE INFORMATION	

Please include any assumptions

PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

		Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value
Weighting Factor Adjustment (kHz)[¥]	2	

[¥] Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 75), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

* BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See [illegible] tab for more information on WFA applicable frequencies)

STEP 3: SOURCE-SPECIFIC INFORMATION

NOTE: Choose either E1-1 OR E.1-2 method to calculate isopleths (not required to fill in sage boxes for both)

E.1-1: METHOD TO CALCULATE PK AND SEL_{cum} (USING RMS SPL SOURCE LEVEL)

SEL_{cum}

Source Level (RMS SPL)	
Number of piles per day	
Strike Duration[&] (seconds)	
Number of strikes per pile	
Duration of Sound Production (seconds)	0
10 Log (duration of sound production)	#NUM!
Propagation (xLogR)	
Distance of source level measurement (meters)[+]	

[&] Window that makes up 90% of total cumulative energy (5%-95%) based on Madsen 2005

[+] Unless otherwise specified, source levels are referenced 1 m from the source.

PK

Source Level (PK SPL)	
Distance of source level measurement (meters)[+]	
Source level at 1 meter	#NUM!

[+] Unless otherwise specified, source levels are referenced 1 m from the source.

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SELcum & PK). Metric producing largest isopleth should be used.

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!

E.1-2: ALTERNATIVE METHOD TO CALCULATE PK AND SEL_{cum} (SINGLE STRIKE EQUIVALENT)

Unweighted SEL_{cum} (at measured distance) = SEL_{ss} + 10 Log (# strikes)	204.0

SEL_{cum}

Source Level (Single Strike SEL)	177
Number of strikes per pile	500
Number of piles per day	1
Propagation (xLogR)	15
Distance of single strike SEL measurement (meters)[+]	10

[+] Unless otherwise specified, source levels are referenced 1 m from the source.

PK

Source Level (PK SPL)	210
Distance of source level measurement (meters)[+]	10
Source level at 1 meter	225.0

[+] Unless otherwise specified, source levels are referenced 1 m from the source.

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SELcum & PK). Metric producing largest isopleth should be used.

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	350.4	6.9	298.5	154.0	9.6
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	2.5	NA	52.1	<2.9	NA

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	-0.01	-19.74	-26.87	-2.09	-1.15

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}$$

E.1: IMPACT PILE DRIVING (STATIONARY SOURCE: Impulsive, Intermittent)

VERSION 2.0: 2018

KEY

	User Provided Information
	NMFS Provided Information (Technical Guidance)
	Resultant Isopleth

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	30-inch steel pipe pile attenuated
PROJECT/SOURCE INFORMATION	

Please include any assumptions

PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

		Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value
Weighting Factor Adjustment (kHz)[¥]	2	

[¥] Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 75), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

* BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)

STEP 3: SOURCE-SPECIFIC INFORMATION

NOTE: Choose either E1-1 OR E.1-2 method to calculate isopleths (not required to fill in sage boxes for both)

E.1-1: METHOD TO CALCULATE PK AND SEL_{cum} (USING RMS SPL SOURCE LEVEL)

SEL_{cum}

Source Level (RMS SPL)	
Number of piles per day	
Strike Duration[a] (seconds)	
Number of strikes per pile	
Duration of Sound Production (seconds)	0
10 Log (duration of sound production)	#NUM!
Propagation (xLogR)	
Distance of source level measurement (meters)[+]	

[a] Window that makes up 90% of total cumulative energy (5%-95%) based on Madsen 2005

[+] Unless otherwise specified, source levels are referenced 1 m from the source.

PK

Source Level (PK SPL)	
Distance of source level measurement (meters)[+]	
Source level at 1 meter	#NUM!

[+] Unless otherwise specified, source levels are referenced 1 m from the source.

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SEL_{cum} & PK). Metric producing largest isopleth should be used.

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!

E.1-2: ALTERNATIVE METHOD TO CALCULATE PK AND SEL_{cum} (SINGLE STRIKE EQUIVALENT)

Unweighted SEL_{cum} (at measured distance) = SEL_{ss} + 10 Log (# strikes)	197.0

SEL_{cum}

Source Level (Single Strike SEL)	170
Number of strikes per pile	500
Number of piles per day	1
Propagation (xLogR)	15
Distance of single strike SEL measurement (meters)[+]	10

[+] Unless otherwise specified, source levels are referenced 1 m from the source.

PK

Source Level (PK SPL)	203
Distance of source level measurement (meters)[+]	10
Source level at 1 meter	219.0

[+] Unless otherwise specified, source levels are referenced 1 m from the source.

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SEL_{cum} & PK). Metric producing largest isopleth should be used.

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	86.6	3.0	101.9	46.9	3.3
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	NA	NA	11.7	NA	NA

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	-0.01	-19.74	-26.87	-2.08	-1.15

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}$$

E.1: IMPACT PILE DRIVING (STATIONARY SOURCE: Impulsive, Intermittent)

VERSION 2.0: 2018

KEY

	User Provided Information
	NMFS Provided Information (Technical Guidance)
	Resultant Isopleth

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	W 40 x 199 wide flange beam unattenuated
PROJECT/SOURCE INFORMATION	
Please include any assumptions	
PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

		Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value
Weighting Factor Adjustment (kHz)[¥]	2	

[¥] Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 75), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

* BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)

STEP 3: SOURCE-SPECIFIC INFORMATION

NOTE: Choose either E1-1 OR E.1-2 method to calculate isopleths (not required to fill in sage boxes for both)

E.1-1: METHOD TO CALCULATE PK AND SEL_{cum} (USING RMS SPL SOURCE LEVEL)

SEL_{cum}

Source Level (RMS SPL)	
Number of piles per day	
Strike Duration[&] (seconds)	
Number of strikes per pile	
Duration of Sound Production (seconds)	0
10 Log (duration of sound production)	#NUM!
Propagation (xLogR)	
Distance of source level measurement (meters)[+]	

[&] Window that makes up 90% of total cumulative energy (5%-95%) based on Madsen 2005

[+] Unless otherwise specified, source levels are referenced 1 m from the source.

PK

Source Level (PK SPL)	
Distance of source level measurement (meters)[+]	
Source level at 1 meter	#NUM!

[+] Unless otherwise specified, source levels are referenced 1 m from the source.

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SELcum & PK). Metric producing largest isopleth should be used.

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!

E.1-2: ALTERNATIVE METHOD TO CALCULATE PK AND SEL_{cum} (SINGLE STRIKE EQUIVALENT)

Unweighted SEL_{cum} (at measured distance) = SEL_{ss} + 10 Log (# strikes)	211.0

SEL_{cum}

Source Level (Single Strike SEL)	178
Number of strikes per pile	500
Number of piles per day	4
Propagation (xLogR)	15
Distance of single strike SEL measurement (meters)[+]	10

[+] Unless otherwise specified, source levels are referenced 1 m from the source.

PK

Source Level (PK SPL)	207
Distance of source level measurement (meters)[+]	10
Source level at 1 meter	222.0

[+] Unless otherwise specified, source levels are referenced 1 m from the source.

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SELcum & PK). Metric producing largest isopleth should be used.

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	738.9	26.3	879.4	393.6	28.7
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	1.6	NA	21.5	1.8	NA

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	-0.01	-19.74	-26.87	-2.08	-1.15

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}$$

E.1: IMPACT PILE DRIVING (STATIONARY SOURCE: Impulsive, Intermittent)

VERSION 2.0: 2018

KEY

(grey)	User Provided Information
(orange)	NMFS Provided Information (Technical Guidance)
(blue)	Resultant Isopleth

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	W 40 x 199 wide flange beam attenuated
PROJECT/SOURCE INFORMATION	

Please include any assumptions

PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value

Weighting Factor Adjustment (kHz)[¥]	2	

[¥] Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 75), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

* BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See [illegible] tab for more information on WFA applicable frequencies)

STEP 3: SOURCE-SPECIFIC INFORMATION

NOTE: Choose either E.1-1 OR E.1-2 method to calculate isopleths (not required to fill in sage boxes for both)

E.1-1: METHOD TO CALCULATE PK AND SEL_{cum} (USING RMS SPL SOURCE LEVEL)

SEL_{cum}

Source Level (RMS SPL)	
Number of piles per day	
Strike Duration[a] (seconds)	
Number of strikes per pile	
Duration of Sound Production (seconds)	0
10 Log (duration of sound production)	#NUM!
Propagation (xLogR)	
Distance of source level measurement (meters)[+]	

[a] Window that makes up 90% of total cumulative energy (5%-95%) based on Madsen 2005

[+] Unless otherwise specified, source levels are referenced 1 m from the source.

PK

Source Level (PK SPL)	
Distance of source level measurement (meters)[+]	
Source level at 1 meter	#NUM!

[+] Unless otherwise specified, source levels are referenced 1 m from the source.

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SEL_{cum} & PK). Metric producing largest isopleth should be used.

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!

E.1-2: ALTERNATIVE METHOD TO CALCULATE PK AND SEL_{cum} (SINGLE STRIKE EQUIVALENT)

Unweighted SEL_{cum} (at measured distance) = SEL_{ss} + 10 Log (# strikes)	199.0

SEL_{cum}

Source Level (Single Strike SEL)	171
Number of strikes per pile	500
Number of piles per day	1
Propagation (xLogR)	15
Distance of single strike SEL measurement (meters)[+]	10

[+] Unless otherwise specified, source levels are referenced 1 m from the source.

PK

Source Level (PK SPL)	200
Distance of source level measurement (meters)[+]	10
Source level at 1 meter	215.0

[+] Unless otherwise specified, source levels are referenced 1 m from the source.

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SEL_{cum} & PK). Metric producing largest isopleth should be used.

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	89.7	3.5	119.6	53.4	3.9
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	NA	NA	7.4	NA	NA

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	-0.01	-19.74	-26.87	-2.08	-1.15

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}$$

E.1: IMPACT PILE DRIVING (STATIONARY SOURCE: Impulsive, Intermittent)

VERSION 2.0: 2018

KEY

	User Provided Information
	NMFS Provided Information (Technical Guidance)
	Resultant Isopleth

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	24-inch Square Concrete Piles Unattenuated
PROJECT/SOURCE INFORMATION	

Please include any assumptions

PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value

Weighting Factor Adjustment (kHz)¥	2	

¥ Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 75), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

* BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See [illegible] tab for more information on WFA applicable frequencies)

STEP 3: SOURCE-SPECIFIC INFORMATION

NOTE: Choose either E.1-1 OR E.1-2 method to calculate isopleths (not required to fill in sage boxes for both)

E.1-1: METHOD TO CALCULATE PK AND SEL_{cum} (USING RMS SPL SOURCE LEVEL)

SEL_{cum}

Source Level (RMS SPL)	
Number of piles per day	
Strike Duration^ (seconds)	
Number of strikes per pile	
Duration of Sound Production (seconds)	0
10 Log (duration of sound production)	#NUM!
Propagation (xLogR)	
Distance of source level measurement (meters)+	

^Window that makes up 90% of total cumulative energy (5%-95%) based on Madsen 2005

+Unless otherwise specified, source levels are referenced 1 m from the source.

PK

Source Level (PK SPL)	
Distance of source level measurement (meters)+	
Source level at 1 meter	#NUM!

+Unless otherwise specified, source levels are referenced 1 m from the source.

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SEL_{cum} & PK). Metric producing largest isopleth should be used.

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!

E.1-2: ALTERNATIVE METHOD TO CALCULATE PK AND SEL_{cum} (SINGLE STRIKE EQUIVALENT)

Unweighted SEL_{cum} (at measured distance) = SEL_{ss} + 10 Log (# strikes)	192.0

SEL_{cum}

Source Level (Single Strike SEL)	165
Number of strikes per pile	500
Number of piles per day	1
Propagation (xLogR)	15
Distance of single strike SEL measurement (meters)+	10

+Unless otherwise specified, source levels are referenced 1 m from the source.

PK

Source Level (PK SPL)	188
Distance of source level measurement (meters)+	10
Source level at 1 meter	203.0

+Unless otherwise specified, source levels are referenced 1 m from the source.

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SEL_{cum} & PK). Metric producing largest isopleth should be used.

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	46.3	1.6	55.1	24.8	1.8
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	NA	NA	1.2	NA	NA

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	-0.01	-19.74	-26.87	-2.08	-1.15

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}$$

E.1: IMPACT PILE DRIVING (STATIONARY SOURCE: Impulsive, Intermittent)

VERSION 2.0: 2018

KEY

	User Provided Information
	NMFS Provided Information (Technical Guidance)
	Resultant Isopleth

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	18-inch Square Concrete Piles Unattenuated
PROJECT/SOURCE INFORMATION	

Please include any assumptions

PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

		Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value
Weighting Factor Adjustment (kHz)¥	2	

¥ Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 76), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

* BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See [illegible] tab for more information on WFA applicable frequencies)

STEP 3: SOURCE-SPECIFIC INFORMATION

NOTE: Choose either E1-1 OR E.1-2 method to calculate isopleths (not required to fill in sage boxes for both)

E.1-1: METHOD TO CALCULATE PK AND SEL_{cum} (USING RMS SPL SOURCE LEVEL)

SEL_{cum}

Source Level (RMS SPL)	
Number of piles per day	
Strike Duration# (seconds)	
Number of strikes per pile	
Duration of Sound Production (seconds)	0
10 Log (duration of sound production)	#NUM!
Propagation (xLogR)	
Distance of source level measurement (meters)*	

#Window that makes up 90% of total cumulative energy (5%-95%) based on Madsen 2005

*Unless otherwise specified, source levels are referenced 1 m from the source.

PK

Source Level (PK SPL)	
Distance of source level measurement (meters)*	
Source level at 1 meter	#NUM!

*Unless otherwise specified, source levels are referenced 1 m from the source.

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SEL_{cum} & PK). Metric producing largest isopleth should be used.

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!

E.1-2: ALTERNATIVE METHOD TO CALCULATE PK AND SEL_{cum} (SINGLE STRIKE EQUIVALENT)

Unweighted SEL_{cum} (at measured distance) = SEL_{ss} + 10 Log (# strikes)	182.0

SEL_{cum}

Source Level (Single Strike SEL)	155
Number of strikes per pile	500
Number of piles per day	1
Propagation (xLogR)	15
Distance of single strike SEL measurement (meters)*	10

*Unless otherwise specified, source levels are referenced 1 m from the source.

PK

Source Level (PK SPL)	185
Distance of source level measurement (meters)*	10
Source level at 1 meter	200.0

*Unless otherwise specified, source levels are referenced 1 m from the source.

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SEL_{cum} & PK). Metric producing largest isopleth should be used.

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	8.6	0.3	10.2	4.6	0.3
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	NA	NA	NA	NA	NA

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	-0.01	-19.74	-26.87	-2.08	-1.15

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}$$

E.1: IMPACT PILE DRIVING (STATIONARY SOURCE: Impulsive, Intermittent)

VERSION 2.0: 2018

KEY

	User Provided Information
	NMFS Provided Information (Technical Guidance)
	Resultant Isopleth

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	14-inch Square Concrete Piles Unattenuated
PROJECT/SOURCE INFORMATION	

Please include any assumptions

PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

		Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value
Weighting Factor Adjustment (kHz)[¥]	2	

[¥] Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 75), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

* BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)

STEP 3: SOURCE-SPECIFIC INFORMATION

NOTE: Choose either E1-1 OR E.1-2 method to calculate isopleths (not required to fill in sage boxes for both)

E.1-1: METHOD TO CALCULATE PK AND SEL_{cum} (USING RMS SPL SOURCE LEVEL)

SEL_{cum}

Source Level (RMS SPL)	
Number of piles per day	
Strike Duration[a] (seconds)	
Number of strikes per pile	
Duration of Sound Production (seconds)	0
10 Log (duration of sound production)	#NUM!
Propagation (xLogR)	
Distance of source level measurement (meters)[+]	

[a] Window that makes up 90% of total cumulative energy (5%-95%) based on Madsen 2005

[+] Unless otherwise specified, source levels are referenced 1 m from the source.

PK

Source Level (PK SPL)	
Distance of source level measurement (meters)[+]	
Source level at 1 meter	#NUM!

[+] Unless otherwise specified, source levels are referenced 1 m from the source.

NOTE: The User Spreadsheet tool provides a means to estimate distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SELcum & PK). Metric producing largest isopleth should be used.

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!

E.1-2: ALTERNATIVE METHOD TO CALCULATE PK AND SEL_{cum} (SINGLE STRIKE EQUIVALENT)

Unweighted SEL_{cum} (at measured distance) = SEL_{ss} + 10 Log (# strikes)	182.0

SEL_{cum}

Source Level (Single Strike SEL)	155
Number of strikes per pile	500
Number of piles per day	1
Propagation (xLogR)	15
Distance of single strike SEL measurement (meters)[+]	10

[+] Unless otherwise specified, source levels are referenced 1 m from the source.

PK

Source Level (PK SPL)	185
Distance of source level measurement (meters)[+]	10
Source level at 1 meter	200.0

[+] Unless otherwise specified, source levels are referenced 1 m from the source.

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SELcum & PK). Metric producing largest isopleth should be used.

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	8.6	0.3	10.2	4.6	0.3
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	NA	NA	NA	NA	NA

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	-0.01	-19.74	-26.87	-2.08	-1.15

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}$$

A.1: Vibratory Pile Driving (STATIONARY SOURCE: Non-Impulsive, Continuous)

VERSION 2.0: 2018

KEY

	User Provided Information
	NMFS Provided Information (Technical Guidance)
	Resultant Isopleth

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	36-inch Steel Pipe Pile
PROJECT/SOURCE INFORMATION	

Please include any assumptions

PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value

Weighting Factor Adjustment (kHz)[¥]	2.5	

[¥] Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 46), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

[¥] BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)

STEP 3: SOURCE-SPECIFIC INFORMATION

Source Level (RMS SPL)	170
Number of piles within 24-h period	1
Duration to drive a single pile (minutes)	10
Duration of Sound Production within 24-h period (seconds)	600
10 Log (duration of sound production)	27.78
Propagation (xLogR)	15
Distance from source level measurement (meters)[+]	10

[+]Unless otherwise specified, source levels are referenced 1 m from the source.

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	199	198	173	201	219
PTS Isopleth to threshold (meters)	8.2	0.7	12.2	5.0	0.4

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	-0.05	-16.83	-23.50	-1.29	-0.60

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}$$

A.1: Vibratory Pile Driving (STATIONARY SOURCE: Non-Impulsive, Continuous)

VERSION 2.0: 2018

KEY

	User Provided Information
	NMFS Provided Information (Technical Guidance)
	Resultant Isopleth

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	30-inch Steel Pipe Pile
PROJECT/SOURCE INFORMATION	

Please include any assumptions

PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value

Weighting Factor Adjustment (kHz)*	2.5	

*Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 46), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

† BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)

STEP 3: SOURCE-SPECIFIC INFORMATION

Source Level (RMS SPL)	170
Number of piles within 24-h period	1
Duration to drive a single pile (minutes)	10
Duration of Sound Production within 24-h period (seconds)	600
10 Log (duration of sound production)	27.78
Propagation (xLogR)	15
Distance from source level measurement (meters)*	10

*Unless otherwise specified, source levels are referenced 1 m from the source.

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	199	198	173	201	219
PTS Isopleth to threshold (meters)	8.2	0.7	12.2	5.0	0.4

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	-0.05	-16.83	-23.50	-1.29	-0.60

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}$$

A.1: Vibratory Pile Driving (STATIONARY SOURCE: Non-Impulsive, Continuous)

VERSION 2.0: 2018

KEY

	User Provided Information
	NMFS Provided Information (Technical Guidance)
	Resultant Isopleth

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	W 40 x 199 wide flange beam
PROJECT/SOURCE INFORMATION	

Please include any assumptions

PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value

Weighting Factor Adjustment (kHz)*	2.5	

*Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 48), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

* BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)

STEP 3: SOURCE-SPECIFIC INFORMATION

Source Level (RMS SPL)	155
Number of piles within 24-h period	1
Duration to drive a single pile (minutes)	10
Duration of Sound Production within 24-h period (seconds)	600
10 Log (duration of sound production)	27.78
Propagation (xLogR)	15
Distance from source level measurement (meters)*	10

*Unless otherwise specified, source levels are referenced 1 m from the source.

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	199	198	173	201	219
PTS Isopleth to threshold (meters)	0.8	0.1	1.2	0.5	0.0

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	-0.05	-16.83	-23.50	-1.29	-0.60

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}$$

A.1: Vibratory Pile Driving (STATIONARY SOURCE: Non-Impulsive, Continuous)

VERSION 2.0: 2018

KEY

	User Provided Information
	NMFS Provided Information (Technical Guidance)
	Resultant Isopleth

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	PZC 13, PZ 27, and PZ 35 steel sheet piles
PROJECT/SOURCE INFORMATION	

Please include any assumptions

PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value

Weighting Factor Adjustment (kHz)[¥]	2.5	

[¥] Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 48), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

[¥] **BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

STEP 3: SOURCE-SPECIFIC INFORMATION

Source Level (RMS SPL)	160
Number of piles within 24-h period	1
Duration to drive a single pile (minutes)	1
Duration of Sound Production within 24-h period (seconds)	60
10 Log (duration of sound production)	17.78
Propagation (xLogR)	15
Distance from source level measurement (meters)*	10

*Unless otherwise specified, source levels are referenced 1 m from the source.

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	199	198	173	201	219
PTS Isopleth to threshold (meters)	0.4	0.0	0.6	0.2	0.0

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	-0.05	-16.83	-23.50	-1.29	-0.60

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}$$

A.1: Vibratory Pile Driving (STATIONARY SOURCE: Non-Impulsive, Continuous)

VERSION 2.0: 2018

KEY

	User Provided Information
	NMFS Provided Information (Technical Guidance)
	Resultant Isopleth

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	16-inch Timber Pile Removal
PROJECT/SOURCE INFORMATION	

Please include any assumptions

PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

		Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value
Weighting Factor Adjustment (kHz)[¥]	2.5	

[¥] Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 48), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

* BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)

STEP 3: SOURCE-SPECIFIC INFORMATION

Source Level (RMS SPL)	152
Number of piles within 24-h period	1
Duration to drive a single pile (minutes)	5
Duration of Sound Production within 24-h period (seconds)	300
10 Log (duration of sound production)	24.77
Propagation (xLogR)	15
Distance from source level measurement (meters)*	10

*Unless otherwise specified, source levels are referenced 1 m from the source.

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	199	198	173	201	219
PTS Isopleth to threshold (meters)	0.3	0.0	0.5	0.2	0.0

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	-0.05	-16.83	-23.50	-1.29	-0.60

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}$$

A.1: Vibratory Pile Driving (STATIONARY SOURCE: Non-Impulsive, Continuous)

VERSION 2.0: 2018

KEY

	User Provided Information
	NMFS Provided Information (Technical Guidance)
	Resultant Isopleth

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	12-inch Concrete Pile Removal
PROJECT/SOURCE INFORMATION	

Please include any assumptions

PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

		Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value
Weighting Factor Adjustment (kHz)*	2.5	

* Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 48), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

* BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)

STEP 3: SOURCE-SPECIFIC INFORMATION

Source Level (RMS SPL)	155
Number of piles within 24-h period	1
Duration to drive a single pile (minutes)	5
Duration of Sound Production within 24-h period (seconds)	300
10 Log (duration of sound production)	24.77
Propagation (xLogR)	15
Distance from source level measurement (meters)*	10

*Unless otherwise specified, source levels are referenced 1 m from the source.

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	199	198	173	201	219
PTS Isopleth to threshold (meters)	0.5	0.0	0.8	0.3	0.0

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.6	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	-0.05	-16.83	-23.50	-1.29	-0.60

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}$$

APPENDIX C ADDITIONAL LEVEL A AND LEVEL B ISOPLETH THRESHOLDS FOR PILE DRIVING NOT USED FOR PROJECT CALCULATIONS

Table C1. Distances (in meters) to Level A and Level B harassment threshold criteria for impact pile driving based on Peak SPLs. Distances were not used for project calculations.

Pile Description	Attenuation	No. of Piles Installed per Day	PTS Isopleth Threshold (m) Based on Peak SPL				
			Cetaceans			Pinnipeds	
			LF	MF	HF	PW	OW
36-in Steel Pipe Piles	Unattenuated	1	3	N/A	34	3	N/A
	Attenuated	1	N/A	N/A	12	N/A	N/A
30-in Steel Pipe Piles	Unattenuated	1	3	N/A	34	3	N/A
	Attenuated	1	N/A	N/A	12	N/A	N/A
W 40x99 wide flange beams	Unattenuated	1	2	N/A	25	3	N/A
	Attenuated	1	N/A	N/A	9	N/A	N/A
24-in Concrete Piles	Unattenuated	1	N/A	N/A	1	N/A	N/A
16-in Concrete Piles	Unattenuated	1	N/A	N/A	N/A	N/A	N/A
14-in Concrete Piles	Unattenuated	1	N/A	N/A	N/A	N/A	N/A

* Note: PTS computations based on Peak SPL will not change depending on the number of piles driven per day. Therefore, distances were computed for only one pile. All distances are less than those calculated with SELcum and so were not used for zone of influence measurements or calculation of take numbers.

Table C2. Distances (in meters) to the adopted marine mammal thresholds for piles driven with an impact hammer in water with 750 strikes per pile. Distances were not used for project calculations.

Pile Description	Attenuation	Number of Piles Installed per Day	Level A/PTS Isopleth Threshold (m) Based on SELcum				
			Cetaceans			Pinnipeds	
			LF	MF	HF	Phocids	Otariids
36-in Steel Pipe Pile	Unattenuated	1	824	29	982	441	32
		3	1,715	61	2,043	918	67
	Attenuated	1	282	10	335	151	11
		3	586	21	697	313	23
30-in Steel Pipe Pile	Unattenuated	1	328	12	391	176	13
	Attenuated	1	136	5	162	73	5
W 40x99 Wide Flange Beam	Unattenuated	1	328	12	391	176	13
		4	827	29	985	443	32
	Attenuated	1	112	4	134	60	4
		4	282	10	336	151	11
24-in Square Concrete Pile	Unattenuated	1	61	2	72	33	2
		4	153	5	182	82	6
16-in Square Concrete Pile	Unattenuated	1	11	<1	13	6	<1
		4	28	1	34	15	1
14-in Square Concrete Pile	Unattenuated	1	11	<1	13	6	<1
		4	28	1	34	15	1

Table C3. Distances (in meters) to the adopted marine mammal thresholds for piles driven with an impact hammer in water with 1,000 strikes per pile. Distances were not used for project calculations.

Pile Description	Attenuation	Number of Piles Installed per Day	Level A/PTS Isopleth Threshold (m) Based on SELcum				
			Cetaceans			Pinnipeds	
			LF	MF	HF	Phocids	Otariids
36-in Steel Pipe Pile	Unattenuated	1	999	36	1,190	534	39
		3	2,077	74	2,474	1,112	81
	Attenuated	1	341	12	406	183	13
		3	709	25	845	380	28
30-in Steel Pipe Pile	Unattenuated	1	398	14	474	213	16
	Attenuated	1	136	5	162	73	5
W 40x99 Wide Flange Beam	Unattenuated	1	398	14	474	213	16
		4	1,002	36	1,193	536	39
	Attenuated	1	136	5	162	73	5
		4	167	6	199	90	7
24-in Square Concrete Pile	Unattenuated	1	74	3	88	39	3
		4	185	7	221	99	7
16-in Square Concrete Pile	Unattenuated	1	14	1	16	7	1
		4	34	1	41	18	1
14-in Square Concrete Pile	Unattenuated	1	14	1	16	7	1
		4	34	1	41	18	1

APPENDIX D MARINE MAMMAL MONITORING PLAN

ALAMEDA MARINA SHORELINE IMPROVEMENT PROJECT

Marine Mammal Monitoring Plan

March 2020

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1. INTRODUCTION

Pacific Shops, Inc. (Applicant) is renovating and rehabilitating the existing Alameda Marina, its shoreline, and land-based facilities. The Alameda Marina Shoreline Improvement Project (Project) located on the Oakland Estuary (Estuary) in the City and County of Alameda, California (Figure 1) will address climate resiliency and rehabilitate existing shoreline and marina facilities so that the shoreline meets current seismic resistance criteria and addresses sea level rise from projected sea levels by 2100 for a medium-high risk aversion. The Project will address seawall maintenance, wharf refurbishment, outfall installation, marina reconfiguration, and addition of a boat hoist. Project construction includes pile driving, pile removal, and sheet pile driving, activities with the potential to result in the incidental take of marine mammals.

Pursuant to the Marine Mammal Protection Act (MMPA), the Applicant is requesting an Incidental Harassment Authorization (IHA) from National Marine Fisheries Service (NMFS) for incidental take by Level B harassment of marine mammals resulting from pile driving and pile removal activities (final draft submitted March 2020). This Marine Mammal Monitoring Plan (Plan) has been prepared based on guidance provided by NMFS. This Plan discusses pile driving activities associated with marina renovation, potential impacts to marine mammals from these activities, and methods for monitoring and reporting the activity of marine mammals near the construction site.

Figure 1. Location of Alameda Marina Shoreline Improvement Project on the Oakland Estuary in Alameda, California.

2. BACKGROUND

2.1. Marine Mammal Species of Concern

Although numerous species of marine mammals exist along the central and northern California coasts, very few are regularly observed in San Francisco Bay (Bay), and even fewer of these are seen in the Estuary. Six species of marine mammals occasionally inhabit or could potentially enter the Estuary and Project area. None of these species are listed as endangered or threatened under the Federal Endangered Species Act (ESA), or as a depleted or strategic stock under the MMPA. The Applicant has applied for an IHA to incidentally take, by Level B harassment, Pacific harbor seals (*Phoca vitulina richardii*), northern elephant seals (*Mirounga angustirostris*), California sea lions (*Zalophus californianus*), northern fur seals (*Callorhinus ursinus*), common bottlenose dolphins (*Tursiops truncatus*), and harbor porpoise (*Phocoena phocoena*) incidental to pile driving activities associated with the Project.

2.2. Marine Mammal Regulations

Under the MMPA, "take" is defined as to "harass, hunt, capture, kill or collect, or attempt to harass, hunt, capture, kill or collect" 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. Harassment which has the potential to disturb a marine mammal by disrupting behavioral patterns including, but not limited to migration, breathing, nursing, breeding, feeding, or sheltering, but which does not have the potential to injure a marine mammal, is defined as Level B harassment.

2.3. Potential Impacts on Marine Mammals from Pile Driving Activities

Pile driving activities associated with the renovation and refurbishment of the Project seawall and associated structures have the potential to result in the incidental take of marine mammals.

Vibratory pile driving produces non-impulse (continuous) noise 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 non-impulse 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 is a form of Level A harassment.

Impact pile driving produces impulsive noise that can cause behavioral disturbance and TTS to marine mammals (Level B harassment), and slight injury, i.e., PTS, in an animal's hearing (Level A harassment).

NMFS has established sound threshold criteria for behavioral disturbance (Level B harassment) and PTS (Level A harassment) to marine mammals from pile driving and other similar activities (Table 1). The underwater sound pressure threshold for Level B harassment is 120 dB root-mean-square (RMS) for non-impulse sound (e.g., vibratory pile driving) and 160 dB RMS for impulse sound (e.g., impact pile driving) for all species (Table 1). The underwater sound pressure threshold for Level A harassment is a dual metric criterion, including both a peak pressure and cumulative SEL (SELcum) threshold that is specific to the

species hearing group (i.e., high-frequency (HF) cetaceans, mid-frequency (MF) cetaceans, low-frequency (LF) cetaceans, phocids, and otariids).

Table 1. Underwater sound threshold criteria for pile driving.

Species Hearing Group	Continuous Sound (Vibratory Pile Driving)		Impulse Sound (Impact Pile Driving)		
	Level B (dB RMS)	Level A (dB SELcum)	Level B (dB RMS)	Level A Dual Criteria (dB Peak SPL)	Level A Dual Criteria (dB SELcum)
High-frequency Cetaceans (e.g., harbor porpoise)	120	173	160	202	155
Mid-frequency Cetaceans (e.g., bottlenose dolphin)		198		230	185
Phocids (e.g., harbor seal, northern elephant seal)		201		218	185
Otariids (e.g., California sea lion, northern fur seal)		219		232	203

Note: All decibels (dB) are referenced to 1 micro Pascal (re 1 μPa).
Source: NMFS 2018

2.4. Marina Renovation and Rehabilitation

Construction activities fall into two general categories: pile removal and pile installation. Piles will be removed and installed in connection with seawall maintenance, wharf refurbishment, marina refurbishment, and boat hoist construction. Permanent sheet piles will be placed to rebuild the seawalls, and temporary sheet piles will be needed to construct a cofferdam as part of outfall installation.

2.4.1. Pile Removal

The Applicant is proposing to remove several degraded wharves, piers, and pier studs (the shoreline portion of a previously removed pier), collectively referred to here as "pile-supported structures." Generally, the pile-supported structures are comprised of piles supporting a wooden platform of timber joists/girders that are covered with timber deck boards. Piles associated with Seawall 1 are also proposed for removal.

Most of the piles that will be removed are 16-inch (in) creosote-treated timber piles, plus a small number of 12-in square concrete piles. All 320 piles will be either vibrated out or cut off at mudline and removed. All piles will be removed in Year 1.

2.4.2. Pile Installation

All piles to be installed are permanent with the exception of the temporary cofferdam for outfall construction. The quantity and type of piles to be installed at each marina feature, as well as the installation method, is separated into Year 1 (Table 2) and Year 2 (

Table 3) below. Piles to be installed include: 36-in and 30-in steel pipe piles; 14-, 16-, and 24-in square concrete piles; wide flange beams; and steel sheet piles.

Table 2. Summary of piles to be installed in Year 1.

Structure	Type of Pile[1]	Number of Piles	Installation Method[2]
Seawall 4	Steel sheet pile (e.g., PZ35)	149	Vibratory hammer
Seawall 6	Steel sheet pile (e.g., PZ35)	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 (e.g., PZ27)	107	Vibratory hammer

[1] The specific type or model of steel sheet piles are identified as examples only. The contractor will choose which sheet piles to install at the time of construction.
[2] Pile installation will be attenuated with the use of a bubble curtain attenuator or other marine pile driving energy attenuator during impact driving of all permanent piles.

Table 3. Summary of piles to be installed in Year 2.

Structure	Type of Pile[1]	Number of Piles	Installation Method[2]
Seawall 1	Steel sheet pile (e.g., PZC13)	233	Vibratory hammer
	Wide flange beam (e.g., W40X199)	117	Vibratory hammer majority of pile; attenuated impact hammer to tip elevation
Seawall 1A	Steel sheet pile (e.g., PZC13)	26	Vibratory hammer
	Wide flange beam (e.g., W40X199)	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

[1] The specific type or model of wide flange beams and steel sheet piles are identified as examples only. The contractor will choose which wide flange beams and sheet piles to install at the time of construction.
[2] Pile installation will be attenuated with the use of a bubble curtain attenuator or other marine pile driving energy attenuator during impact driving of all permanent piles.

Sheet piles will be installed with a crane- or excavator-mounted vibratory hammer to a design depth. Sheet pile installation will be conducted from both land and water.

All steel pipe piles will be initially installed with a vibratory hammer through the top soft soils until the vibration cannot advance the pile further into the substrate. In some cases, the entire steel pile may be installed by vibratory means if final depths can be achieved. A crane- or excavator-mounted impact hammer will be used to complete pipe pile installation and drive to final depths. All impact driving of steel piles will be attenuated. Pipe pile installation will be conducted from both land and water.

All concrete piles will be installed entirely with a crane- or excavator-mounted impact hammer, and may include use of a wood block cushion for attenuation. Concrete pile installation will be conducted from both land and water.

A number of measures will be taken to attenuate the underwater sound generated from installation of steel and/or concrete piles with impact driving hammers. A bubble curtain attenuator or other marine pile driving energy attenuator (such as an isolation casing) will be used during impact pile driving. A wood block cushion may also be used during impact pile driving of concrete piles to reduce hydroacoustic disturbance. The following operating standards for bubble curtains will be met:

- The bubble curtain will distribute air bubbles around 100 percent of the piling perimeter for the full depth of the water column.
- The lowest bubble ring will be in contact with the mudline for the full circumference of the ring, and the weights attached to the bottom ring will ensure 100 percent mudline contact. No parts of the ring or other objects will prevent full mudline contact.
- Air flow to the bubblers will be balanced around the circumference of the pile.

The anticipated pile installation rate is three to five piles per day.

A soft start will be implemented before operating the impact hammer at full capacity. The soft start will consist of an initial set of strikes at reduced energy, followed by a 30-sec waiting period, then two subsequent reduced-energy strikes separated by the waiting period. A soft start will be implemented at the start of each day's impact pile driving and at any time following cessation of impact pile driving for 30 min or longer. Pile installation with both impact and vibratory pile driving hammers will occur behind a turbidity curtain to minimize impacts to water quality.

2.5. Noise Levels from Construction Activities

The distance to marine mammal threshold criteria for the particular pile driving scenarios of this Project, i.e., Level A and Level B isopleth distances, have been modeled by the acoustic engineering firm Illingworth and Rodkin, Inc. (I&R), based on underwater sound and pressure measurements from similar construction activities (CalTrans 2007, 2015; The Greenbusch Group, Inc. 2018).

Threshold distances were calculated by I&R using the NMFS' User Spreadsheet Tool Version 2.0 associated with the 2018 revision of the Marine Mammal Hearing Technical Guidance (NMFS 2018; spreadsheet available at http://www.nmfs.noaa.gov/pr/acoustics/guidelines.html). For calculation of SELcum threshold distances, it was assumed that only one type and size of pile would be installed on the same day and that only one pile installation method, vibratory or impact, would be performed on the same day. Limits on the maximum number of piles to be driven each day are listed in Table 4 and Table 5 together with the distances to the Level A and Level B marine mammal threshold criteria for each pile type. Some Level A thresholds have been rounded up for ease of use in the field.

Table 4. Distances in meters to Level A and Level B harassment threshold criteria for vibratory pile driving.

Pile Description	Maximum Piles Installed per Day	Level A/PTS Exclusion Zone (m)		Level B (120 dB RMS) Behavioral Monitoring Zone for All Species (m)
		Porpoise	Dolphin and Pinniped	
36-in Steel Pipe Pile	3	25	10	21,544
30-in Steel Pipe Pile	1	25	10	21,544
W 40x99 Wide Flange Beam	4	10	10	2,154
PZC 13, PZ 27, and PZ 35 Steel Sheet Pile	20	10	10	4,642
16-in Timber Pile Removal	10	10	10	1,359
12-in Concrete Pile Removal	10	10	10	2,154

Source: Haase 2019

Table 5. Distances in meters to Level A and Level B harassment threshold criteria for impact pile driving based on SELcum. Isopleth thresholds based on Peak SPLs were also calculated, however all isopleth distances were less than those calculated based on SELcum and therefore are not shown here.

Pile Description	Attenuation	Maximum Piles Installed per Day	Level A/PTS Exclusion Zone (m)		Level B (160 dB RMS) Behavioral Monitoring Zone for All Species (m)
			Porpoise	Dolphin and Pinniped	
36-in Steel Pipe Pile	Attenuated	3	540	240	541
30-in Steel Pipe Pile	Attenuated	1	140	70	341
W 40x99 Wide Flange Beam	Attenuated	4	300	140	341
24-in Square Concrete Pile	Unattenuated	4	140	70	117
16-in Square Concrete Pile	Unattenuated	4	30	25	25
14-in Square Concrete Pile	Unattenuated	4	30	25	25

Source: Haase 2019

3. TAKE AUTHORIZATION

The numbers of marine mammals by species that may be taken by each type of construction activity were calculated based on the estimated frequency of each species in the Project area and the number of days of vibratory and impact pile driving. The estimated frequency of animals was used to calculate take estimates as there was insufficient data to estimate species densities in the Estuary.

The Applicant has requested authorization from NMFS for the incidental taking of Pacific harbor seals, northern elephant seals, California sea lions, northern fur seals, common bottlenose dolphins, and harbor porpoise by Level B harassment over two years of construction activities (Table 6 and Table 7). No Level A harassment take was requested, as mitigation measures will prevent any such take.

Table 6. Summary of requested marine mammal Level B take over 68 days of pile driving in Year 1 of construction activities. Pile driving will not begin if a marine mammal is within the Level A/PTS MMEZ. Therefore, no animals will be taken by Level A harassment.

Species	Requested Level B Take in Year 1
Pacific Harbor Seal	**68**
California Sea Lion	**14**
Bottlenose Dolphin	**14**
Harbor Porpoise	**14**
Northern Elephant Seal	**6**
Northern Fur Seal	**6**

Table 7. Summary of requested marine mammal Level B take over 98 days of pile driving in Year 2 of construction activities. Pile driving will not begin if a marine mammal is within the Level A/PTS MMEZ. Therefore, no animals will be taken by Level A harassment.

Species	Requested Level B Take in Year 2
Pacific Harbor Seal	**98**
California Sea Lion	**20**
Bottlenose Dolphin	**20**
Harbor Porpoise	**20**
Northern Elephant Seal	**6**
Northern Fur Seal	**6**

4. MARINE MAMMAL MONITORING

This Plan will be employed to document the number and species of animals potentially exposed to Level B harassment, to avoid take of any species in exceedance of what is authorized by NMFS, and to avoid taking in a manner not authorized by NMFS under the requested IHA for Project activities.

4.1. Pre-Construction Briefings

Briefings will be conducted for construction supervisors and crews, the marine mammal monitoring team, and Applicant staff prior to the start of all pile driving activity, and when new personnel join the work. Briefings will explain personnel responsibilities, communication procedures, the marine mammal monitoring protocol, and operational procedures.

4.2. Exclusion and Monitoring Zones for Pile Driving Activities

Marine mammal exclusion zones (MMEZs) and behavioral monitoring zones (MZs) were established based on consultation with NMFS. MMEZs include all areas where underwater sound pressure levels (SPLs) are expected to reach or exceed the Level A harassment criteria for marine mammals. MZs include all areas where SPLs are expected to reach or exceed the Level B behavioral disturbance criteria.

Before vibratory or impact pile driving, Level A MMEZs and Level B MZs will be established at the conservatively estimated distances to acoustic threshold criteria shown in Table 4 and Table 5. MMEZs will be fully monitored by marine mammal observers (MMOs) and a representative portion of Level B MZs will be fully monitored to provide an accurate sample size of animals taken by Project activities, and to ensure that animals approaching the MMEZs are detected. Figures 2 through 5 show the Level A MMEZs and Level B MZs for vibratory and impact driving as a function of the geography in the Estuary.

After pile driving activity begins, hydroacoustic measurements will be collected by I&R for the specific activity (location and size/type of pile). These hydroacoustic monitoring results will be provided to NMFS, and the radius of the Level B monitoring zone may be adjusted, based on measured sound pressure levels. I&R's hydroacoustic monitoring plan for the Project is provided as Appendix E in the Project IHA Application.

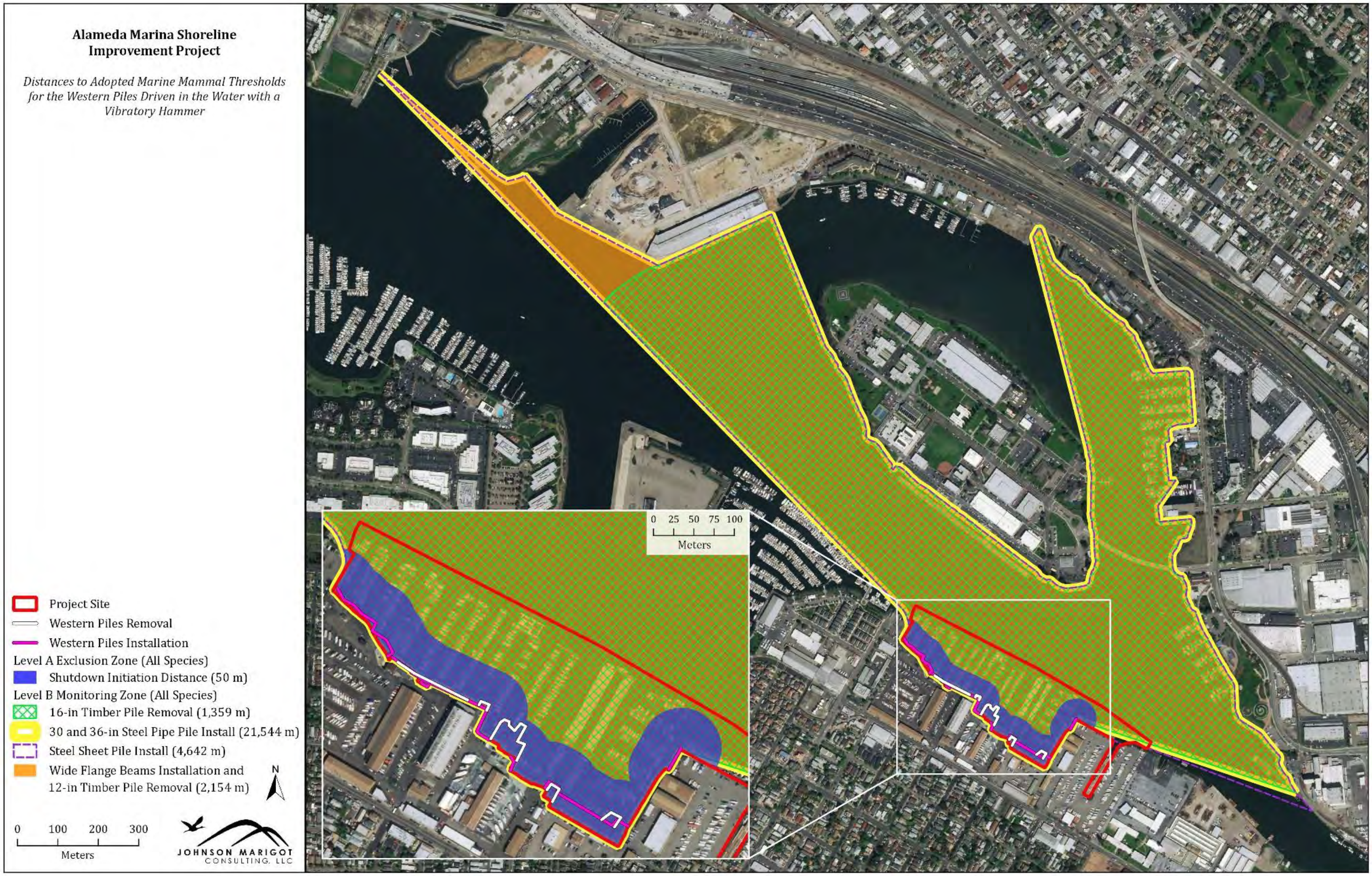

Figure 2. Level A exclusion zones and Level B monitoring zones for piles driven or removed by vibratory hammer on the western side of the Alameda Marina.

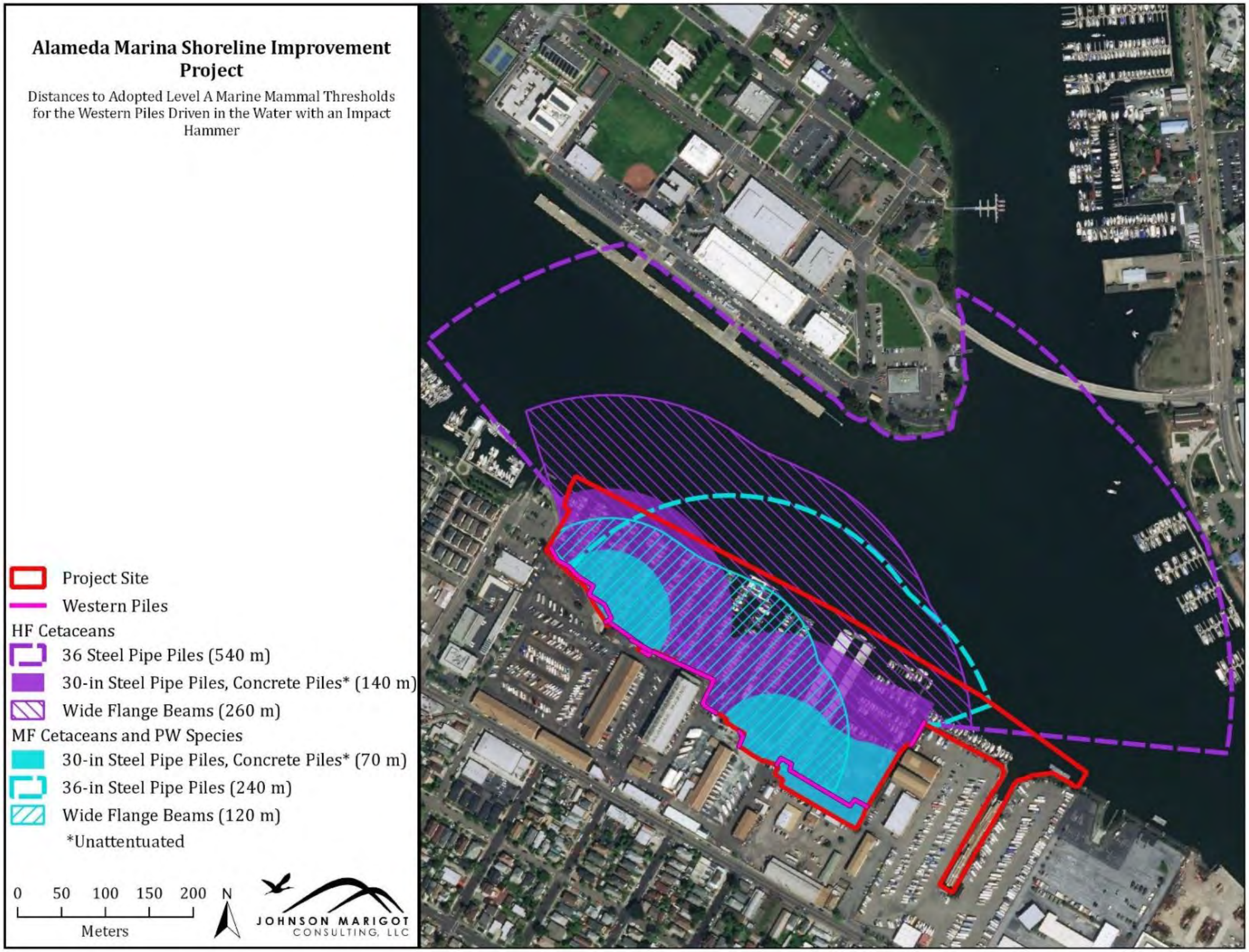

Figure 3. Level A exclusion zones for piles driven by impact hammer on the western side of the Alameda Marina.

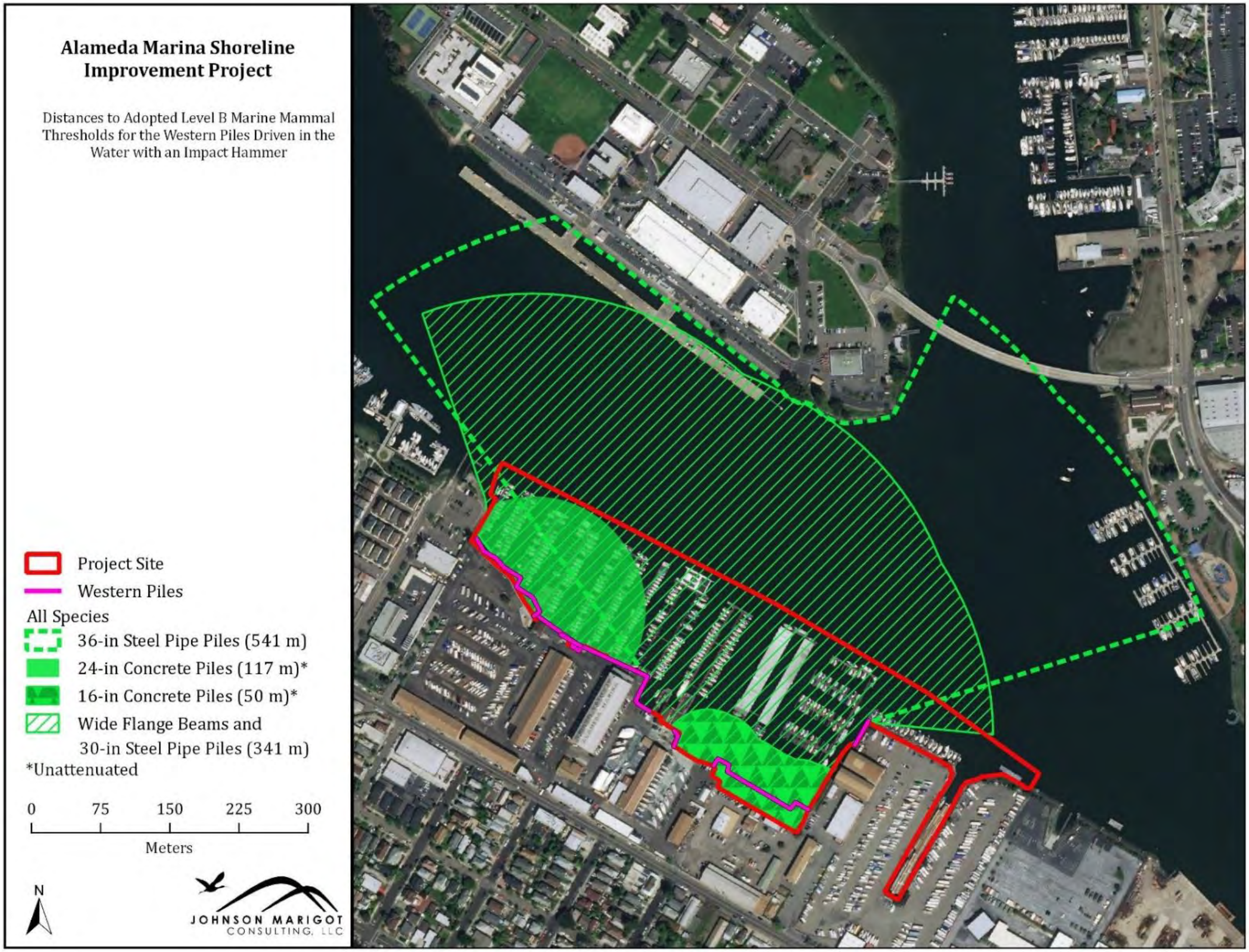

Figure 4. Level B monitoring zones for piles driven by impact hammer on the western side of the Alameda Marina.

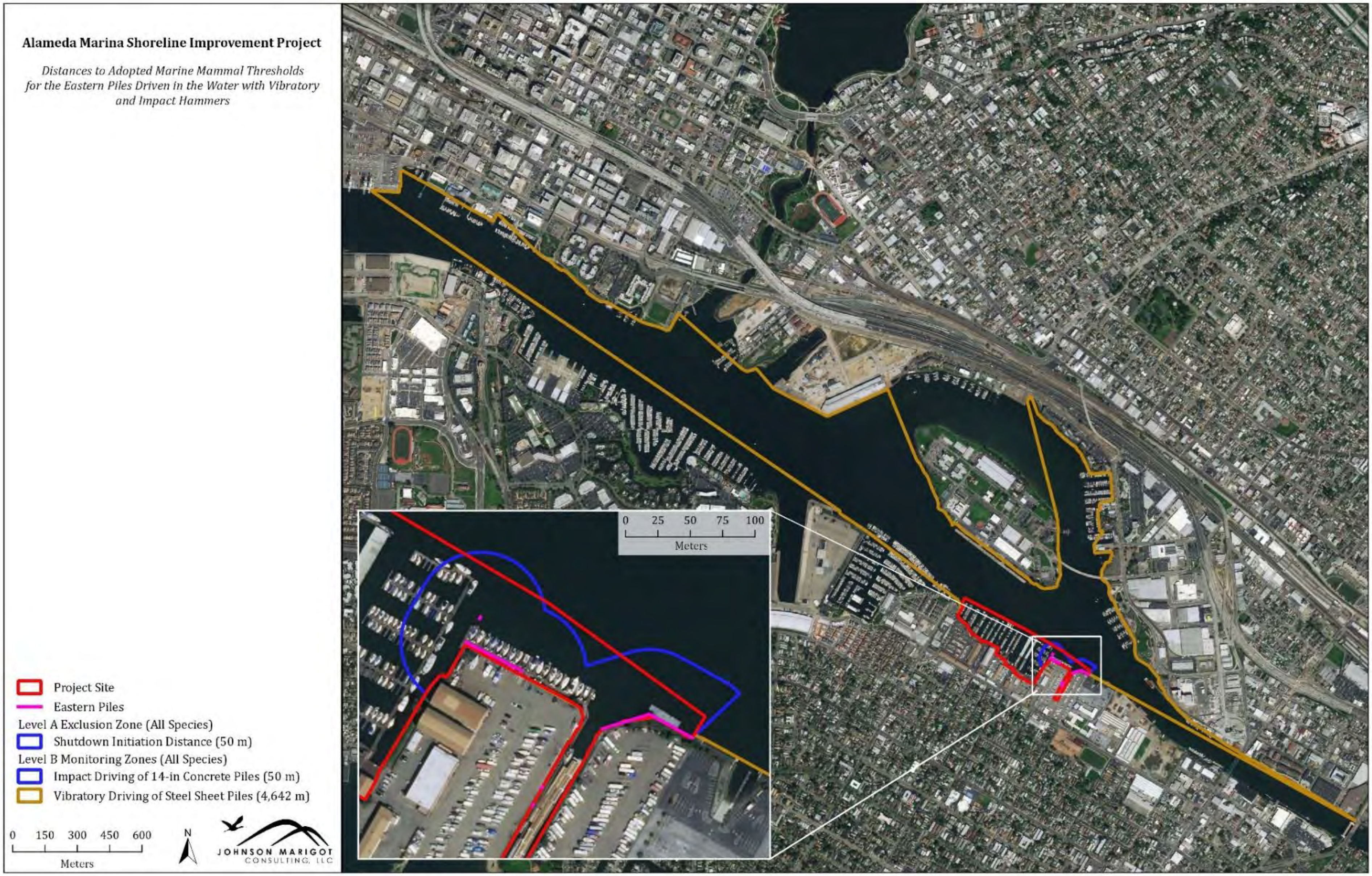

Figure 5. Level A exclusion zones and Level B monitoring zones for piles driven by impact and vibratory hammer on the eastern side of the Alameda Marina.

4.3. Marine Mammal Monitoring

4.3.1. Marine Mammal Observers

Monitoring during pile driving activities will be conducted by qualified NMFS-approved MMOs. A minimum of two MMOs will be on site at all times during pile driving activities. One MMO will be designated as the Lead MMO, who will receive updates from other MMOs on the presence or absence of marine mammals within the applicable MMEZs and MZs. The Lead MMO will be stationed at the active pile driving rig or at the best vantage point practicable to monitor the MMEZs for marine mammals and implement shutdown and delay procedures when applicable through communication with the on-site supervisor. The other MMO(s) will be stationed at the best vantage points practicable to observe the monitoring zones. Exact locations will be determined in the field based on the pile driving site, field conditions, and in coordination with the contractors, but may include docks, barges, and tower structures. Observations will be made using binoculars (10x42 or similar) or spotting scopes and the naked eye during daylight hours. Each member of the monitoring team will have a radio (and mobile phone for backup) for contact with the Lead MMO and other observers.

4.3.2. Data Collection and Observation Recording

Standardized data collection sheets will be provided to the MMOs (see Appendix A for example datasheet). Each MMO will record the following information:

- Dates and times (beginning and end) of all marine mammal monitoring.
- Construction activities occurring during each daily observation period, including how many and what type of piles were driven or removed and by what method (i.e., impact or vibratory).
- Weather parameters and water conditions during each monitoring period (e.g., wind speed, percent cloud cover, visibility, Beaufort sea state).
- The number of marine mammals observed, by species, relative to the pile location and if pile driving or removal was occurring at time of sighting.
- Age and sex class, if possible, of all marine mammals observed.
- MMO locations during marine mammal monitoring.
- Distances and bearings of each marine mammal observed to the pile being driven or removed for each sighting (if pile driving or removal was occurring at time of sighting).
- Description of any marine mammal behavior patterns during observation, including direction of travel.
- Detailed information about implementation of any mitigation triggered (e.g., shutdowns and delays), a description of specific actions that ensued, and resulting behavior of the animal, if any.

4.3.3. Marine Mammal Monitoring During Pile Driving

Predetermined Level A MMEZs and Level B MZs will be monitored during all vibratory and impact pile driving, as defined in Table 4 and Table 5 and Figures 2–5.

Pile driving will be conducted only during daylight hours and with enough time for pre- and post-construction monitoring, and with full visibility of the MMEZs. If the entire MMEZ is not visible (e.g., due to fog or heavy rain), pile driving and removal will be delayed until the MMOs are confident that marine mammals within the MMEZ could be detected.

The Lead MMO will be in contact with other MMO(s) and the Project on-site supervisor. MMOs will begin monitoring at least 30 minutes before pile driving begins and will continue to monitor the area for at least 30 minutes after pile driving has ended for the day.

4.3.4. Impact Pile Driving Soft Starts

Before operating impact pile driving hammers at full capacity, the Applicant will implement a soft start. The soft start will consist of an initial set of strikes at reduced energy, followed by a 30-second waiting period, then two subsequent reduced-energy strikes separated by the waiting period. A soft start will be implemented at the start of each day's impact pile driving and at any time following cessation of impact pile driving for 30 minutes or longer.

4.3.5. Delay and Shutdown Procedures

If any marine mammal enters a MMEZ within 15 minutes of the beginning of pile driving, pile driving will be delayed until the animal leaves the area or at least 15 minutes have passed since the last observation of the animal. If a marine mammal approaches or enters the MMEZ during pile driving, the activity will be halted. The Lead MMO will notify the on-site supervisor that a marine mammal is approaching or within an MMEZ and the pile driving activity needs to be temporarily shut down. The on-site supervisor will direct the equipment operator to temporarily shut down pile driving activity. Pile driving may resume after the animal has moved out of and is moving away from the MMEZ or after at least 15 minutes have passed since the last observation of the animal, if it is not seen leaving the MMEZ.

If a species for which authorization has not been granted, or a species for which authorization has been granted but the authorized takes are met, is observed approaching or within the Level B harassment zone (i.e., MZ), pile driving and removal activities will shut down immediately. Activities will not resume until the animal has been confirmed to have left the area or the observation period (15 minutes), has elapsed.

For all in-water construction using heavy machinery other than pile driving equipment (e.g., use of barge-mounted excavators or riprap placement in water), a 10-m shutdown zone will be in effect. If a marine mammal comes within 10 m, the Applicant will cease operations and reduce vessel speed to the minimum required to maintain steerage and safe working conditions. Monitoring of this shutdown zone does not require an MMO; the contractor can implement this measure.

4.3.6. Minimum Qualifications for MMOs

MMOs on the Project will have the following minimum qualifications:

- Independent MMOs (i.e., not construction personnel) who have no other assigned tasks during monitoring periods will be used.

- If a team of three or more MMOs is required, a lead observer (i.e., Lead MMO) or monitoring coordinator will be designated. The Lead MMO will have prior experience working as a marine mammal observer during construction.
- Other MMOs may substitute education (degree in biological science or related field) or training for experience.
- The Applicant will submit MMO CVs for approval by NMFS prior to the onset of pile driving.
- MMOs will have the following additional qualifications:
  - Ability to conduct field observations and collect data according to assigned protocols.
  - Experience or training in the field identification of marine mammals, including the identification of behaviors.
  - Sufficient training, orientation, or experience with the construction operation to provide for personal safety during observations.
  - Writing skills sufficient to prepare a report of observations including but not limited to the number and species of marine mammals observed; dates and times when in-water construction activities were conducted; dates, times, and reason for implementation of mitigation (or why mitigation was not implemented when required); and marine mammal behavior.
  - Ability to communicate orally, by radio or in person, with project personnel to provide real-time information on marine mammals observed in the area as necessary.

4.4. Reporting

The Applicant will submit a draft report on all monitoring conducted under the IHA within 90 calendar days of the completion of marine mammal and acoustic monitoring or 60 days prior to the issuance of any subsequent IHA for this Project, whichever comes first. A final report will be prepared and submitted within 30 days following resolution of comments on the draft report from NMFS. This report will contain the informational elements described in Section 4.3.2.

In addition, the report will contain the following information:

- Number of individuals of each species (differentiated by month as appropriate) detected within the monitoring zone, and estimates of number of marine mammals taken, by species.
- Description of attempts to distinguish between the number of individual animals taken and the number of incidences of take, such as ability to track groups or individuals.
- In the case where MMOs were not able to observe the entire Level B harassment zone, an extrapolation of the estimated takes by Level B harassment based on the number of observed exposures within the Level B harassment zone and the percentage of the Level B harassment zone that was not visible.
- The Applicant will submit all PSO datasheets and/or raw sighting data in a separate file from the final report referenced above.

4.4.1. Take of Marine Mammal due to Project Activity

In the unanticipated event that the Project activity clearly causes the take of a marine mammal in a manner prohibited by the MMPA, such as serious injury or mortality, the Applicant will immediately cease the specified activities and report the incident to the NMFS Office of Protected Resources and the NMFS West Coast Region Stranding Coordinator. The report will include the following information:

- Time and date of the incident,
- Description of the incident,
- Environmental conditions (e.g., wind speed and direction, Beaufort sea state, cloud cover, and visibility),
- Description of all marine mammal observations and active sound source use in the 24 hours preceding the incident,
- Species identification or description of the animal(s) involved,
- Fate of the animal(s), and
- Photographs or video footage of the animal(s).

Activities will not resume until NMFS is able to review the circumstances of the prohibited take. NMFS will work with the Applicant to determine what measures are necessary to minimize the likelihood of further prohibited take and ensure MMPA compliance. The Applicant may not resume their activities until notified by NMFS.

4.4.2. Discovery of an Injured or Dead Marine Mammal

In the event the Applicant discovers an injured or dead marine mammal, and the Lead PSO determines that the cause of the injury or death is unknown and the death is relatively recent (e.g., in less than a moderate state of decomposition), the Applicant will immediately report the incident to the NMFS Office of Protected Resources and the NMFS West Coast Region Stranding Coordinator. The report will include the same information listed in Section 4.4.1 above. Construction activities may continue while NMFS reviews the circumstances of the incident. NMFS will work with the Applicant to determine whether additional mitigation measures or modifications to the activities are appropriate.

In the event that the Applicant discovers an injured or dead marine mammal, and the Lead PSO determines that the injury or death is not associated with or related to the specified activities (e.g., previously wounded animal, carcass with moderate to advanced decomposition, or scavenger damage), the Applicant will report the incident to the NMFS Office of Protected Resources and the NMFS West Coast Region Stranding Coordinator within 24 hours of the discovery.

6. REFERENCES

California Department of Transportation (Caltrans). 2007. *Compendium of Pile Driving Sound Data.* Prepared by Illingworth & Rodkin, Inc.

———. 2015. Technical Guidance for the Assessment and Mitigation of the Hydroacoustic Effects of Pile Driving on Fish. Caltrans Division of Environmental Analysis, Sacramento, California. 532 pp. http://www.dot.ca.gov/hq/env/bio/files/bio_tech_guidance_hydroacoustic_effects_110215.pdf.

Haase, P. 2019. 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.

National Marine Fisheries Service (NMFS). 2018. *2018 Revisions to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts*. U.S. Dept. of Commerce, NOAA. NOAA Technical Memorandum NMFS-OPR-59, 167 p.

APPENDIX A EXAMPLE DATASHEET

Date ______________ Start/End Time _________/_________ MMO ___________________________ Observing Location ____
Weather (wind speed and direction, Beaufort, vis., cloud cover, precip.)____

____

Number and type of piles driven/removed? Vibratory or impact?____

____

Stg #	Time (Start/ End)	Species	# of Inds.	Location (Level A or Level B zone, initial and closest distance to pile driving [in meters])	Behavior (initial and any observed change or reaction, direction of travel, etc.)	Construction Activity	Notes (age and sex of animal(s) if known, animal seen before?, details of any mitigation request and construction's response, etc.)

APPENDIX E HYDROACOUSTIC MONITORING PLAN

ALAMEDA MARINA PROJECT PREDICTION OF UNDERWATER SOUND LEVELS

Alameda, California

February 2020

Submitted to:

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Project No: 19-133

INTRODUCTION

This study is an assessment of potential sound levels generated by planned repairs and retrofitting of the existing Alameda Marina on Alameda Island, 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.

This report includes the prediction of underwater sound levels calculated based on the results of measurements for similar projects. Predicted underwater sound levels are compared against interim thresholds that have been accepted by the National Oceanic and Atmospheric Administration (NOAA). To reasonably predict underwater sound levels from these activities, this analysis relies on acoustic data measured at similar projects. Available underwater sound data for projects involving the installation of similar piles was reviewed. The sound levels for pile driving activities proposed by the project were estimated using these data combined with an understanding of how and where these activities will occur. These predictions are a best estimate based on empirical data and engineering judgment and include a certain degree of uncertainty due to the site conditions.

UNDERWATER SOUNDS FROM PILE DRIVING

Fundamentals of Underwater Noise

When a pile driving hammer strikes a pile, a pulse is created that propagates through the pile and radiates sound into the water, the ground, and the air. The pulse amplitude and propagation are dependent on a variety of factors, including but not limited to pile size, hammer type, sediment composition, water depth, and water properties (conductivity, temperature, and pressure). Generally, the majority of the acoustic energy is confined to frequencies below 2 kilohertz (kHz) and there is very little energy above 20 kHz.

Sound pressure pulse as a function of time is referred to as the waveform. In terms of acoustics, these sounds are described by the peak pressure, the root-mean-square pressure (RMS), and the sound exposure level (SEL). The peak pressure is the highest absolute value of the measured waveform and can be a negative or positive pressure peak. For pile driving pulses, RMS level is determined by analyzing the waveform and computing the average of the squared pressures over the time that comprises that portion of the waveform containing the sound energy.[1] The pulse RMS has been approximated in the field for pile driving sounds by measuring the signal with a precision sound level meter set to the "impulse" RMS setting and is typically used to assess impacts to marine mammals. Another measure of the pressure waveform that can be used to describe the pulse

[1] Richardson, Greene, Malone & Thomson, *Marine Mammals and Noise,* Academic Press, 1995, and Greene, personal communication.

is the sound energy itself. The total sound energy in the pulse is referred to in many ways, most commonly as the "total energy flux"[2]. The "total energy flux" is equivalent to the un-weighted sound exposure level (SEL) for a plane wave propagating in a free field, a common unit of sound energy used in airborne acoustics to describe short-duration events. The unit used is dB re 1μPa^2-sec. In this report, peak pressures levels are expressed in decibels re 1 μPa; however, in other literature they can take varying forms such as a Pascals or pounds per square inch. The total sound energy in an impulse accumulates over the duration of that pulse. How rapidly the energy accumulates may be significant in assessing the potential effects of impulses on fish. Figure 1 illustrates the acoustical characteristics of an underwater pile driving pulse. Table 1 includes the definitions of terms commonly used to describe underwater sounds.

The variation of instantaneous pressure over the duration of a sound event is referred to as the waveform. The waveform can provide an indication of rise time or how fast pressure fluctuates with time; however, rise time differences are not clearly apparent for pile driving sounds due to the numerous rapid fluctuations that are characteristic to this type of impulse. A plot showing the accumulation of sound energy over the duration of the pulse (or at least the portion where much of the energy accumulates) illustrates the differences in source strength and rise time. An example of the underwater acoustical characteristics of a typical pile driving pulse is shown in Figure 1.

SEL is an acoustic metric that provides an indication of the amount of acoustical energy contained in a sound event. For pile driving, the typical event can be one pile driving pulse or many pulses such as pile driving for one pile or for one day of pile driving. Typically, SEL is measured for a single strike and a cumulative condition. The cumulative SEL associated with the driving of a pile can be estimated using the single strike SEL value and the number of pile strikes through the following equation:

$SEL_{CUMULATIVE} = SEL_{SINGLE\ STRIKE} + 10 \log (\#\text{ of pile strikes})$

For example, if a single strike SEL for a pile is 165 dB and it takes 1000 strikes to drive the pile, the cumulative SEL is 195 dBA (165 dB + 30 dB = 195 dB), where $10 * \text{Log}_{10}(1000) = 30$.

[2] Finerran, et. al., *Temporary Shift in Masked Hearing Thresholds in Odontocetes after Exposure to Single Underwater Impulses from a Seismic Watergun*, Journal of the Acoustical Society of America, June 2002.

Table 1 - Definitions of Underwater Acoustical Terms

Term	Definitions
Peak Sound Pressure Level, (dB re 1 μPa)	Peak sound pressure level based on the largest absolute value of the instantaneous sound pressure. This pressure is expressed in this report as a decibel (referenced to a pressure of 1 μPa) but can also be expressed in units of pressure, such as μPa or PSI.
Root-Mean-Square Sound Pressure Level, (dB re 1 μPa)	The average of the squared pressures over the time that comprise that portion of the waveform containing 90 percent of the sound energy for one pile driving impulse[3].
Sound Exposure Level, (dB re 1 μPa^2 sec)	Proportionally equivalent to the time integral of the pressure squared and is described in this report in terms of dB re 1 μPa^2 sec over the duration of the impulse. Similar to the unweighted Sound Exposure Level (SEL) standardized in airborne acoustics to study noise from single events.
Cumulative SEL , (dB re 1 μPa^2 sec)	Measure of the total energy received through a pile-driving event (here defined as pile driving that occurs with a day).
Waveforms, μPa over time	A graphical plot illustrating the time history of positive and negative sound pressure of individual pile strikes shown as a plot of μPa over time (i.e., seconds).
Frequency Spectra, dB over frequency range	A graphical plot illustrating the distribution of sound pressure vs. frequency for a waveform, dimension in rms pressure and defined frequency bandwidth.

[3] The underwater sound measurement results obtained during the Pile Installation Demonstration Project indicated that most pile driving impulses occurred over a 50 to 100 millisecond (msec) period. Most of the energy was contained in the first 30 to 50 msec. Analysis of that underwater acoustic data for various pile strikes at various distances demonstrated that the acoustic signal measured using the standard "impulse exponential-time-weighting" (35-msec rise time) correlated to the RMS (impulse) level measured over the duration of the impulse.

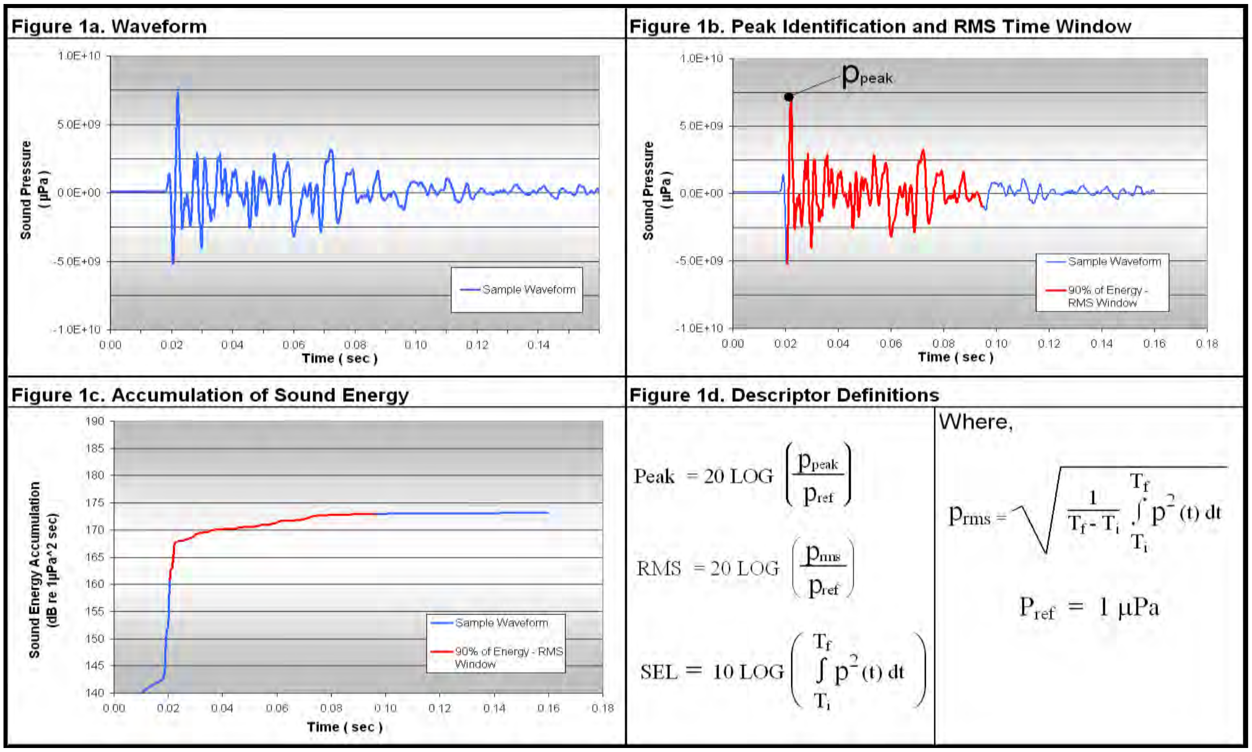

Figure 1 – Underwater Acoustical Characteristics of a Pile Driving Pulse

Underwater Sound Thresholds

Fish

On June 12, 2008, NOAA's National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service, California, Oregon, and Washington Departments of Transportation, California Department of Fish and Game and the U.S. Federal Highway Administration agreed in principal to interim criteria to protect fish from pile driving activities (Table 2). The adopted injury criteria listed in Table 2 are for pulse-type sounds (e.g., impact pile driving) and do not address sound from vibratory driving.

Table 2 - Fish Criteria Used for Injury and Area of Effect

Interim Criteria	Injury/Behavior	Sound Levels Agreed in Principle
Peak	Injury	206 dB re: 1 µPa (for all size of fish)
Cumulative SEL		187 dB re: 1 µPa^2-sec – for fish size of two grams or greater. 183 dB re: 1 µPa^2-sec – for fish size of less than two grams.
RMS	Area of Effect	150 dB re: 1 µPa (for all size of fish)

Marine Mammals

Under the Marine Mammal Protection Act, NMFS has defined levels of harassment for marine mammals. Level A harassment is defined as "Any act of pursuit, torment, or annoyance which has the potential to injure a marine mammal or marine mammal stock in the wild." Level B harassment is defined as "Any act of pursuit, torment, or annoyance which has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including but not limited to migration, breathing, nursing, breeding, feeding or sheltering." The sound criteria for Level A and Level B harassment are shown in Table 3.

Current NMFS guidance[4] categorizes marine mammals into several hearing groups, as shown in Table 4. For this project location, functional hearing groups assumed to be present include phocid pinnipeds and otariid pinnipeds. Injury harassment (Level A) takes into consideration the onset of auditory injury thresholds as defined by permanent threshold shifts (PTS). Level A thresholds are distinct for each hearing group, based on the frequency-weighted hearing sensitivity of the associated species. Exposure to impulse sounds includes the evaluation of the Peak and SEL_{cum} as a dual criterion, whereas exposure to continuous sounds relies solely on the SEL_{cum}.

Behavioral harassment (Level B) is considered to have occurred when marine mammals are exposed to sounds of 160 dB RMS or greater for impulse sounds (e.g., impact pile driving) and 120 dB RMS or greater for continuous sounds (e.g., vibratory pile driving). The application of the 120 dB RMS threshold can sometimes be problematic because this threshold level can be either at or below the ambient noise level of certain locations.

[4] NMFS. 2016 Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts. July.

Table 3 - Underwater Acoustic Criteria Used for Marine Mammals

Species Hearing Group	Non-Impulse Sound (Vibratory Pile Driving)		Impulse Sound (Impact Pile Driving)		
	Level A	Level B	Level A Dual Criteria		Level B
	(dB SEL_{cum})	(dB RMS)	(dB Peak SPL)	(dB SEL_{cum})	(dB RMS)
Low-Frequency Cetaceans (e.g., gray whales)	199	120	219	183	160
Mid-Frequency Cetaceans (e.g., bottlenose dolphin)	198		230	185	
High-Frequency Cetaceans (e.g., harbor porpoise)	173		202	155	
Phocids (e.g., harbor seal)	201		218	185	
Otariids (e.g., California sea lion)	219		232	203	
Note: All decibels (dB) are referenced to 1 micro Pascal (re: 1 μPa).					

Table 4 - Definition of Marine Mammal Hearing Group

Marine Mammal Hearing Groups	
Functional Hearing Group	**Functional Hearing Range[1]**
Low-frequency cetaceans - gray whales	7 Hz to 35 kHz
Mid frequency cetaceans - Dolphins, toothed whales, beaked whales, bottlenose whales	150 Hz to 160 kHz
High frequency cetaceans - True porpoises, *Kogia*, river dolphins, cehalorhynchid, *Lagenorhynchus cruciger* & *L. australis*	275 Hz to 160 kHz
Phocid pinnipeds - True seals including harbor seals	50 Hz to 86 kHz
Otariid pinnipeds - Sea lions and fur seals	60 Hz to 39 kHz

PROJECT SOUND GENERATING ACTIVITIES

The primary source of underwater sound will be from the vibratory and impact driving of piles located throughout the project site. Seawalls will be constructed with steel sheet piles or a combination (combi-wall) of steel sheet piles and wide flange beams. The headwalk, promenade wharf, boat hoist, building 5 wharf, building 13 wharf, and building 14 wharf will be constructed with a combination of steel pipe piles and square concrete piles of varying sizes. Cofferdams will be constructed with steel sheet piles. Piles to be removed consist of timber piles and square concrete piles. A summary of the piles to be installed and removed are shown in Tables 5 and 6, respectively.

A vibratory hammer will be used to remove all piles and install all sheet piles, whereas an impact hammer will be used to install all concrete piles. A vibratory hammer will also be used to initially drive wide flange beams and steel pipe piles below mudline. An impact hammer will then be used to drive the wide flange beams and steel pipe piles to final depths. A bubble curtain attenuator will be used to reduce hydroacoustic disturbance for the impact driving of the steel pipe piles and may be used for the impact driving of wide flange beams.

Table 5 – Summary of Piles to be Installed

Structure	Type of Pile	Number of Piles	Area (Ft^2)
Seawall 1	steel sheet pile (PZC 13)	233	2182
	wide flange beam (W 40 X 199)	117	618
Seaswall 1A	steel sheet pile (W40 X 199)	26	249
	wide flange beam (W40 X 199)	13	71
Seawall 4	steel sheet pile (PZ 35)	149	420
Seawall 6	steel sheet pile (PZ 35)	106	300
Promenade Wharf	16” square concrete	39	70.2
Building 14	36” cylindrical steel	1	7.1
Headwalk Piles	14” square concrete	19	25.9
Building 5	16” square concrete	1	1.8
Building 13	36” cylindrical steel	2	14.2
	16” square concrete	1	1.8
Boat Hoist	24” square concrete	8	32
	30” cylindrical steel	1	5
Cofferdams	steel sheet pile (PZ 27)	214	9

Table 6 – Summary of Piles to be Removed

Structure	Type of Pile	Number of Piles	Area (Ft^2)
Seawall 1	16" timber	150	225
Pier 6 Stud	16" timber	20	30
Pier 4 Stud	16" timber	16	24
Building 14 Wharf	16" timber	20	30
Boat Elevator Wharf	16" timber	7	10.5
	12" square concrete	12	12
Boat Lift Wharf	16" timber	25	37.5
	12" square concrete	7	7
Pier Outboard of Promenade Wharf	16" timber	60	90
Building 13 Wharf	16" timber	3	4.5

Prediction of Pile Driving Sound Levels

In November 2015, Caltrans published the *Technical Guidance for Assessment and Mitigation of the Hydroacoustic Effects of Pile Driving on Fish*[5]. Tables I.2-1 and I.2-2 of Appendix 1 contain average sound pressure levels for different types of unattenuated piles driven by impact and vibratory hammers. This data was reviewed to make predictions of underwater sound that would occur from this project, as shown in Tables 7 and 8. For source level predictions that aren't based on data from Tables I.2-1 and I.2-2, the data used for the predictions are footnoted. For piles driven within bubble curtains, it is assumed that source levels would be reduced by 7 dB.

Based on site-specific assumptions and preliminary scoping by the construction estimator, it is anticipated that the installation of each pile will require up to approximately 500[6] strikes for impact driving and 10 minutes for vibratory driving. Based on a review of the sheet pile types proposed for seawall construction, the PZC 13, PZ 35, and PZ 27 sheet piles are assumed to generate similar noise levels and are evaluated as the same type of sheet pile for the purpose of this assessment. Up to approximately 10 timber and/or concrete piles will be removed per day, with the removal of each pile occurring over a duration of approximately five minutes. It is anticipated that up to 10 pairs of sheet piles will be installed per day, whereas four piles will be installed per day for all other pile types, up to the maximum number of piles proposed. For example, since there are only three 36-inch steel pipe piles and one 30-inch steel pipe piles proposed throughout the project, it

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[5] Caltrans. 2015. *Technical Guidance for Assessment and Mitigation of the Hydroacoustic Effects of Pile Driving on Fish*. November. Document prepared by ICF Jones & Stokes and Illingworth & Rodkin, Inc. under contract to Caltrans.

[6] The actual number of strikes for impact driving may vary from this estimate due to variable substrate at the project site and other unanticipated conditions. Although the number of strikes is not expected to exceed 500, predicted impacts to marine mammals and fish based on adopted thresholds from additional strikes are provided in Appendix C.

is assumed that up to three 36-inch steel pipe piles and up to one 30-inch steel pipe pile will be driven per day.

Table 7 – Impact Pile Driving Near-Source Levels (Unattenuated)

Pile type	Distance (Meters)	Peak (dB re 1µPa)	RMS (dB re 1µPa)	Single-Strike SEL (dB re 1µPa)
36-inch steel pipe pile	10	210	193	183
30-inch steel pipe pile	10	210	190	177
W 40 x 199 wide flange beam[1]	10	207	194	178
24-inch square concrete pile	10	188	176	166
16-inch square concrete pile[2]	10	185	166	155
14-inch square concrete pile[2]	10	185	166	155

[1]Source levels based on 24-inch steel pipe pile, per comments received from NMFS
[2]Source levels based on 18-inch square concrete piles

Table 8 - Vibratory Pile Driving/Removal Near-Source Levels (Unattenuated)

Pile type	Distance (Meters)	Peak (dB re 1µPa)	RMS (dB re 1µPa)	One Second SEL (dB re 1µPa)
36-inch steel pipe pile	10	180	170	170
30-inch steel pipe pile	10	180	170	170
W 40 x 199 wide flange beam[1]	10	170	155	155
PZC 13, PZ 27, and PZ 35 steel sheet piles	10	175	160	160
16-inch timber pile removal[2]	10	162	152	152
12-inch concrete pile removal	10	171	155	155

[1]Source levels based on 38-inch x 18-inch king piles at the Naval Station Mayport in Jacksonville, Florida
[2]Source levels based on vibratory driving of 14-inch timber piles (The Greenbusch Group, Inc., 2018). Peak computed as +10dB

Predicted Impacts to Fish

The NMFS Pile Driving Calculator was used to predict zones where injury and disturbance are expected to fish, assuming a transmission loss constant of 15 (i.e. 15 x Log[R_1/R_2]). All distances were computed for impact pile driving based on the near-source levels in Table 7. Both the unattenuated and attenuated distances to the adopted interim fish thresholds are shown in Tables 9 and 10, respectively. Distances are shown for the driving of one pile as well as the maximum number of piles per day for each pile type, based on the assumptions previously outlined. While the actual number of piles installed per day may vary, note that the distance to the SEL_{cum} threshold will be the only variable that changes. While distances are shown for threshold exceedances that are estimated to occur at less than 10 meters, monitoring is generally not performed within 10 meters of pile driving due to safety concerns and the inherent variability of drop-off rates in close proximity to the pile. Screenshots of NMFS Pile Driving Calculator spreadsheets used to calculate threshold distances are shown in Appendix A.

Table 9 – Distances (in meters) to Adopted Fish Thresholds for Unattenuated Piles Driven in the Water

Pile type	No. of Piles Installed per Day	187 dB SEL_{cum}	183 dB SEL_{cum}	206 dB Peak	150 dB RMS (Disturbance)
36-inch steel pipe pile	1	341	630	18	7,356
	3	709	1,310		
30-inch steel pipe pile	1	136	251	18	4,642
W 40 x 199 wide flange beam	1	158	292	12	8,577
	4	399	737		
24-inch square concrete pile	1	25	46	1	541
	4	63	117		
16-inch square concrete pile	1	5	9	NA	117
	4	12	22		
14-inch square concrete pile	1	5	9	NA	117
	4	12	22		

Table 10 – Distances (in meters) to Adopted Fish Thresholds for Attenuated Piles Driven in the Water

Pile type	No. of Piles Installed per Day	187 dB SEL_{cum}	183 dB SEL_{cum}	206 dB Peak	150 dB RMS (Disturbance)
36-inch steel pipe pile	1	116	215	6	2,512
	3	242	447		
30-inch steel pipe pile	1	46	86	6	1,585
W 40 x 199 wide flange beam	1	54	100	4	2,929
	4	136	252		

Predicted Impacts to Marine Mammals

The following threshold distances were computed to assess impacts to marine mammals:

- Distance to onset PTS Isopleth for each hearing group
  - Unattenuated
  - Attenuated
- Distance for Unweighted 120-dB Vibratory and 160-dB Impulse Behavioral Isopleth
  - Unattenuated
  - Attenuated

The NMFS Companion User Spreadsheet (Version 2.0 [2018]) to the *National Marine Fisheries Service (NMFS): Technical Guidance for Assessing the Effects of Anthropogenic Noise on Marine Mammal Hearing: Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts* was used to predict zones where the onset of Permanent Threshold Shift (PTS) to marine mammal hearing could occur. Source sound levels from Tables 5 and 6 were used to calculate PTS isopleths with a propagation assumption of 15 x Log(R_1/R_2). The default weighting factor adjustment of 2.0 kHz was applied to impact pile driving calculations and the default weighting factor adjustment of 2.5 kHz was applied to vibratory pile driving calculations. Screenshots of user spreadsheets used to calculate Level A harassment isopleths are shown in Appendix B.

The calculations of PTS threshold distances (isopleths) for impulsive sounds are based on a dual metric threshold between the higher level of the SEL_{cum} or Peak SPL. Since the onset of PTS based on the distance to the SEL_{cum} threshold is further from the pile for all pile types than it would be using Peak SPL computations, Table 9 only includes PTS isopleths based SEL_{cum} computations. PTS isopleths based on Peak SPL computations are included in Appendix C. Since the majority of pile driving work will be along the shoreline within the Oakland Estuary, sound levels measured in the field will have substantial attenuation over greater distances and may not extend to the full distances shown for the behavioral harassment zones. While distances are shown for threshold exceedances that are estimated to occur at less than 10 meters, monitoring is generally not performed within 10 meters of pile driving due to safety concerns and the inherent variability of drop-off rates in close proximity to the pile.

Calculations of PTS threshold distances for 750 strike and 1,000 strike scenarios are included in Appendix D.

Table 11 – Distances (in meters) to the adopted Marine Mammal Thresholds for Piles Driven with an Impact Hammer in Water

Pile Description	Attenuation	No. of Piles Installed per Day	PTS Isopleth Threshold (m) Based on SEL_{cum}					160 dB RMS Behavioral Harassment Zone (m)
			Cetaceans			Pinnipeds		
			LF	MF	HF	PW	OW	
36-inch steel pipe pile	Unattenuated	1	629	22	749	337	25	1,585
		3	1,308	47	1,559	700	51	
	Attenuated	1	215	8	256	115	8	541
		3	447	16	532	239	17	
30-inch steel pipe pile	Unattenuated	1	250	9	298	134	10	1,000
	Attenuated	1	86	3	102	46	3	341
W 40 x 199 wide flange beam	Unattenuated	1	292	10	348	156	11	1,848
		4	736	26	876	394	29	
	Attenuated	1	100	4	119	53	4	631
		4	251	9	299	135	10	
24-inch concrete pile	Unattenuated	1	46	2	55	25	2	117
		4	117	4	139	62	5	
16-inch concrete pile	Unattenuated	1	9	<1	10	5	<1	25
		4	22	1	26	12	1	
14-inch concrete pile	Unattenuated	1	9	<1	10	5	<1	25
		4	22	1	26	12	1	

Table 12 – Distances (in meters) to the adopted Marine Mammal Thresholds for Piles Driven with a Vibratory Hammer in Water

Pile Description	No. of Piles Installed per Day	PTS Isopleth Threshold (m) Based on SEL_{cum}					120 dB RMS Behavioral Harassment Zone (m)
		Cetaceans			Pinnipeds		
		LF	MF	HF	P	O	
36-inch steel pipe pile	1	8	1	12	5	<1	21,544
	3	17	2	25	10	1	
30-inch steel pipe pile	1	8	1	12	5	<1	21,544
W 40 x 199 wide flange beam	1	1	<1	1	1	<1	2,154
	4	2	<1	3	1	<1	
PZC 13, PZ 27, and PZ 35 steel sheet pile	1	<1	<1	1	<1	<1	4,642
	10	2	<1	3	1	<1	
16-inch timber pile removal	1	<1	<1	1	<1	<1	1,359
	10	2	<1	2	1	<1	
12-inch concrete pile removal	1	1	<1	1	<1	<1	2,154
	10	2	<1	4	2	<1	

APPENDIX A

36-inch Steel Pipe Piles Unattenuated

strikes 500

1 Pile

	Acoustic Metric		
	Peak	RMS	SEL
Measured single strike level (dB)	210	193	183
Distance (m)	10	10	10

Estimated number of strikes	500

Cumulative SEL at measured distance
210

	Distance (m) to threshold			
	Peak	RMS	Cumulative SEL**	Cumulative SEL**
Transmission loss constant (15 if unknown)	206	150	187	183
15	18	7356	341	630

3 Piles

Fill in green cells: estimated sound levels and distances at which they were measured, estimated

	Acoustic Metric		
	Peak	RMS	SEL
Measured single strike level (dB)	210	193	183
Distance (m)	10	10	10

Estimated number of strikes	1500

Cumulative SEL at measured distance
215

	Distance (m) to threshold			
	Peak	RMS	Cumulative SEL**	Cumulative SEL**
Transmission loss constant (15 if unknown)	206	150	187	183
15	18	7356	709	1310

36-inch Steel Pipe Piles Attenuated

strikes 500

1 Pile

	Acoustic Metric		
	Peak	RMS	SEL
Measured single strike level (dB)	203	186	176
Distance (m)	10	10	10

Estimated number of strikes	500

Cumulative SEL at measured distance
203

	Distance (m) to threshold			
	Peak	RMS	Cumulative SEL**	Cumulative SEL**
Transmission loss constant (15 if unknown)	206	150	187	183
15	6	2512	116	215

3 Piles

Fill in green cells: estimated sound levels and distances at which they were measured, estimated

	Acoustic Metric		
	Peak	RMS	SEL
Measured single strike level (dB)	203	186	176
Distance (m)	10	10	10

Estimated number of strikes	1500

Cumulative SEL at measured distance
208

	Distance (m) to threshold			
	Peak	RMS	Cumulative SEL**	Cumulative SEL**
Transmission loss constant (15 if unknown)	206	150	187	183
15	6	2512	242	447

30-inch Steel Pipe Piles Unattenuated

strikes 500

1 Pile

	Acoustic Metric		
	Peak	RMS	SEL
Measured single strike level (dB)	210	190	177
Distance (m)	10	10	10

Estimated number of strikes	500

Cumulative SEL at measured distance
204

	Distance (m) to threshold			
	Peak	RMS	Cumulative SEL**	Cumulative SEL**
Transmission loss constant (15 if unknown)	206	150	187	183
15	18	4642	136	251

30-inch Steel Pipe Piles Attenuated

1 Pile

strikes 500

	Acoustic Metric		
	Peak	RMS	SEL
Measured single strike level (dB)	203	183	170
Distance (m)	10	10	10

Estimated number of strikes	500

Cumulative SEL at measured distance
197

	Distance (m) to threshold			
	Peak	RMS	Cumulative SEL**	Cumulative SEL**
Transmission loss constant (15 if unknown)	206	150	187	183
15	6	1585	46	86

W 40 x 199 Wide Flange Beams Unattenuated

strikes 500

1 Pile

	Acoustic Metric		
	Peak	RMS	SEL
Measured single strike level (dB)	207	194	178
Distance (m)	10	10	10

Estimated number of strikes	500

Cumulative SEL at measured distance
205

	Distance (m) to threshold			
	Peak	RMS	Cumulative SEL**	Cumulative SEL**
Transmission loss constant (15 if unknown)	206	150	187	183
15	12	8577	158	292

4

Fill in green cells: estimated sound levels and distances at which they were measured, estimated

	Acoustic Metric		
	Peak	RMS	SEL
Measured single strike level (dB)	207	194	178
Distance (m)	10	10	10

Estimated number of strikes	2000

Cumulative SEL at measured distance
211

	Distance (m) to threshold			
	Peak	RMS	Cumulative SEL**	Cumulative SEL**
Transmission loss constant (15 if unknown)	206	150	187	183
15	12	8577	399	737

W 40 x 199 Wide Flange Beams Attenuated					# strikes	500
1 Pile						

	Acoustic Metric		
	Peak	RMS	SEL
Measured single strike level (dB)	200	187	171
Distance (m)	10	10	10

Estimated number of strikes	500

Cumulative SEL at measured distance
198

	Distance (m) to threshold			
	Peak	RMS	Cumulative SEL**	Cumulative SEL**
Transmission loss constant (15 if unknown)	206	150	187	183
15	4	2929	54	100

4

Fill in green cells: estimated sound levels and distances at which they were measured, estimated

	Acoustic Metric		
	Peak	RMS	SEL
Measured single strike level (dB)	200	187	171
Distance (m)	10	10	10

Estimated number of strikes	2000

Cumulative SEL at measured distance
204

	Distance (m) to threshold			
	Peak	RMS	Cumulative SEL**	Cumulative SEL**
Transmission loss constant (15 if unknown)	206	150	187	183
15	4	2929	136	252

24-inch Concrete Piles Unattenuated

strikes 500

1 Pile

	Acoustic Metric		
	Peak	RMS	SEL
Measured single strike level (dB)	188	176	166
Distance (m)	10	10	10

Estimated number of strikes	500

Cumulative SEL at measured distance
193

	Distance (m) to threshold			
	Peak	RMS	Cumulative SEL**	Cumulative SEL**
Transmission loss constant (15 if unknown)	206	150	187	183
15	1	541	25	46

4 Piles

Fill in green cells: estimated sound levels and distances at which they were measured, estimated

	Acoustic Metric		
	Peak	RMS	SEL
Measured single strike level (dB)	188	176	166
Distance (m)	10	10	10

Estimated number of strikes	2000

Cumulative SEL at measured distance
199

	Distance (m) to threshold			
	Peak	RMS	Cumulative SEL**	Cumulative SEL**
Transmission loss constant (15 if unknown)	206	150	187	183
15	1	541	63	117

16-inch Concrete Piles Unattenuated

strikes 500

1 Pile

	Acoustic Metric		
	Peak	RMS	SEL
Measured single strike level (dB)	185	166	155
Distance (m)	10	10	10

Estimated number of strikes	500

Cumulative SEL at measured distance
182

	Distance (m) to threshold			
	Peak	RMS	mulative SEL	Cumulative SEL**
Transmission loss constant (15 if unknown)	206	150	187	183
15	0	117	5	9

4 Piles

Fill in green cells: estimated sound levels and distances at which they were measured, estimated

	Acoustic Metric		
	Peak	RMS	SEL
Measured single strike level (dB)	185	166	155
Distance (m)	10	10	10

Estimated number of strikes	2000

Cumulative SEL at measured distance
188

	Distance (m) to threshold			
	Peak	RMS	mulative SEL	Cumulative SEL**
Transmission loss constant (15 if unknown)	206	150	187	183
15	0	117	12	22

14-inch Concrete Piles Unattenuated

strikes 500

1 Pile

	Acoustic Metric		
	Peak	RMS	SEL
Measured single strike level (dB)	185	166	155
Distance (m)	10	10	10

Estimated number of strikes	500

Cumulative SEL at measured distance
182

	Distance (m) to threshold			
	Peak	RMS	mulative SE	Cumulative SEL**
Transmission loss constant (15 if unknown)	206	150	187	183
15	0	117	5	9

4 Piles

Fill in green cells: estimated sound levels and distances at which they were measured, estimated

	Acoustic Metric		
	Peak	RMS	SEL
Measured single strike level (dB)	185	166	155
Distance (m)	10	10	10

Estimated number of strikes	2000

Cumulative SEL at measured distance
188

	Distance (m) to threshold			
	Peak	RMS	mulative SE	Cumulative SEL**
Transmission loss constant (15 if unknown)	206	150	187	183
15	0	117	12	22

APPENDIX B

E.1: IMPACT PILE DRIVING (STATIONARY SOURCE: Impulsive, Intermittent)

VERSION 2.0: 2018

KEY

(gray)	**User Provided Information**
(orange)	**NMFS Provided Information (Technical Guidance)**
(blue)	**Resultant Isopleth**

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	36" Steel Pipe Unattenuated
PROJECT/SOURCE INFORMATION	Alameda Marina

Please include any assumptions

PROJECT CONTACT	Cameron Heyvaert

STEP 2: WEIGHTING FACTOR ADJUSTMENT

		Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value
Weighting Factor Adjustment (kHz)¥	2	

¥ Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 75), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

*** BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

STEP 3: SOURCE-SPECIFIC INFORMATION

NOTE: Choose either E1-1 OR E.1-2 method to calculate isopleths (not required to fill in sage boxes for both)

E.1-1: METHOD TO CALCULATE PK AND SEL_{cum} (USING RMS SPL SOURCE LEVEL)

SEL_{cum}

Source Level (RMS SPL)	
Number of piles per day	
Strike Duration^Δ (seconds)	
Number of strikes per pile	
Duration of Sound Production (seconds)	0
10 Log (duration of sound production)	#NUM!
Propagation (xLogR)	
Distance of source level measurement (meters)*	

^Δ Window that makes up 90% of total cumulative energy (5%-95%) based on Madsen 2005

*Unless otherwise specified, source levels are referenced 1 m from the source.

PK

Source Level (PK SPL)	
Distance of source level measurement (meters)*	
Source level at 1 meter	#NUM!

*Unless otherwise specified, source levels are referenced 1 m from the source.

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SELcum & PK). Metric producing largest isopleth should be used.

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**

E.1-2: ALTERNATIVE METHOD TO CALCULATE PK AND SEL_{cum} (SINGLE STRIKE EQUIVALENT)

Unweighted $SEL_{cum\ (at\ measured\ distance)}$ = SEL_{ss} + 10 Log (# strikes)	**210.0**

SEL_{cum}

Source Level (Single Strike SEL)	183
Number of strikes per pile	500
Number of piles per day	1
Propagation (xLogR)	15
Distance of single strike SEL measurement (meters)*	10

*Unless otherwise specified, source levels are referenced 1 m from the source.

PK

Source Level (PK SPL)	210
Distance of source level measurement (meters)*	10
Source level at 1 meter	225.0

*Unless otherwise specified, source levels are referenced 1 m from the source.

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SELcum & PK). Metric producing largest isopleth should be used.

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	**629.1**	**22.4**	**749.4**	**336.7**	**24.5**
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	**2.5**	**NA**	**34.1**	**2.9**	**NA**

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	**-0.01**	**-19.74**	**-26.87**	**-2.08**	**-1.15**

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}$$

E.1: IMPACT PILE DRIVING (STATIONARY SOURCE: Impulsive, Intermittent)

VERSION 2.0: 2018

KEY

(gray)	**User Provided Information**
(orange)	**NMFS Provided Information (Technical Guidance)**
(blue)	**Resultant Isopleth**

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	36" Steel Pipe Attenuated
PROJECT/SOURCE INFORMATION	

Please include any assumptions

PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

		Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value
Weighting Factor Adjustment (kHz)¥	2	

¥ Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 75), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

*** BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

STEP 3: SOURCE-SPECIFIC INFORMATION

NOTE: Choose either E1-1 OR E.1-2 method to calculate isopleths (not required to fill in sage boxes for both)

E.1-1: METHOD TO CALCULATE PK AND SEL_{cum} (USING RMS SPL SOURCE LEVEL)

SEL_{cum}

Source Level (RMS SPL)	
Number of piles per day	
Strike Duration^Δ (seconds)	
Number of strikes per pile	
Duration of Sound Production (seconds)	0
10 Log (duration of sound production)	#NUM!
Propagation (xLogR)	
Distance of source level measurement (meters)⁺	

^ΔWindow that makes up 90% of total cumulative energy (5%-95%) based on Madsen 2005

⁺Unless otherwise specified, source levels are referenced 1 m from the source.

PK

Source Level (PK SPL)	
Distance of source level measurement (meters)⁺	
Source level at 1 meter	#NUM!

⁺Unless otherwise specified, source levels are referenced 1 m from the source.

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SELcum & PK). Metric producing largest isopleth should be used.

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**

E.1-2: ALTERNATIVE METHOD TO CALCULATE PK AND SEL_{cum} (SINGLE STRIKE EQUIVALENT)

Unweighted $SEL_{cum\ (at\ measured\ distance)}$ = SEL_{ss} + 10 Log (# strikes)	**203.0**

SEL_{cum}

Source Level (Single Strike SEL)	176
Number of strikes per pile	500
Number of piles per day	1
Propagation (xLogR)	15
Distance of single strike SEL measurement (meters)⁺	10

⁺Unless otherwise specified, source levels are referenced 1 m from the source.

PK

Source Level (PK SPL)	203
Distance of source level measurement (meters)⁺	10
Source level at 1 meter	218.0

⁺Unless otherwise specified, source levels are referenced 1 m from the source.

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SELcum & PK). Metric producing largest isopleth should be used.

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	**214.8**	**7.6**	**255.9**	**115.0**	**8.4**
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	**NA**	**NA**	**11.7**	**NA**	**NA**

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	**-0.01**	**-19.74**	**-26.87**	**-2.08**	**-1.15**

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}$$

E.1: IMPACT PILE DRIVING (STATIONARY SOURCE: Impulsive, Intermittent)

VERSION 2.0: 2018

KEY

(gray)	**User Provided Information**
(orange)	**NMFS Provided Information (Technical Guidance)**
(blue)	**Resultant Isopleth**

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	30-inch steel pipe pile unattenuated
PROJECT/SOURCE INFORMATION	

Please include any assumptions

PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

		Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value
Weighting Factor Adjustment (kHz)[¥]	2	

[¥] Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 75), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

*** BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

STEP 3: SOURCE-SPECIFIC INFORMATION

NOTE: Choose either E1-1 OR E.1-2 method to calculate isopleths (not required to fill in sage boxes for both)

E.1-1: METHOD TO CALCULATE PK AND SEL_{cum} (USING RMS SPL SOURCE LEVEL)

SEL_{cum}

Source Level (RMS SPL)	
Number of piles per day	
Strike Duration[Δ] (seconds)	
Number of strikes per pile	
Duration of Sound Production (seconds)	0
10 Log (duration of sound production)	#NUM!
Propagation (xLogR)	
Distance of source level measurement (meters)*	

[Δ]Window that makes up 90% of total cumulative energy (5%-95%) based on Madsen 2005

*Unless otherwise specified, source levels are referenced 1 m from the source.

PK

Source Level (PK SPL)	
Distance of source level measurement (meters)*	
Source level at 1 meter	#NUM!

*Unless otherwise specified, source levels are referenced 1 m from the source.

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SELcum & PK). Metric producing largest isopleth should be used.

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**

E.1-2: ALTERNATIVE METHOD TO CALCULATE PK AND SEL_{cum} (SINGLE STRIKE EQUIVALENT)

Unweighted $SEL_{cum\ (at\ measured\ distance)}$ = SEL_{ss} + 10 Log (# strikes)	**204.0**

SEL_{cum}

Source Level (Single Strike SEL)	177
Number of strikes per pile	500
Number of piles per day	1
Propagation (xLogR)	15
Distance of single strike SEL measurement (meters)*	10

*Unless otherwise specified, source levels are referenced 1 m from the source.

PK

Source Level (PK SPL)	210
Distance of source level measurement (meters)*	10
Source level at 1 meter	225.0

*Unless otherwise specified, source levels are referenced 1 m from the source.

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SELcum & PK). Metric producing largest isopleth should be used.

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	**250.4**	**8.9**	**298.3**	**134.0**	**9.8**
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	**2.5**	**NA**	**34.1**	**2.9**	**NA**

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	**-0.01**	**-19.74**	**-26.87**	**-2.08**	**-1.15**

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}$$

E.1: IMPACT PILE DRIVING (STATIONARY SOURCE: Impulsive, Intermittent)

VERSION 2.0: 2018

KEY

	User Provided Information
	NMFS Provided Information (Technical Guidance)
	Resultant Isopleth

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	30-inch steel pipe pile attenuated
PROJECT/SOURCE INFORMATION	

Please include any assumptions

PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value

Weighting Factor Adjustment (kHz)[¥]	2	

[¥] Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 75), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

*** BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

STEP 3: SOURCE-SPECIFIC INFORMATION

NOTE: Choose either E1-1 OR E.1-2 method to calculate isopleths (not required to fill in sage boxes for both)

E.1-1: METHOD TO CALCULATE PK AND SEL_{cum} (USING RMS SPL SOURCE LEVEL)

SEL_{cum}

Source Level (RMS SPL)	
Number of piles per day	
Strike Duration[Δ] (seconds)	
Number of strikes per pile	
Duration of Sound Production (seconds)	0
10 Log (duration of sound production)	#NUM!
Propagation (xLogR)	
Distance of source level measurement (meters)*	

[Δ]Window that makes up 90% of total cumulative energy (5%-95%) based on Madsen 2005

*Unless otherwise specified, source levels are referenced 1 m from the source.

PK

Source Level (PK SPL)	
Distance of source level measurement (meters)*	
Source level at 1 meter	#NUM!

*Unless otherwise specified, source levels are referenced 1 m from the source.

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SELcum & PK). Metric producing largest isopleth should be used.

Hearing Group	**Low-Frequency Cetaceans**	**Mid-Frequency Cetaceans**	**High-Frequency Cetaceans**	**Phocid Pinnipeds**	**Otariid Pinnipeds**
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**

E.1-2: ALTERNATIVE METHOD TO CALCULATE PK AND SEL_{cum} (SINGLE STRIKE EQUIVALENT)

Unweighted $SEL_{cum\ (at\ measured\ distance)}$ = SEL_{ss} + 10 Log (# strikes)	**197.0**

SEL_{cum}

Source Level (Single Strike SEL)	170
Number of strikes per pile	500
Number of piles per day	1
Propagation (xLogR)	15
Distance of single strike SEL measurement (meters)*	10

*Unless otherwise specified, source levels are referenced 1 m from the source.

PK

Source Level (PK SPL)	203
Distance of source level measurement (meters)*	10
Source level at 1 meter	218.0

*Unless otherwise specified, source levels are referenced 1 m from the source.

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SELcum & PK). Metric producing largest isopleth should be used.

Hearing Group	**Low-Frequency Cetaceans**	**Mid-Frequency Cetaceans**	**High-Frequency Cetaceans**	**Phocid Pinnipeds**	**Otariid Pinnipeds**
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	**85.5**	**3.0**	**101.9**	**45.8**	**3.3**
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	**NA**	**NA**	**11.7**	**NA**	**NA**

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	**Low-Frequency Cetaceans**	**Mid-Frequency Cetaceans**	**High-Frequency Cetaceans**	**Phocid Pinnipeds**	**Otariid Pinnipeds**
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	**-0.01**	**-19.74**	**-26.87**	**-2.08**	**-1.15**

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a\,[1+(f/f_2)^2]^b}\right\}$$

E.1: IMPACT PILE DRIVING (STATIONARY SOURCE: Impulsive, Intermittent)

VERSION 2.0: 2018

KEY

	User Provided Information
	NMFS Provided Information (Technical Guidance)
	Resultant Isopleth

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	W 40 x 199 wide flange beam unattenuated
PROJECT/SOURCE INFORMATION	

Please include any assumptions

PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

		Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value
Weighting Factor Adjustment (kHz)¥	2	

¥ Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 75), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

*** BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

STEP 3: SOURCE-SPECIFIC INFORMATION

NOTE: Choose either E1-1 OR E.1-2 method to calculate isopleths (not required to fill in sage boxes for both)

E.1-1: METHOD TO CALCULATE PK AND SEL_{cum} (USING RMS SPL SOURCE LEVEL)

SEL_{cum}

Source Level (RMS SPL)	
Number of piles per day	
Strike Duration^Δ (seconds)	
Number of strikes per pile	
Duration of Sound Production (seconds)	0
10 Log (duration of sound production)	#NUM!
Propagation (xLogR)	
Distance of source level measurement (meters)+	

^Δ Window that makes up 90% of total cumulative energy (5%-95%) based on Madsen 2005

+Unless otherwise specified, source levels are referenced 1 m from the source.

PK

Source Level (PK SPL)	
Distance of source level measurement (meters)+	
Source level at 1 meter	#NUM!

+Unless otherwise specified, source levels are referenced 1 m from the source.

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SELcum & PK). Metric producing largest isopleth should be used.

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!

E.1-2: ALTERNATIVE METHOD TO CALCULATE PK AND SEL_{cum} (SINGLE STRIKE EQUIVALENT)

Unweighted $SEL_{cum\ (at\ measured\ distance)}$ = SEL_{ss} + 10 Log (# strikes)	**211.0**

SEL_{cum}

Source Level (Single Strike SEL)	178
Number of strikes per pile	500
Number of piles per day	4
Propagation (xLogR)	15
Distance of single strike SEL measurement (meters)+	10

+Unless otherwise specified, source levels are referenced 1 m from the source.

PK

Source Level (PK SPL)	207
Distance of source level measurement (meters)+	10
Source level at 1 meter	222.0

+Unless otherwise specified, source levels are referenced 1 m from the source.

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SELcum & PK). Metric producing largest isopleth should be used.

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	735.8	26.2	876.4	393.8	28.7
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	1.6	NA	21.5	1.8	NA

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	-0.01	-19.74	-26.87	-2.08	-1.15

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}$$

E.1: IMPACT PILE DRIVING (STATIONARY SOURCE: Impulsive, Intermittent)

VERSION 2.0: 2018

KEY

(gray)	**User Provided Information**
(orange)	**NMFS Provided Information (Technical Guidance)**
(blue)	**Resultant Isopleth**

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	W 40 x 199 wide flange beam attenuated
PROJECT/SOURCE INFORMATION	

Please include any assumptions

PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

		Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value
Weighting Factor Adjustment (kHz)[¥]	2	

[¥] Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 75), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

*** BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

STEP 3: SOURCE-SPECIFIC INFORMATION

NOTE: Choose either E1-1 OR E.1-2 method to calculate isopleths (not required to fill in sage boxes for both)

E.1-1: METHOD TO CALCULATE PK AND SEL_{cum} (USING RMS SPL SOURCE LEVEL)

SEL_{cum}

Source Level (RMS SPL)	
Number of piles per day	
Strike Duration[Δ] **(seconds)**	
Number of strikes per pile	
Duration of Sound Production (seconds)	0
10 Log (duration of sound production)	#NUM!
Propagation (xLogR)	
Distance of source level measurement (meters)*	

[Δ]Window that makes up 90% of total cumulative energy (5%-95%) based on Madsen 2005

*Unless otherwise specified, source levels are referenced 1 m from the source.

PK

Source Level (PK SPL)	
Distance of source level measurement (meters)*	
Source level at 1 meter	#NUM!

*Unless otherwise specified, source levels are referenced 1 m from the source.

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SELcum & PK). Metric producing largest isopleth should be used.

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**

E.1-2: ALTERNATIVE METHOD TO CALCULATE PK AND SEL_{cum} (SINGLE STRIKE EQUIVALENT)

Unweighted $SEL_{cum\ (at\ measured\ distance)}$ = SEL_{ss} + 10 Log (# strikes)	**198.0**

SEL_{cum}

Source Level (Single Strike SEL)	171
Number of strikes per pile	500
Number of piles per day	1
Propagation (xLogR)	15
Distance of single strike SEL measurement (meters)*	10

*Unless otherwise specified, source levels are referenced 1 m from the source.

PK

Source Level (PK SPL)	200
Distance of source level measurement (meters)*	10
Source level at 1 meter	215.0

*Unless otherwise specified, source levels are referenced 1 m from the source.

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SELcum & PK). Metric producing largest isopleth should be used.

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	**99.7**	**3.5**	**118.8**	**53.4**	**3.9**
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	**NA**	**NA**	**7.4**	**NA**	**NA**

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	**-0.01**	**-19.74**	**-26.87**	**-2.08**	**-1.15**

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}$$

E.1: IMPACT PILE DRIVING (STATIONARY SOURCE: Impulsive, Intermittent)

VERSION 2.0: 2018

KEY

(gray)	**User Provided Information**
(orange)	**NMFS Provided Information (Technical Guidance)**
(blue)	**Resultant Isopleth**

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	24-inch Square Concrete Piles Unattenuated
PROJECT/SOURCE INFORMATION	

Please include any assumptions

PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

		Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value
Weighting Factor Adjustment (kHz)[¥]	2	

[¥] Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 75), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

*** BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

STEP 3: SOURCE-SPECIFIC INFORMATION

NOTE: Choose either E1-1 OR E.1-2 method to calculate isopleths (not required to fill in sage boxes for both)

E.1-1: METHOD TO CALCULATE PK AND SEL_{cum} (USING RMS SPL SOURCE LEVEL)

SEL_{cum}

Source Level (RMS SPL)	
Number of piles per day	
Strike Duration[Δ] **(seconds)**	
Number of strikes per pile	
Duration of Sound Production (seconds)	0
10 Log (duration of sound production)	#NUM!
Propagation (xLogR)	
Distance of source level measurement (meters)*	

[Δ]Window that makes up 90% of total cumulative energy (5%-95%) based on Madsen 2005

*Unless otherwise specified, source levels are referenced 1 m from the source.

PK

Source Level (PK SPL)	
Distance of source level measurement (meters)*	
Source level at 1 meter	#NUM!

*Unless otherwise specified, source levels are referenced 1 m from the source.

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SELcum & PK). Metric producing largest isopleth should be used.

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**

E.1-2: ALTERNATIVE METHOD TO CALCULATE PK AND SEL_{cum} (SINGLE STRIKE EQUIVALENT)

Unweighted $SEL_{cum\ (at\ measured\ distance)}$ = SEL_{ss} + 10 Log (# strikes)	**193.0**

SEL_{cum}

Source Level (Single Strike SEL)	166
Number of strikes per pile	500
Number of piles per day	1
Propagation (xLogR)	15
Distance of single strike SEL measurement (meters)*	10

*Unless otherwise specified, source levels are referenced 1 m from the source.

PK

Source Level (PK SPL)	188
Distance of source level measurement (meters)*	10
Source level at 1 meter	203.0

*Unless otherwise specified, source levels are referenced 1 m from the source.

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SELcum & PK). Metric producing largest isopleth should be used.

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	**46.3**	**1.6**	**55.1**	**24.8**	**1.8**
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	**NA**	**NA**	**1.2**	**NA**	**NA**

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	**-0.01**	**-19.74**	**-26.87**	**-2.08**	**-1.15**

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}$$

E.1: IMPACT PILE DRIVING (STATIONARY SOURCE: Impulsive, Intermittent)

VERSION 2.0: 2018

KEY

(gray)	**User Provided Information**
(orange)	**NMFS Provided Information (Technical Guidance)**
(blue)	**Resultant Isopleth**

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	16-inch Square Concrete Piles Unattenuated
PROJECT/SOURCE INFORMATION	

Please include any assumptions

PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value

Weighting Factor Adjustment (kHz)[¥]	2	

[¥] Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 75), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

*** BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

STEP 3: SOURCE-SPECIFIC INFORMATION

NOTE: Choose either E1-1 OR E.1-2 method to calculate isopleths (not required to fill in sage boxes for both)

E.1-1: METHOD TO CALCULATE PK AND SEL_{cum} (USING RMS SPL SOURCE LEVEL)

SEL_{cum}

Source Level (RMS SPL)	
Number of piles per day	
Strike Duration[Δ] (seconds)	
Number of strikes per pile	
Duration of Sound Production (seconds)	0
10 Log (duration of sound production)	#NUM!
Propagation (xLogR)	
Distance of source level measurement (meters)*	

[Δ]Window that makes up 90% of total cumulative energy (5%-95%) based on Madsen 2005

*Unless otherwise specified, source levels are referenced 1 m from the source.

PK

Source Level (PK SPL)	
Distance of source level measurement (meters)*	
Source level at 1 meter	#NUM!

*Unless otherwise specified, source levels are referenced 1 m from the source.

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SELcum & PK). Metric producing largest isopleth should be used.

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**

E.1-2: ALTERNATIVE METHOD TO CALCULATE PK AND SEL_{cum} (SINGLE STRIKE EQUIVALENT)

Unweighted $SEL_{cum\ (at\ measured\ distance)}$ = SEL_{ss} + 10 Log (# strikes)	**182.0**

SEL_{cum}

Source Level (Single Strike SEL)	155
Number of strikes per pile	500
Number of piles per day	1
Propagation (xLogR)	15
Distance of single strike SEL measurement (meters)*	10

*Unless otherwise specified, source levels are referenced 1 m from the source.

PK

Source Level (PK SPL)	185
Distance of source level measurement (meters)*	10
Source level at 1 meter	200.0

*Unless otherwise specified, source levels are referenced 1 m from the source.

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SELcum & PK). Metric producing largest isopleth should be used.

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	**8.6**	**0.3**	**10.2**	**4.6**	**0.3**
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	**NA**	**NA**	**NA**	**NA**	**NA**

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	**-0.01**	**-19.74**	**-26.87**	**-2.08**	**-1.15**

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}$$

E.1: IMPACT PILE DRIVING (STATIONARY SOURCE: Impulsive, Intermittent)

VERSION 2.0: 2018

KEY

	User Provided Information
	NMFS Provided Information (Technical Guidance)
	Resultant Isopleth

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	14-inch Square Concrete Piles Unattenuated
PROJECT/SOURCE INFORMATION	

Please include any assumptions

PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

		Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value
Weighting Factor Adjustment (kHz)[¥]	2	

[¥] Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 75), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

*** BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

STEP 3: SOURCE-SPECIFIC INFORMATION

NOTE: Choose either E1-1 OR E.1-2 method to calculate isopleths (not required to fill in sage boxes for both)

E.1-1: METHOD TO CALCULATE PK AND SEL_{cum} (USING RMS SPL SOURCE LEVEL)

SEL_{cum}

Source Level (RMS SPL)	
Number of piles per day	
Strike Duration[Δ] (seconds)	
Number of strikes per pile	
Duration of Sound Production (seconds)	0
10 Log (duration of sound production)	#NUM!
Propagation (xLogR)	
Distance of source level measurement (meters)*	

[Δ]Window that makes up 90% of total cumulative energy (5%-95%) based on Madsen 2005

*Unless otherwise specified, source levels are referenced 1 m from the source.

PK

Source Level (PK SPL)	
Distance of source level measurement (meters)*	
Source level at 1 meter	#NUM!

*Unless otherwise specified, source levels are referenced 1 m from the source.

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SELcum & PK). Metric producing largest isopleth should be used.

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**

E.1-2: ALTERNATIVE METHOD TO CALCULATE PK AND SEL_{cum} (SINGLE STRIKE EQUIVALENT)

Unweighted $SEL_{cum\ (at\ measured\ distance)}$ = SEL_{ss} + 10 Log (# strikes)	**182.0**

SEL_{cum}

Source Level (Single Strike SEL)	155
Number of strikes per pile	500
Number of piles per day	1
Propagation (xLogR)	15
Distance of single strike SEL measurement (meters)*	10

*Unless otherwise specified, source levels are referenced 1 m from the source.

PK

Source Level (PK SPL)	185
Distance of source level measurement (meters)*	10
Source level at 1 meter	200.0

*Unless otherwise specified, source levels are referenced 1 m from the source.

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SELcum & PK). Metric producing largest isopleth should be used.

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	**8.6**	**0.3**	**10.2**	**4.6**	**0.3**
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	**NA**	**NA**	**NA**	**NA**	**NA**

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	**-0.01**	**-19.74**	**-26.87**	**-2.08**	**-1.15**

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}$$

A.1: Vibratory Pile Driving (STATIONARY SOURCE: Non-Impulsive, Continuous)

VERSION 2.0: 2018

KEY

(gray)	**User Provided Information**
(peach)	**NMFS Provided Information (Technical Guidance)**
(blue)	**Resultant Isopleth**

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	36-inch Steel Pipe Pile
PROJECT/SOURCE INFORMATION	

Please include any assumptions

PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value

Weighting Factor Adjustment (kHz)¥	2.5	

¥ Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 48), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

*** BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

STEP 3: SOURCE-SPECIFIC INFORMATION

Source Level (RMS SPL)	170
Number of piles within 24-h period	1
Duration to drive a single pile (minutes)	10
Duration of Sound Production within 24-h period (seconds)	600
10 Log (duration of sound production)	27.78
Propagation (xLogR)	15
Distance from source level measurement (meters)⁺	10

⁺Unless otherwise specified, source levels are referenced 1 m from the source.

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	199	198	173	201	219
PTS Isopleth to threshold (meters)	**8.2**	**0.7**	**12.2**	**5.0**	**0.4**

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	**-0.05**	**-16.83**	**-23.50**	**-1.29**	**-0.60**

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}$$

A.1: Vibratory Pile Driving (STATIONARY SOURCE: Non-Impulsive, Continuous)

VERSION 2.0: 2018

KEY

(gray)	**User Provided Information**
(peach)	**NMFS Provided Information (Technical Guidance)**
(blue)	**Resultant Isopleth**

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	30-inch Steel Pipe Pile
PROJECT/SOURCE INFORMATION	

Please include any assumptions

PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

		Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value
Weighting Factor Adjustment (kHz)[¥]	2.5	

[¥] Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 48), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

*** BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

STEP 3: SOURCE-SPECIFIC INFORMATION

Source Level (RMS SPL)	170
Number of piles within 24-h period	1
Duration to drive a single pile (minutes)	10
Duration of Sound Production within 24-h period (seconds)	600
10 Log (duration of sound production)	27.78
Propagation (xLogR)	15
Distance from source level measurement (meters)[+]	10

[+]Unless otherwise specified, source levels are referenced 1 m from the source.

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	199	198	173	201	219
PTS Isopleth to threshold (meters)	**8.2**	**0.7**	**12.2**	**5.0**	**0.4**

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	**-0.05**	**-16.83**	**-23.50**	**-1.29**	**-0.60**

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}$$

A.1: Vibratory Pile Driving (STATIONARY SOURCE: Non-Impulsive, Continuous)

VERSION 2.0: 2018

KEY

	User Provided Information
	NMFS Provided Information (Technical Guidance)
	Resultant Isopleth

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	W 40 x 199 wide flange beam
PROJECT/SOURCE INFORMATION	

Please include any assumptions

PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value

Weighting Factor Adjustment (kHz)[¥]	2.5	

[¥] Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 48), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

*** BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

STEP 3: SOURCE-SPECIFIC INFORMATION

Source Level (RMS SPL)	155
Number of piles within 24-h period	1
Duration to drive a single pile (minutes)	10
Duration of Sound Production within 24-h period (seconds)	600
10 Log (duration of sound production)	27.78
Propagation (xLogR)	15
Distance from source level measurement (meters)[+]	10

[+]Unless otherwise specified, source levels are referenced 1 m from the source.

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	199	198	173	201	219
PTS Isopleth to threshold (meters)	**0.8**	**0.1**	**1.2**	**0.5**	**0.0**

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	**-0.05**	**-16.83**	**-23.50**	**-1.29**	**-0.60**

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}$$

A.1: Vibratory Pile Driving (STATIONARY SOURCE: Non-Impulsive, Continuous)

VERSION 2.0: 2018

KEY

	User Provided Information
	NMFS Provided Information (Technical Guidance)
	Resultant Isopleth

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	PZC 13, PZ 27, and PZ 35 steel sheet piles
PROJECT/SOURCE INFORMATION	

Please include any assumptions

PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value

Weighting Factor Adjustment (kHz)[¥]	2.5	

[¥] Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 48), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

*** BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

STEP 3: SOURCE-SPECIFIC INFORMATION

Source Level (RMS SPL)	160
Number of piles within 24-h period	1
Duration to drive a single pile (minutes)	1
Duration of Sound Production within 24-h period (seconds)	60
10 Log (duration of sound production)	17.78
Propagation (xLogR)	15
Distance from source level measurement (meters)[+]	10

[+]Unless otherwise specified, source levels are referenced 1 m from the source.

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	199	198	173	201	219
PTS Isopleth to threshold (meters)	**0.4**	**0.0**	**0.6**	**0.2**	**0.0**

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	**-0.05**	**-16.83**	**-23.50**	**-1.29**	**-0.60**

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}$$

A.1: Vibratory Pile Driving (STATIONARY SOURCE: Non-Impulsive, Continuous)

VERSION 2.0: 2018

KEY

(gray)	**User Provided Information**
(peach)	**NMFS Provided Information (Technical Guidance)**
(blue)	**Resultant Isopleth**

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	16-inch Timber Pile Removal
PROJECT/SOURCE INFORMATION	

Please include any assumptions

PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

		Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value
Weighting Factor Adjustment (kHz)[¥]	2.5	

[¥] Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 48), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

*** BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

STEP 3: SOURCE-SPECIFIC INFORMATION

Source Level (RMS SPL)	152
Number of piles within 24-h period	1
Duration to drive a single pile (minutes)	5
Duration of Sound Production within 24-h period (seconds)	300
10 Log (duration of sound production)	24.77
Propagation (xLogR)	15
Distance from source level measurement (meters)⁺	10

⁺Unless otherwise specified, source levels are referenced 1 m from the source.

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	199	198	173	201	219
PTS Isopleth to threshold (meters)	**0.3**	**0.0**	**0.5**	**0.2**	**0.0**

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	**-0.05**	**-16.83**	**-23.50**	**-1.29**	**-0.60**

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}$$

A.1: Vibratory Pile Driving (STATIONARY SOURCE: Non-Impulsive, Continuous)

VERSION 2.0: 2018

KEY

(gray)	**User Provided Information**
(tan)	**NMFS Provided Information (Technical Guidance)**
(blue)	**Resultant Isopleth**

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	12-inch Concrete Pile Removal
PROJECT/SOURCE INFORMATION	

Please include any assumptions

PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value

Weighting Factor Adjustment (kHz)¥	2.5	

¥ Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 48), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

*** BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

STEP 3: SOURCE-SPECIFIC INFORMATION

Source Level (RMS SPL)	155
Number of piles within 24-h period	1
Duration to drive a single pile (minutes)	5
Duration of Sound Production within 24-h period (seconds)	300
10 Log (duration of sound production)	24.77
Propagation (xLogR)	15
Distance from source level measurement (meters)⁺	10

⁺Unless otherwise specified, source levels are referenced 1 m from the source.

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	199	198	173	201	219
PTS Isopleth to threshold (meters)	**0.5**	**0.0**	**0.8**	**0.3**	**0.0**

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	**-0.05**	**-16.83**	**-23.50**	**-1.29**	**-0.60**

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}$$

APPENDIX C

Distances (in meters) to the adopted Marine Mammal Thresholds for Piles Driven with an Impact Hammer in Water Based on Peak SPL*

Pile Description	Attenuation	No. of Piles Installed per Day	PTS Isopleth Threshold (m) Based on Peak SPL				
			Cetaceans			Pinnipeds	
			LF	MF	HF	PW	OW
36” Steel Pipe Piles	Unattenuated	1	3	NA	34	3	NA
	Attenuated	1	NA	NA	12	NA	NA
30” Steel Pipe Piles	Unattenuated	1	3	NA	34	3	NA
	Attenuated	1	NA	NA	12	NA	NA
W 40 x 199 wide flange beam	Unattenuated	1	2	NA	25	2	NA
	Attenuated	1	NA	NA	9	NA	NA
24” Concrete Piles	Unattenuated	1	NA	NA	1	NA	NA
16” Concrete Piles	Unattenuated	1	NA	NA	NA	NA	NA
14” Concrete Piles	Unattenuated	1	NA	NA	NA	NA	NA

*Note that PTS computations based on Peak SPL will not change depending on the number of piles driven per day. Therefore, distances were computed for one pile.

APPENDIX D

Distances (in meters) to Adopted Fish Thresholds for Unattenuated Piles Driven in the Water with 750 Strikes

Pile type	No. of Piles Installed per Day	187 dB SEL_{cum}	183 dB SEL_{cum}
36-inch steel pipe pile	1	447	825
	3	929	1717
30-inch steel pipe pile	1	178	329
W 40 x 199 wide flange beam	1	178	329
	4	448	828
24-inch square concrete pile	1	33	61
	4	83	153
16-inch square concrete pile	1	6	11
	4	15	28
14-inch square concrete pile	1	6	11
	4	15	28

Distances (in meters) to Adopted Fish Thresholds for Attenuated Piles Driven in the Water with 750 Strikes

Pile type	No. of Piles Installed per Day	187 dB SEL_{cum}	183 dB SEL_{cum}
36-inch steel pipe pile	1	153	282
	3	317	586
30-inch steel pipe pile	1	61	112
W 40 x 199 wide flange beam	1	61	112
	4	153	283

Distances (in meters) to the adopted Marine Mammal Thresholds for Piles Driven with an Impact Hammer in Water with 750 Strikes

Pile Description	Attenuation	No. of Piles Installed per Day	PTS Isopleth Threshold (m) Based on SEL_{cum}				
			Cetaceans			Pinnipeds	
			LF	MF	HF	PW	OW
36-inch steel pipe pile	Unattenuated	1	824	29	982	441	32
		3	1,715	61	2,043	918	67
	Attenuated	1	282	10	335	151	11
		3	586	21	697	313	23
30-inch steel pipe pile	Unattenuated	1	328	12	391	176	13
	Attenuated	1	136	5	162	73	5
W 40 x 199 wide flange beam	Unattenuated	1	328	12	391	176	13
		4	827	29	985	443	32
	Attenuated	1	112	4	134	60	4
		4	282	10	336	151	11
24-inch concrete pile	Unattenuated	1	61	2	72	33	2
		4	153	5	182	82	6
16-inch concrete pile	Unattenuated	1	11	<1	13	6	<1
		4	28	1	34	15	1
14-inch concrete pile	Unattenuated	1	11	<1	13	6	<1
		4	28	1	34	15	1

Distances (in meters) to Adopted Fish Thresholds for Unattenuated Piles Driven in the Water with 1,000 Strikes

Pile type	No. of Piles Installed per Day	187 dB SEL_{cum}	183 dB SEL_{cum}
36-inch steel pipe pile	1	541	1,000
	3	1,126	2,080
30-inch steel pipe pile	1	215	398
W 40 x 199 wide flange beam	1	215	398
	4	543	1003
24-inch square concrete pile	1	40	74
	4	100	185
16-inch square concrete pile	1	7	14
	4	19	34
14-inch square concrete pile	1	7	14
	4	19	34

Distances (in meters) to Adopted Fish Thresholds for Attenuated Piles Driven in the Water with 1,000 Strikes

Pile type	No. of Piles Installed per Day	187 dB SEL_{cum}	183 dB SEL_{cum}
36-inch steel pipe pile	1	185	341
	3	384	710
30-inch steel pipe pile	1	74	136
W 40 x 199 wide flange beam	1	74	136
	4	185	343

Distances (in meters) to the adopted Marine Mammal Thresholds for Piles Driven with an Impact Hammer in Water with 1,000 Strikes

Pile Description	Attenuation	No. of Piles Installed per Day	PTS Isopleth Threshold (m) Based on SEL_{cum}				
			Cetaceans			Pinnipeds	
			LF	MF	HF	PW	OW
36-inch steel pipe pile	Unattenuated	1	999	36	1,190	534	39
		3	2,077	74	2,474	1,112	81
	Attenuated	1	341	12	406	183	13
		3	709	25	845	380	28
30-inch steel pipe pile	Unattenuated	1	398	14	474	213	16
	Attenuated	1	136	5	162	73	5
W 40 x 199 wide flange beam	Unattenuated	1	398	14	474	213	16
		4	1,002	36	1,193	536	39
	Attenuated	1	136	5	162	73	5
		4	167	6	199	90	7
24-inch concrete pile	Unattenuated	1	74	3	88	39	3
		4	185	7	221	99	7
16-inch concrete pile	Unattenuated	1	14	1	16	7	1
		4	34	1	41	18	1
14-inch concrete pile	Unattenuated	1	14	1	16	7	1
		4	34	1	41	18	1