Naval Base Point Loma Fuel Pier Fleet Logistics Center Replacement Project

Acoustic, Marine Mammal, Green Sea Turtle, and California Least Tern Monitoring Report

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Acronyms and Abbreviations

%	percent
˚	Degrees
˚C	Degrees Celsius
˚F	Degrees Fahrenheit
µPa	microPascals
APE	American Piledriving Equipment, Inc.
AT	Acoustic Technician
BD	Boat Driver
BSS	Beaufort Sea State
cm	centimeter
DA	Database Administrator
dB	decibel
DHS	Department of Homeland Security
EA	Environmental Assessment
FLC	Fleet Logistics Center
ft	feet
ft-lbs	foot-pounds
HTI	High Tech, Inc
HZ	Hazer
Hz	hertz
IHA	Incidental Harassment Authorization
IPP	Indicator Pile Program
kHz	kilohertz
km	kilometers
kph	kilometers per hour
LD	Larson Davis
LZ_{eq}	Level Z weighted (unweighted), equivalent
LZF_{max}	Level Z weighted (unweighted), fast
m	meters
MC	Monitoring Coordinator
MMCC	Marine Mammal Compliance Coordinator
MMO	Marine Mammal Observers
MMP	Marine Mammal Program
MMPA	Marine Mammal Protection Act
MOD	Modification
mph	miles per hour
MTS	Marine Taxonomic Services
NAVFAC SW	Naval Facilities Command Southwest
NBPL	Naval Base Point Loma
NEPA	National Environmental Policy Act
NMAWC	Naval Mine and Anti-submarine Warfare Center
NMFS	National Marine Fisheries Service
NMMF	National Marine Mammal Foundation
PM	Project Manager
QA/QC	Quality Assurance/Quality Control

re 1 µPa	referenced to one microPascal
re 20 µPa	referenced to 20 microPascals
rms	Root Mean Square
RVS	received voltage sensitivity
SEL	Sound Exposure Level
SEL_{cum}	Cumulative SEL
SL	Sea Lion (in reference to SL1 and SL2 observer locations)
SLM	Sound Level Meter
SPL	Sound Pressure Level
SSC	Space and Naval Warfare Systems Command Systems Center
UW APL	University of Washington Applied Physics Laboratory
ZOI	Zone of Influence

1.0 Introduction

This report summarizes the Year 1 marine species and acoustic monitoring effort implemented for activities associated with pile driving at the Naval Mine and Anti-submarine Warfare Center (NMAWC) and at the existing Naval Base Point Loma (NBPL) Fleet Logistics Center (FLC) Fuel Pier (Figure 1-1) in San Diego Bay, California from January 2014, through May 2014. The purpose of this program is to replace the aging and seismically deficient fuel pier at NBPL FLC. For Year 1, hydroacoustic monitoring was used to assess transmission loss and to determine the distance(s) at which sound pressure levels (SPLs; both airborne and underwater) reached established thresholds where sound may result in injury or behavioral disturbance to marine species.

Pursuant to National Environmental Policy Act (NEPA), an environmental impact analysis was conducted and the final Environmental Assessment for Naval Base Point Loma Fuel Pier Replacement and Dredging (EA) dated June 2013 (Navy 2013a) was prepared for all activities associated with the NBPL FLC Fuel Pier Replacement Project. One of the potential impacts identified in the EA was the impact of noise generated from pile driving on marine species. The EA, prescribed mitigation and monitoring measures, including both acoustic and marine species monitoring to minimize the impacts to marine species from pile driving to the lowest extent practicable.

This report presents the results of acoustic and marine species (marine mammals, green sea turtles, and California least terns) monitoring during the Fuel Pier Replacement (P-1306) Project. In addition, several studies were conducted to investigate further the impacts of the project and accompany the monitoring program including studies to assess ambient noise, eelgrass, and fish in the project area. Each of the studies and their results are available in the Appendices A, B, and C. The various special studies and reports in Appendices were included in this report at the request of the Navy in order to present a comprehensive evaluation of monitoring efforts and to consolidate reporting.

1.1 Project Description

1.1.1 Project Location

The existing fuel pier at NBPL FLC (Figure 1-2) is over 100 years old and is not consistent with current standards (including seismic and California State Lands Commission safety standards). The poor condition of the existing fuel pier was noted in the Navy Region Southwest, Port Operations Shore Infrastructure Plan, dated April 2009 (Navy 2010). The pier serves as a fuel depot for loading and unloading tankers, U.S. Navy (Navy) replenishment vessels, Department of Homeland Security (DHS), Department of Defense, and foreign Navy vessels. In addition to the poor condition of the structure itself, the existing fuel pier has reached a maximum capacity for the deeper outer berth, resulting in vessels being turned away due to a lack of available docking and mooring space. It is anticipated that future classes of ships would generally be more multi-purpose, require more frequent fueling, and further increase the fuel capacity loading requirement for the new replacement fuel pier (Navy 2010). The fuel pier at the NBPL FLC is critical to the mission of the Navy and is the largest active Navy fueling facility in southern California.

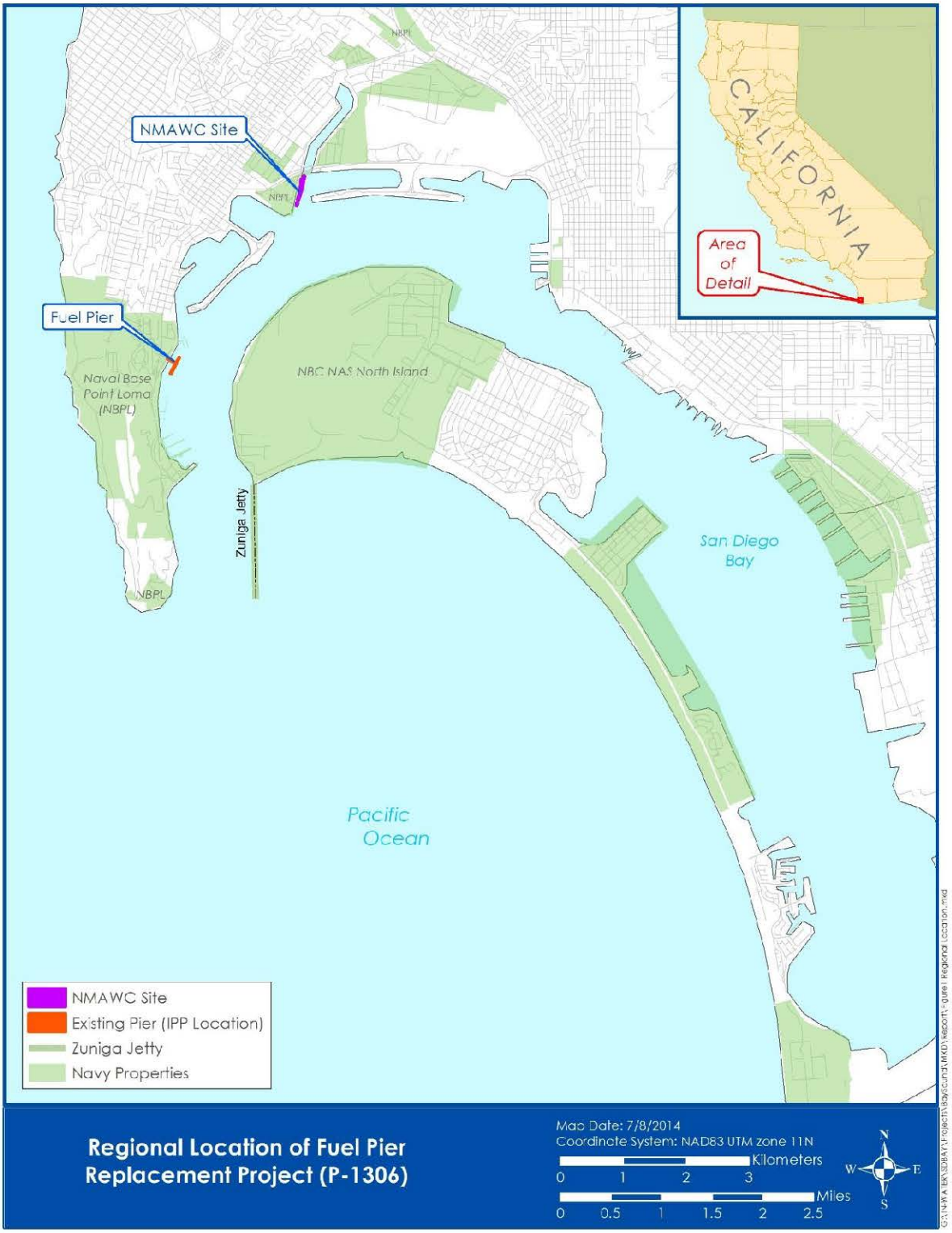


Figure 1-1. Regional Location of the P-1306 Project.

Figure 1-2. Map of NMAWC and IPP Project Areas.

The purpose of this project is to replace the aging and seismically deficient fuel pier. The new pier would be capable of fueling existing and future classes of naval vessels and would meet current California State Lands Commission Marine Oil Terminal Engineering and Maintenance Standards regulations. It would also meet projected Navy and Coast Guard ship fueling requirements and ensure that the Navy and DHS have adequate and safe ship fueling facilities now and in the future. Through improved safety features, fuel reception and delivery capability, the Navy and DHS would be able to accomplish their missions of security and national defense (Navy 2013a).

The project will be phased over approximately a four-year timeline. The first phase involved the temporary relocation of the Navy Marine Mammal Program (MMP) to the NMAWC and the Indicator Pile Program (IPP) at the existing NBPL FLC Fuel Pier. Although not an element of the fuel pier replacement project, during this phase, the Everingham Brothers Bait Company Bait Barges were also relocated to a site outside of the underwater construction noise zone of influence (ZOI) during pile driving activities. This was to reduce the potential pile driving impacts to marine mammals that haul out on the barges and to mitigate any potential impacts to fish species used for commercial and recreational bait.

1.1.1.1 SSC Marine Mammal Relocation at Naval Mine and Anti-submarine Warfare Center (NMAWC)

Prior to the IPP, the Navy MMP, administered by Space and Naval Warfare (SPAWAR) Systems Command Systems Center (SSC), was temporarily relocated to NMAWC, which is approximately 3 kilometers (km; 1.8 miles) northeast of the existing fuel pier (see Figure 1 2). The Navy MMP was moved to prevent the program's working marine mammals from being exposed to noise and vibrations associated with the construction of the Fuel Pier. NMAWC is outside of the anticipated sound footprint for pile driving during construction of the new fuel pier. After completion of the new fuel pier, the Navy MMP would be moved back to their original location adjacent to the fuel pier, and the temporary facilities at NMAWC would be removed.

1.1.1.2 Everingham Brothers San Diego Bait Barge Relocation

Although not an element of the Fuel Pier Replacement (P-1306) Project, in April, 2014, the Everingham Brothers San Diego Bait Barge was temporarily relocated by the owners. The two barges, which were anchored in Navy waters approximately 500 meters (m; 1,640 feet [ft]) south of the existing fuel pier, were moved southeast of Harbor Island, parallel to Harbor Island Drive and approximately 1,000 m (3,280 ft) from the fuel pier. The two barges attract large numbers of California sea lions, and their relocation was anticipated to reduce the number of individuals that were exposed to noise levels constituting harassment under the MMPA. Barge relocation also avoided the potential for noise disturbance to the bait fish sold at the barge, which might otherwise affect their viability as a bait fish for recreational and commercial use. The barges could be moved back to their existing location when in-water construction activities are not occurring (from May to August each year).

1.1.1.3 Fuel Pier Replacement Project at Naval Base Point Loma Fleet Logistics Center (Indicator Pile Program)

The IPP took place at the existing fuel pier located at the FLC Fuel Facility at NBPL. NBPL is located on the west side of San Diego Bay, near the mouth of the bay and directly opposite Naval

Air Station North Island (see Figure 1-2). All of the land within NBPL boundaries is restricted from general public access. The adjacent waters of San Diego Bay are heavily used by the public and the Navy.

1.2 Purpose of the Monitoring Program

The acoustic and marine mammal monitoring program was implemented, along with the avoidance and minimization measures for pile driving activities, to minimize impacts to marine species. Objectives and protocols for both were established by the Navy in the Final Acoustic and Marine Species Monitoring Plan for the Navy's Fuel Pier Replacement Project at Naval Base Point Loma as part of the Incidental Harassment Authorization (IHA) application (Navy 2013b) and submitted to National Marine Fisheries Service (NMFS) for approval prior to the start of construction. The following sections outline the acoustic and marine mammal monitoring objectives.

1.2.1 Acoustic Monitoring

1.2.1.1 Monitoring Plan Objectives

The Monitoring Plan included in the IHA (Navy 2013a) provided an in-depth description of the various monitoring efforts including protocols for the acquisition and processing of both underwater and airborne sounds during the proposed in-water construction activities. The objectives in the Monitoring Plan were broadly stated based on the proposed actions described in the EA (Navy 2013a). The objectives below were refined based on changes in the means and methods of in-water construction for both NMAWC and the IPP project phases and include:

1. Implement the proposed acoustic and marine species monitoring protocols at NMAWC to refine monitoring, data acquisition, and processing methods in conjunction with construction personnel, equipment, and logistics.
2. Indicator Pile Program – Implement a robust in-situ monitoring effort to measure SPLs at various distances for each of the different in-water construction project activities including vibratory and impact pile driving of 30- and 36-inch steel pipe piles.
3. Validate the acoustic ZOI contours utilizing hydroacoustic measurements collected during the IPP to update estimated SPL contours (isopleths) developed from the transmission loss modeling effort conducted prior to the start of the project. Utilize in situ SPL measurements collected during the IPP to reduce the spatial extent to the conservatively modeled isopleths and resulting ZOIs that defined marine species take thresholds.
4. Continue the Navy's collection of ambient underwater sound measurements in the absence of project activities to develop a rigorous baseline for the San Diego Bay region.
5. Determine spreading loss for airborne and underwater sound generated by in-water construction and demolition activities.

1.2.1.2 Overview of the Acoustic Monitoring Program

Multiple acoustic data collection systems were utilized to accomplish the objectives of the Monitoring Plan in the IHA Application (Navy 2013b) and to record both underwater and airborne sound levels for the various project phases including the NMAWC, IPP, and Bay-wide ambient

data collection efforts. Airborne and hydroacoustic sound data acquisition equipment used during the NMAWC, IPP, and Bay-wide study evaluating ambient sound utilized the same sound level meters (SLMs) and hydrophone/microphone configurations. Additional instrumentation deployed by the University of Washington Applied Physics Laboratory (UW APL) during the IPP provided complementary, redundant, and Quality Assurance/Quality Control (QA/QC) data collection measures. The separate sound recording devices and additional personnel implemented during the IPP allowed for expanded applications during pile driving events in terms of developing QA/QC comparisons of root mean square (rms) SPL levels from the various instruments as well as to make real time rms measurements at graduated distances from pile locations.

Acoustic monitoring data collection efforts varied slightly between the various phases of the project in order to effectively determine SPLs and determine applicable ZOIs while meeting the IHA's (NMFS 2013) reporting requirements and maintaining consistency with National Oceanic and Atmospheric Administration (NOAA) guidance. Additionally, the complexity of each individual site and pile locations warranted adjustments to monitoring locations and equipment settings.

1.2.1.2.1 Acoustic Terminology

This report uses specialized terminology related to underwater sound and technical aspects of the monitoring program. Terminology is described below:

1. Sound Pressure Level: Sound pressure is the force per unit area, usually expressed in microPascals (µPa), where 1 Pascal equals 1 Newton exerted over an area of 1 square meter. The SPL is expressed in decibels (dB) as 20 times the logarithm to the base 10 of the ratio between the pressure exerted by the sound to a referenced sound pressure. SPL is the quantity that is directly measured by a sound level meter.
2. Underwater sound pressure: SPL in dB is referenced to one microPascal (re 1 µPa), unless otherwise stated.
3. Airborne sound pressure: SPL in dB is referenced to 20 microPascals (re 20 µPa), unless otherwise stated.
4. Frequency: Frequency is expressed in terms of oscillations, or cycles, per second. Cycles per second are commonly referred to as hertz (Hz). Typical human hearing ranges from 20 Hz to 20 kilohertz (kHz).
5. Peak sound pressure: the instantaneous maximum of the absolute positive or negative pressure over the frequency range from 20 Hz to 20 kHz and is presented as dB re 1 µPa.
6. Root Mean Square sound pressure level: For impact pile driving characterize overall dB rms levels by integrating sound for each waveform across 90 percent (%) of the acoustic energy in each wave and averaging all waves in the pile-driving event. This value is referred to as the rms 90%. With this method, the time averaging per pulse varies.
7. Sound Exposure Level (SEL): is a measure of energy. Specifically, it is the dB level of the time integral of the squared-instantaneous sound pressure, normalized to a 1-sec period. It can be an extremely useful metric for assessing cumulative exposure because it enables sounds of

differing duration, to be compared in terms of total energy. The accumulated SEL (SEL_{cum}) is used to describe the SEL from multiple events (e.g., many pile strikes). This can be calculated directly as a logarithmic sum of the individual single-strike SELs for the pile strikes that were used to install the pile.

8. Level Z weighted (unweighted), equivalent (LZ_{eq}): LZ_{eq} is a value recorded by the SLM that represent SEL SPL over a specified time period or interval. The LZ_{eq} is most typically referred to in 1-second intervals or over an entire event in this report.
9. Level Z weighted (unweighted), fast (LZF_{max}): LZF_{max} is a value recorded by the SLM that represents the maximum rms value recorded for any 125 millisecond time frame during each individual recording.

1.2.2 Marine Mammal Monitoring

1.2.2.1 Monitoring Plan Objectives

The Monitoring Plan in the IHA Application (Navy 2013b) provides an in-depth description of the various monitoring efforts for marine species, including timeframes, data acquisition requirements, and protocols for marine species monitoring. Marine mammals identified in the IHA and the Monitoring Plan (Navy 2013b) as potentially occurring during the project timeframe and in San Diego Bay included the harbor seal (*Phoca vitulina richardii*), California sea lion (*Zalophus californianus californianus*), bottlenose dolphin (*Tursiops truncatus*), and the gray whale (*Eschrichtius robustus*). Other marine species that may occur during this project included the green sea turtle (*Chelonia midas*) and the California least tern (*Sterna antillarum browni*). Objectives associated with marine species monitoring at NMAWC and during the IPP included:

1. Enumeration of the number and types of species identified relative to the project time frame;
2. Improvement of marine species take estimates by applying differences between the measured and modeled ZOIs and implementing the amended marine species monitoring stations; and
3. Minimization of the potential impacts of the project on those species, while still allowing the project to achieve the projected construction milestones.

1.2.2.2 Overview of the Marine Species Monitoring

Marine species monitoring was conducted before, during, and after pile driving and extraction activities within the modeled ZOIs for potential injury and behavioral disturbance thresholds. The monitoring evaluated sightings relative to the type and number of marine species exposed to underwater and airborne sound levels that would constitute “takes” under the Marine Mammal Protection Act (MMPA; see the most recent IHA application (Navy 2013b) for a definition of “take” under the MMPA). Marine Mammal Observers (MMO) documented the presence of any marine species in the project area and recorded potential disruptions to behavioral patterns that might constitute Level B harassment. MMOs also identified marine species that might enter the Level A harassment (physical injury) ZOI during P-1306 construction. In addition, the monitoring program documented the foraging success of California least terns in the project area, as the IPP occurred during the beginning of the tern breeding season. The current Level A (injury) and Level B (behavioral disturbance) thresholds are provided in Table 1-1.

Table 1-1. Injury and Disturbance Thresholds for Underwater and Airborne Sounds.

Marine Mammal Group	Underwater Criteria (re: 1 µPa)				Airborne Criteria[3] (re: 20 µPa)
	Vibratory Pile Driving[1]		Impact Pile Driving[2]		
	Level A (Injury)	Level B (Behavioral)	Level A (Injury)	Level B (Behavioral)	
Cetaceans	180 dB rms	120 dB rms	180 dB rms	160 dB rms	N/A
Harbors Seals	190 dB rms	120 dB rms	190 dB rms	160 dB rms	90 dB rms[4]
All Other Pinnipeds					100 dB rms[4]

[1] Non-pulsed/continuous sounds.
[2] Pulsed sounds
[3] Sound level at which pinniped haul out disturbance has been documented. Not an official threshold, but used as a guideline.
[4] Unweighted

1.3 Special Studies

Three special studies were performed to assess the potential impacts to eelgrass and fish in the project area and to determine the ambient noise in separate regions in San Diego Bay. The methods used and the results of these studies are presented in Appendices A, B, and C.

2.0 Methods

2.1 Overview of the Monitoring Program Methods

In order to fulfill the requirements of all applicable regulatory documents, data was collected for the presence of marine species and for in-water and airborne sound during both construction and non-construction timeframes. While the marine species monitors focused on marine mammals, and were designated as MMOs, they were also responsible for identifying important marine species other than marine mammals (namely California least terns and green sea turtles). In most cases, MMOs and acoustic technicians (ATs) were co-located on the same vessel. Acousticians from SPAWAR and UW were integrated into the acoustic data collection process and provided QA/QC for data collected as part of the project.

Marine species and acoustic monitoring occurred between January 29 and March 13, 2014 at NMAWC, and between April 29 and May 15, 2014 for the IPP. Effort was focused on northern San Diego Bay, with both far-field and near-field (close to the individual pile) monitoring locations based on the modeled marine mammal behavioral and injury ZOIs. Monitoring methods and results are reported here in the context of these two construction phases and describe differences in monitoring techniques and the levels of effort involved.

2.1.1 Project Staffing

During activities at NMAWC and for the IPP (Table 2-1), staff included the project manager (PM), marine mammal compliance coordinator (MMCC), database administrator (DA), primary and secondary MMOs, ATs, boat drivers (BD), and hazers (HZ). Marine species observers were experienced in marine species identification, and had extensive knowledge of the biology and behavior of locally occurring marine species. Furthermore, prior to beginning their observation, all MMOs received training on the specific species in San Diego Bay. Prior to construction activity, ATs were trained on the basics of sound in the water and how to use the acoustic data logging equipment. While personnel may have had several roles throughout the project timeframe, personnel only performed one task at a time on any given day.

2.1.1.1 Roles and Responsibilities

Project Manager. The PM's role was to act as a liaison between the construction crew/managers and the project team. The PM also coordinated all special studies, monitoring efforts and personnel on a daily basis and provided updates, via radio, on the current status of pile driving activities.

Marine Mammal Compliance Coordinator. The MMCC acted as a primary MMO and was responsible for confirming times for the beginning and end of each individual construction phase and relaying those times to the PM and other MMOs, as needed. The MMCC was stationed near the shutdown zone for cetaceans to account for any animals (pinnipeds and/or cetaceans) that might enter the shutdown zone.

Table 2-1. Project Staff.

Company	Name	Role(s)[1]	Construction Location
Tierra Data, Inc.	Derek Lerma	PM, MC, AT, MMO	NMAWC/IPP
	Lauren Washington	MMCC (NMAWC)	NMAWC
	Todd McConchie	MMO, HZ, DA	NMAWC/IPP
	Jim Kellogg	AT, BD, MMO	NMAWC/IPP
	Brent Mardian	AT, BD, MMO	IPP
	Mike Moss	AT, BD	NMAWC/IPP
	Sam Chin	AT, BD	IPP
	Chris Clark	AT, BD	NMAWC
	Andy Ferdell	AT, MMO	IPP
	Harry Smead	AT, MMO	NMAWC/IPP
SSC/National Marine Mammal Foundation (NMMF)	Victoria Bowman	MMCC (IPP)	IPP
	Daniell Hepting	BD	IPP
	Evan Miracle	BD	IPP
	Sal Koutsis	BD	IPP
ECORP	Danny Heilprin	AT, BD, MMO	IPP
	Max Murray	AT, BD, MMO	IPP
	Todd Chapman	AT, BD, MMO	IPP
	Devon O'Meara	AT, BD, MMO	IPP
	Brian Zitt	AT, BD, MMO	IPP
	Adam Schroeder	MMO	IPP
	Terrance Wroblewski	BD, MMO	IPP
Marine Taxonomic Services	Robert Mooney	AT, BD, MMO	IPP
	Seth Jones	MMO	IPP
	Kees Schipper	AT, BD, MMO	IPP
	Heather Krish	AT, BD, MMO	IPP
UW	Peter Dahl	AT	IPP
	Brian Dickinson	AT	IPP
	David Dall'Osto	AT	IPP
	Dara Farrell	AT	IPP
Naval Facilities Command Southwest (NAVFAC SW)	Kari Coler	HZ, MMO (secondary)	IPP
	Rebecca Loomis	HZ, MMO (secondary)	IPP
	Sean Suk	HZ, MMO (secondary)	IPP
	Michele Desrochers	HZ, MMO (secondary)	IPP
	Rick Basinet	HZ, MMO (secondary)	IPP

[1]PM=Project Manager; MMCC=Marine Mammal Compliance Coordinator; AT=Acoustic Technician; MMO=Marine Mammal Observer; HZ=Hazer; BD=Boat Driver; DA=Database Administrator

Marine Mammal Observers. Primary MMOs were experienced in marine species identification and had extensive knowledge of the biology and behavior of locally-occurring species. Their primary responsibility was to identify marine species and log observations of individuals or groups of marine species. Their primary focus was on the marine mammals that occurred in the vicinity of construction activities.

Hazers/Marine Mammal Observers (Secondary). During the initial stages of pile driving, hazers were utilized to haze animals off of specific haul out locations (see Figure 2-1). After the hazing prescription was completed, they then transitioned into the role of secondary MMOs. These secondary MMOs provided full coverage for all areas associated with the project and were utilized to relay information to the primary MMOs. For instance, because the primary MMO stationed on P-160 could not see the docks low in the water to the north of P-159 (known as H11/H12 [see Figure 2-1]), a secondary MMO was stationed on P-159 while the primary MMO was stationed on P-160 to monitor areas that the shutdown MMO could not monitor. The primary MMO was the sole note-taker and provided verification of any questionable species identification.

Acoustic Technicians. Acoustic technicians were responsible for deploying hydrophones and documenting readings from the Larson Davis (LD) 831 SLMs. At the far-field locations, in most cases, the ATs were also the BDs. At the source, a stationary, designated AT deployed and logged all acoustic data.

Boat Drivers. The BDs responsibility was to relay MMOs or ATs to their designated station, based on information as provided by the project manager at the beginning of each day. They were also responsible for setting the anchor, as well as boat maintenance issues.

2.1.2 Acoustic Monitoring Program Methods

The following sections describe equipment and methods used in monitoring sound in the environment. Separate setting configurations were applied for in-water construction activities examining impulse sounds versus ambient data collections conducted both within the project footprint and throughout San Diego Bay. Hydroacoustic and airborne data collection methods were based on the most current NOAA guidance at the time the Monitoring Plan (Navy 2013b) was developed.

2.1.2.1 Acoustic Measurements

2.1.2.1.1 Acoustic Monitoring Equipment

Three separate types of SLMs or acoustic data loggers were utilized during the various stages of the project to collect sound level recordings (

Table 2-2). To comply with the requirement to observe SPLs in real time during in-water construction activity the LD 831 SLM was selected as the primary unit for ATs. The primary acoustic data collection systems utilized during all phases of monitoring consisted of LD 831 Class 1 integrate sound level meters (SLMs) and Reson TC-4033 spherical hydrophones, deployed at mid depth at each station. Concurrently, during the IPP, subcontracted ATs from the UW APL deployed Loggerhead® DSG-ocean acoustic data loggers outfitted with a High Tech,

Inc. (HTI) 96-min hydrophones, with 180 dBV/µPa sensitivity. The Loggerhead® data loggers were positioned at both the source (10 m [32.8 ft]) and the shutdown (125 to 300 m [410 to 984 ft]) station locations in tandem with LD 831 SLMs. Additionally, UW APL acousticians used a Hydro DB real time SLM mobile unit, at various distances, to validate predicted source rms SPLs.

Sound level recordings collected by LD 831 SLM units simultaneously record in two file formats: one as a raw wav file recorded at 48 kHz, and the other as a summary file archiving several metrics including the LZF_{max}. The LZF_{max} is the highest rms sound level collected over a 125 millisecond interval.

Raw wav files are post processed, in our case using Matlab, to identify peak pile strikes and calculated associated rms SPLs for individual sound producing activities. In the case of the LD 831 SLMs a calibration reference file was required to determine the voltage to receiving voltage sensitivity (RVS) and calculate accurate rms SPL values. When raw wav files or calibration files experienced deviations or errors reliable rms SPLs were unable to be calculated. In order to examine and report rms SPL values, for sound level recordings with corrupted or missing raw wav files, the archived LD 831 SLM LZF_{max} recording metric was utilized. LZF_{max} sound levels were only presented when raw wav file sound level recordings were unavailable, corrupted, or unreliable due to reference calibration issues. Comparisons between raw wav file rms SPL values and LZF_{max} values, for both continuous and impulse sounds, were used to develop a relationship between the two dB rms SPL metrics.

Examining pile strikes during both NMAWC and the IPP, the median duration of pile driving strikes, trimmed to 90% cumulative energy, was 34 milliseconds. Since LZF_{max} values were recorded over 125 milliseconds, an estimate of the SPL from the reliable LZF_{max} values is:

$$SPL \sim LZF_{max} + 10 * \log_{10}(125/34) \quad SPL \sim LZF_{max} + 5.65 \text{ dB}.$$

The average difference between SPLs derived directly from the wav file data and those derived from LZF_{max} values was less than 1dB for sound level recordings 10 m (32.8 ft) from the source. For continuous sound sources such as pile removal and vibratory pile driving which are calculated over longer time frames, the LZF_{max} metric provide dB levels directly comparable to those calculated from processed raw wav files (see IPP Vibratory Pile Driving Results).

Table 2-2 provides the make and model of the equipment used to monitor of underwater SPLs. All applicable equipment was calibrated to standards set by the National Institute of Standards and Technology.

Table 2-2. Sound Monitoring Equipment.

Item	Make	Model
Sound Level Meter	Larson Davis	LD 831
Firmware Interval Logging	Larson Davis	LD Log
Firmware 1/3 Octave Analysis	Larson Davis	831-OB3

Firmware GPS Integration	Larson Davis	831-GPS
Microphone	PCB	377B02
Preamplifier for Microphone	PCB	PRM 831
Preamplifier for Hydrophone	PCB	ADP 097
Hydrophone (LD 831)	Reson	TC-4033
Pistonphone, HI Pressure	ETMC Technologies	42AC
DSG-ocean acoustic data logger	Loggerhead	DSG-Ocean
Hydrophone (Loggerhead® DSG-Ocean)	HTI	96-min
Hydro DB Real Time SLM	UW (custom)	
Hydrophone (Hydro DB SLM)	HTI	96-min

2.1.2.2 Instrument Calibration

Individual Reson hydrophones and PCB microphones were calibrated daily and, in the case of hydrophones, calibration tones recorded for thirty seconds to establish relative voltage to RVS relationships needed for post-processing. Calibrations were made using an ETMC 42AC piston phone equipped with a custom coupler designed for a Reson TC-4033 hydrophone. The piston phone generates a consistent 100 Pascal signal and calibrations were made at 156.6 dB re 1 µPa at 250 Hz for each hydrophone and 134.0 dB re 20 µPa at 250 Hz for airborne microphones each day. Calibrations were logged for each color coded hydrophone and individual microphones and are listed in Appendix D. The equipment used by UW APL was calibrated by the UW APL ATs intermittently during the first two weeks of IPP data collection. The calibration methods were similar to those implemented for the LD 831 SLMs and hydrophones using the ETMC 42AC piston phone. The Loggerhead® DSG-Ocean data logger sound recording files were also compared to LD 831 SLMs for the same data collection time frames and locations to conduct reference calibrations and ensure consistent results.

2.1.2.3 Acoustic Data Collection and Management

Acoustic information was documented on hardcopy forms and then transferred to a Microsoft Access database (see Appendix E). Information collected included: observation date/time, AT, location, station, general morning/afternoon weather information (wind, waves, and air temperature), pile number, hydrophone location, hydrophone depth, water depth, start/end time of activity, type of activity, maximum observed LZ_{eq} -1sec SPL, file name from the recording device, and any other notes or comments. This data was then added to a master database that housed all of the acoustic and marine species data for the entire project. Data records were double checked during data entry and printed copies for each day were archived with the original field data forms. Additional data QA/QC was conducted using saximeter recordings recorded by the construction contractor. Saximeter data provided pile numbers, pile driving times, number of strikes per pile and the depth of the piles. All raw acoustic files were saved as files with a .wav extension for analysis.

Raw wav files for NMAWC were analyzed for reporting metrics identified in the IHA (NMFS 2013b) with the exception of rise time, by Dr. Ken Richter (SPAWAR). Raw wav files for the IPP were analyzed by Dr. Peter Dahl and his UW APL ATs for similar reporting metric. The reporting metric were amended by Dr. Peter Dahl to better define processing time frames, variables, and questionable metrics. (see Appendices J and L). The revised reporting metrics

developed by Dr. Peter Dahl are presented below. For acoustically monitored piles, data from the continuous monitoring locations (~10 and ~450 m [32.8 and 1,476 ft] from source) were post-processed to obtain the following sound measures:

- Maximum peak pressure level recorded for all the strikes associated with each pile, expressed in dB re 1 µPa. This maximum value will originate from the phase of pile driving during which hammer energy was also at maximum (referred to as Level 4.)

From all the strikes associated with each pile occurring during the Level 4 phase these additional measures will be made:

- Mean, minimum, and maximum rms pressure level in dB re 1 µPa
- Mean duration of a pile strike (based on the 90% energy criterion)
- Number of hammer strikes
- Mean, minimum, and maximum single strike SEL in dB re µPa2 sec
- Cumulative SEL as defined by the mean single strike SEL + 10*log (# hammer strikes) in dB re µPa2 sec
- A frequency spectrum (pressure spectral density) in dB re µPa2 per Hz based on the average of up to eight successive strikes with similar sound. Spectral resolution will be 1 Hz and the spectrum will cover nominal range from 7 Hz to 20 kHz.

The cumulative SEL was computed from all the strikes associated with each pile occurring during all phases (i.e., soft start, Level 1-to-Level 4). This measure is defined as the sum of all single strike SEL values. The sum is taken of the antilog, with log10 taken of result to express in dB re µPa2 sec.

2.1.2.3.1 SSC Marine Mammal Relocation at NMAWC-Acoustic Monitoring

For in-water construction including pile driving and removal activities conducted at NMAWC, a continuous hydroacoustic monitoring system was positioned at source (10 m [32.8 ft] from the pile being installed or removed) and at the edge of the predicted outer limit of the behavioral ZOI (160 dB re 1 µPa [rms]). The behavioral ZOI was estimated to be approximately 74 m (243 ft), based on impact pile driving of 16-inch concrete piles (Caltrans 2009). Hydrophones were deployed from the dock, barge, or moored vessel at half the water depth measured by a weighed measuring tape or calibrated depth sounder. SPLs measured at the far-field varied in distance from 25 to 400 m (82 to 1312.3 ft) from the installed pile to determine variations in transmission loss for individual piles and sites. Airborne sound was collected at 15.2 m (50 ft) and also at distances ranging from 30.5 to 122 m (100 to 400 ft) using LD 831 SLMs mounted on tripods at 1.5 m (5 ft) elevation above the dock. Airborne sound measurements were collected intermittently, but in sufficient amounts to determine airborne ZOIs for the two applicable pinniped species.

Hydroacoustic data collection was coordinated with the pile driving contractor and documented the implementation of the soft start technique. The soft start technique consisted of one pile strike on the lowest hammer power setting (1 of 4), followed by a 30 second stand down. This was repeated in succession two more times for a total of three reduced energy pile strikes. Hydroacoustic data files were collected from just prior to soft start to the completion of pile driving activities with

changes in power settings and intermissions in pile driving activities recorded by the AT at the source. For NMAWC and during the IPP, the AT at the source served as the primary communication link between the pile driving contractor and marine mammal observers responsible for implementing shutdown procedures. Communication between the source AT and MMO's was conducted by way of a VHF radio. Marine mammal monitors were located in tandem with acoustic monitoring locations (Figure 2-1).

2.1.2.3.2 Fuel Pier Replacement Project at Naval Base Point Loma Fleet Logistics Center (Indicator Pile Program)-Acoustic Monitoring

For in water construction, including vibratory and impact pile driving conducted at the Fuel Pier, continuous hydroacoustic monitoring systems recorded underwater sound levels for each type, and size, of pile or construction activity. Hydroacoustic monitoring systems recorded underwater sound levels from piers, barges, or anchored vessels at source (10 m [32.8 ft]), shutdown (125 to 300 m [410 to 984 ft]), and at the predicted far-field behavioral threshold ZOI (160 dB re 1 µPa [rms]) locations (Figure 2-1). The far-field locations were located near Harbor Island to the northeast and adjacent to the Zuniga Jetty to the southeast (offshore) approximately 1,500 to 4,000 m from source (4,921 to 13,123 ft) from the pile driving activities. The UW APL ATs deployed Loggerhead® hydroacoustic data loggers at both the source and the shutdown station locations. The data loggers were deployed at the same source and shutdown locations (pier, barge, or vessel) and depths as the LD 831 SLMs units. The UW APL also utilized Hydro DB SLM to document rms SPLs, in real time, at various distances during both impact and vibratory pile driving. During all vessel-based sound recordings, the vessels engine and depth sounder were turned off and the vessel was placed at anchor, or adrift. GPS positions were logged for each individual sound recording file and location.

During the IPP, airborne sound level recordings were collected at 15.2 m (50 ft) and at distances ranging from 93 to 400 m (305 to 1,312 ft) using LD 831 SLMs mounted on tripods elevated 1.5 m (5 ft) above the dock structure. Airborne sound measurements were collected intermittently, but in sufficient amounts to determine airborne ZOIs for the two applicable pinniped species.

The LD 831 SLMs displayed real time LZ_{eq}-1sec values that were continuously observed by the AT's. ATs in the field documented the maximum LZ_{eq}-1sec values for each recorded sound file for each impact and vibratory pile driving event. The LZ_{eq}-1sec values were used to estimate the location of the shutdown and behavioral threshold boundaries. Reporting of rms SPLs was calculated from raw wav files recorded simultaneously at each of the four sound level recording locations. Raw wav file recordings were post-processed to the appropriate frequency range at the end of the recording periods.

For pile driving activities, the LD 831 SLMs provided real time displays of the LZ_{eq}-1sec that were converted to rms SPL estimate values based on correlations. Because the LZ_{eq}-1sec is based on a 1 second fixed time constant where the rms for impact pile strikes is based on the duration of the pulse, typically 40 to 50 milliseconds, the observed LZ_{eq}-1sec was used only as a surrogate for estimating rms SPL values. For continuous vibratory sounds produced during vibratory pile driving the recorded LZ_{eq}-1sec provided a more directly applicable measurement of rms SPLs.

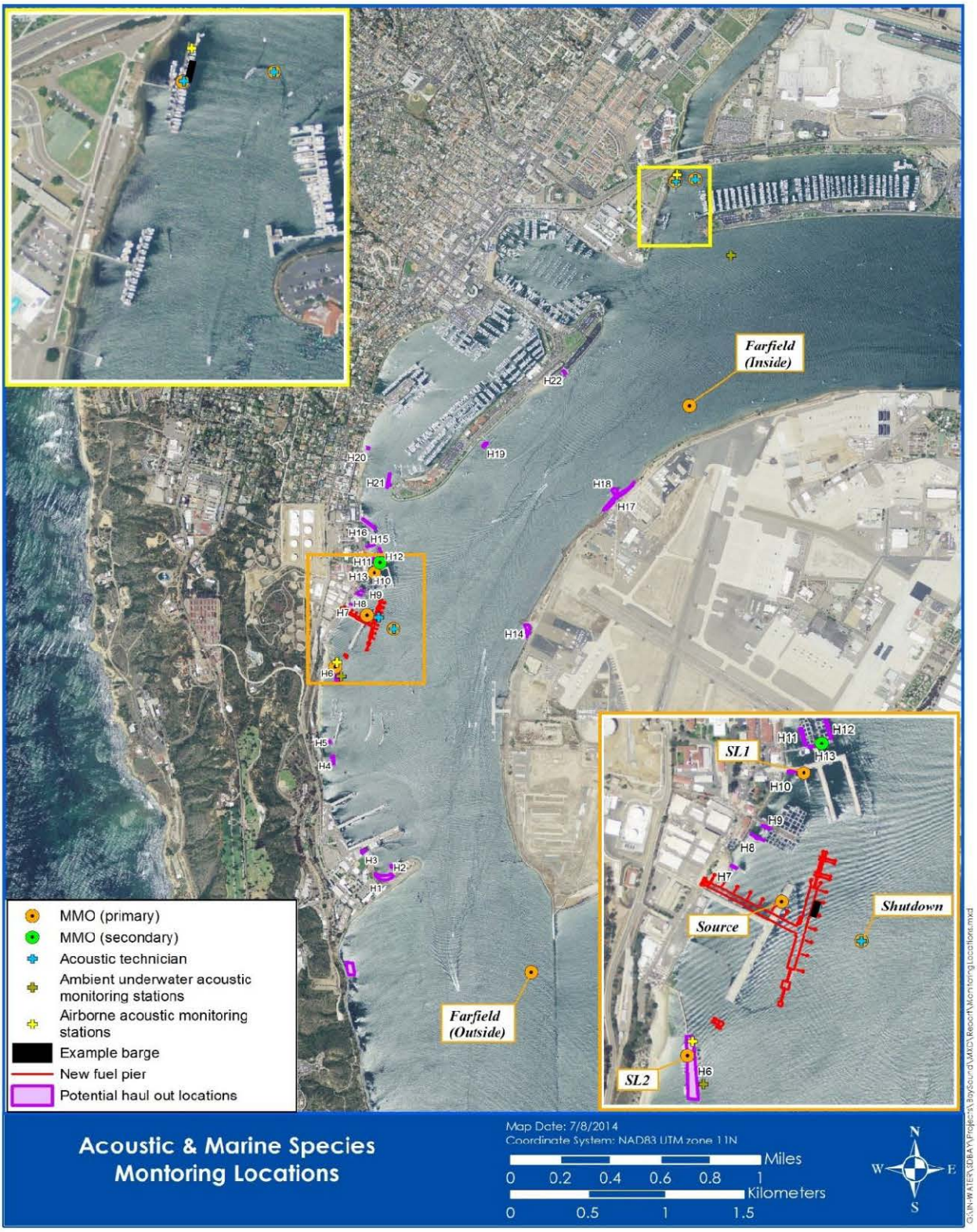


Figure 2-1. Representative Monitoring Locations at NMAWC and During the IPP, Including Identified Seal/Sea Lion Haul out Locations.

2.1.2.4 Ambient Data Collection

Ambient data collection consisted of two separate efforts and was conducted in a manner consistent with NOAA guidance for both underwater and airborne measurements (NOAA 2012). Ambient underwater and airborne sound level recordings were collected for three 8-hour days at NMAWC between March 20 and March 27, 2014 and for the IPP from April 24 to May 23, 2014. Ambient sound level recordings were collected in the absence of construction activities, and during typical construction time periods (0700 to 1600), at from locations that were between 400 and 1000 m (1,312 and 3,280 ft) from each site. Sites were chosen to minimize boat traffic effects that might impact results.

Underwater ambient data collection efforts were collected in April and May, 2014 at six locations throughout San Diego Bay (Figure 2-2). The Baywide ambient data collections were a continuation of previous efforts examining the temporal and spatial sound level differences in the various ecoregions of San Diego Bay. Building on data sets previously collected in 2012 and 2013, similar methods and locations were selected to document underwater SPLs in the various ecoregions of San Diego Bay. One hour LD 831 SLM recordings segregated into mostly 10 second time histories were collected at each of the six stations between 0700 and 1700 (Monday-Friday). Recordings were made using a time history setting that combined records in 10 second time bins and reported individual LZ_{eq}, LZF_{max}, and LZ_{peak} values for each 10 second bin.

2.1.2.5 Acoustic Data Processing

Acoustic sound level recording files were saved on individual SLMs using file extensions that identified the unit and its data collection location. Each unit was assigned a unique monitoring location and file names contained the prefix for that location. For example LD1.001 represents the file name for file number 1 collected at the source location. Sound recording files were transferred from the SLM units to a USB drive and then to the main database after each day of monitoring. Files were stored on the main database by date and monitoring location. Each sound level recording file contained both the raw wav file and a LD 831 reporting metrics file that were archived into a Data-Raw folder prior to processing. After archiving, sound level recording files were copied into a Data-Processed folder and processed using the Larson Davis Slim Utility-G3 software to extract and save the wav file and convert the reporting metrics from the SLM into a Microsoft Excel file. Processed wav files were archived and labeled as either a calibration file (Cal), impact pile driving file (I), or a vibratory pile driving file (V) prior to distribution to SPAWAR or UW APL ATs for post-processing.

Raw wav files were processed by SPAWAR and UW APL acousticians using Matlab®. Calibration files were analyzed to obtain a RVS for each hydrophone. These RVSs were applied to the respective wav files to obtain a time series in micropascals. The impact pile driving recordings were analyzed using an in-house algorithm for isolating each impact pile strike, taking the 90% rms of each isolated impact pile strike, and reporting the greatest 90% rms observed during maximum energy, level four, pile driving. The vibratory pile driving was analyzed by selecting from the time series just the time periods when the vibratory driving was occurring then taking the rms of the greatest selection that lasted more than 10 seconds.

Figure 2-2. Ambient Data Collection Points in San Diego Bay.

2.1.3 Marine Species Monitoring Program Methods

2.1.3.1 Observer Training

Prior to the start of all pile driving activity, the MMCC conducted a briefing for construction supervisors and crews, Navy staff, and the marine mammal and acoustic monitoring teams. New personnel were also briefed when they joined the construction project. All MMOs were further trained with more detail of the project, marine mammals covered under the IHA, as well as California least tern, and green sea turtle identification and mitigation measures. Each observer was informed of their roles and responsibilities as an observer, including regulatory requirements (i.e., MMPA), professional behavior, and project discretion. All observers were trained to be consistent, diligent, and free of distractions for the entirety of the monitoring period. Additionally, observers were instructed on proper methods for locating marine species, sighting cues for the various species anticipated to occur in the project area, and how to estimate distances between the MMO and observed species.

2.1.3.2 Marine Species Visual Monitoring Protocol

MMOs were placed at the best vantage point to effectively monitor for marine species using the naked eye or binoculars, with a specific focus on marine mammals. Based on the location of the pile being driven during both NMAWC and IPP, MMOs would adjust their locations to provide the best visibility around the pile or barge. In-water pile operations ceased when sighting conditions (e.g., fog, rain, and high waves) did not allow for effective monitoring of the shutdown zone and surrounding waters.

The shutdown and buffer zones were monitored before, during, and after pile driving and removal. Procedures for visual monitoring identified in the IHA (NMFS 2013), and the IHA application (Navy 2013b) were followed, unless otherwise noted below.

The MMCC was responsible for the suspension and shutdown of in-water pile driving operation (except as outlined below in the monitoring modifications regarding common dolphin sightings). MMOs radioed the MMCC if an animal was observed within or approaching the shutdown zone. The MMCC would then notify the PM or the pile driving foreman to suspend in-water pile driving operations. Once the animal was observed leaving the shutdown zone, or the animal had not been re-detected for at least 15 minutes, the MMCC notified the PM, who then notified the pile driving foreman that in-water pile operations could commence.

All marine mammal observations were recorded, including animals observed outside of the shutdown and buffer zones. Sighting information was documented in either a hardcopy form, or on a Dell© tablet using a Microsoft Access database (see Appendix F). If data was collected on a hardcopy form, it was transferred to a tablet at the end of the day. On a nightly basis, this data was added to a master database that housed all of the sightings for all MMOs for the entirety of the project. Because the AT near the pile being driven (source) kept a detailed log of when pile driving occurred, all observations were evaluated nightly relative to when the hammer was noted as driving the pile (see Table 2-3 for an example):

Table 2-3. Sample Timeline for Pile Driving Activities.

Time	Sample Activity
09:00 to 09:02	Pile Driving, Soft Start
09:03 to 09:04	Pile Driving, Hammer Level 1
09:05 to 09:06	Stop pile driving due to technical difficulties
09:07 to 09:10	Pile Driving, Hammer Level 2
09:11 to 09:20	Stop pile driving due to technical difficulties, or hammer adjustment
09:21 to 09:22	Pile Driving, Hammer Level 3
09:23	All stop on Pile Driving

In the timeline above, if marine species observations occurred at 09:01, 09:03, 09:08, and 09:22, then they would be considered as a preliminary take based solely on the fact that the sighting occurred during pile driving, regardless of animal location relative to the pile. However, if an observation occurred at 09:05, or at 09:12, then it would not be considered as a preliminary take. During the post-analysis processing of the acoustic data, these sightings were then evaluated relative to the adjusted shutdown and buffer zones, and on a per pile basis. If they occurred within the zones associated with the pile, then they were considered as finalized take and are reported as such in this document.

Throughout the course of the project, some modifications to initial monitoring protocols were implemented in order to properly document and track individual animals and better address the potential for take in the project area. Modifications included adding or deleting fields to the data collection sheets, adjusting distances of the far-field boats to account reduced distances to regulatory thresholds, and adding more MMOs to provide full visual monitoring. Detailed descriptions of the modifications are fully described in Appendix G.

To minimize the probability of multiple MMOs counting a single animal (and thereby potentially overestimating take), sightings were tracked on a continuous basis by an observer on one monitoring platform and then “handed off” to an observer on a second platform if the animal(s) were moving in the direction of the second monitoring platform. Observers kept detailed sighting data and, whenever possible, indicated in their field notes if an animal was a re-sighting.

MMOs also were also responsible for documenting observations of green sea turtles and California least terns. Sighting information for green sea turtles and California least terns included all data that was collected for marine mammals; however, a specific focus of the California least terns was whether they were foraging during pile driving. As a result, specific attention was paid to whether California least terns were successfully or unsuccessfully foraging in the area. Due to the focus of the MMOs on marine mammals in the area, successful foraging was only noted if a bird was seen with a fish in its beak, but the number of times that an animal successfully, versus unsuccessfully, foraged was not tracked.

In the event that a dead or injured marine mammal was observed and the death or injury was suspected to be as a result the project, a Level A harassment form was filled out (Appendix H). The

PM and MMCC would have notified the Navy contact and shutdown all in-water pile operations until NMFS was able to review the report of the potential Level A harassment.

2.1.3.3 Marine Mammal Hazing

To reduce the likelihood for pinnipeds using local docks as resting sites (identified as Haul out [or "H"] stations with unique numbers for the purposes of monitoring [H1 to H22]) near the project area, hazing was conducted under MMPA Section 109(h), which authorizes the taking of marine mammals as part of official duties. There were direct discussions with the NMFS regional office to address hazing as part of on-going U.S. Navy operational activities. This activity entailed using water hoses to spray pinnipeds that were resting on the docks and forcing them into the water prior to pile driving, or during soft start. Trained Navy personnel were assigned to individual zones where pinniped species might view semi-dry areas as likely haul-out locations. Each individual was responsible for several different haul-out locations, and moved between each location either by foot or vehicle. The number of hazing events were tracked using a hardcopy form, and then added to an electronic database at the end of each day.

The intent of hazing was to: a) force animals into the water during soft start procedures to alert them that the area will have an increase in the underwater noise levels (with the assumption that they will leave the area); and b) reduce the number of takes by not allowing the animals to return to known/potential haul out locations where they might haul out, and then re-enter the water. These prescriptions ranged from flushing animals into the water before pile driving events, moving known haul out sites to areas outside of the Level B ZOI, and creating barriers at existing haul out sites to keep animals from remaining in the area. No animals were harmed during any of the hazing prescriptions. The following were implemented:

1. Prescription 1 (HZ1): Pinnipeds hauled out within the level B ZOI were flushed into the water prior to soft start pile driving. The goal was to have the animals in the water when soft start began to deter the animals from the immediate area. Hazing personnel then monitored and recorded the number of animals hazed and their general behaviors. Once flushed, animals were allowed to return to the haul out site of their own volition and were not be hazed again.
2. Prescription 2 (HZ2): Pinnipeds hauled out on docks within the level B ZOI were not hazed and continued to be monitored during pile driving events. If an animal was resting on a dock during pile driving, but it was outside of the 90/100 dB airborne acoustic threshold ZOIs, it was not hazed into the water. Under this prescription, hazing personnel relayed any sighting information such as new sightings or behavioral changes to designated MMOs (either at Source or Shutdown). To decrease workload on the primary MMOs at shutdown and source, primary MMOs were placed at the haul out locations closest to the Fuel Pier, H6 through H12.
3. Prescription 3 (HZ3): A barrier (plastic fencing) was installed to prohibit pinnipeds from hauling out onto the black jet dock at P-122 (H6), one of the largest haul out sites within the project area. Hazing personnel would remain at each haul out site and would continue to relay any sighting information such as new sightings or behavioral changes to designated MMOs (either at Source or Shutdown).

Data was collected using a hardcopy datasheet, with information added to an MS Access database at the end of each night (Appendix I). Once it was realized that hazing was not a viable option for mitigating "take," the hazers monitored potential haul-out locations during construction-related activities as secondary MMOs.

2.1.4 Monitoring Zones

The analysis of acoustic data presented within the final EA (Navy 2013a) were used to develop the shutdown and buffer zones for in-water pile operations. While the acoustic ZOIs varied based on the pile locations, the diameter and composition of pile, and types of installation and removal methodologies, shutdown and buffer zones were based on the modeled maximum ZOI for all in-water pile operations. Monitoring of ZOIs and the implementation of other mitigation measures were designed to minimize impacts of underwater sound from in-water pile operations on marine mammals. All shutdown and buffer zones were monitored for the presence of marine mammals before, during, and after pile operations. Also, during pile driving operations, acoustic data was recorded at all boat-based locations as well as at 10 m (32.8 ft) from the source.

Shutdown Zone. The shutdown zone included all areas where the underwater sound was anticipated to equal or exceed the Level A (injury) harassment criteria for marine mammals (Figure 2-3 and Figure 2-4). Modeling indicated that these distances ranged from 10 to 452 m (32.8 ft to 1,482.9 ft) from each pile, depending on hammer and pile type (Table 2-4).

Table 2-4. Modeled Distances to Injury and Disturbance Thresholds for Sound.

Activity	Modeled Distances to Threshold (meters [feet])					
	Underwater				Airborne	
	Level A		Level B		Level B	
	190 dB	180 dB	160 dB	120 dB	100 dB	90 dB
Impact driving, steel piles[1]	36 (118)	452 (1,483)	5,484 (17,992)	N/A	113 (371)	358 (1,175)
Vibratory driving, steel piles[1,2]	10 (32.8)	14 (45.9)	N/A	6,470 (21,227)	9 (30)	28 (92)
Impact driving, concrete piles	10 (32.8)	10 (32.8)	84 (276)	N/A	N/A	N/A

[1] Based on 48-inch steel piles, and source levels of 180 dB rms for vibratory pile driving, and 195 dB rms for impact pile driving.
[2] The vibratory driving steel pile Level A ZOI for pinnipeds (190 dB) is modeled to be less than 3 m (9.8 ft) from the source.

Buffer Zone. The buffer zone included all areas that may have been exposed to underwater sound that might have led to Level B (behavioral disturbance) harassment for marine mammals (Figure 2-3 and Figure 2-4). Modeling indicated that these distances ranged from 505 to 6,470 m (1,656.8 to 21,227 ft) from each pile, depending on hammer and pile type (Table 2-4).

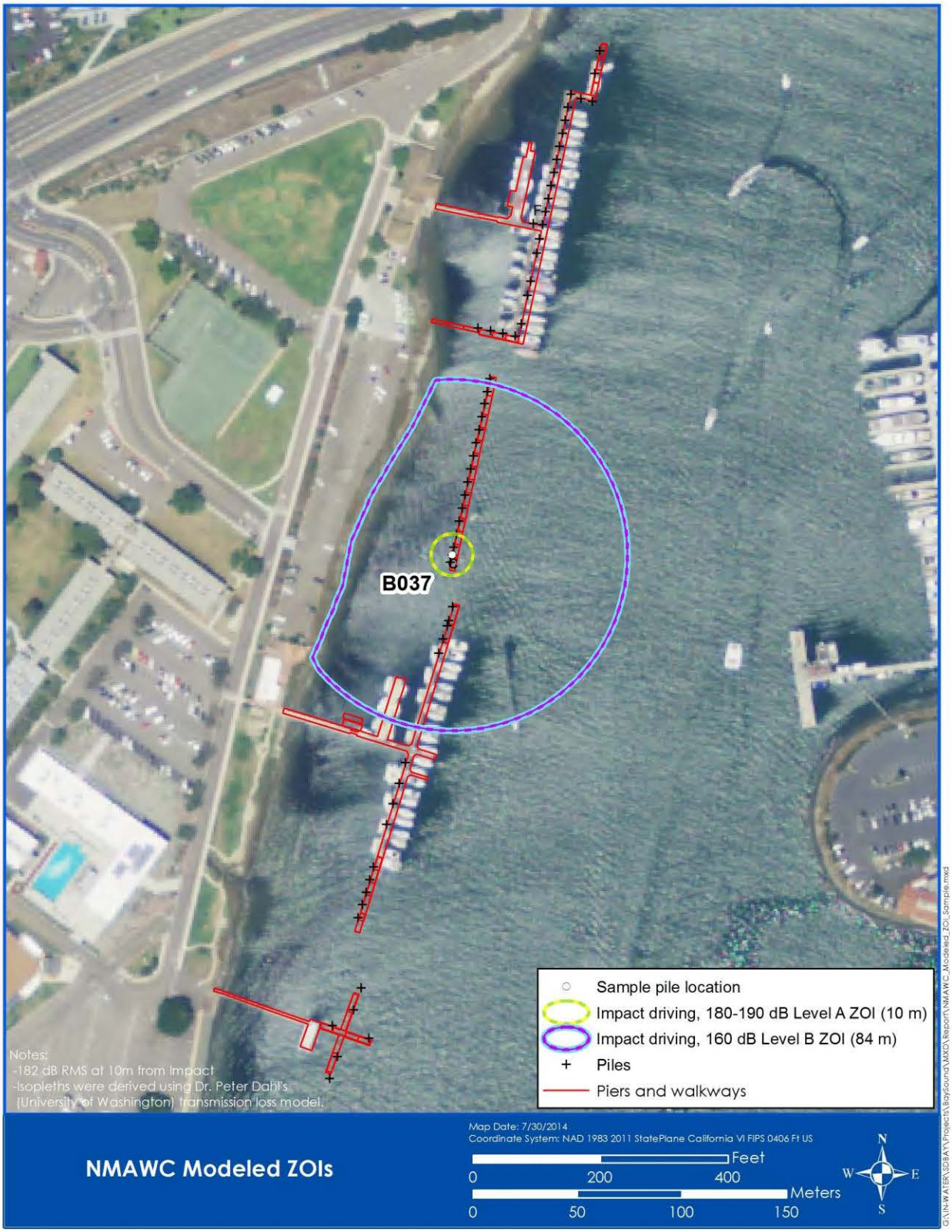


Figure 2-3. Modeled Shutdown and Buffer zones for the SSC Marine Mammal Relocation at NMAWC.

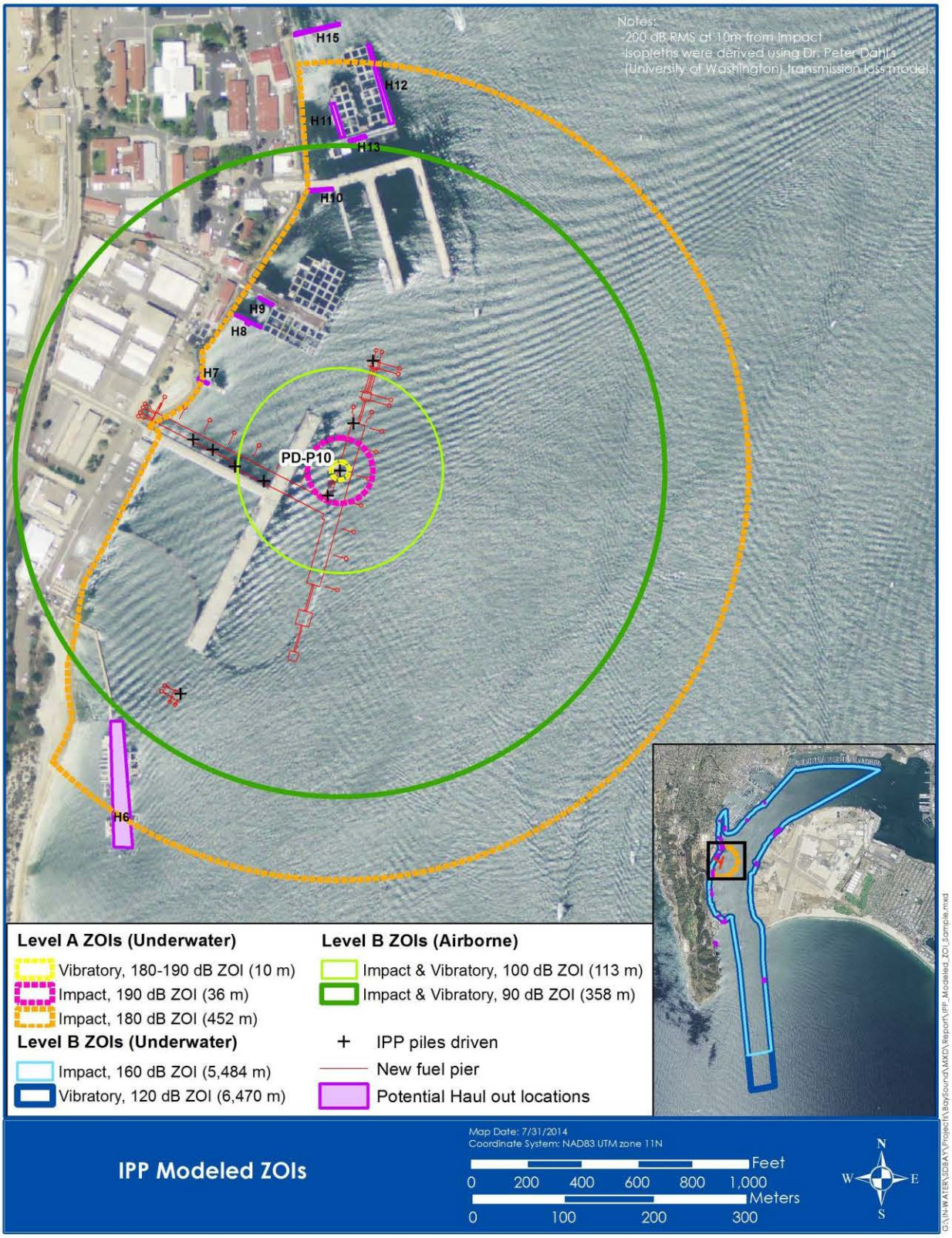


Figure 2-4. Modeled Shutdown and Buffer zones for the NBPL FLC Fuel Pier Replacement Project (IPP).

Airborne Zone. The airborne zone included all areas where pinniped species might be behaviorally impacted by pile driving while hauled out of the water (Figure 2-3 and Figure 2-4). The zones were determined based on spherical spreading loss and were modeled to be from 9 to 358 m (30 to 1,175 ft), depending hammer and pile type (Table 2-4).

2.1.4.1 SSC Marine Mammal Relocation at NMAWC

Acoustic Technicians observed the maximum LZ_{eq}-1sec SPLs during each in-water construction activity sufficient to document source and shutdown threshold SPLs. Final acoustical analysis of all data was performed after the conclusion of pile driving activities at NMAWC. As a result, all modeled shutdown and buffer zones were monitored throughout the NMAWC pile driving activities and all marine species sightings recorded. Boat captains and observers were equipped with vessel-mounted and hand-held GPS units in order to ensure correct positioning and effective coverage of shutdown and buffer zones.

2.1.4.2 Fuel Pier Replacement Project at Naval Base Point Loma Fleet Logistics Center (Indicator Pile Program)

Similar to NMAWC, AT's observed the maximum LZ_{eq}-1sec SPLs during each in-water pile driving event to document source and shutdown threshold SPLs. Throughout pile driving activities, modeled shutdown and buffer zones were monitored and marine species sighting recorded. Pile driving activities conducted within the shallow areas of the project area (interior of the existing fuel pier) required movement of the shutdown vessel to multiple locations and the addition of several shore (dock/pier) based MMOs to adequately observer the various zones. Preliminary acoustical analysis during pile driving indicated that the 160 dB rms isopleth was at approximately 2,200 m (7,218 ft). The vibratory buffer zone (120 dB rms) was initially modeled to be 6,470 m (21,227 ft) and was to be verified as part of the Fuel Pier replacement project (IPP). Collection of ambient acoustic data prior to the Fuel Pier Replacement project found that the median ambient SPL in San Diego Bay was be approximately 128 dB rms. During the Fuel Pier Replacement project (IPP), in conjunction with the collection of measured dB rms values for vibratory pile driving collected near the source (10 m [32.8 ft]) and at various shut down ranges (100 to 200 m [328 to 656 ft]), a propagation model predicted that dB rms values decayed to ambient SPLs at 3,000 m (9,842 ft). As a result, the far-field MMOs were shifted closer to the Fuel Pier to account for the refined area of responsibility. Boat captains and observers were equipped with vessel-mounted and hand-held GPS units in order to ensure correct positioning and effective coverage of shutdown and buffer zones.

2.1.5 Monitoring Platforms and Locations

Monitoring platforms included small vessels, piers, docks, and barges with observations locations approximately 1 to 12 m (3.3 ft to 4 ft) above the water line. All vessels were equipped with a VHF radio and chart plotters and all captains were familiar with San Diego Bay. Secondary hand-held VHF radios were also used to communicate with other MMOs. In most cases for both the pile driving at NMAWC and during the IPP, both AT and MMOs were on the same boats, or within close proximity to one another on the docks/barge/piers. In all cases the source acoustic data was collected at 10 m (33 ft) from the source. During seven days of the IPP, a separate UW APL AT was employed to validate acoustic data being collected at the source, shutdown and far-field locations. This AT was either on a separate boat, or on a boat with another AT/MMO crew.

2.1.5.1 Vessel-Based Monitoring

A single far-field 21-foot Boston Whaler® was used during NMAWC pile driving activities to record acoustic data and provide a platform for the MMOs stationed at the far-field ZOI. The area associated with the shutdown zone for NMAWC was small and was observed from a MMO for the pile being driven. Furthermore, because the ZOIs were relatively small, all personnel associated with the construction crew were trained in basic marine mammal identification techniques and acted as unofficial secondary MMOs. An AT and an MMO were positioned at various vessel-based observation sites, depending on the pile location, but always in areas where the Buffer Zone was in full view.

The NMAWC site was segregated into three distinct areas based on the three Piers identified in Figure 1-2 (P-548, P-607, and P-619). Many of the existing dock structures and pilings were left in place to minimize potential resource impacts, additional pile driving effort, and associated costs. The shallow nature of the NMAWC site, complexity of existing structures, and the location of the pile driving and flat deck material barge required to conduct pile driving created a myriad of logistical constraints and boundary conditions with respect to both underwater and airborne acoustic data collection efforts.

For in-water pile operations during the IPP, there were three boat-based MMOs and three ATs (two in the far-field locations, and one at the shutdown ZOI). The vessel at the shutdown zone was a 21-foot Boston Whaler®, and the two far-field observation platforms included a 17-foot Boston Whaler® (inside), and a 21-foot Boston Whaler® (outside).

The shutdown ZOIs for pinnipeds (36 m [118.1 ft]) and cetaceans (452 m [1,482.9]) were fully monitored by either vessel-based or pier- and barge-based MMOs. In order to adequately cover both the pinniped and cetacean shutdown zones, MMOs were positioned either near to the source, or from 125 to 300 m (410 to 984 ft) from the source, depending on best location to view the zone or address security requirements. The maximum buffer zone (for the 120 dB isopleth) was initially estimated to extend 6,470 m (21,227 ft) from the source and covered an area of approximately 11.5 square kilometers (km2; 4.45 square miles). Because monitoring an area of that size was impractical, MMOs were placed at the furthest extent practicable to be able to monitor the buffer zone (see Figure 2-1). Initially, MMOs were placed near the end of the Zuniga Jetty and near Harbor Island (at approximately 3,500 to 4,000 m [11,482 to 13,123 ft] from the source). As preliminary acoustic data was processed, and the buffer zone looked to be smaller than was modeled, the MMOs were brought closer to the source and were placed at approximately 2,200 m (7,218 ft) to the south and northeast of project area (Figure 2-1).

2.1.5.2 Dock, Pier, and Barge-Based Monitoring

For both projects, a single MMO was stationed as close as possible to the pile location to adequately monitor the shutdown zone. An AT was also stationed in close proximity to the pile to record sound associated with the source pile driving. Based on the pile location, this was primarily on the pier adjacent to the barge, but also occasionally on the barge as well. This MMO was typically located on a pier near in-water pile operations, or, depending on the pile location, on the barge with construction crew and machinery that was typically from 5 to 20 m (6 to 66 ft) from the pile. The MMO had a full view of the sea lion shutdown zone (at 36 m [118 ft]). The PM was

positioned in close proximity to the construction foreman to ensure that a shutdown of operations could occur quickly after the initial observation of a marine mammal within or approaching the shutdown zone.

As the IPP project progressed, it was quickly realized that there were areas that were within close proximity to pile driving activities that could not be adequately observed by a single MMO, and a pier-based secondary MMO was added. As a result, three dock-, pier-, and barge-based MMOs (one in close proximity to the pile being driven, and two in close proximity to known haul out locations for seals and sea lions to the north and south of the pier [see Figure 2-1]) were used to provide complete coverage for the buffer and shutdown zones.

3.0 Results

The results of acoustic, marine species, and special study monitoring efforts agreed upon in the IHA (NMFS 2013) and in the EA (Navy 2013a) associated with this project are presented in individual sections or separately in Appendices. Results are focused on complying with the specific reporting metrics of the IHA (NMFS 2013) and species also regulated by the NMFS Office of Protected Resources. Results of acoustic and marine species monitoring are segregated for NMAWC and the Fuel Pier Replacement IPP. Acoustic and marine species monitoring of in-water construction activity, including vibratory and impact pile driving and pile removal activities, was conducted for 227 hours and 31 minutes over 35 days from January 28 to May 25, 2014 (Table 3-1).

Table 3-1. Summary of All In-water Pile Operations.

Project Location	Pile Driving Timeframe	Total Number of Days	Total Time on Station[1]	Observation Time[1] (Pre-, During, and Post-Construction)	Pile Driving Time[1]
NMAWC	28-Jan-14 to 13-Mar-14	25	153:35	55:48	13:25
IPP	29-Apr-14 to 15-May-14	10	73:56	42:18	06:50
TOTAL		**35**	**227:31**	**98:06**	**20:15**

Notes: [1] All times in hh:mm.

Analysis of representative sound level recordings and resulting wav files were analyzed to determine the greatest hydroacoustic and airborne dB rms SPLs for each construction activity, with some exceptions. Results presented for the IPP and utilized for determining transmission loss and associated marine species ZOIs were solely based on dB rms SPL calculations from wav file sound level recordings. All dB rms values presented in these results are in dB re 1µPa, unless otherwise stated.

3.1 SSC Marine Mammal Relocation at NMAWC

3.1.1 In-Water Pile Operations Effort

Pile removal and pile driving activities at NMAWC occurred over 25 in-water construction days from January 28, 2014 to March 13, 2014 and involved the removal and installation of a total of 111 (30 removed and 81 driven) 12-inch and 16-inch concrete piles (Table 3-2). Pile removal and pile driving equipment included a 50 ton block main hoist crane with a 36.5 m (120 ft) boom mounted on a 12.2 x 24.4 m (40 x 80 ft) spud barge, and a 12.2 x 48.8 m (40 x 160 ft) flat deck material barge. The impact hammer and power pack used for pile driving was a D19-42 American Pile Driving Equipment, Inc. (APE) diesel hammer with a maximum energy of 42,800 foot pounds (ft-lbs) and minimum energy of 23,566 ft-lbs. The hammer was fitted with a hydraulic tripping cylinder with four adjustable power settings that could be reset while driving. Pile removal equipment included a 300-horsepower diesel engine and 300 pounds per square inch pump attached to a 30.5 m (100 ft) long by 10 centimeter (cm; 4 inch) flex hose and a 15.2 m (50 ft) long by 3 inch (7.6 cm) diameter jet pipe. Acoustic and marine species monitors were on location at NMAWC during all in-water construction days. Monitoring was not continuous throughout this time.

Table 3-2. In-water Pile Operations at NMAWC.

Date	Activity[1]	Daily Start Time[2]	Daily End Time[2]	Total Time on Station[2]	Observation Time[2] (Pre-, During, and Post-Construction)	Pile Driving Time[2]	Pile Number(s)[4]
28-Jan-14	PR	08:42	15:43	07:01	-	-	N/A
29-Jan-14	PR	08:40	14:26	05:46	-	-	N/A
30-Jan-14	PR	07:51	15:18	07:27	-	-	N/A
31-Jan-14	PR	07:51	11:03	03:12	-	-	N/A
4-Feb-14	PD	10:30	14:30	04:00	02:24	00:45	**B18**, **B19**
5-Feb-14	PD	08:50	13:40	04:50	01:08	00:22	B19[5], **B20**
13-Feb-14	M	06:45	09:00	02:15	-	-	N/A
14-Feb-14	M	06:45	09:00	02:15	-	-	N/A
17-Feb-14	PD	08:23	15:14	06:51	04:13	01:14	**E07**, E08, **E09**, **E10**, E11, **E12**
18-Feb-14	PD	10:29	11:32	01:03	01:48	00:24	**E05**, E06, **F04**, H04
19-Feb-14	PD	08:41	13:03	04:22	03:00	00:38	**E03**, E15, **E16**, **G02**
20-Feb-14	PD	08:06	14:55	06:49	04:23	01:06	**D013**, **D014**, **E021**, **G001**
21-Feb-14	PD	10:07	13:20	03:13	01:44	00:14	B010, **B011**, **B012**
24-Feb-14	PD	06:45	15:00	08:15	02:39	00:41	**B006**, **B007**, **B008**, **B009**, **B013**
25-Feb-14	PD	07:00	15:22	08:22	02:12	00:31	**B015**, **B016**, **B017**
26-Feb-14	PD	07:30	15:00	07:30	03:18	00:50	**B003**, **B004**, **B005**, **B014**
3-Mar-14	PD	07:00	16:00	09:00	03:53	00:51	**B018NE**, **B020**, **B021**, **DCP-1**
4-Mar-14	PD	06:45	14:00	07:15	03:26	01:07	**DCP-2**, **DCP-3**, **DCP-4**, **DCP-5**, **DCP-6**
5-Mar-14	PD	07:00	16:05	09:05	03:41	00:58	**B22**, **B23**, **B24**, **B25**, **F.1**, **G.1**
6-Mar-14	PD	06:47	15:45	08:58	05:53	01:28	**A3**, **B01**, **B02**, **B1**, **B2**, **C3**
7-Mar-14	PD	06:50	14:20	07:30	03:27	00:35	**B26**, **B4**, **B5**, **C22**
10-Mar-14	PD	06:45	15:00	08:15	04:49	00:55	**A28.3**, **B23**, **B24**, **B25**, **B30**, **B31**, **B32**
11-Mar-14	PD	07:20	15:07	07:47	03:50	00:46	**B27**, **B28**, **B29**, **B33**, **B34**, **B35**, B38
12-Mar-14[3]	PD	07:45	15:22	07:37	-	-	B36, B37, B39
13-Mar-14[3]	PD	07:00	11:57	04:57	-	-	S01, S02, S03
Total				**153:35**	**55:48**	**13:25**	

Notes:
[1] PR=Pile Removal; M=Monitoring only (No Piles driven); PD=Pile Driving
[2] All times in hh:mm
[3] MMOs were observing throughout the day, but no Acoustic Data was collected
[4] Bold text indicates piles where acoustic data was collected
[5] Restrike
[6] Pile Driving occurred on these two days, but no acoustic data was collected

While Time on Station totaled 153:35, only 55:48 (36%) of that time was spent monitoring the during pre-construction, pile driving, or post-construction time frames. Based on acoustic data collected at the source, of the over 55 hours of monitoring effort, 13:25 (24%) of that time was during actual pile driving. The remaining 42:23 (76%) was during the pre- and post-construction observation timeframes.

3.1.2 Acoustic Results

Hydroacoustic SPLs were collected for 64 of the 81 (79%) piles driven and 16 of the 30 piles (53%) removed at NMAWC. Sound level recordings during pile driving and removal activities typically captured the entire event. In the case of pile removal the events included barge movement, setup, dead pull and dead pull with jetting. During pile driving sound level recordings activities captured included set up, soft start, and the full sequence of pile driving power settings.

3.1.2.1 Pile Removal

Pile removal activities conducted at NMAWC between January 28, 2014 and January 31, 2014 were recorded as non-impulse continuous sound recordings. Raw wav file recordings were unavailable for rms SPL analysis due to voltage to RVS calibration issues but comparable LZF_{max} sound levels were collected, archived, and analyzed. During the various removal activities utilized to extract concrete piles at NMAWC LZF_{max} sound levels at source (10 m [32.8 ft]) ranged from approximately 140 to 155 dB. The greatest sound levels were generated by pile removal techniques using crane dead pulling in conjunction with water jetting. The LZF_{max} sound levels are presented in Table 3-3. The LZF_{max} is the maximum sound level recorded of any 125 millisecond interval in the sound record and proved to be a suitable surrogate for rms SPL for non-impulse continuous sound sources (see IPP Vibratory results). The dead pull with jetting pile removal technique generated LZF_{max} sound levels averaging 149.9 dB rms (n=15; standard deviation [SD] = ± 3.0). Dead pull only pile removal LZF_{max} sound levels averaged 141.6 dB rms (n=5; SD = ± 0.92) (Table 3-3). Differences in the number of cases reflected the fact that dead pull without jetting was abandoned after multiple unsuccessful attempts and the limited turbidity generated from water jetting in conjunction with dead pulling of both 12-inch and 16-inch concrete piles did not restrict the use of jetting. Water jetting during pile removal generated noticeable changes in the surface turbidity within areas less than 200 m2 (0.4 acres). The greatest turbidity was generated when the jet hose was not fully submerged in the bay bottom prior to jetting.

Table 3-3. Summary of SPLs Associated with Pile Removal Activities at NMAWC.

Date	Activity Start Time	Activity End Time	Pile Number	Pile Removal Activity	dB rms (LZF_{max})
28-Jan-2014	13:28	13:32	13	Dead Pull-Jetting	146.4
	14:38	14:54	1	Dead Pull-Jetting	148.8
	15:35	15:43	10	Dead Pull-Jetting	148.7
29-Jan-2014	9:02	9:05	9	Dead Pull-Jetting	153.0
	9:29	9:30	7	Dead Pull	141.8
	9:45	10:23	6	Dead Pull	142.5
	10:23	10:25	2	Dead Pull	142.5
	10:42	10:44	3	Dead Pull	140.1
	10:59	11:01	4	Dead Pull	141.0
	13:14	13:37	8	Dead Pull-Jetting	150.9
	14:20	14:26	8	Dead Pull-Jetting	148.2
30-Jan-2014	8:03	8:12	9	Dead Pull-Jetting	153.1
	8:47	8:50	10	Dead Pull-Jetting	146.7
	9:23	9:30	8	Dead Pull-Jetting	145.7
	11:27	11:43	7	Dead Pull-Jetting	153.2
	14:25	14:40	5	Dead Pull-Jetting	149.7
	15:10	15:18	4	Dead Pull-Jetting	150.9
31-Jan-2014	9:14	9:28	3	Dead Pull-Jetting	145.3
	9:55	10:05	2	Dead Pull-Jetting	155.1
	10:40	11:03	1	Dead Pull-Jetting	146.4

3.1.2.2 Pile Driving

Pile driving activities conducted at NMAWC between February 4, 2014 and March 13, 2014 generated SPL values at source (10 m [32.8 ft]) ranging from of 169.1 to 188.5 dB rms. LZF_{max} values for the same piles ranged from 165 to 185 dB. SPL values derived from raw wav files post-processing analysis were to variable to determine meaningful results and associated standard deviations so LZF_{max} values are presented when necessary. For reference, the relationship between rms SPLs and LZF_{max} dB levels are presented in the methods section and equate to approximately 5.6 dB lower LZF_{max} dB values for hydroacoustic impacts from pile driving. Pile driving of 12-inch concrete piles (n=13) averaged LZF_{max} values of 176.9 dB (SD = ± 2.47). Pile driving of 16-inch concrete piles (n=45) averaged LZF_{max} values of 176.6 dB (SD = ± 3.7) (Table 3-4). The depth in which pile driving took place ranged between 2.4 and 4.7 m (7.9 and 15.4 ft). A full summary of pile driving metrics including, but not limited to, pile number, location, depth, number of pile strikes, and time are presented in Appendix J. Sound level recordings at the far-field locations ranged from 25 to 400 m (82 to 1312 ft) from source and transmission loss varied from 10 to 36 dB rms respectively (Appendix J). Transmission loss for NMAWC piles was calculated by plotting all source and far-field dB rms SPLs derived from good far-field wav files (Figure 3-1) and from LZF_{max} values (Figure 3-2). In both cases the transmission loss coefficient was approximately 20logR placing the 160 dB rms behavioral disturbance ZOI for marine mammals at between 100 and 125 m (328 to 410 ft) for the highest source levels of 180 to 182 dB rms, respectively. Measured distances to the Level A/B ZOIs

were 10 m (32.8 ft; 190 dB), 12.6 m (41.3 ft; 180 dB), and 126 (413.3 ft; 160 dB) and are represented in Figure 3-3.

Table 3-4. Summary of Average SPLs for Pile Driving of Concrete Piles at NMAWC.

Pile Size and Type[1]	Average LZF_{max} (dB rms [SD])	Average Wave form (dB rms [SD])	Total Number of Piles
12-inch	176.9 (2.47)	181.8 (2.63)	13
16-inch	176.6 (3.67)	182.1 (7.12)	45

Note: [1] Concrete piles only

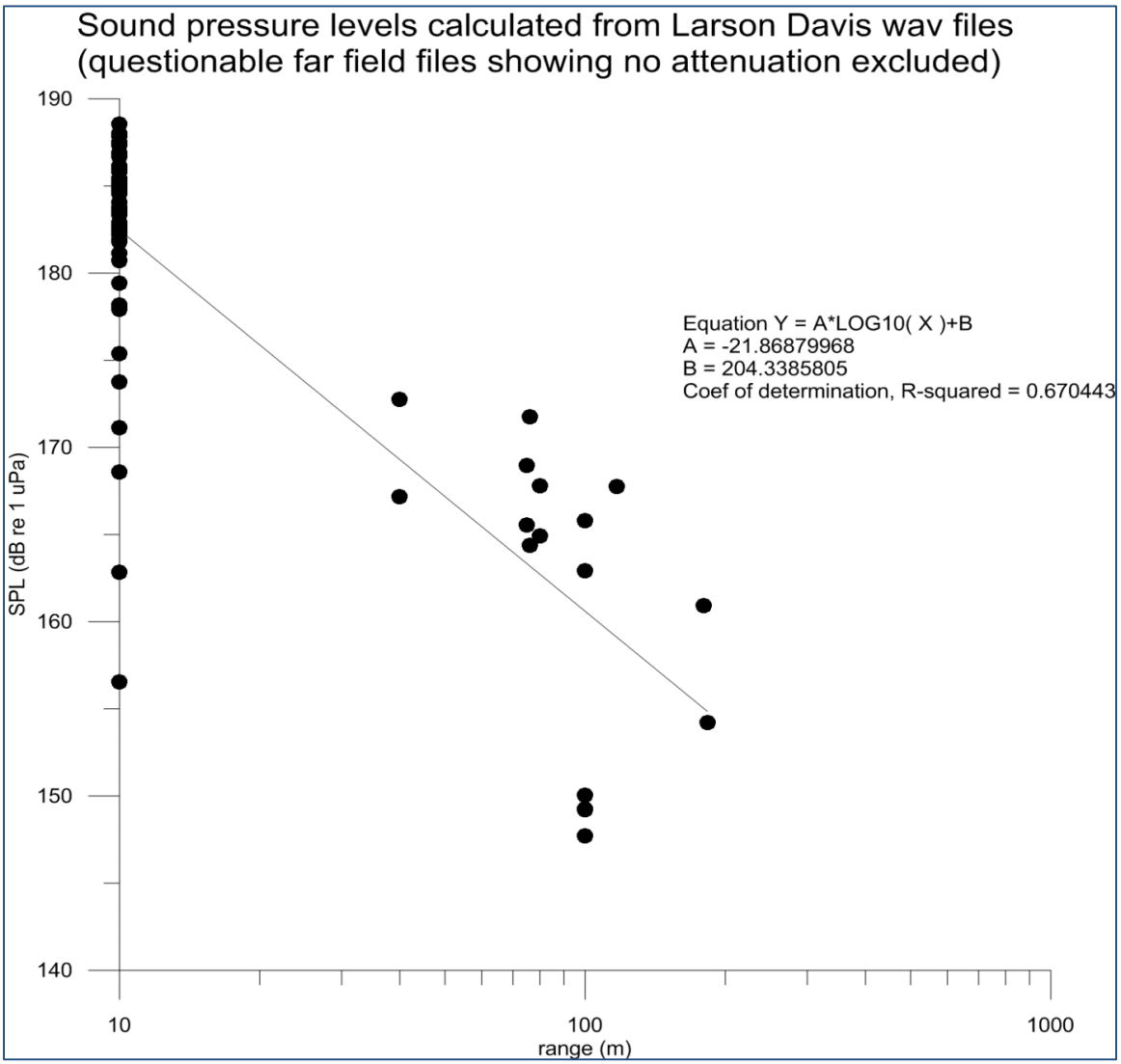


Figure 3-1. SPL Transmission Loss with Range at NMAWC (Calculated From wav Files).

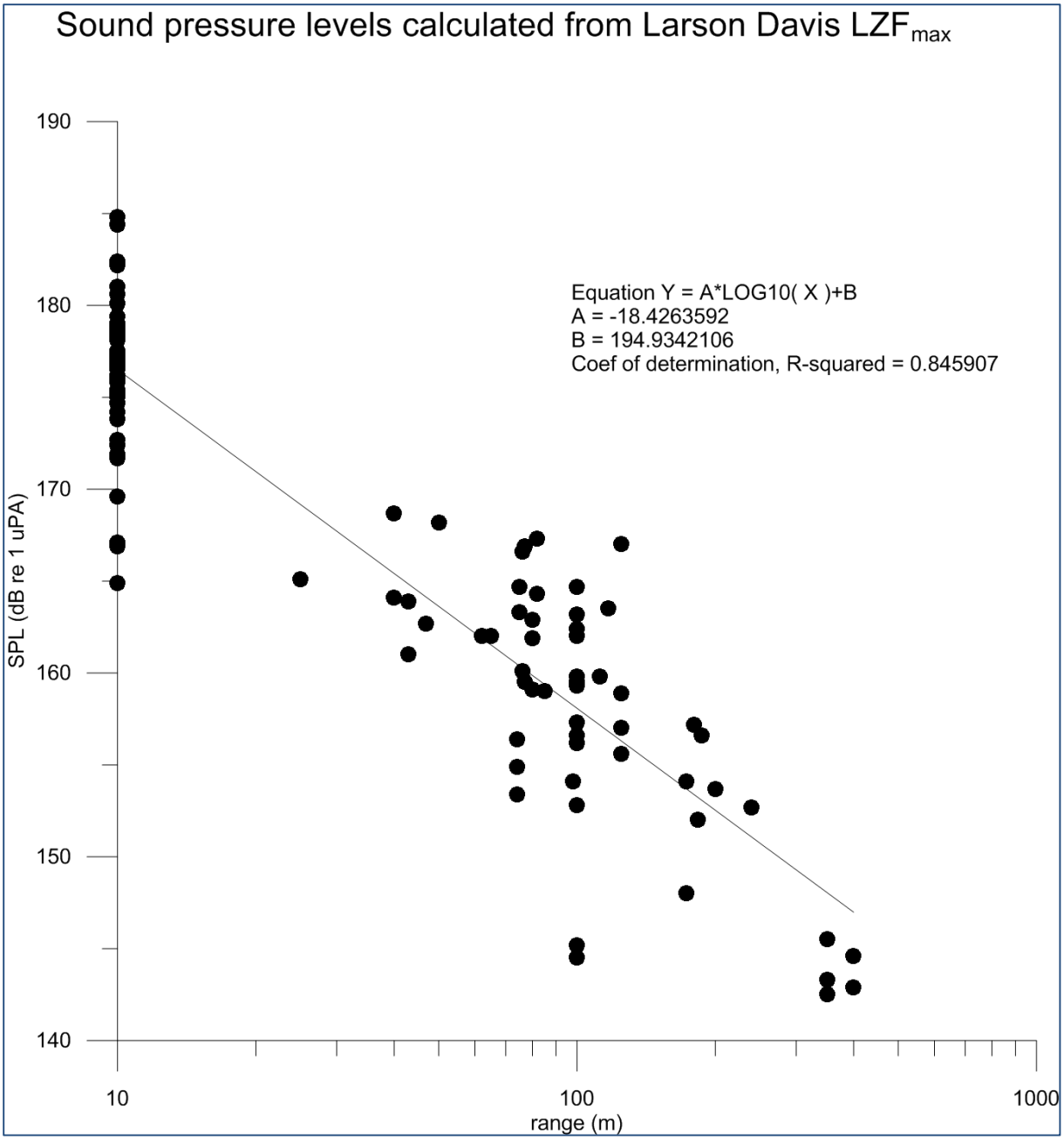


Figure 3-2. SPL Transmission Loss with Range at NMAWC (Calculated From LZF_{max} Values).

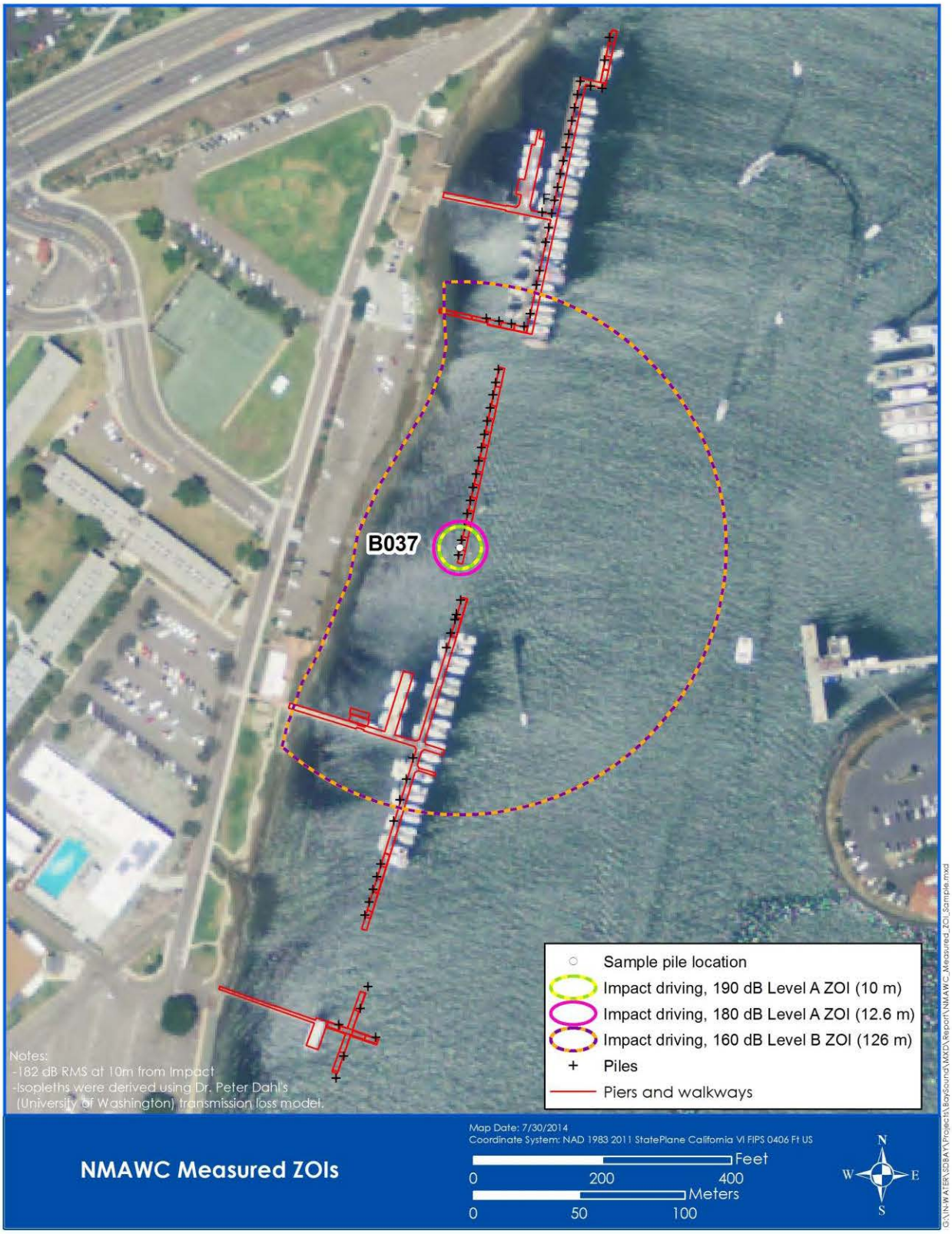


Figure 3-3. Measured Shutdown and Buffer zones for the SSC Marine Mammal Relocation at NMAWC Using a Sample Pile Location.

SPLs generated during pile driving increased steadily through the four hammer energy levels and were observed to be consistent among strikes of the same energy setting. The initial hammer energy setting during soft start was level 1, to set the piles in place. After soft start, pile driving proceeded with regularity rapidly progressing to level 3 or level 4 depending on substrate resistance levels. The pile driving sequence was intermittently stopped to examine depth and tolerances. Representative wav file voltages post processed to develop dB rms SPL and SEL plots showed consistent source and far-field sound levels (Figure 3-4).

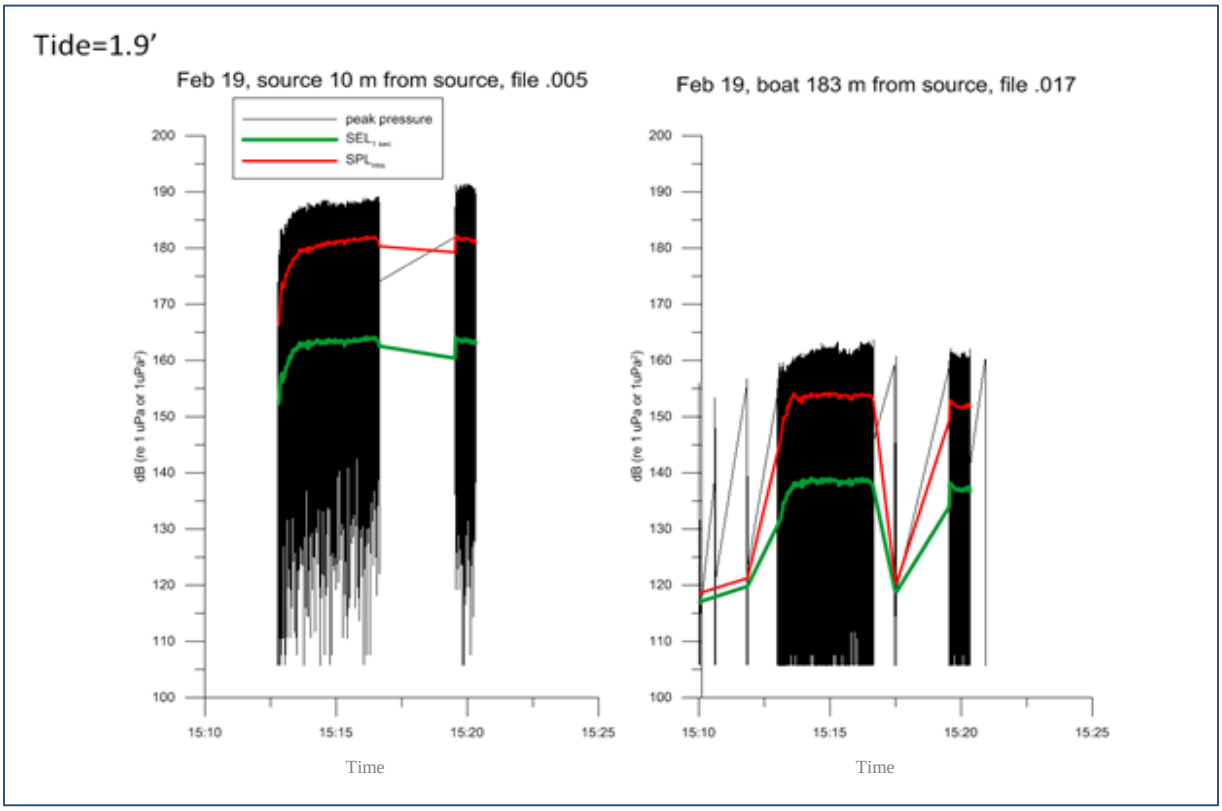


Figure 3-4. Representative dB rms SPLs for Both Source and Far-field Locations for a 16-inch Concrete Pile at NMAWC.

Examination of analyzed frequency spectra between 20 Hz and 20 kHz displayed consistent pressure levels between strikes for a 16-inch concrete pile, during maximum hammer energy. The maximum SPLs were concentrated between 200 and 500 Hz with another noticeable spike at approximately 1 to 2 kHz. SPLs less than 130 dB rms accounted for nearly all the frequencies below 40 Hz and greater than 5 kHz (Figure 3-5).

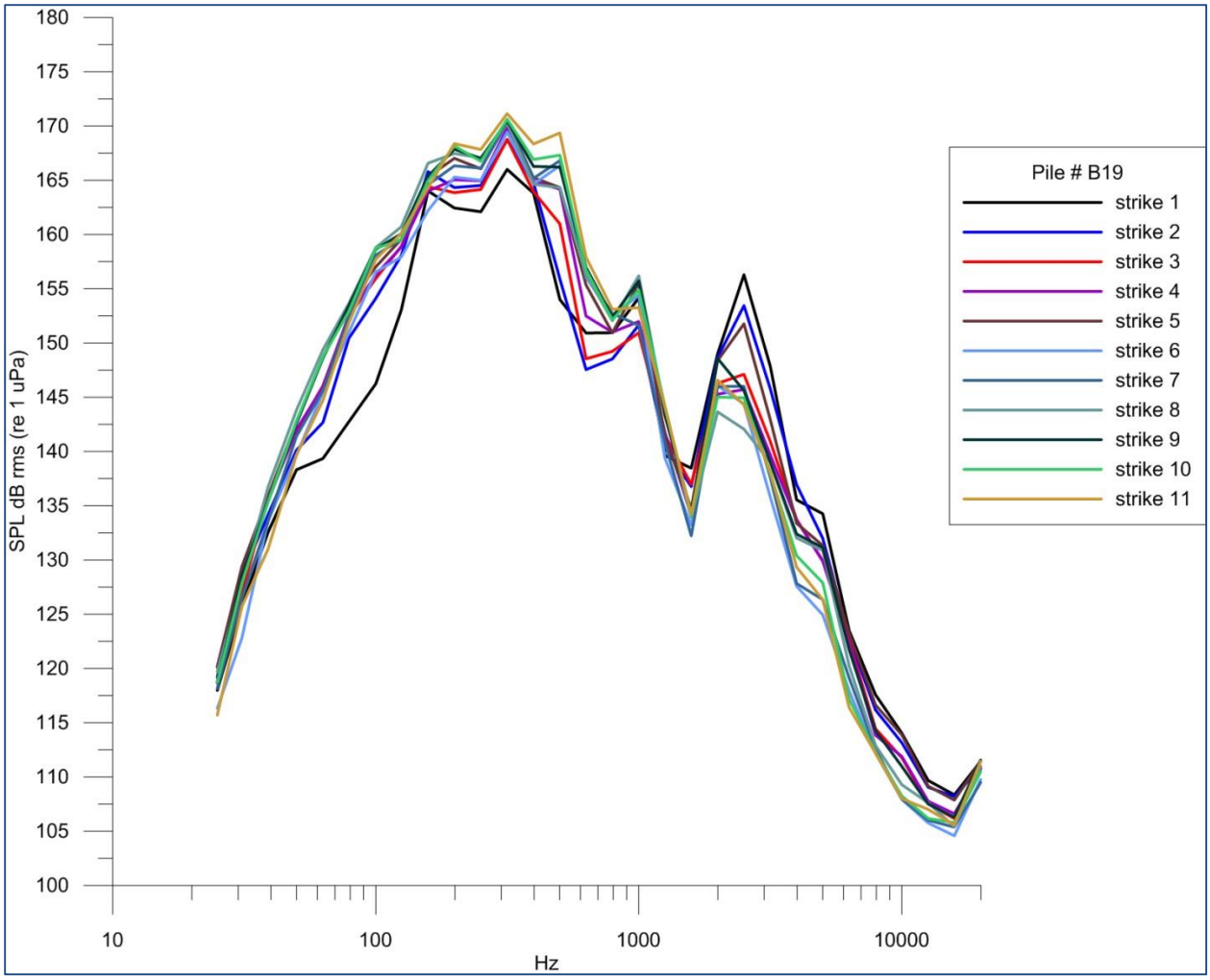


Figure 3-5. Sound Pressure Levels for Frequencies from 20 Hz to 20 kHz for a 16-inch Concrete Pile at NMAWC.

3.1.2.3 Airborne Sound

Pile driving activities conducted at NMAWC between February 4, 2014 and March 13, 2014 produced airborne SPL values ranging from 104.5 to 111.3 dB rms re 20 µPa at 15.2 m (50 ft) (Table 3-5). Airborne SPLs were collected at P-548 and P-607 (see Figure 2-1) as those sites represented the majority of pile driving activity. The transmission loss coefficient for airborne sound was less than expected and was calculated at 11.9 dB rms re 20 µPa (Figure 3-6). Based on the calculated transmission loss coefficient the 100 dB rms re 20 µPa and 90 dB rms re 20 µPa isopleths were located at 105 and 728 m (344.5 and 2,388.5 ft), respectively.

Table 3-5. NMAWC Airborne SPL values from Source (15.2 m [50 ft]) and Graduated Distances.

Date	Pile Number[1]	Distance (m)	LZF_{max}[2]	dB_{peak}[2]	dB_{sel}[2]
Source					
10-Mar-2014	A-28.3	15.2	109.40	127.40	93.70
10-Mar-2014	B-23	15.2	108.70	126.50	94.10
10-Mar-2014	B-24	15.2	111.30	130.10	95.10
10-Mar-2014	B-25	15.2	104.50	124.00	89.40
10-Mar-2014	B-30	15.2	108.20	127.90	95.70
10-Mar-2014	B-32	15.2	105.00	120.40	91.90
11-Mar-2014	B-33	15.2	107.20	126.80	93.40
Far-field					
10-Mar-2014	B-30	33	104.50	124.00	89.40
10-Mar-2014	B-32	33	105.00	120.40	91.90
13-Mar-2014	N/A	33	108.20	116.30	93.60
10-Mar-2014	B-33	62	99.90	117.80	87.40
12-Mar-2014	N/A	62	103.60	118.20	89.60
12-Mar-2014	N/A	62	101.90	120.00	89.30
12-Mar-2014	N/A	62	103.00	116.50	88.90
13-Mar-2014	N/A	123	94.40	109.10	80.40
13-Mar-2014	N/A	123	96.30	116.30	85.30

Notes:
[1] N/A indicates that data for that specific pile was not collected, but that airborne acoustic data was collected at specific distances throughout the day
[2] All airborne sound units are in dB re 20 uPA

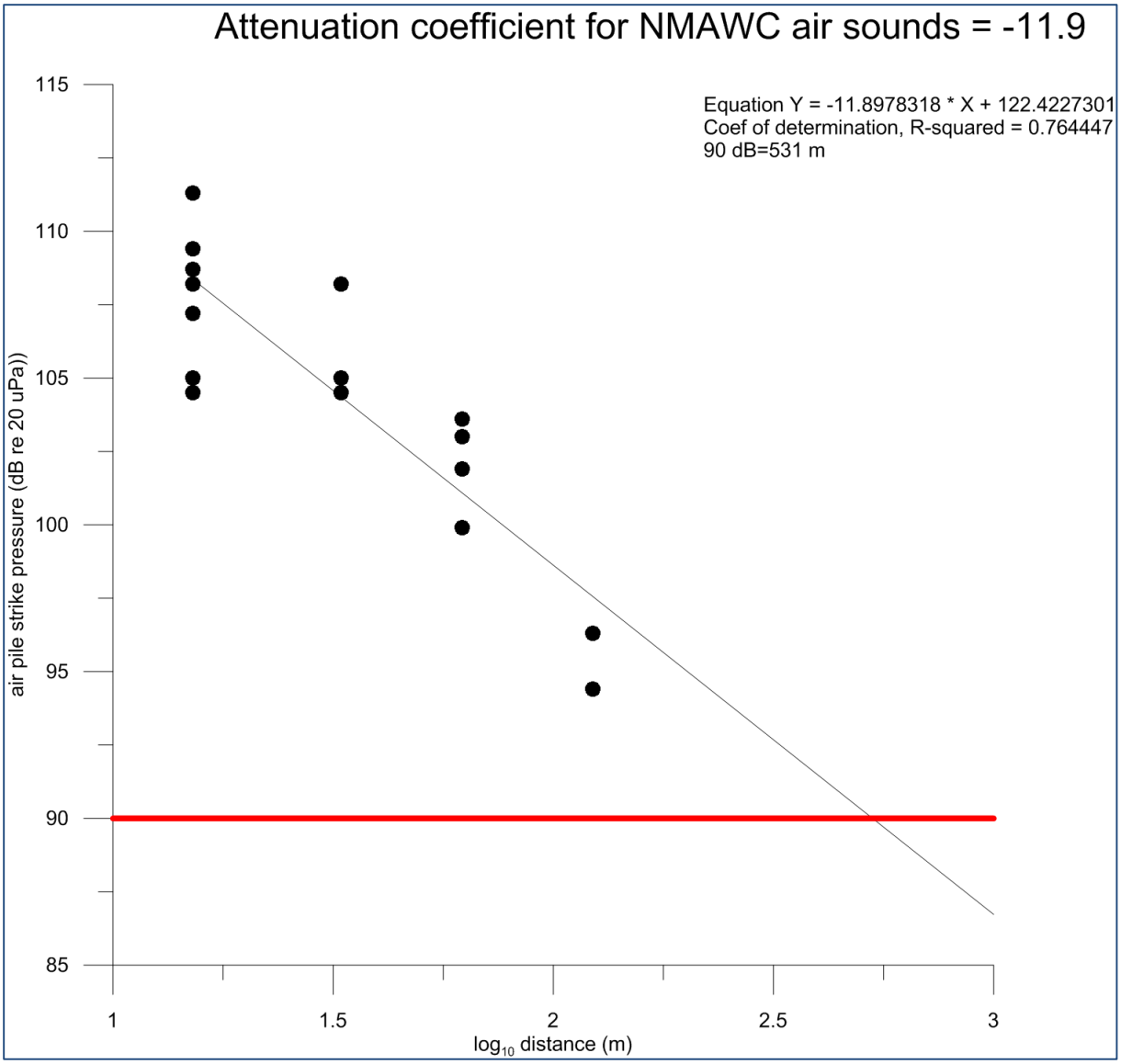


Figure 3-6. Airborne Sound Level Transmission Loss with Range at NMAWC (Calculated from LZF_{max} Values).

3.1.2.4 Ambient Sound

3.1.2.4.1 Hydroacoustic

Ambient hydroacoustic sound level recordings were conducted outside of the NMWAC project site the week following the end of pile driving activities and documented daily LZF_{max} averages of approximately 123.5 dB and a median of 122.8 dB (Figure 3-7). The area adjacent to the NMAWC project site is a high traffic area housing a large marina and San Diego Bay's primary public fueling facility. Spike measurements regularly eclipsed LZF_{max} values of 135 dB with one instance reaching near 150 dB on March 20, 2014 at approximately 13:40 (Figure 3-7). Ambient LZF_{max} values collected over consecutive 10 minutes intervals were consistent with previous measured values throughout San Diego Bay and were recorded within expected ranges (Appendix A).

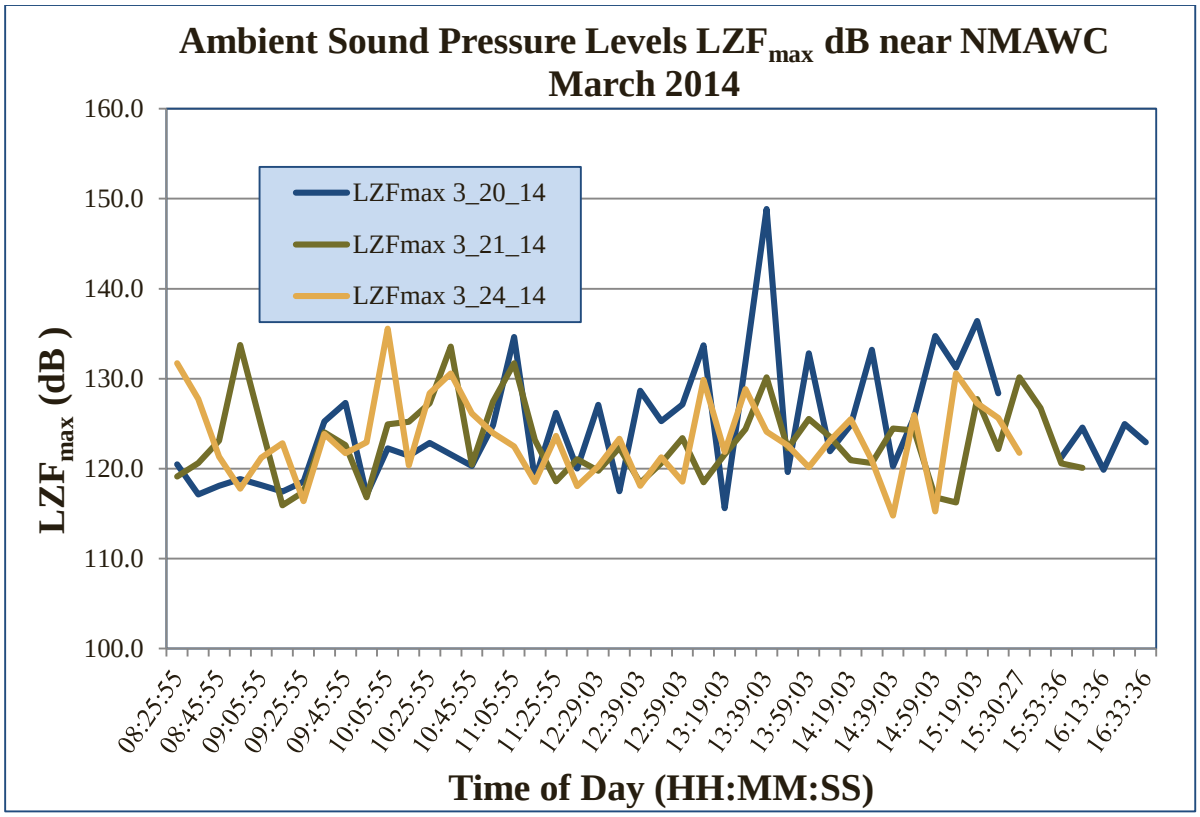


Figure 3-7. NMAWC Hydroacoustic Ambient LZFmax Values for Three Continuous 8 Hour Time Periods.

3.1.2.4.2 Airborne Sound

Airborne sound level recordings were collected throughout the construction time period at two locations near the outboard edge of the construction site. LZF_{max} values during non-pile driving time periods were examined and averaged between 70.2 and 71.6 dB re 20 µPa, over four separate days (Table 3-6)

Table 3-6. NMAWC Average Airborne Ambient SPLs.

Date	Average LZF_{max} (dB re 20 µPa)
24-Feb-2014	71.6
26-Feb-2014	70.2
4-Mar-2014	71.5
7-Mar-2014	72.1

3.1.3 Marine Species Monitoring Results

There were a total of 33 sightings composed of 34 individual marine mammals during monitoring of in-water operations at NMAWC. Of the four marine mammal species that were anticipated to occur within the project site, three were observed: California sea lions, Pacific harbor seals, and California coastal bottlenose dolphins. No green sea turtles or California least terns were observed in the vicinity of NMAWC. Data for all sightings is available in Appendix K.

The most common species sighted throughout the entire monitoring effort at NMAWC was the California sea lion (74%), followed by the harbor seal (18%), unknown pinnipeds (6%) and coastal bottlenose dolphin (3%). All species were primarily observed singularly with the exception of one sighting where two California sea lions were observed during one sighting (Table 3-7).

Table 3-7. Total Number of Animals and Sightings by Species, NMAWC.

Species	Total Number of Individuals	Total Number of Sightings	Group Size		
			Mean	Maximum	Minimum
California sea lion	25	24	1.04	2	1
Coastal bottlenose dolphin	1	1	1.00	1	1
Pacific harbor seal	6	6	1.00	1	1
Unknown pinniped	2	2	1.00	1	1
Total	**34**	**33**			

Most marine mammal sightings at NMAWC (n=14, 42%) occurred during pre-construction monitoring, followed by post-construction (n=10, 30%), during construction (n=6, 18%), and standby (n=3, 9%) (Figure 3-8 and Figure 3-9).

3.1.3.1 Summary of Marine Species Sightings, by Species

3.1.3.1.1 Coastal Bottlenose Dolphins

A sighting of a single coastal bottlenose dolphins was observed during the pre-construction survey (Figure 3-8 and Figure 3-9). The animal was outside of the entrance to the small embayment where NMAWC is located, and was approximately 350 m (1,148 ft) from the pile that was going to be driven. The behavioral observation indicated that the animal was swimming towards the north, but the notes also say that there was possible foraging behavior.

3.1.3.1.2 California Sea Lions

California sea lions were most commonly observed during post-construction (n=10, 40%), followed by pre-construction (n=8, 32%), during construction (n=4, 16%), and standby (n=3, 2%; Figure 3-8 and Figure 3-9). There were two unidentified pinnipeds sighted during the pre-construction phase. Given that California sea lions were the most abundant pinniped species sighted in the NMAWC project area, these animals were most likely California sea lions. Sightings of identified California sea lions were evenly distributed within the NMAWC project area (Figure 3-8).

The most common primary behavior seen during California sea lion sightings was swimming (22 individuals, 88%) followed by successful foraging (2 individuals, 8%), and rafting (1 individuals, 4%). Secondary behaviors included diving and swimming.

3.1.3.1.3 Pacific Harbor Seal

Pacific harbor seals were most commonly observed during pre-construction (n=2, 50%), followed by during construction (n=1, 25%) and post-construction (n=1, 25%; Figure 3-8 and Figure 3-9). The most common primary behavior seen during Pacific harbor seal sightings was looking (4 individuals, 67%) followed by swimming (2 individuals, 33%). Diving was the only secondary behavior noted during sightings.

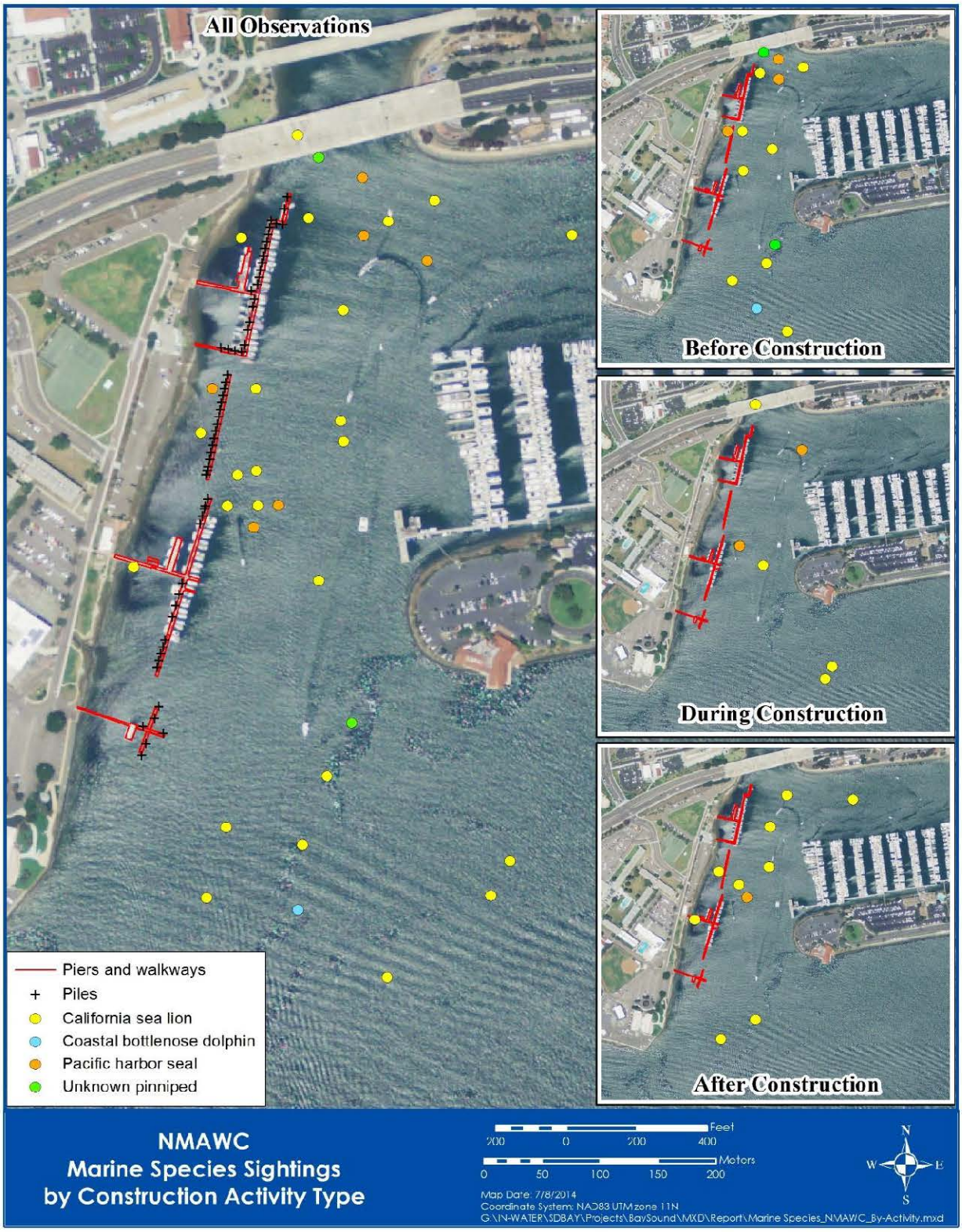


Figure 3-8. All Marine Mammal Sightings at NMAWC.

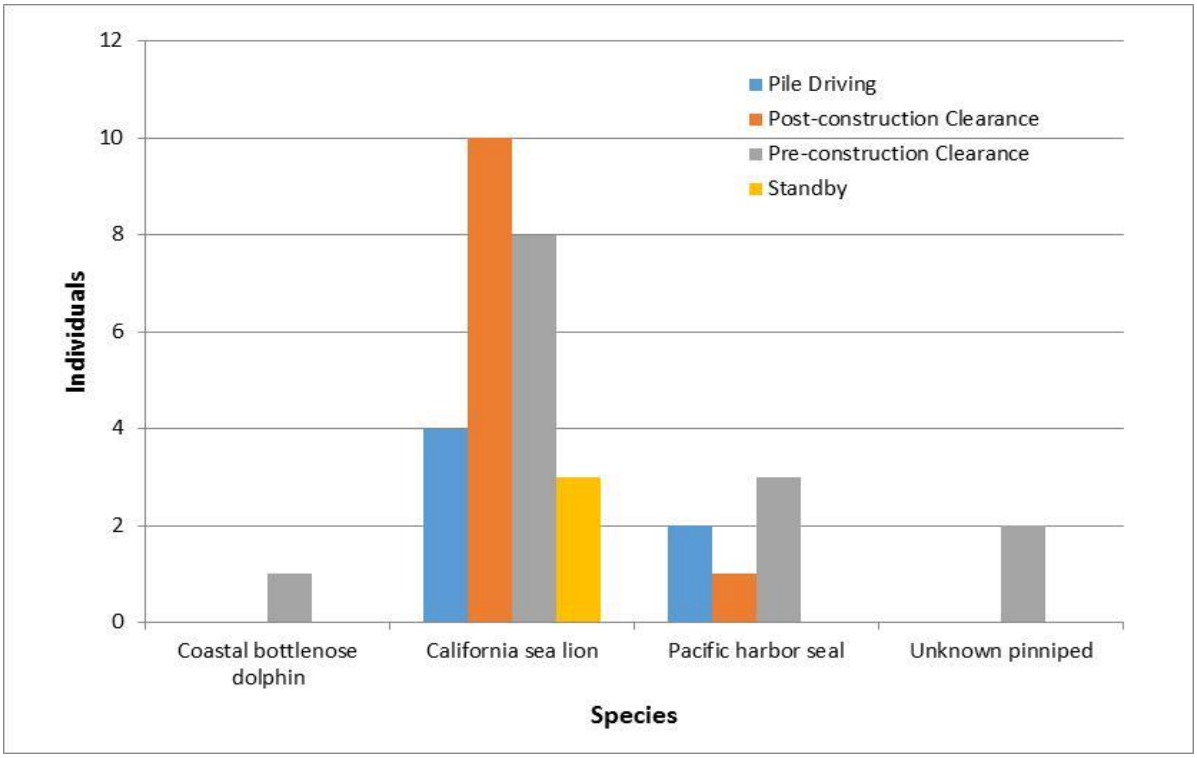
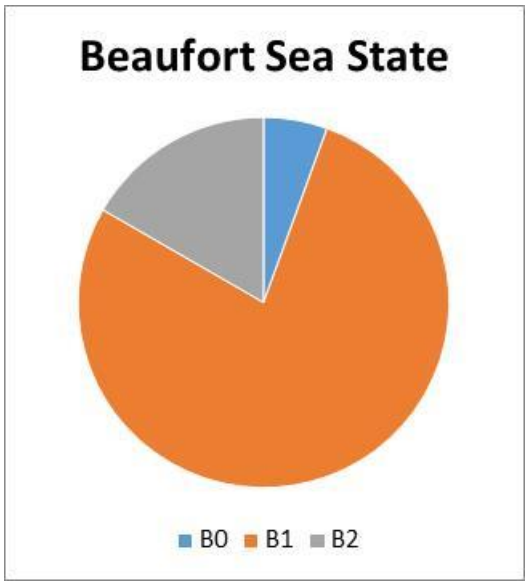


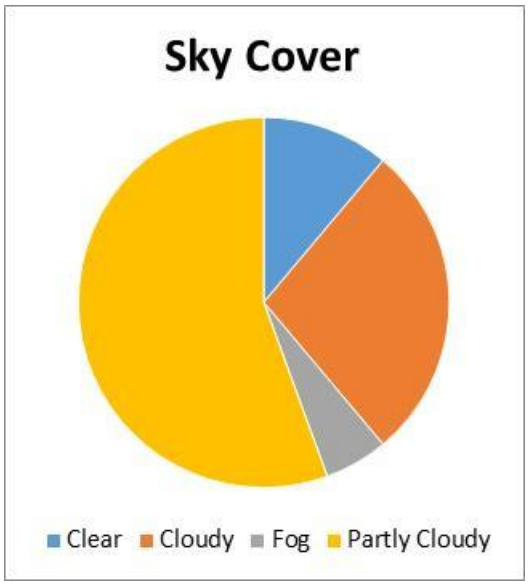
Figure 3-9. Marine Mammal Sightings at NMAWC, by Construction Activity.

3.1.3.2 Marine Mammal Sightings and Environmental Conditions

Sightings were made in good weather conditions with most sightings occurring during Beaufort Sea States (BSS) of 1 (wave heights of from 0 to 0.2 m [0 to 1 ft] and winds from 1.6 to 4.8 kilometers per hour [kph; 1 to 3 miles per hour {mph}]) (Figure 3-10a), partly cloudy conditions (Figure 3-10b), and with moderate visibility of from 1 to 10 km (0.6 to 6.2 miles; Figure 3-10c). Sea surface temperatures during the pile driving timeframe were on average 63 degrees Fahrenheit (˚F; 17 degrees Celsius [˚C]), with minimum and maximum temperatures of 61 ˚F (16 ˚C) and 65 (18 ˚C), respectively. Air temperatures were, on average, 57 ˚F (14 ˚C), with minimum and maximum temperatures of 49 ˚F (9 ˚C) and 78 (26 ˚C), respectively. There were more sightings during the ebb tide (65%) than during the flood tide (35%).[1] Two sightings did not include the time of the sighting due to technical issues, so tide flow could not be determined.

[1] Air and sea surface temperatures data for NMAWC and the IPP were from NOAA-sponsored weather stations (Air Temperature: http://tidesandcurrents.noaa.gov/stationhome.html?id=9410172; and Sea Surface Temperature: http://tidesandcurrents.noaa.gov/stationhome.html?id=9410170).

a. 

b. 

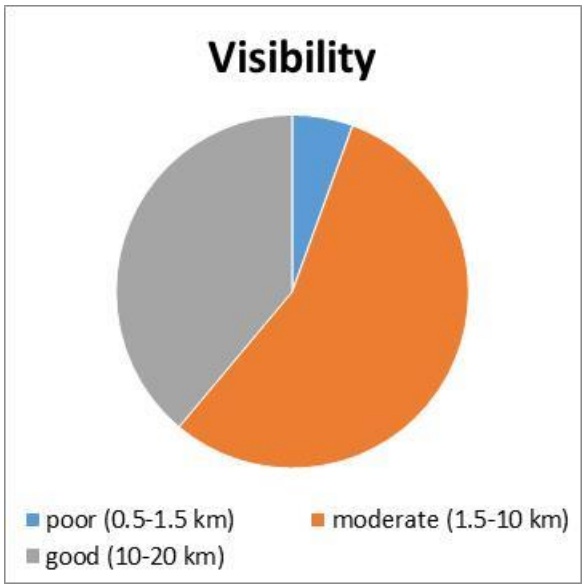
c. 

Figure 3-10a, b, c. Weather Conditions from Sightings at NMAWC.

3.1.3.3 Summary of Take

3.1.3.3.1 Level A "Take"

There were no sightings within the Level A injury zone during in-water construction at NMAWC.

3.1.3.3.2 Level B "Take"

The total number and location of the Level B "take" for marine mammals at NMAWC is summarized in Table 3-8 and Figure 3-11. During monitoring at NMAWC, there were no in-water construction shutdowns or delays due to the presence of marine mammals approaching, or within, the shutdown zone.

Table 3-8. Summary of Observed Level B Harassment "Take", at NMAWC.

Species	Allowed "Take"[1]	Total Number of Individuals[2]	Total Number of Sightings[2]	Total Level B "Take" (Percent of allowed "Take")
California sea lion	994	25	24	1 (<1%)
Coastal bottlenose dolphin	307	1	1	0
Pacific harbor seal	90	6	6	1 (1%)
Total		32	31	2

Note: [1] Includes Level B "take" only
[2] Does not include unknown pinnipeds

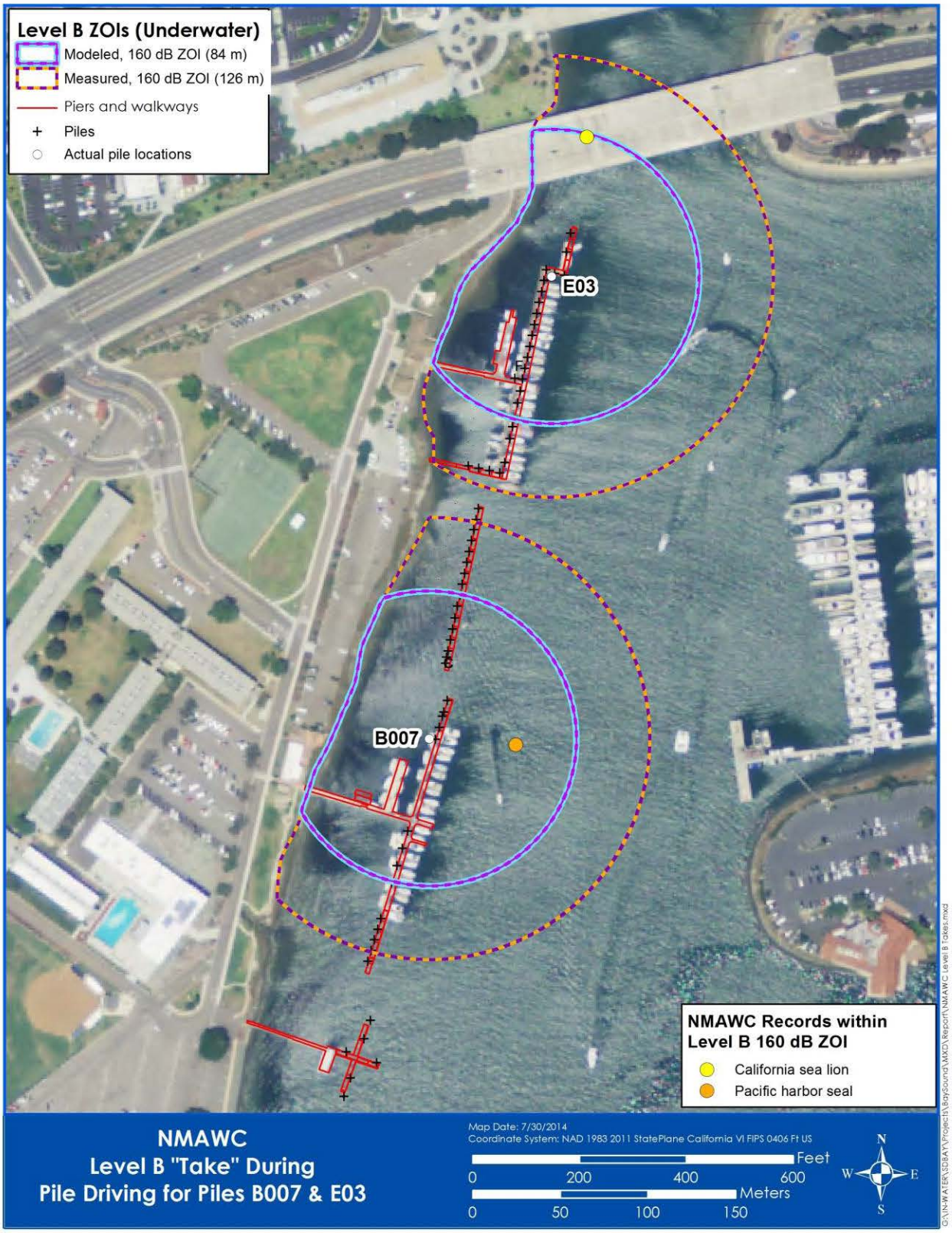


Figure 3-11. Sightings and Level B "Take" at NMAWC.

3.2 Fuel Pier Replacement Project at Naval Base Point Loma Fleet Logistics Center (Indicator Pile Program)

3.2.1 In-Water Pile Operations Effort

In-water construction activities during the IPP consisted of exclusively pile driving activities encompassing 10 days from April 28, 2014 to May 15, 2014. Pile driving involved both vibratory and impact pile driving activities during the installation of a total of nine 30 inch and 36 inch steel pipe piles (Table 3-9). A restrike of each installed pile was completed approximately 5 to 7 days after the initial installation of individual piles. Initially, a total of 11 steel pipe piles were anticipated to be driven as part of the IPP, but ship movement conflicts truncated the installation of two of the 36-inch piles on the outboard portion of the existing fuel pier. Pile driving equipment utilized during the IPP included a Sumitomo Model LS-248RH-5 hydraulic crawler crane with a 47.2 m (155 ft) boom secured to a 54.9 x 15.2 x 3.7 m (180 x 50 x 12 ft) spud barge, and a 48.8 x 12.2 m (160 x 40 ft) flat deck material barge. For the IPP all piles were installed initially using an APE Variable Moment 250 VM Vibratory Hammer Extractor powered by a model 765 hydraulic power source creating a maximum driving force of 2,389 kilonewtons (269 tons). Impact pile driving equipment consisted of a single acting diesel impact hammer model D62-22 DELMAG with a maximum energy of 153,799 ft-lbs and minimum energy of 76,899 ft-lbs. The hammer was fitted with a hydraulic tripping cylinder with four adjustable power settings that could be reset while driving. Acoustic and marine species monitors were on station during all in-water construction days and conducted environmental education briefings for all personnel participating in in-water construction activities. Monitoring was not continuous throughout this time frame. In total, monitoring of in-water pile driving operations occurred on 10 days during the IPP (Table 3-9). Due to technical issues with the pile on April 29, 2014, no pile was actually driven, but monitoring still occurred regardless.

3.2.2 Acoustic Results

The means and methods of the IPP pile driving plan submitted to the Navy by the construction contractor proposed pile driving of steel pipe piles in two distinct locations relative to the existing fuel pier (P-180). Pile driving activities initially occurred shoreward of the existing fuel pier (P-180) (inside) and took place in waters less than 4.7 m (15.4 ft) depth. Pile driving at the outer pile locations (outside) occurred in waters from 12 to 17 m (39.4 to 55.8 ft) depth (Figure 3-12).

3.2.2.1 Vibratory Pile Driving

All piles were initially driven using the APE Variable Moment 250VM vibratory hammer resulting in SPLs ranging from 154 to 174 dB rms, calculated from processed raw wav files (Table 3-10). No vibratory hammering was performed during the restrikes limiting the data set to 9 vibratory events, one for each individual pile installed during the IPP. Average maximum SPLs recorded for the 9 individual piles varied approximately 5 dB rms among all 30-inch and 36-inch piles with no measurable differences between pile sizes (Table 3-10). Differences in average SPLs between pile locations (inside versus outside) was approximately 5 dB rms less for the inside piles using the wav file processed rms SPLs.

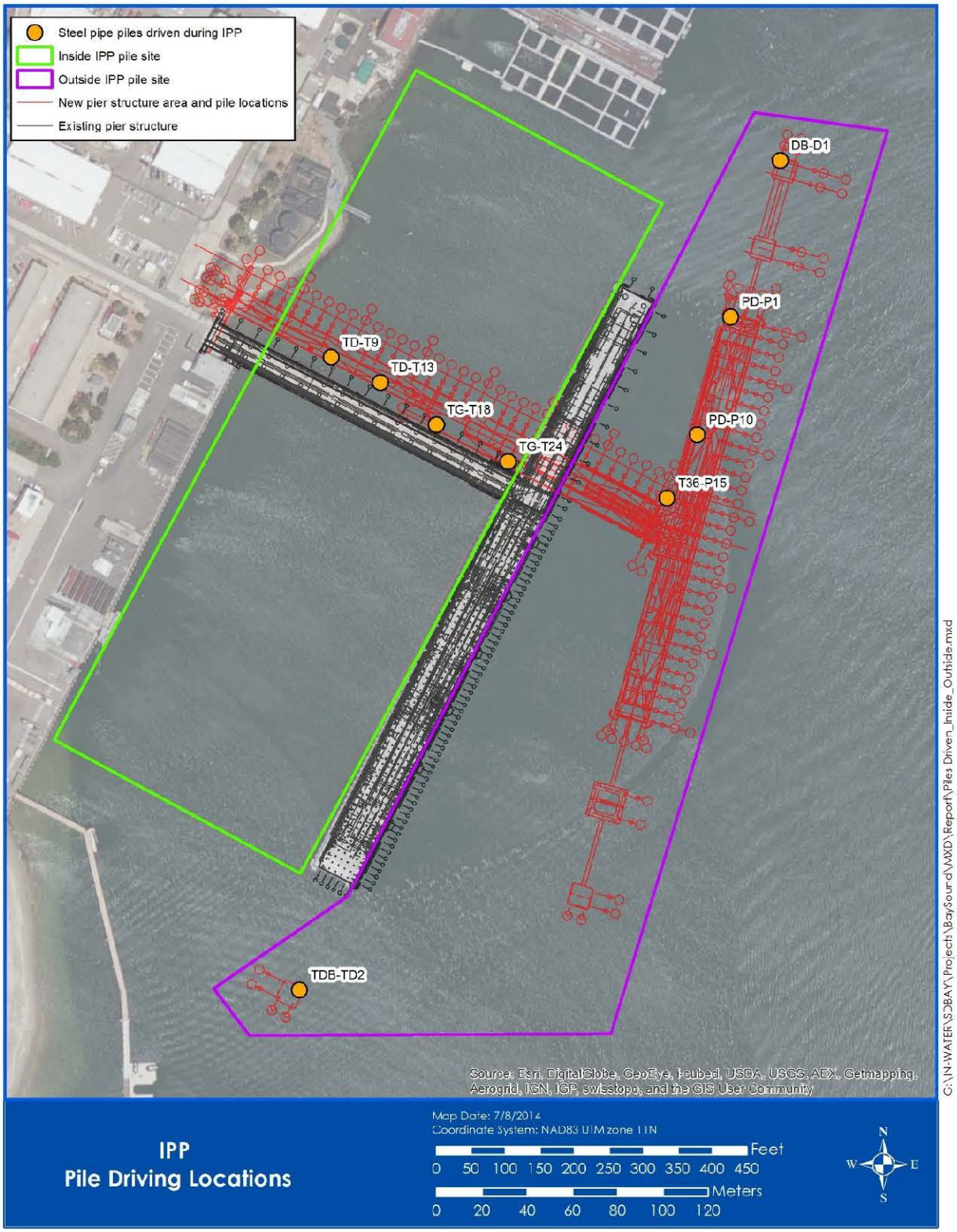


Figure 3-12. Pile Driving Locations during the NBPL FLC Fuel Pier Replacement Project (Inside versus Outside for the Fuel Pier).

Table 3-9. In-water Pile Operations during the IPP.

Date	Activity[1]	Daily Start Time[2]	Daily End Time[2]	Total Time on Station[2]	Observation Time[2] (Pre-, During, and Post-Construction)	Pile Driving Time[2]	Pile Number(s)
29-Apr-14	M	10:21	14:55	04:34	-	-	N/A
30-Apr-14	PD	7:50	15:35	07:45	02:28	00:42	TD-T13
1-May-14	PD	7:15	15:45	08:30	03:45	00:43	TG-T18, TG-T24
2-May-14	PD	6:45	14:45	08:00	02:59	00:42	TG-T24, TG-T09
5-May-14	PD	6:50	14:45	07:55	04:08	00:48	PD-P1
6-May-14	PD	6:50	14:52	08:02	03:41	01:19	PD-P10, T36-P15
7-May-14	PD	7:11	15:00	07:49	04:32	00:35	DB-D1
8-May-14	PD	7:00	15:30	08:30	04:54	00:30	TD-T13, TG-T18, TD-TD2
13-May-14[3]	PD	7:33	15:24	07:51	05:10	00:58	PD-P1, PD-P10, TG-T24, TG-T09
15-May-14[3]	PD	7:00	12:00	05:00	03:51	00:33	DB-D1, T36-P15, TD-TD2
Total				**73:56**	**42:18**	**06:50**	

[1] M=Monitoring only (No Piles driven); PD=Pile Driving
[2]All times in hh:mm
[3] Restrike days

Table 3-10. Vibratory Pile Driving Sound Pressure Levels (dB rms) from Processed Wav Files and LZF_{max} Reporting Metrics for Inside and Outside IPP Piles.

Pile Type	Pile Number	wav file (dB rms)	LZF_{max} (dB rms)	Distance (m)
36-inch Inside	TD-T13	159.0	157.9	10.0
	TG-T18	166.0	169.2	10.0
	TG-T24	174.0	181.0	10.0
	TG-0T9	154.0	No Data	10.0
36-inch Outside	PD-P1	170.0	174.3	10.0
	PD-P10	170.0	179.3	10.0
	T36-P15	170.0	173.3	10.0
30-inch Outside	DB-D1	172.0	178.4	10.0
	TD-TD2	168.0	172.2	10.0

Differences in wav file rms SPL and LZF_{max} values were mostly between 0 and 4 dB and are accounted for by the fact that the LZF_{max} values are the single greatest sound level value for 125 millisecond time frames over the recording period while the wav file sound level is the average sound level value calculated over a 10 second period of the continuous maximum energy wave form. Higher LZF_{max} values highlight the short duration variation in SPLs observed during an entire vibratory driving event. Variation in the pressure levels, seen in the wave forms generated

from raw wav files show doubling of pressure levels during a single vibratory event (Figure 3-13). Maximum observed LZ_{eq} 1-sec values from the LD 831 SLMs were recorded in real time by the ATs during each vibratory driving event and display comparable values to the sound levels calculated from processed wav files and the LZF_{max} metric logged in the LD 831 SLM for both source and shutdown locations (Table 3-11Table 3-11).

Vibratory pile driving SPL dB rms levels calculated from raw wave files and LZF_{max} values archived in LD 831 SLMs at the far-field locations ranged from 130 to 155 dB (Appendix L). In some cases values displayed nominal differences from ambient sound levels while other times recorded dB levels differed by as much as 10 dB for positions similar distances from source. ATs from UW APL applied measured values from each of the acoustic monitoring stations to validate the model predictions and determine a transmission loss coefficient for vibratory sound source levels. Insufficient data records were available to conclusively identify the distance at which continuous sounds generated during vibratory pile driving became indistinguishable from ambient sound levels but model outcomes placed that location at approximately 3,000 m (9,843 ft) from source (see Section 2.1.4.2 for a discussion of how this distance was generated).

Table 3-11. Summary of Reporting Metrics Analyzed for Source and Shutdown Acoustic Monitoring Locations for All Vibratory Pile Driving Events.

Date	Pile Number	Location	Distance from Source (m)	Latitude	Longitude	Wave form (dB rms)	LZF_{max} (dB rms)	$LZ_{eq\text{-}1sec}$ dB Observed
30-Apr-14	TD-T13	Source	10	32.70102	-117.23742	159.0	157.9	157.7
		Shutdown	141	32.70081	-117.23591	N/A	142.1	137.7
1-May-14	TG-T18	Source	10	32.70091	-117.23708	166.0	169.2	168.8
		Shutdown	127	32.70091	-117.23578	148.0	148.0	143.1
	TG-T24	Source	10	32.70080	-117.23672	174.0	181.0	179.4
		Shutdown	136	32.70083	-117.23548	151.0	150.4	149.4
2-May-14	TG-T09	Source	10	32.70118	-117.23771	154.0	N/A	157.2
		Shutdown	183	32.70157	-117.23575	N/A	136.6	128.3
5-May-14	PD-P1	Source	10	32.70129	-117.23586	170.0	174.3	173.2
		Shutdown	174	32.70240	-117.23437	160.0	159.6	157.0
6-May-14	PD-P10	Source	10	32.70079	-117.23585	170.0	179.3	174.2
		Shutdown	196	32.70162	-117.23402	159.0	158.2	157.1
	T36-P15	Source	10	32.70053	-117.23603	170.0	173.3	172.5
		Shutdown	220	32.70201	-117.23437	157.0	156.0	153.2
7-May-14	DB-D1	Source	10	32.70199	-117.23540	172.0	178.4	177.2
		Shutdown	154	32.70111	-117.23427	162.0	162.2	160.2
8-May-14	TD-TD2	Source	10	32.69866	-117.23793	168.0	172.2	170.9
		Shutdown	272	32.69855	-117.23492	155.0	153.2	150.0

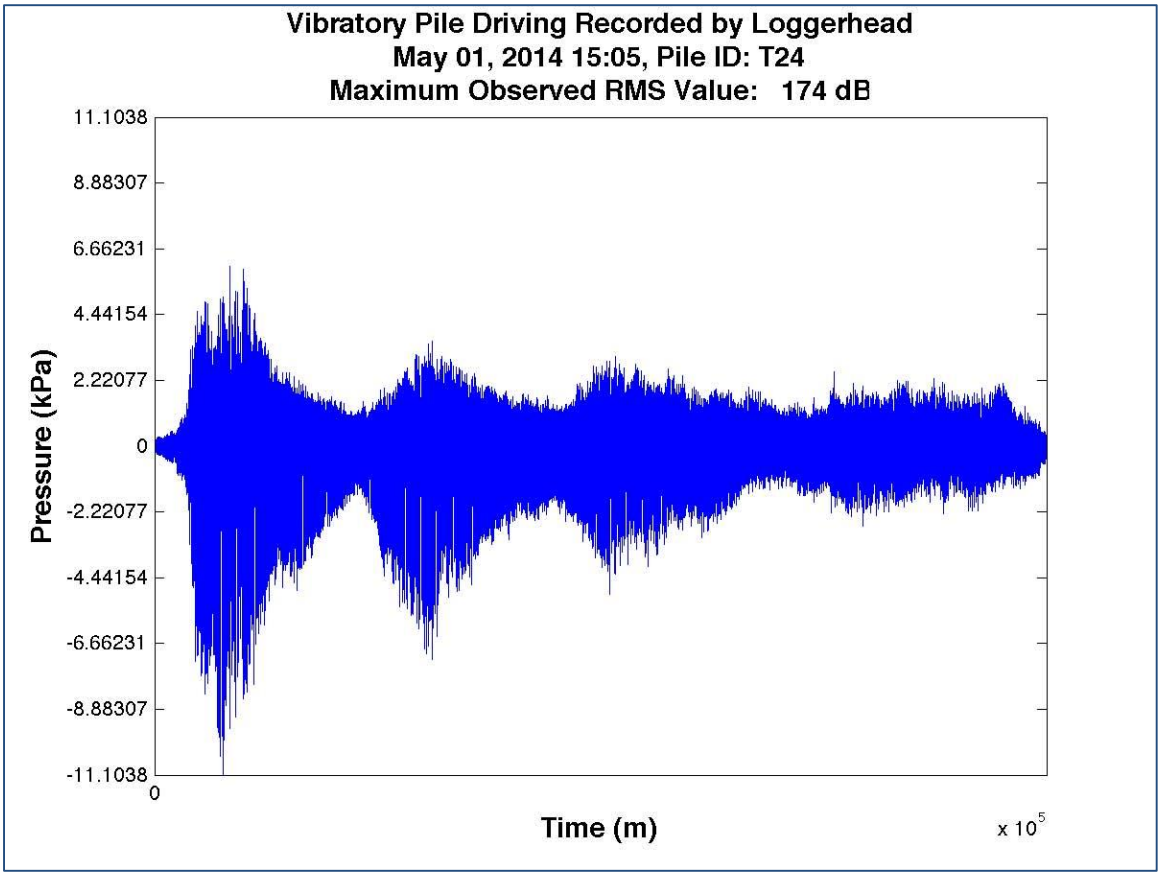


Figure 3-13. Wave Form of Pile TD-T24 Vibratory Pile Driving Displaying Changes in Sound Pressure Levels over Time.

3.2.2.2 Impact Pile Driving

Pile driving activities conducted during the IPP produced maximum SPL values at source (10 m [32.8 ft]) ranging from approximately 194.6 to 202.2 dB rms based on post processed wav files collected from the LD 831 SLM, Loggerhead® acoustic data recorder, and/or the Hydro DB SLM (Table 3-12). SPL values recorded at source during initial impact pile driving of the different sizes steel pipe piles (30-inch and 36-inch) varied on average approximately 5 dB rms. The outside 30-inch steel pipe piles (n=2) averaged 195.0 dB rms (SD = ± 0.4) while the source rms SPL values of the outside 36-inch steel pipe piles (n=3) averaged 200.8 dB rms (SD = ± 0.54) and inside 36-inch steel pipe piles (n=4) averaged 199.6 dB rms (SD = ± 1.76) (Table 3-12). Soft start pile driving on the Level 1 hammer energy setting produced SPL values between 185 and 190 dB rms (see the first three set of dots in Figure 3-14 at 10, 60, and 100 seconds). SPL values recorded during restrikes were at or below initial impact pile driving values prompting no further analysis in terms of maximum rms SPLs per individual pile but are included in Appendix L. Errors in SLM calibration files recorded at source during the restrikes limited source date results to LZF_{max} values (Appendix L). The depth in which pile driving took place ranged between 2.4 and 4.7 m (7.9 and 15.4 ft) for the inside pile locations and 12.0 to 17.0 m (39.4 to 55.8 ft) for the outside pile locations. A full summary of pile driving metrics including but not limited to pile number, location, depth, number of pile strikes, and time are presented in Appendix L.

Table 3-12. Sound Levels at Source (10 m [32.8 ft]) dB rms for All Impact Driven IPP Piles.

Pile Type	Pile #	dB rms	Distance (m)
36-inch Inside	TD-T13	197.4	10.0
	TG-T18	198.8	10.0
	TG-T24	199.9	10.0
	TG-T09	202.2	10.0
36-inch Outside	PD-P1	201.2	10.0
	PD-P10	200.0	10.0
	T36-P15	201.1	10.0
30-inch Outside	DB-D1	195.4	10.0
	TD-TD2	194.6	10.0

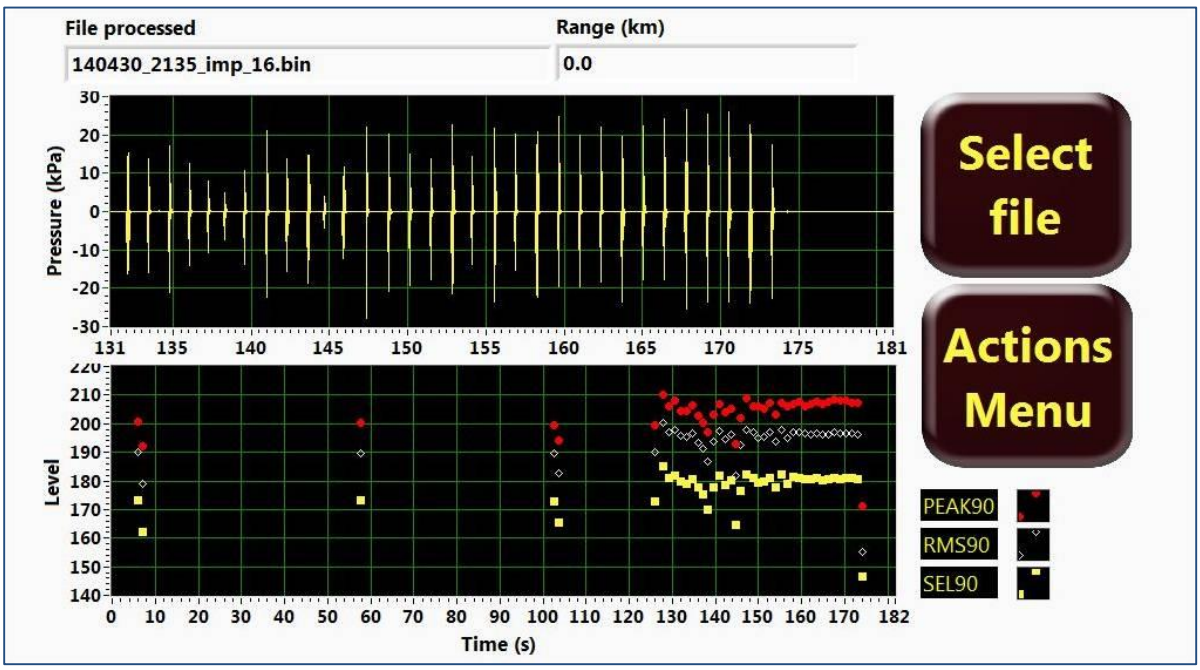


Figure 3-14. Soft Start SPLs for 36-inch Steel Pipe Piles.

Sound level recordings collected at the shutdown location, which ranged from 125 to 300 m (492 to 984 ft) from source, recorded SPL values varying from 173.5 to 187.6 dB rms (Table 3-13). Sound level recordings for far-field locations, which ranged from 1,500 to 4,000 m (4,921 to 13,123 ft) from source, recorded rms SPLs ranging from approximately 142.8 to 167.4 dB rms (Appendix L).

Table 3-13. Sound Levels at Shutdown (125 to 300 m [410 to 984 ft]) dB rms for All Impact Driven IPP Piles.

Pile Type	Pile #	dB rms	Distance (m)
36-inch Inside	TD-T13	No Data	160.0
	TG-T18	180.3	133.0
	TG-T24	175.2	136.0
	TG-T09	173.5	187.0
36-inch Outside	PD-P1	186.6	204.6
	PD-P10	186.5	215.8
	T36-P15	185.5	226.8
30-inch Outside	DB-D1	187.6	124.0
	TD-TD2	184.8	279.0

Differences in calculated SPLs for impact pile driving within each of the two distinct Fuel Pier locations (inside vs outside) produced separate transmission loss values coefficients. The respective measured transmission loss values coefficients were then applied to validate the modeled transmission loss and calculate applicable ZOI distances for marine species take calculations. Table 3-13 and Figure 3-15 summarizes the RMS values measured for the inside piles at various ranges, starting from 10 m (32.8 ft; source range). Upon inspection of the figure, the ZOIs for 190 dB, 180 dB, and 160 dB, are estimated to be 40 m, 100 m, and 2,000 m (131 ft, 328 ft, and 6,561 ft), respectively. Note that the multi-range measurement (made at ranges of 10, 20, 40 and 80 m [32.8, 66, 131, and 262 ft] on the same pile) supports the modeled distances for the 190 and 180 dB ZOIs.

Table 3-14. Measured Distances to Injury and Disturbance Thresholds for Sound (Inside piles).

Activity	Measured Distances to Threshold (meters [feet])					
	Underwater				Airborne[1]	
	Level A		Level B		Level B	
	190 dB	180 dB	160 dB	120 dB[2]	100 dB	90 dB
Impact driving, steel piles[3]	40 (131)	100 (328)	2,000 (6,561)	n/a	71 (232)	233 (764)
Vibratory driving, steel piles[3]	10[4] (32.8)	10[4] (32.8)	n/a	3,000 (9,842)		

[1] Distances are based on impact pile driving with steel piles, which is a worst-case scenario.
[2] The ambient sound levels in San Diego Bay are louder than 120 dB.
[3] Based on 36-inch steel piles, and source levels of 174 dB rms for vibratory pile driving, and 200 dB rms for impact pile driving.
[4] Measured values are less than 10 m (32.8 ft). For measured distances of less than 10 m (32.8 ft), the regulatory requirements is a minimum monitoring distance of 10 m (32.8 ft).

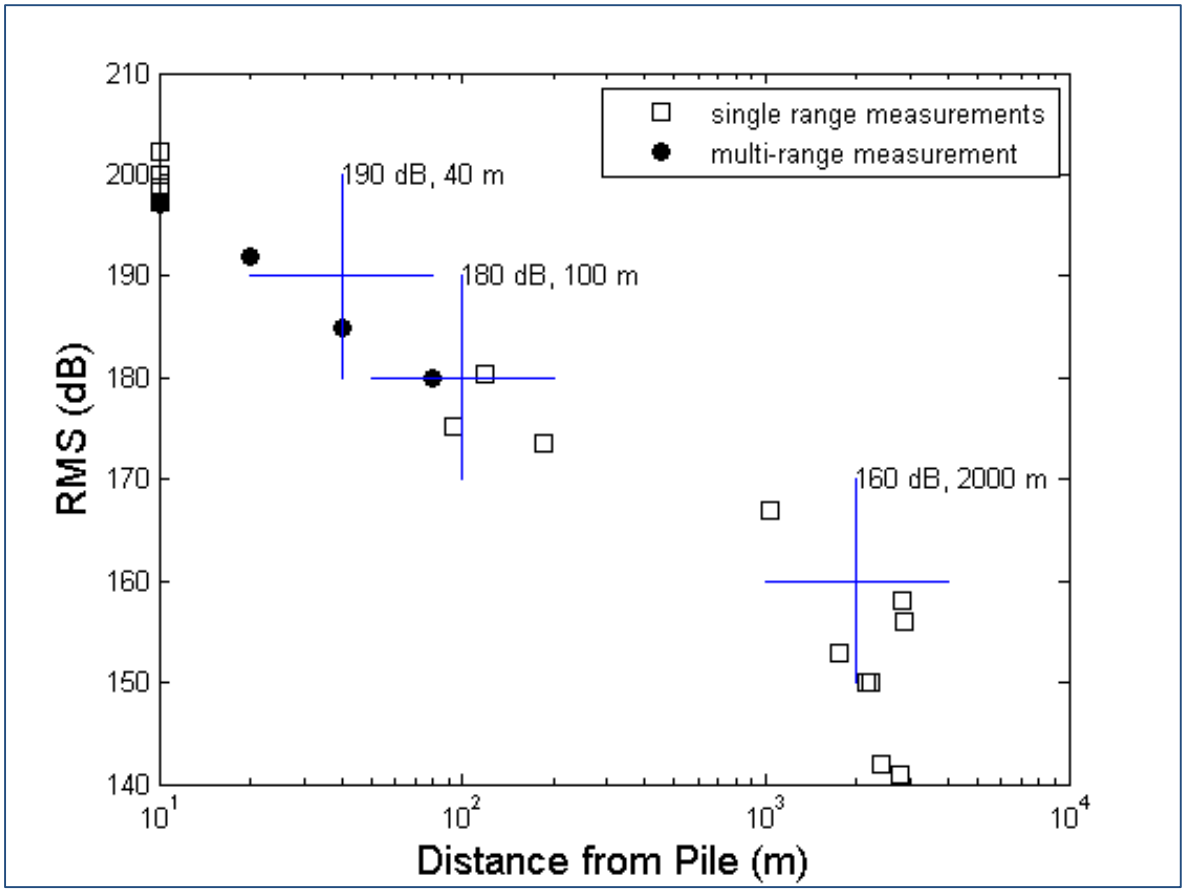


Figure 3-15. Summary of Inside Pile Measurements and Estimated ZOIs for the 190, 180 and 160 dB Thresholds.

Table 3-15, Figure 3-16, and summarize the RMS values measured for the outside piles at various ranges, starting from 10 m (32.8 ft; source range). Unlike the case for the inside piles, we do not have enough granularity in range to estimate ZOIs directly from the data. Instead, a model (Dahl et al. 2012) is used to fill in the gaps in the data and from this we infer the ZOIs for 190 dB, 180 dB, and 160 dB, to be 75 m, 450 m, and 2,500 m (246 ft, 1,476 ft, and 8,202 ft), respectively. These ZOIs are greater than corresponding ZOIs for the inside piles because the outside piles were in deeper water, which is more favorable for acoustic propagation, as well as the absence of shadowing by the piers which reduces transmission loss for the inside piles. The model fit is reasonable given the inherent variation in pile source strength and propagation conditions.

Examination of the analyzed frequency spectra between 20 Hz and 20 kHz, for a 36-inch steel pipe pile installed during the IPP, displayed consistent pressure levels between strikes during maximum hammer energy. The maximum SPLs were concentrated between 200 and 1,000 Hz with another noticeable spike at approximately 3 to 5 kHz. SPLs less than 160 dB rms accounted for nearly all the frequencies below 100 Hz and greater than 10 kHz (Figure 3-18).

Table 3-15. Measured Distances to Injury and Disturbance Thresholds for Sound (Outside piles).

Activity	Measured Distances to Threshold (meters [feet])					
	Underwater				Airborne[1]	
	Level A		Level B		Level B	
	190 dB	180 dB	160 dB	120 dB[2]	100 dB	90 dB
Impact driving, steel piles[3]	75 (246)	450 (1,476)	2,500 (8,202)	n/a	71 (232)	233 (764)
Vibratory driving, steel piles[3,]	10[4] (32.8)	10[4] (32.8)	n/a	3,000 (9,842)		

[1] Distances are based on impact pile driving with steel piles, which is a worst-case scenario.
[2] The ambient sound levels in San Diego Bay are louder than 120 dB.
[3] Based on 36-inch steel piles, and source levels of 174 dB rms for vibratory pile driving, and 200 dB rms for impact pile driving.
[4] Measured values are less than 10 m (32.8 ft). For measured distances of less than 10 m (32.8 ft), the regulatory requirements is a minimum monitoring distance of 10 m (32.8 ft).

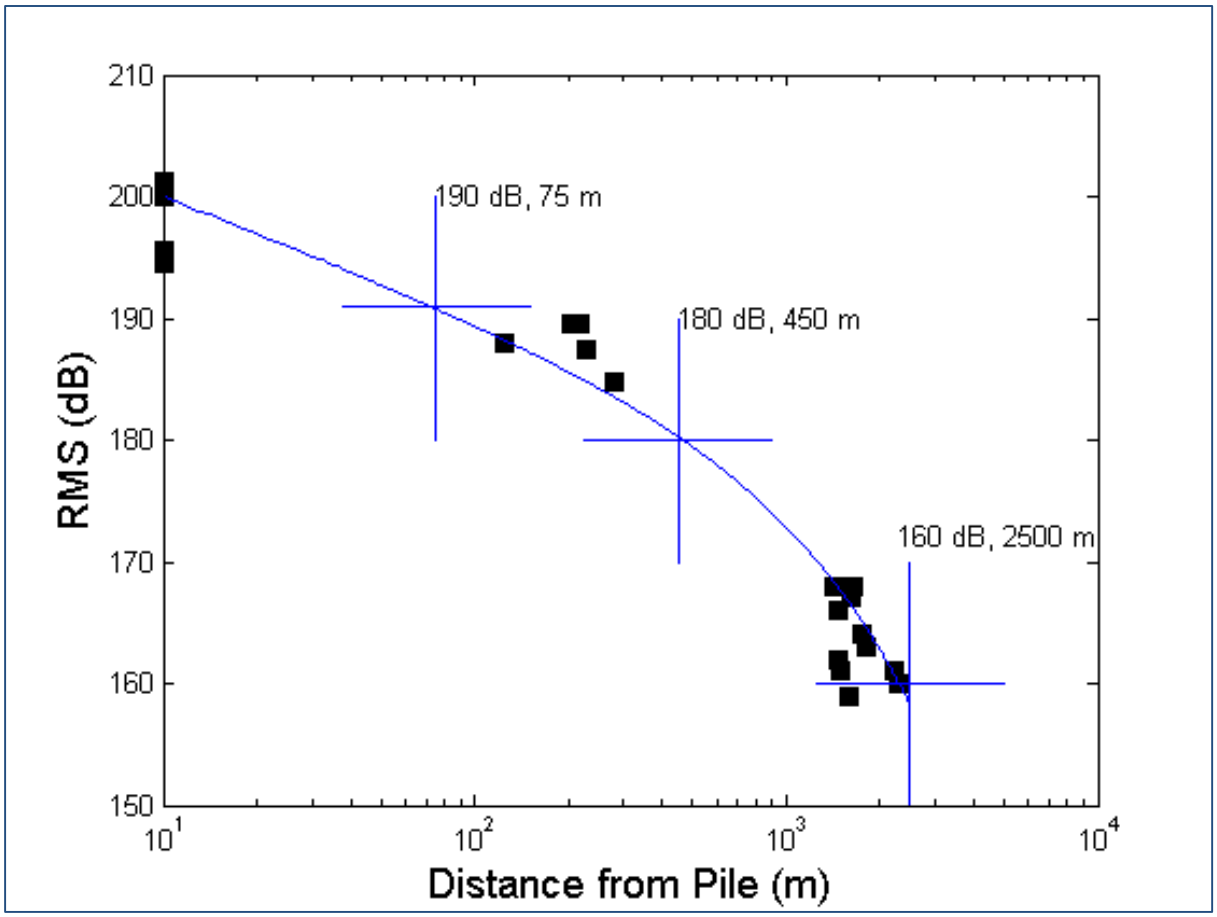


Figure 3-16. Summary of Outside Pile Measurements and Estimated ZOIs for the 190, 180 and 160 dB Thresholds.

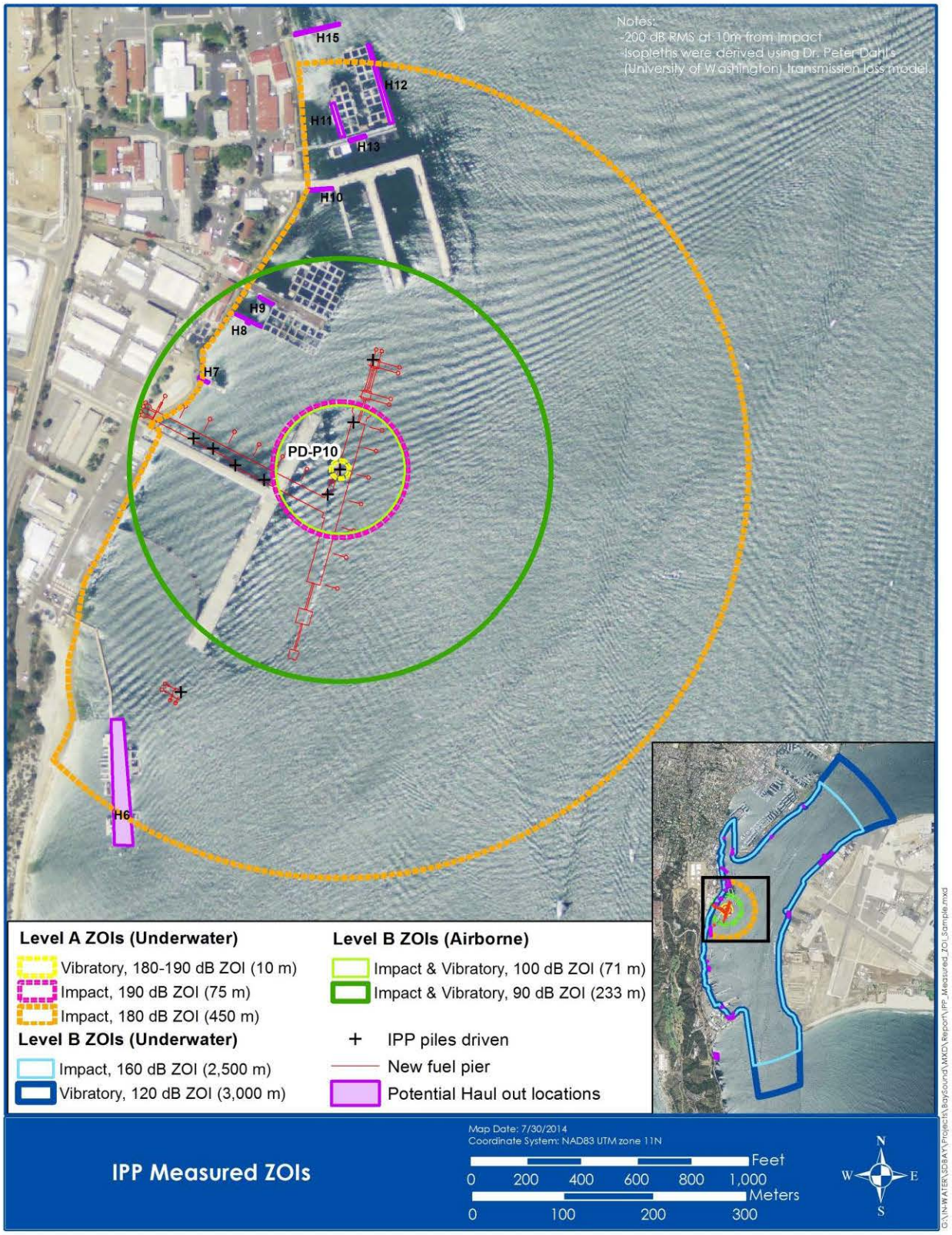


Figure 3-17. Measured Shutdown and Buffer zones for the NBPL FLC Fuel Pier Replacement Project (IPP) Using a Sample Pile Location.

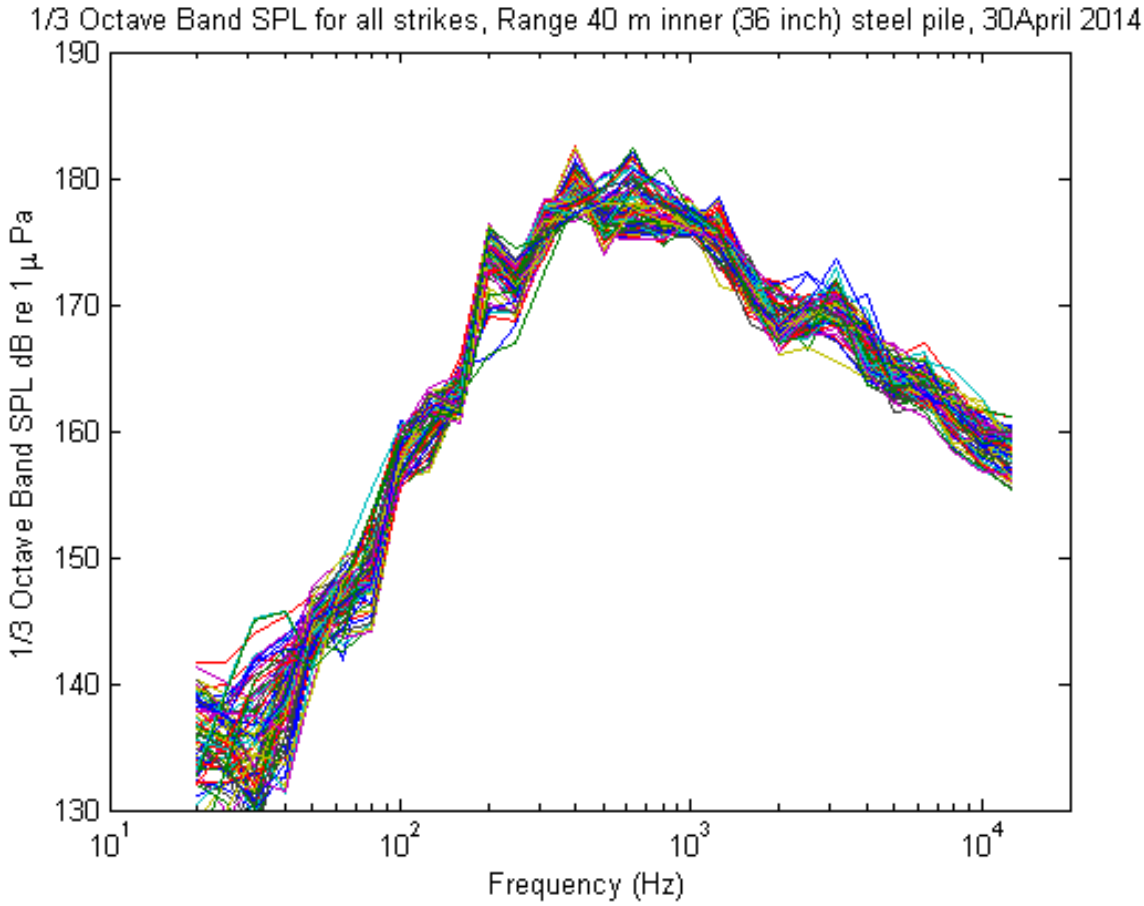


Figure 3-18. Sound Pressure Levels for Frequencies from 20 Hz to 20 kHz for a 36-inch Steel Pipe Pile during the IPP.

3.2.2.3 Airborne Sound

Pile driving activities conducted during the IPP between April 28, 2014 and May 15, 2014 produced airborne dB rms values ranging from 104.9 to 115.8 dB re 20 µPa at 15.2 m (50 ft) (Table 3-16). Airborne sound levels were collected at various sites and distances along the shoreline and fuel pier to evaluated ZOI threshold distances associated with pile driving activity. The transmission loss coefficient of airborne sound was near expected values and was calculated at 19.4 dB re 20 µPa (Figure 3-19). Based on the calculated transmission loss coefficient the LZF_{max} 100 dB re 20 µPa and 90 dB re 20 µPa isopleths were located at 71.1 and 233 m (344.5 and 2,388.5 ft), respectively for a LZF_{max} 113 dB re 20 µPa source. Differences in calculated transmission loss coefficients between this report and the IHA (Navy 2013b) are accounted for by decimal places as the IHA was calculated based on a transmission loss coefficient of 19 dB re 20 µPa and these results utilize 19.4 dB re 20 µPa. As a result, the isopleths are marginally different, with the IHA presenting more conservative distances.

Table 3-16. IPP Airborne SPL Values from Source (15.2 m [50 ft]) and Graduated Distances.

Area	Date	Pile #	Unit Location	Distance (m)	dB rms	dB_{peak}	dB_{sel}
36-inch Piles (Inside)	30-Apr-2014	TD-T13	Source	15.2	115.81	129.31	105.43
			Far-field	No Data			
	1-May-2014	TG-T18	Source	No Data			
			Far-field	No Data			
	2-May-2014	TG-T24	Source	No Data			
			Far-field	No Data			
		TD-T09	Source	No Data			
			Far-field	No Data			
36-inch Piles (Outside)	5-May-2014	PD-P1	Source	15.2	114.10	127.60	105.00
			Far-field	No Data			
	6-May-2014	PD-P10	Source	15.2	114.93	128.43	105.54
			Far-field	160	97.78	111.28	95.72
		T36-P15	Source	15.2	112.10	125.60	103.74
			Far-field	168	102.37	115.87	95.43
30-inch Piles (Outside)	7-May-2014	DB-D1	Source	15.2	112.64	126.14	104.42
			Far-field	170	98.36	111.86	92.41
	8-May-2014	TDB-TD2	Source	15.2	113.16	126.66	104.09
			Far-field	No Data			
36-inch Piles (Restrike)	13-May-2014	TG-T24R	Source	15.2	107.42	120.92	99.37
			Far-field	319	81.11	94.61	80.54
		TD-T09R	Source	15.2	100.11	113.61	95.29
			Far-field	330	81.29	94.79	78.58
		PD-P1R	Source	15.2	108.04	121.54	100.30
			Far-field	326	81.09	94.59	79.69
		PD-P10R	Source	15.2	104.91	118.41	94.52
			Far-field	378	76.31	89.81	75.73
	15-May-2014	T36-P15R	Source	15.2	108.49	121.99	98.74
			Far-field	348	81.54	95.04	76.81
30-inch Piles (Restrike)	15-May-2014	DB-D1R	Source	15.2	106.55	120.05	97.16
			Far-field	292	81.42	94.92	77.97
		TDB-TD2R	Source	15.2	105.75	119.25	96.29
			Far-field	93	93.55	107.05	85.50

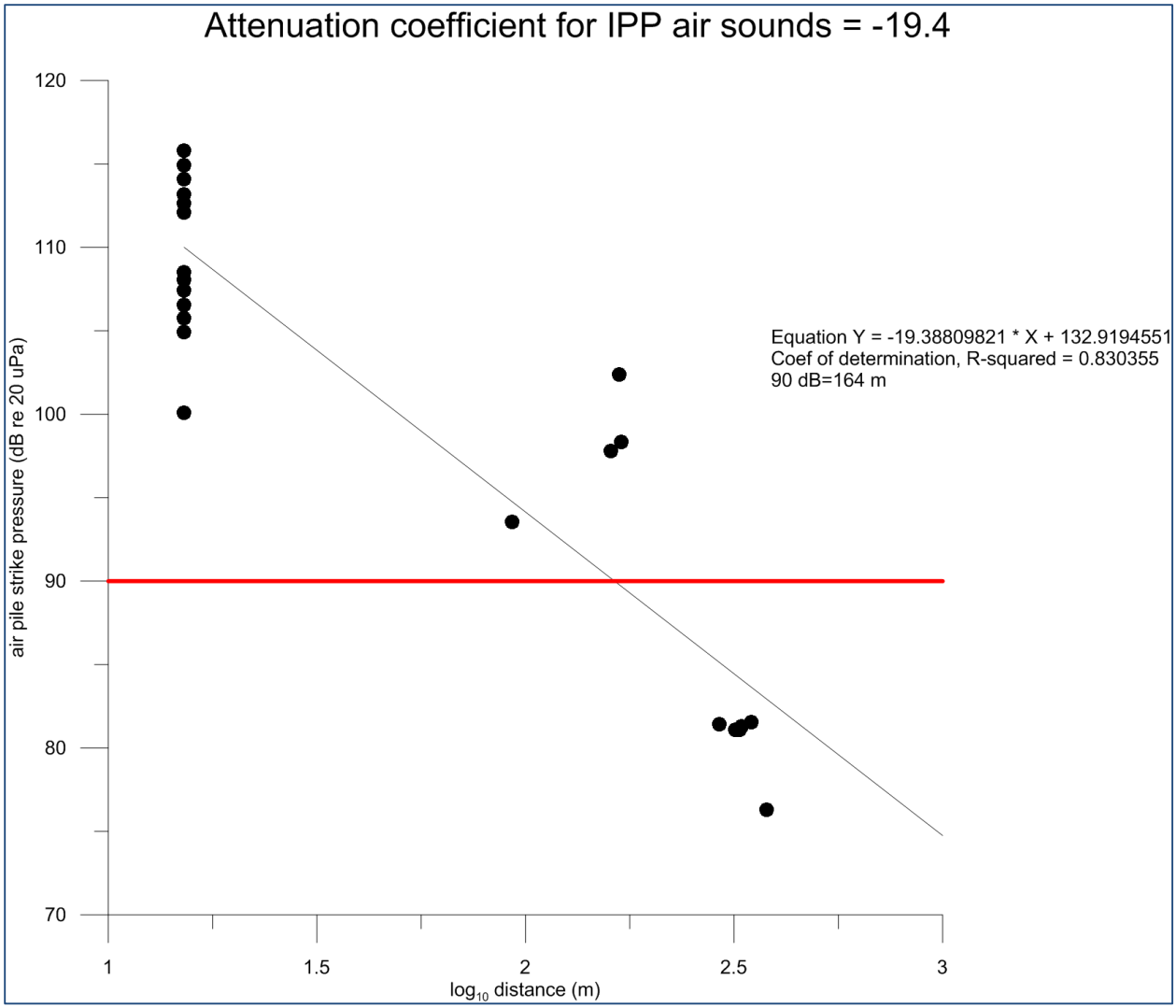


Figure 3-19. Airborne Sound Level Transmission Loss with Range for the NBPL FLC Fuel Pier Project Location (Calculated from LZF_{max} Values).

3.2.2.4 Ambient Sound

3.2.2.4.1 Hydroacoustic

Ambient hydroacoustic sound level recordings were conducted adjacent to the Fuel Pier IPP project site week prior to and following IPP pile driving activities and documented daily LZF averages of approximately 128 dB and a median of 127.1 dB (Figure 3-20). The area adjacent to the Fuel Pier IPP project site is a high traffic area supporting Navy fuel operations and is in close proximity 500 m (1,640 ft) of the main San Diego Bay navigation channel. Spike measurements eclipsed 140 dB with one instance reaching near 155 dB on April 28, 2014 at approximately 11:00 (Figure 3-20). Ambient hydroacoustic LZF were consistent with previous measured values throughout San Diego Bay and were recorded within expected ranges (Table 3-18).

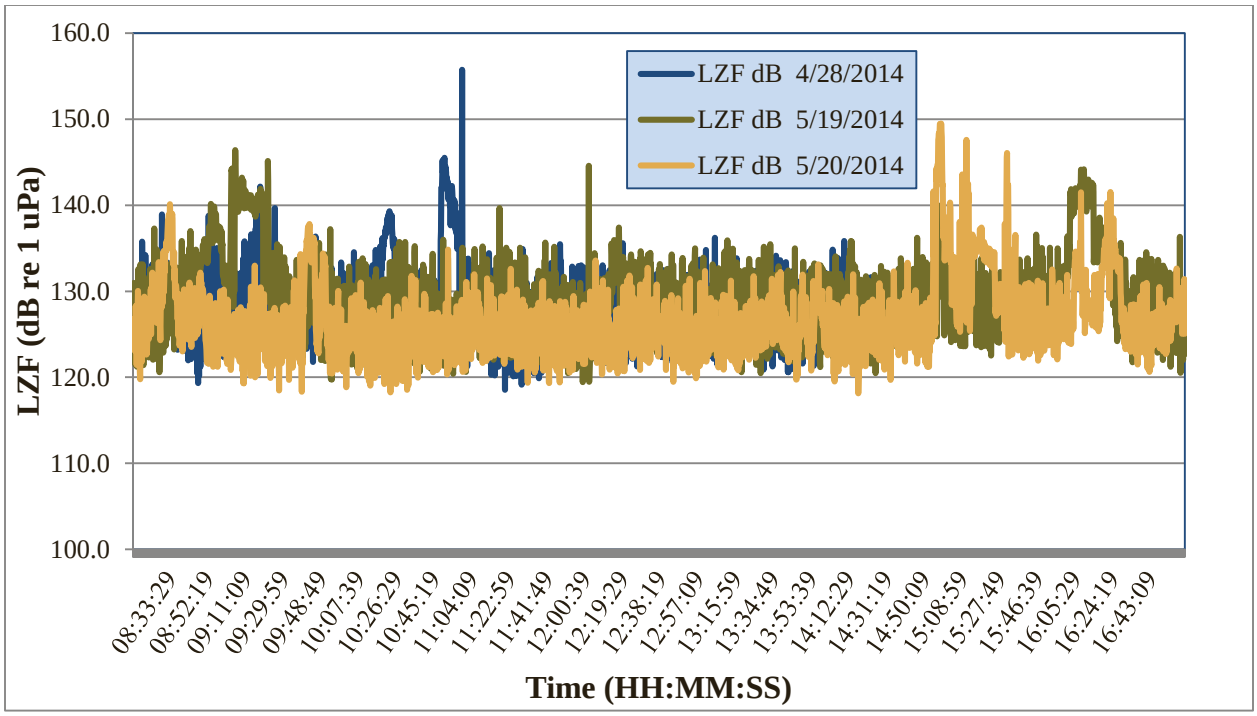


Figure 3-20. Fuel Pier IPP Ambient Hydroacoustic Sound Pressure Levels.

3.2.2.4.2 Airborne Sound

Ambient airborne sound level recordings were collected before and after the construction time period approximately 500 m (1,640 ft) from the all but one pile driving location. SPLs during non-pile driving time periods were examined and averaged between 77.2 and 81.2 dB rms, over four separate days (Table 3-17).

Table 3-17. Fuel Pier IPP Average Ambient Airborne SPLs.

Date	Average LZF (dB)
24-Apr-2014	77.3
28-Apr-2014	81.2
29-Apr-2014	77.2
20-May-2014	80.9

3.2.2.4.3 San Diego Baywide Hydroacoustic Ambient Sound

The collection of hydroacoustic ambient data in San Diego Bay documented hydroacoustic SPLs ranging from between 115.3 and 125.2 dB for distinct ecoregions (Table 3-18). Sound levels were based on LZF (Z weighted sound levels in dB over 125 millisecond time frames) averages of consecutive 10 second time histories collected over one hour recordings at each station location. Distribution of the station locations are presented in (see Figure 2-2 for data collection locations). Sound levels were consistent with previously reported results from April 2012 to October 2013 (Appendix A) as well as site specific ambient sound levels presented for both the NMAWC and IPP project locations presented in these results.

Table 3-18. Ambient Sound Levels in San Diego Bay.

San Diego Bay Ecoregion	Station Number	Average LZF (dB)	
		April 2014	May 2014
Outer Bay	8	125.1	124.8
North Bay (Fuel Pier)	6B	125.2	124.0
North Bay (Harbor Island)	2	121.3	120.9
North Central	P8	124.8	124.6
South Central	P3	120.1	120.4
South Bay	P1	116.2	115.3

3.2.3 Marine Species Monitoring Results

During the IPP, there were a total of 1,122 sightings with 2,427 individuals sighted over the course of 42:18 survey hours. Four identifiable marine mammal species were sighted during the IPP timeframe: Coastal bottlenose dolphins, California sea lions, Pacific harbor seal, and common dolphins. The common dolphin was not expected to occur based on data as provided in the IHA application (Navy 2013b) for this phase of the project. A single unidentified cetacean (a large whale) was also sighted, but was too far away from the MMO to identify to the species level (Table 3-19). Data for all sightings is available in Appendix K.

Table 3-19. Total Number of Individuals and Sightings by Species, IPP.

Species	Total Number of Individuals	Total Number of Sightings	Group Size		
			Mean	Maximum	Minimum
California sea lion	2,299	1,061	2.17	73	1
Coastal bottlenose dolphin	83	34	2.44	5	1
Common dolphin	19	3	6.33	12	2
Pacific harbor seal	25	23	1.09	2	1
Unknown Cetacean	1	1	1.00	1	1
Total	**2,427**	**1,122**			

Observers were on station from 4 to 8.5 hours per day (see Table 3-9); however, they were not monitoring throughout that full time period and documented marine species observations only during the required monitoring period for pile driving activities (at a minimum of 15 minute pre-survey, during pile installation/removal activities, and 30-minutes post survey). Pile installation during the IPP utilized both vibratory and impact hammers integrating the soft start technique; therefore, there were four types of construction that constituted “during” pile driving: soft start vibratory pile driving, vibratory pile driving, soft start impact pile driving, and impact pile driving. All other construction-related activities fell under the pre- and post-construction monitoring. The remainder of this section focuses on the pre-, during, and post-construction time periods only.

3.2.3.1 Summary of Marine Species Sightings, by Species

3.2.3.1.1 California Sea Lion

California sea lions were the most frequently observed species of marine mammal during the IPP with 2,299 individuals and 1,601 sightings (see Table 3-19). Of the 2,299 individuals, 1,607 (70%) were sighted during non-pile driving monitoring, and 692 (30%) were sighted during pile driving. For the sightings that occurred during non-pile driving, 422 sightings (40% of all sightings) occurred during pre-construction, with the remaining sightings occurring during the post-construction monitoring. Figure 3-21 shows the number of individuals sighted relative to each construction phase on a daily basis. Over the course of the 10 days of monitoring effort (piles were driven on 9 of the 10 days), there was an average of 229.9 individuals observed per day.

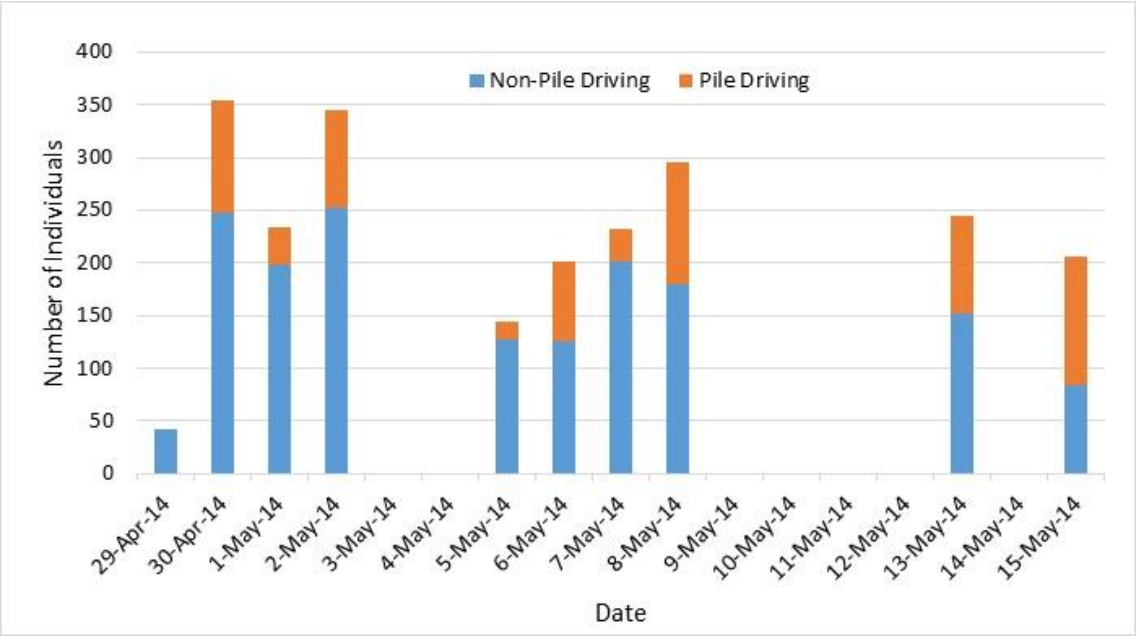


Figure 3-21. California Sea Lion Sightings Per Day, During Non-pile Driving and Pile Driving Activities.

There were identifiable groupings of sea lions to the north and south of the Fuel Pier, as well as near the far-field observation platform at the entrance to San Diego Bay. The groupings near the Fuel Pier were likely due to a higher degree of effort (a minimum four observers were on, or in the vicinity of, the Fuel Pier at all times) as well as haul out locations that attracted California sea lions to these areas (Figure 3-22). Regardless, of observer effort or potential haul out locations, distribution of sea lions did not appreciably change in the vicinity of the pile driving throughout pile driving activities.

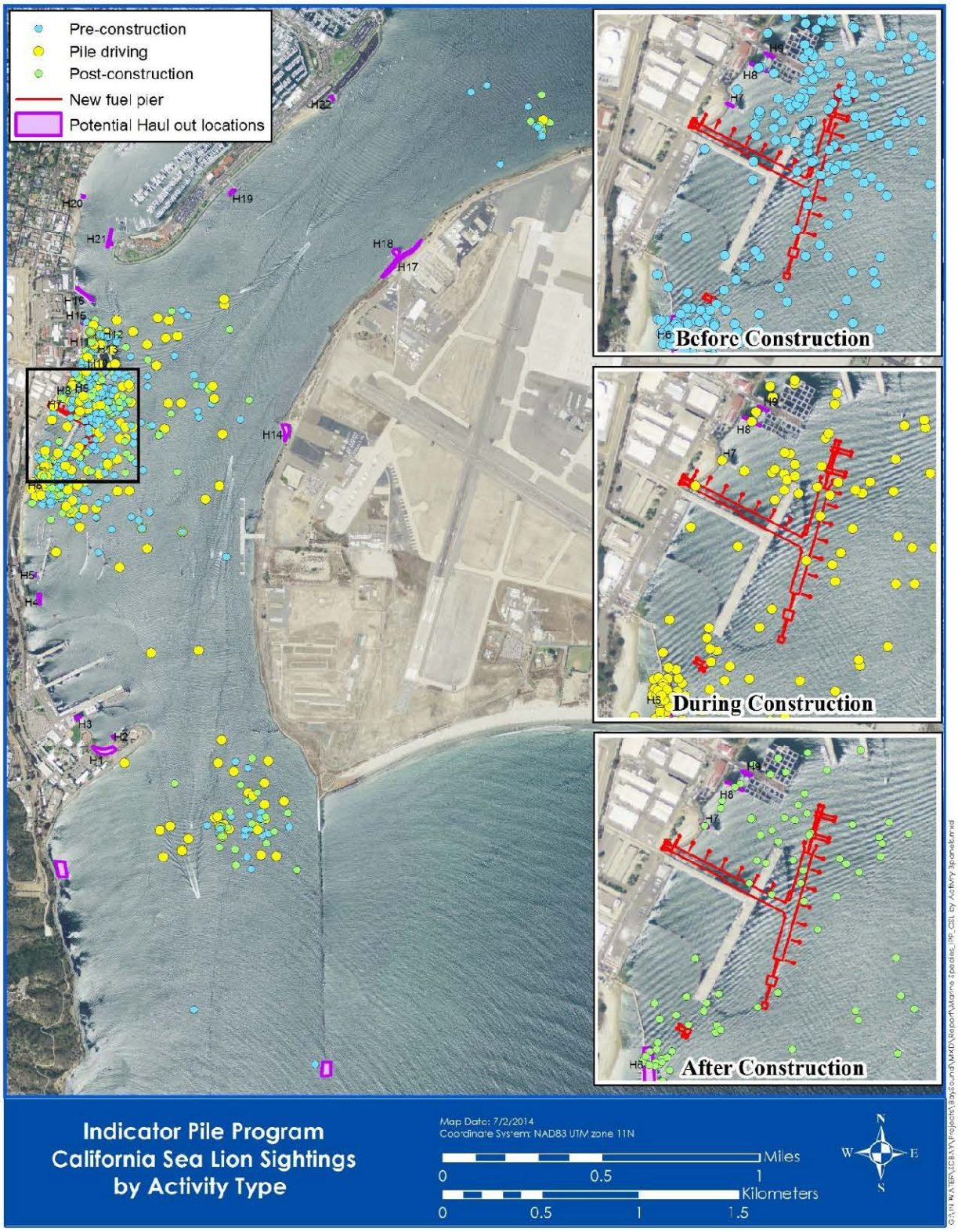


Figure 3-22. All California Sea Lion Sightings Before, During, and After Pile Driving.

Prior to the initiation of the IPP, the Everingham Brothers Bait Company Bait Barges were relocated to a site outside of the underwater construction noise ZOI to the south of Shelter Island in San Diego Bay. This was to reduce the potential pile driving impacts to marine mammals that haul out on the barges and to mitigate any potential impacts to fish species used for commercial and recreational bait. However, the California sea lion was still the most sighted species at the identified haul out locations in the vicinity of the NBPL FLC Fuel Pier project. The highest concentration of animals was noted at the EOD Dock (P-122, identified as H6 in Figure 3-22), which is to the immediate south of the Fuel Pier. On average, the group size at this location was 23.57 animals throughout the project time frame, with a maximum of 73 individuals in one sighting. This is in contrast to the average group size of all California sea lion sightings (2.17 animals/sightings). The former Navy marine mammal pens to the north of the Fuel Pier, identified as H11 on Figure 3-22, had the next highest abundance with an average group size of 10.42 animals per sighting, and a maximum of 43 animals in one sighting.

On April 29 and 30, 2014, the hazing prescription HZ1 was implemented and 159 California sea lions were flushed off of the docks near the Fuel Pier once on April 29, 2014 and seven times on April 30, 2014 (H6 [n=4], H8 [n=2], H10 [n=1], and H12 [n=1]). In all cases, the animals were noted as swimming away from the docks and individuals could not be visually followed. Because the number of “takes” on those days were high, hazing the animals into the water was discontinued. As a result, the less intensive hazing prescriptions, HZ2 and HZ3, were implemented for the remainder of the project.

The overall number of California sea lion sightings were generally consistent throughout the early to mid-morning, with a slight decrease in sightings in the early afternoon. The group size increased in the early morning (from 08:00 to 09:00) and gradually decreased until approximately 14:00 when the group size increased again (Figure 3-23). During the 14:00 to 14:59 hour, the mean group size of 4.0 individuals/sighting was almost double the overall mean group size of 2.17 individuals/sighting.

California sea lions were most often seen swimming, or hauled out on docks and navigation buoys in the area. Secondary behaviors included milling, entering the water from a haul out location, exiting the water to a haul out location, looking, porpoising, jug handling, successful foraging, and diving. Further behavioral analysis is presented in response to issues with potential “take” (see Appendix M). Results related to “take” in Appendix M were preliminary and were presented to provide context for behavioral impacts as a result of the IPP. However, the behavioral data is still applicable to finalized results.

There were four California sea lion sightings (0.3% of all California sea lion sightings) of one animal each with a behavioral change that was considered as a reaction to a stimulus (see the Marine Species Visual Monitoring Protocols section above for a full description of the behaviors; Table 3-20). Based on the MMO notes, three of the four changes in behavior were preceded by looking in the general vicinity of the Fuel Pier, and two sightings included porpoising after the initial sighting.

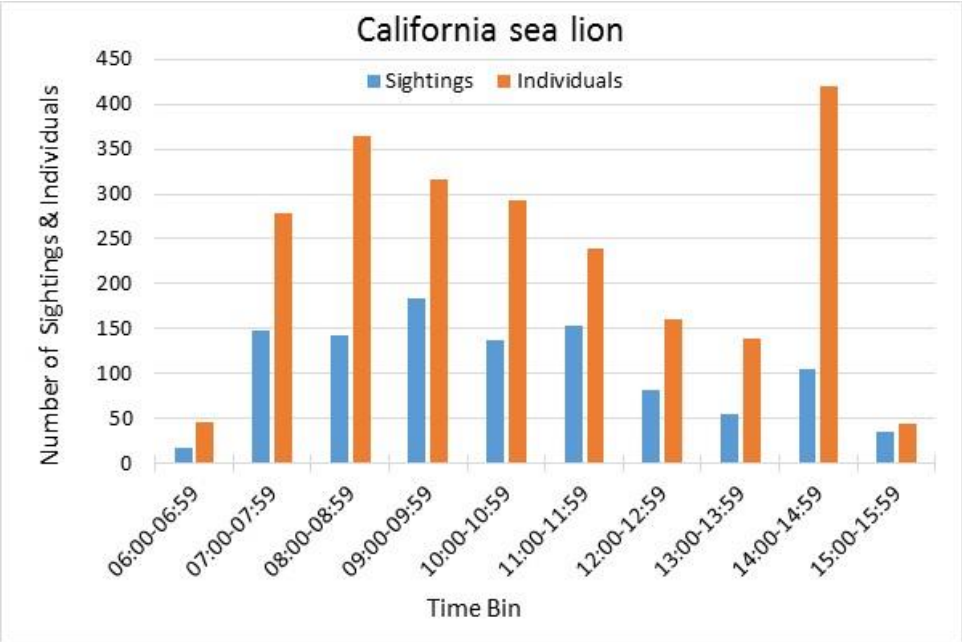


Figure 3-23. California Sea Lion Sightings and Individuals Per Hour.

Table 3-20. Summary of Potential Reactions by California Sea Lions to a Stimulus.

Date	Obs. Time	Observer Location	Behavior	Const. Activity	Pile Number	Pile Driving Time	Distance to Pile (m)
30-Apr-14	14:47	Shutdown	Abrupt change in direction	Pile driving	TD-T13	14:46-14:47	135
30-Apr-14	14:55	Shutdown	Abrupt change in direction	Pile driving	TD-T13	14:54-15:01	240
06-May-14	12:48	Shutdown	Increased Swim Rate	Pile driving	T36-P15	12:48-12:54	273
15-May-14	07:27	SL2	Abrupt change in direction	Pile driving	T36-P15	07:27-07:32	253

There were seven sightings of one California sea lion pup each either being identified via direct callouts in the age class data field or in the notes of a “mixed” age class. Of those sightings, three dead pups were found in the vicinity of the EOD dock (P-122) to the south of the Fuel Pier. There were also sightings of live pups with orange tags (indicating that they were tagged by the local stranding network). Two of the three dead California sea lion pups were found On May 5, 2014 near the EOD dock. One pup was found in the water near the abutment piles supporting the quay wall, and the second pup was found on the EOD dock itself. On May 12, 2014 a single pup was found on floating docks (“jet docks”) adjacent to the EOD dock. This pup appeared to have been dead longer than the other two pups based on the amount of decay and scavenger activity noted by the MMO. In all cases TDI personnel notified the U.S. Navy Biologist associated with the IPP project, who then notified the U.S. Navy Station biologist and a U.S. Army veterinarian stationed at NBPL. The veterinarian examined the animals and determined that they died as a result of crushing (May 5, 2014) and malnutrition (May 5 and May 12, 2014). After examination, standardized reporting forms were completed and faxed to the local stranding network offices.

3.2.3.1.2 Pacific Harbor Seal

Pacific harbor seals were sighted 23 times with 25 individuals. Of the 25 individuals, 14 (56%) were sighted during non-pile driving monitoring, and 11 (44%) were sighted during pile driving. For the sightings that occurred during non-pile driving, six sightings (22% of all sightings) occurred during pre-construction, with the remaining sightings occurring during the post-construction monitoring. Figure 3-24shows the number of individuals sighted relative to each construction phase on a daily basis

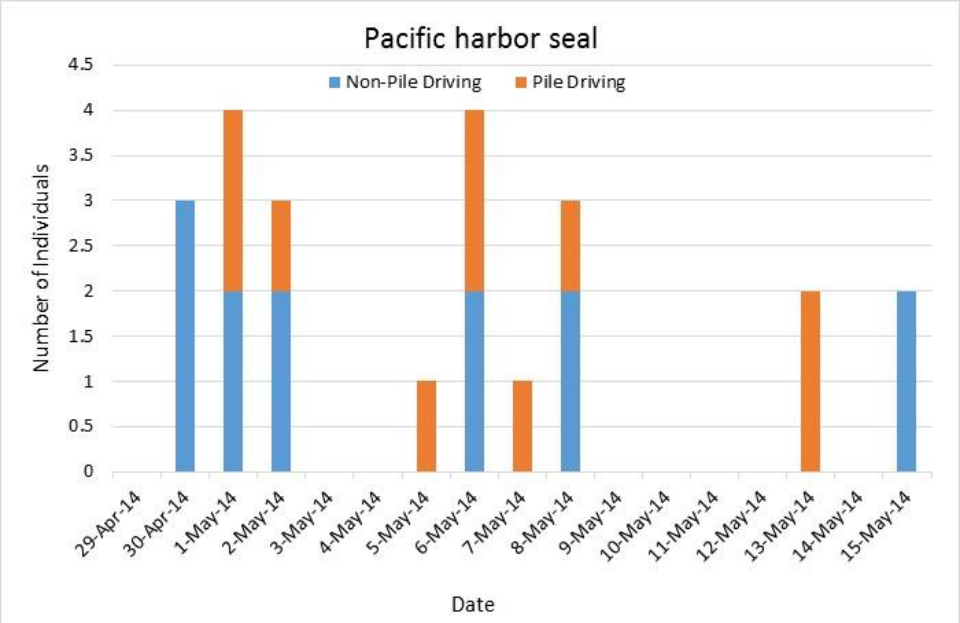


Figure 3-24. Pacific Harbor Seal Sightings Per Day, During Non-pile Driving and Pile Driving Activities.

Pacific harbor seal were sighted consistently throughout each day (Figure 3-25). The increase in sightings and individuals during the timeframe from 14:00 to 14:59 was due to an increase in sightings on one day (May 1, 2014) with six individuals sighted. There was no apparent reason for this increase in sightings.

A majority of the Pacific harbor seals were sighted in the vicinity of the Fuel Pier. Pacific harbor seals were seen hauled out at H6 on five occasions with an average group size of 1.2 animals, and with a maximum of two individuals in one sighting. A single individual was noted on H10 on one occasion (Figure 3-26). Based on physical characteristics, it appeared that there were two adult individuals of unknown sex that were sighted on a regular basis either in the water or hauled out on the docks in the general area. Baywide marine mammal surveys (Merkel and Assoc. 2008; TDI 2014) have identified an area of higher concentration of Pacific harbor seals seaward of Ballast Point and along the shoreline. A single Pacific harbor seal was sighted by the MMO stationed at the entrance to San Diego Bay (Figure 3-26), but none were sighted in the area of known concentration south of Ballast Point. This is likely due to the distance to the shoreline (generally greater than 1 km [0.6 miles]) from the MMO, and the cryptic coloration of Pacific harbor seals which would have made individuals hard to identify if they were in the water or hauled out along the shoreline.

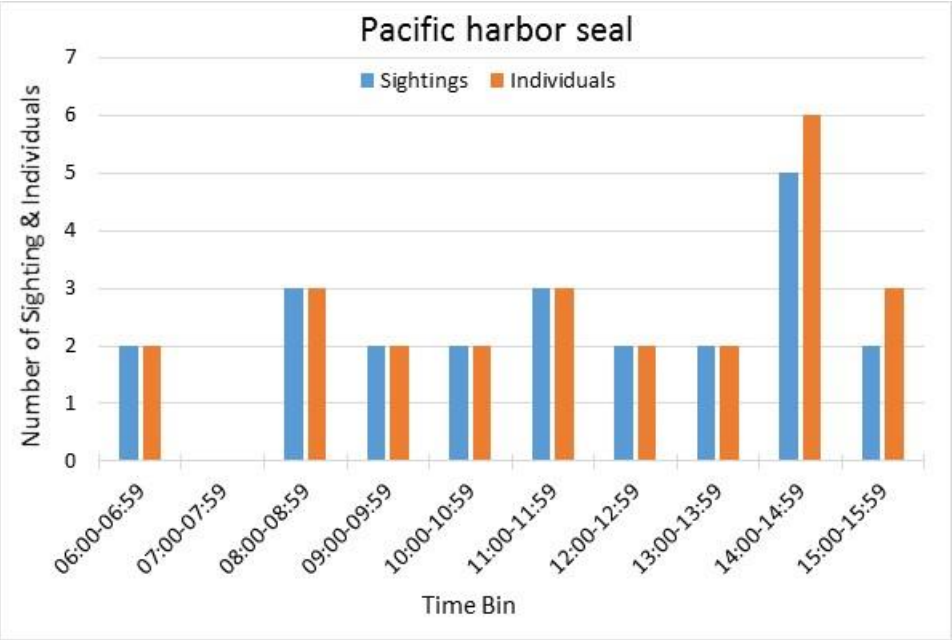


Figure 3-25. Pacific Harbor Seal Sightings and Individuals Per Hour.

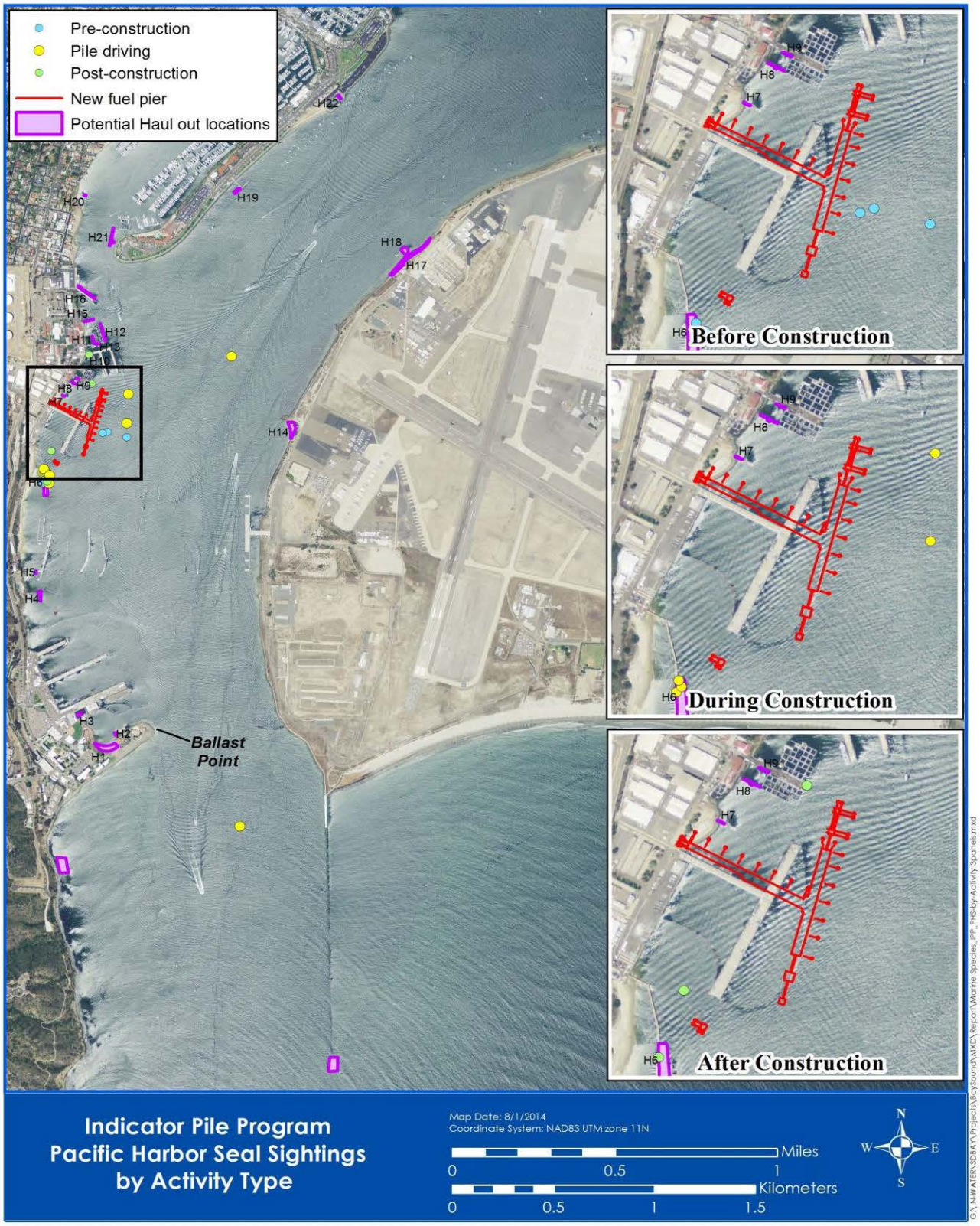


Figure 3-26. All Pacific Harbor Seal Sightings Before, During, and After Pile Driving.

3.2.3.1.3 Coastal Bottlenose Dolphin

Coastal bottlenose dolphins were sighted 34 times with 83 individuals noted during those sightings. Of the 83 individuals, 58 (70%) individuals were sighted during non-pile driving, and 25 (30%) were sighted during pile driving. For the sightings that occurred during non-pile driving, 12 sightings (35% of all sightings) occurred during pre-construction, with the remaining sightings occurring during the post-construction monitoring. Figure 3-27 shows the number of individuals sighted relative to each construction phase on a daily basis. The mean group size during pile driving was 8.29 animals, while the mean group size during non-pile driving activities was 5.0 animals.

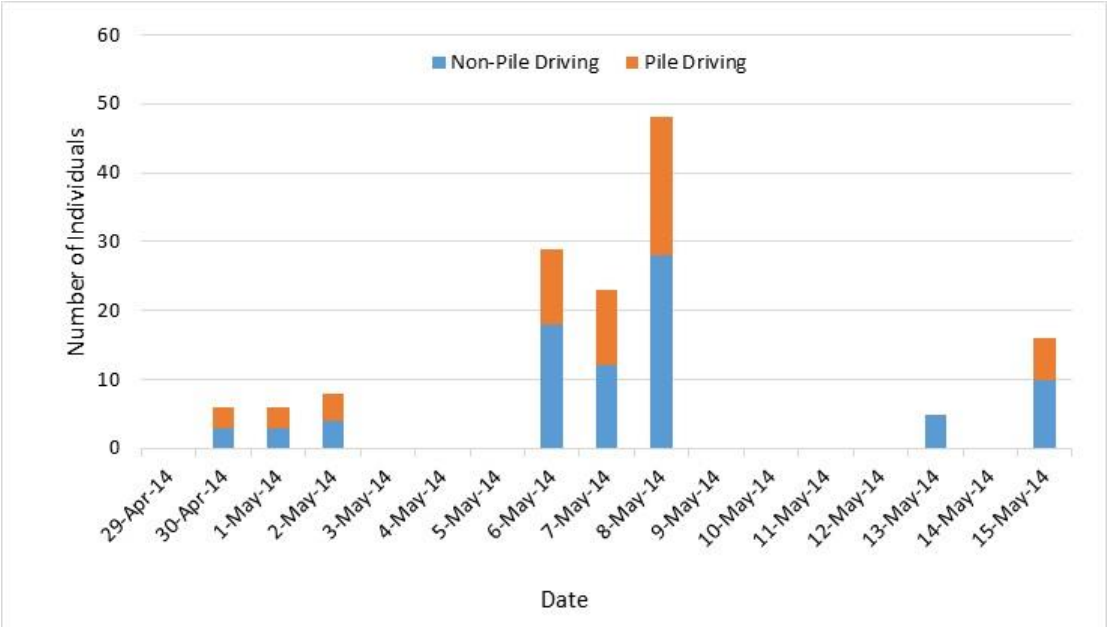


Figure 3-27. Coastal Bottlenose Dolphin Sightings Per Day, During Non-pile Driving and Pile Driving Activities.

Over half of the coastal bottlenose dolphin sightings occurred at the mouth of San Diego Bay with 20 sightings (58% of all sightings) and 45 individuals observed. The MMO closest to the Fuel Pier saw the next highest number of coastal bottlenose dolphin sightings with 10 sightings (29% of all sightings) and 29 individuals observed. All other locations noted from one to three sightings with from two to seven individuals per sighting (Figure 3-28).

Coastal bottlenose sightings and the number of individuals in each sighting were evenly distributed throughout the day. Group size was variable with higher group sizes seen in the morning and mid-afternoon (Figure 3-29).

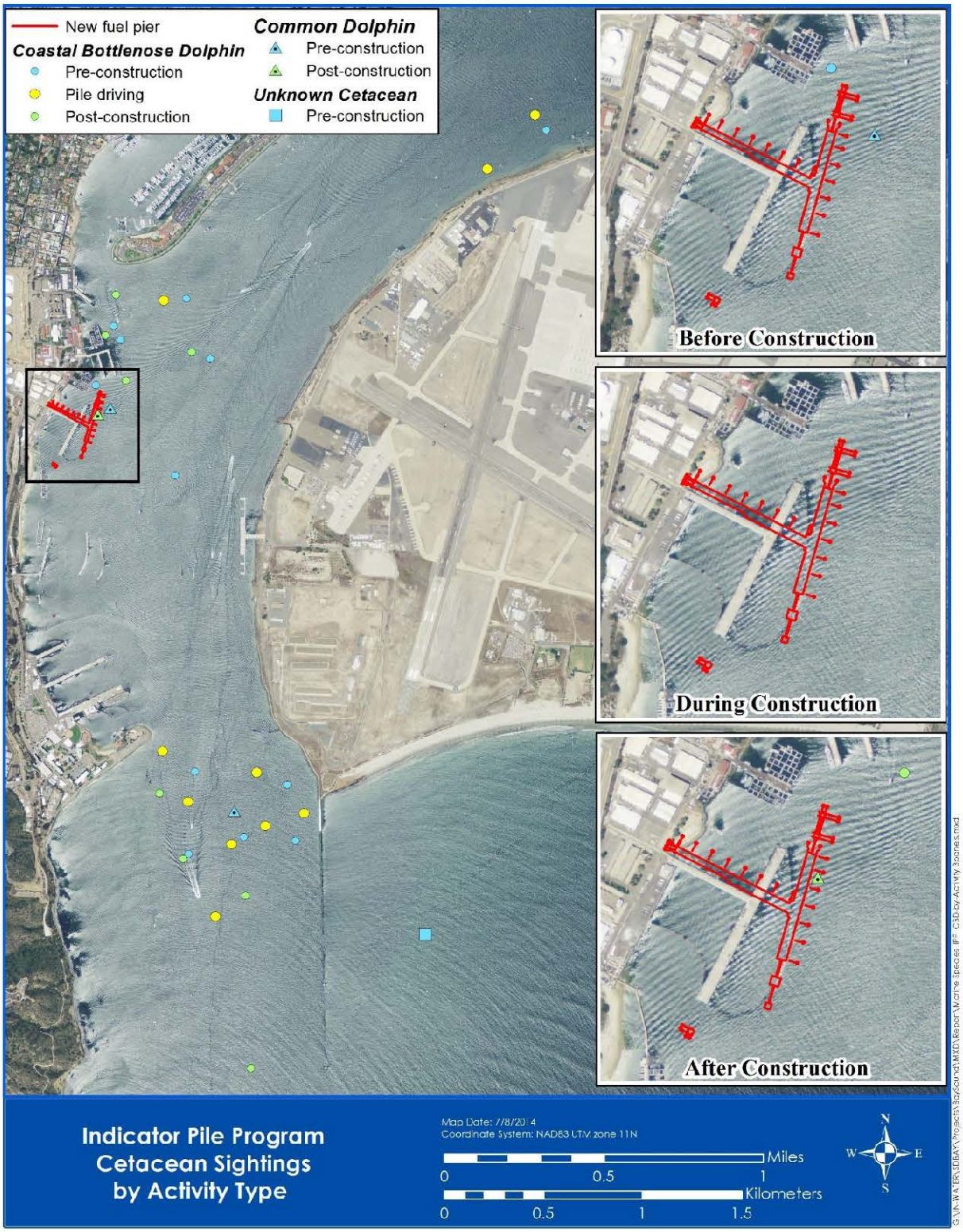


Figure 3-28. All Cetacean Sightings Before, During, and After Pile Driving.

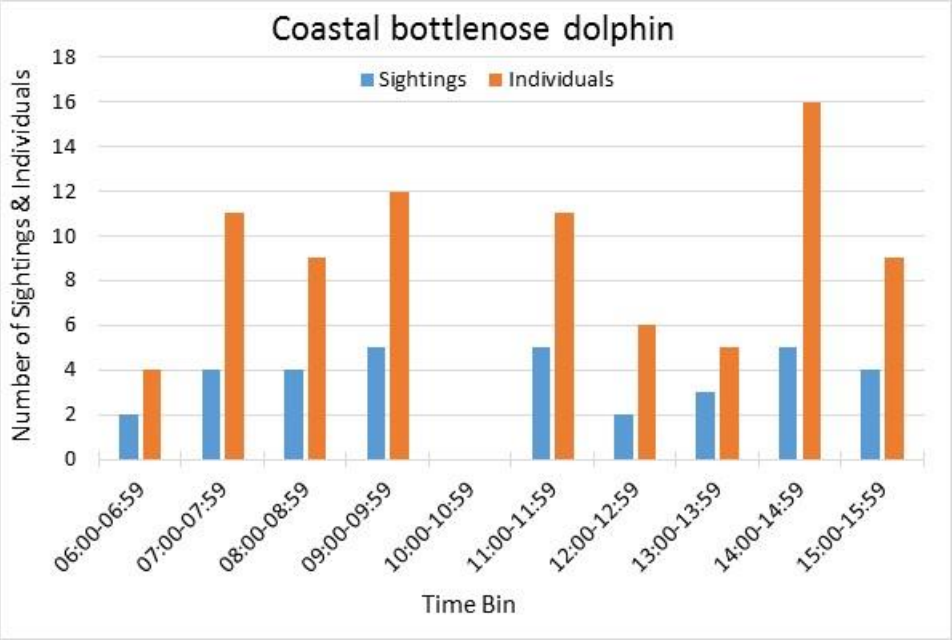


Figure 3-29. Coastal Bottlenose Dolphin Sightings and Individuals Per Hour.

Coastal bottlenose dolphins were most often observed swimming (53 sightings, 64%), followed by milling (21 sightings, 25%). All other primary behaviors were from one to four percent of the observed behaviors. Secondary behaviors included swimming (most often after milling) and porpoising. Porpoising was most often associated with coastal bottlenose dolphins approaching a large ship as it left or entered San Diego Bay to initiate bowriding. On May 1, 2014, there was a sighting of one individual with a behavioral change that was considered a reaction to a stimulus. This animal was sighted by the SL1 MMO at 14:56 as Soft Start began (pile driving occurred from 14:55 to 15:13). The individual was sighted just off the pier at H12 heading west towards the pier. The individual abruptly changed direction and headed northeast into San Diego Bay. The individual was visually monitored for two to three minutes before it was lost from sight.

3.2.3.1.4 Common Dolphin

Common dolphins were sighted on two separate days with two sightings on May 1, 2014 (12 and 5 individuals, respectively) and one sighting (two individuals) on May 5, 2014 (see Figure 3-28). The sighting of 12 individuals occurred during post-construction, and the sightings of two and five individuals occurred during pre-construction surveys. The first sighting on May 1, 2014 occurred 14 minutes after pile driving had ended, while the other sightings occurred 19 minutes before pile driving. Both of these sightings were noted by the MMO ("shutdown") who was closest to the piles being driven on that day. The sightings that occurred on May 5, 2014 was during the pre-construction survey time period. Pile driving did not begin until 1 hour and 51 minutes after the sighting (see Figure 3-28). The behavior for individuals in all of the sighting were noted as porpoising.

3.2.3.1.5 Unidentified Cetacean

A single unidentified cetacean (a large whale based on spout height and size in the water) was sighted on May 15, 2014 during the pre-construction monitoring. The individual was approximately 1 km (0.6 miles) from the observer and on the east side of the Zuniga jetty with the jetty between the MMO and the whale (see Figure 3-28). As a result, species identification was not possible. However,

based on the time of the year, and the proximity to the shoreline (approximately 1 km [0.6 miles]), this individual may have been a grey whale migrating northwards.

3.2.3.1.6 California Least Tern

A total of 164 California least terns were sighted during 50 sightings. Most California least terns were sighted by the MMOs near Naval Air Station, North Island ("inside") station, followed by the boat-based MMO closest to the pile driving activity ("shutdown") (Figure 3-30). Most sightings (n=107, 65% of all sightings) occurred during non-pile driving activities, with 71 sightings (66%) occurring during the pre-construction monitoring and 36 sightings (34%) occurring during the post-construction monitoring (see Figure 3-30). The remaining sightings (n=57, 35%) occurred during pile driving activities. Foraging behaviors were observed during both pile driving and non-pile driving activities, with all individual birds identified as foraging during pile driving successfully foraging (n=28, 100%), and a mixture of successful foraging (n=37, 86%) and unsuccessful foraging (n=6, 14%) during non-pile driving activities. During pile driving activities, individual birds that were sighted near the Fuel Pier (at monitoring stations shutdown, SL1, and SL2) were from 88 m (288 ft) and 543 m (1,781 ft) from the piles being driven. The birds that were sighted by the "inside" and "outside" MMOs were greater than 2,500 m (8,200 ft) from the piles. On those days when pile driving occurred and California least terns were observed, sightings rates during pile driving were on average higher (13.9 individuals per hours) than during non–pile driving activities (4.07 individuals/hour). Appendix N provides a detailed summary of the sightings during the IPP, as well as their relationship to the project and the California least tern population in the vicinity of the project.

3.2.3.2 Marine Mammal Sightings and Environmental Conditions

Most sightings during the IPP occurred during BSS of 1 (Figure 3-31a), clear conditions (Figure 3-31b), and good visibility of from 10 to 20 km (6.2 to 12.4 miles; Figure 3-31c). Sea surface temperatures during monitoring were on average 67 ˚F (19 ˚C), with minimum and maximum temperatures of 64 ˚F (18 ˚C) and 69 (21 ˚C), respectively. Air temperatures were, on average, 65 ˚F (18 ˚C), with minimum and maximum temperatures of 57 ˚F (14 ˚C) and 89 (32 ˚C), respectively. There were more sightings during the flood tide (59%) than during the ebb tide (41%).

As would be expected, sightability decreased with an increase in BSS. Of the 1,122 total sightings, there were 84 sightings (7%) during sea states of 3 or greater, with 70 California sea lions (83%), 12 coastal bottlenose dolphins (14%), 1 Pacific harbor seal (1%) and 1 common dolphin (1%) (Table 3-21). With the exception of California sea lions, group size decreased with the increased BSS (Table 3-21).

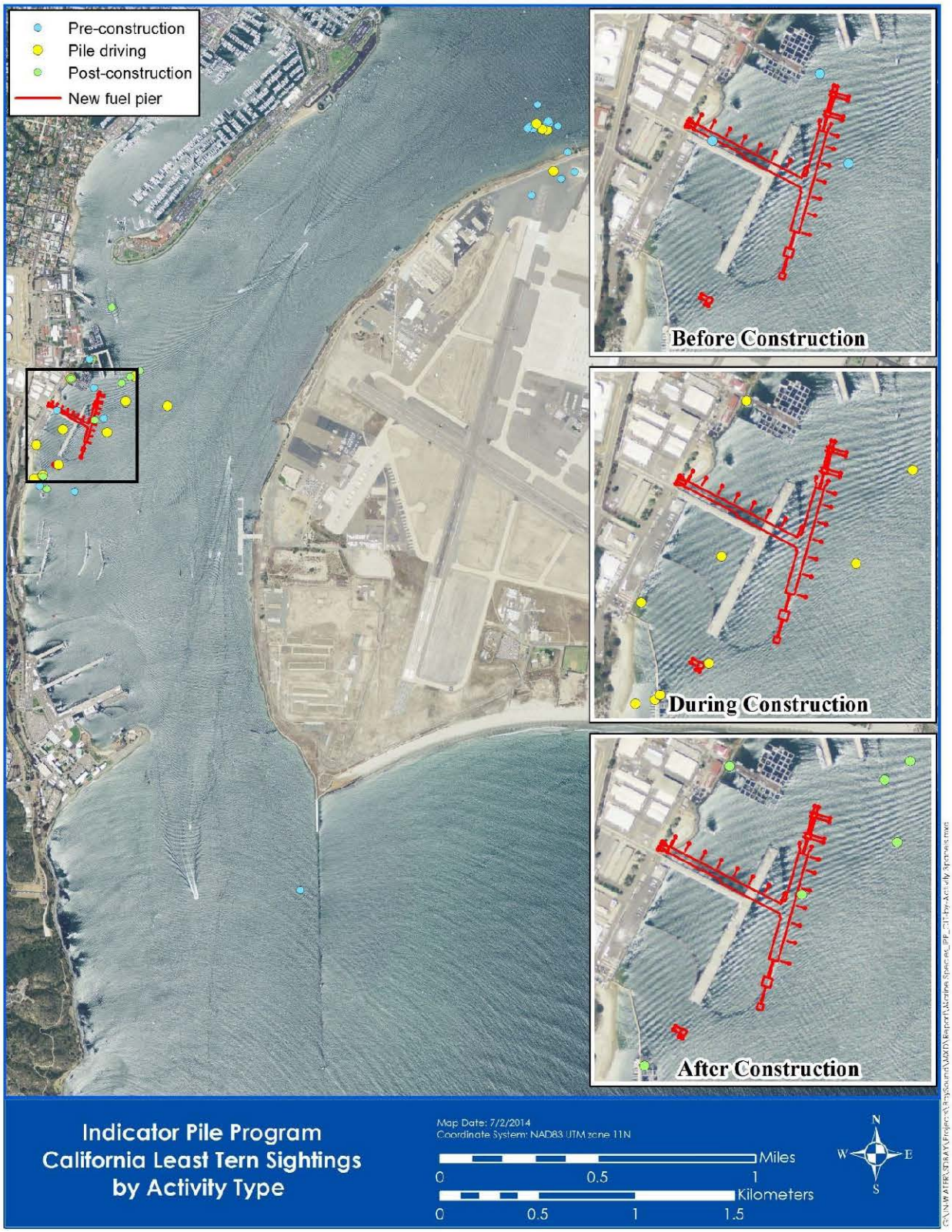
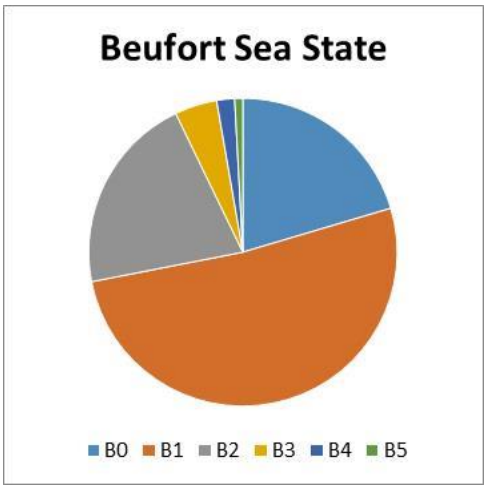
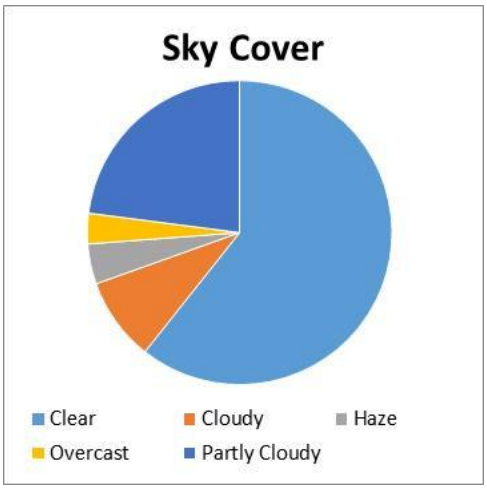


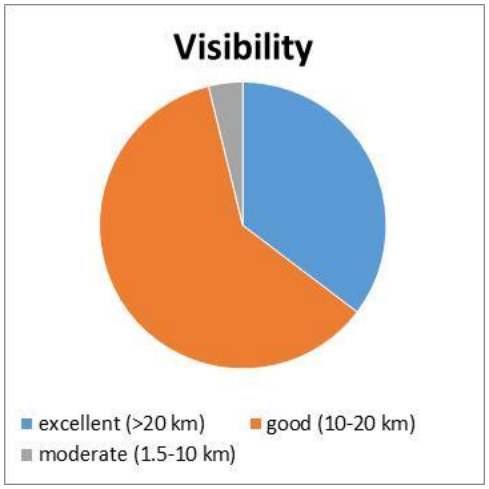
Figure 3-30. All California Least Tern Sightings Before, During, and After Pile Driving.



a.



b.



c.

Figure 3-31a, b, c. Weather Conditions from Sightings During the IPP.

Table 3-21. Summary of Sightings and BSS During the IPP.

Species	Beaufort Sea State (Number of Sightings [Percentage of Sightings at that BSS])							
	0	1	2	Mean Group Size (BSS 0-2)	3	4	5	Mean Group Size (BSS 3-5)
California sea lion	225 (97%)	533 (95%)	233 (97%)	2.29	43 (83%)	18 (82%)	9 (90%)	2.33
Coastal bottlenose dolphin	-	19 (3%)	3 (1%)	2.69	7 (13%)	4 (18%)	1 10%)	2.11
Common dolphin	-	1 (<1%)	1 (<1%)	8.5	1 (2%)	-	-	2.00
Pacific harbor seal	8 (3%)	10 (2%)	4 (2%)	1.07	1 (2%)	-	-	1.00
Unknown cetacean	-	1 (<1%)	-	1.00	-	-	-	0.00
Total	**233**	**564**	**241**		**52**	**22**	**10**	

3.2.3.3 Summary of "Take"

3.2.3.3.1 Level A "Take"

A California sea lion was sighted within the measured Level A injury ZOI (75 m [246 ft]) during the IPP in-water construction (Figure 3-32). The animal was an adult male sighted at 11:54 on May 13, 2014. It was estimated to be 140 m (459 ft) away from the observer at a bearing of 250 degrees. Pile driving times show that pile driving (restrike) occurred for periods of time between 11:49 and 12:05 (for pile number PD-P1). The animal was almost directly in-line with respect to the pile location and the MMO (Figure 3-32). After correcting for animal location based on distance and bearing relative to the observer, the distance from the animal to the pile was determined to be approximately 30 m (98 ft). Using the source acoustician location data, the source acoustician was south of the pile, while the observer was to the northeast of the pile. The exact placement of the barge relative to the pile on that day is known and may have obscured the pile location. The barge location may have impacted the observers' ability to judge distance relative to the pile. Although the sea lion was sighted relatively close to the shutdown zone, the MMO assumed that, since it was seen passing the 48.8 x 12.2 m (160 x 40 ft) barge, it was outside of the shutdown ZOI. The note associated with this record says, "goes right past barge, no change. Continues southeast then turns southwest towards EOD pier." Also, based on the swim speed and direction of travel of the individual, and because it would have taken time to initiate the shutdown procedures, the sea lion would have been outside of the Level A ZOI before shutdown procedures could have been initiated. A sea lion sighting at 11:59 from the EOD Dock MMO ("SL2") may have been this animal off the south end of the Fuel Pier. This animal was also an adult male that was initially noted as swimming. There were no notes associated with this second sighting, so it is assumed that the animal was acting in a "normal" manner for the sea lions in the area and was treated as a regular sighting; however, it cannot be confirmed at this time that this was indeed the same animal as was sighted by the MMO at the shutdown ZOI.

A second California sea lion was sighted on April 30, 2014 and was found to be within the 75 m (246 ft) Level A ZOI. This individual was sighted on the inside portion of the Fuel Pier and was associated with pile number TD-T13. However, the attenuation rate of the inside piles was found to be greater than the outside piles, leading to a reduced Level A injury zone ZOI for the inside piles of 40 m (131 ft). As a result, the individual associated with the inside pile is not considered as a Level A "take," but rather is a Level B "take" based on the smaller ZOI.

3.2.3.3.2 Level B "Take"

The total number of Level B harassment takes for marine mammals during the IPP is summarized in Table 3-22.

During monitoring associated with the IPP, there were no in-water construction shutdowns; however, during the setup phases for two separate piles, the MMCC notified the construction crew that animals were sighted in the shutdown zone. The animals were swimming through the area, were in the shutdown zone from one to two minutes each, and were out of the shutdown zone before pile driving began. Pile driving was not delayed as a result of the sightings.

Table 3-22. Summary of Observed Level A and B Harassment "Take", during the IPP.

Species	Allowed "Take"[1]	Total Number of Individuals	Total Number of Sightings	Total "Take" (Percent of allowed "Take")	
				Level A	Level B
California sea lion	994	2,299	1,061	1	387 (39%)
Coastal bottlenose dolphin	307	83	34	0	13 (4%)
Common dolphin	0	19	3	0	0
Pacific harbor seal	90	25	23	0	6 (7%)
Total		2,426	1,121	1	406

Note: [1] Includes Level B "take" only

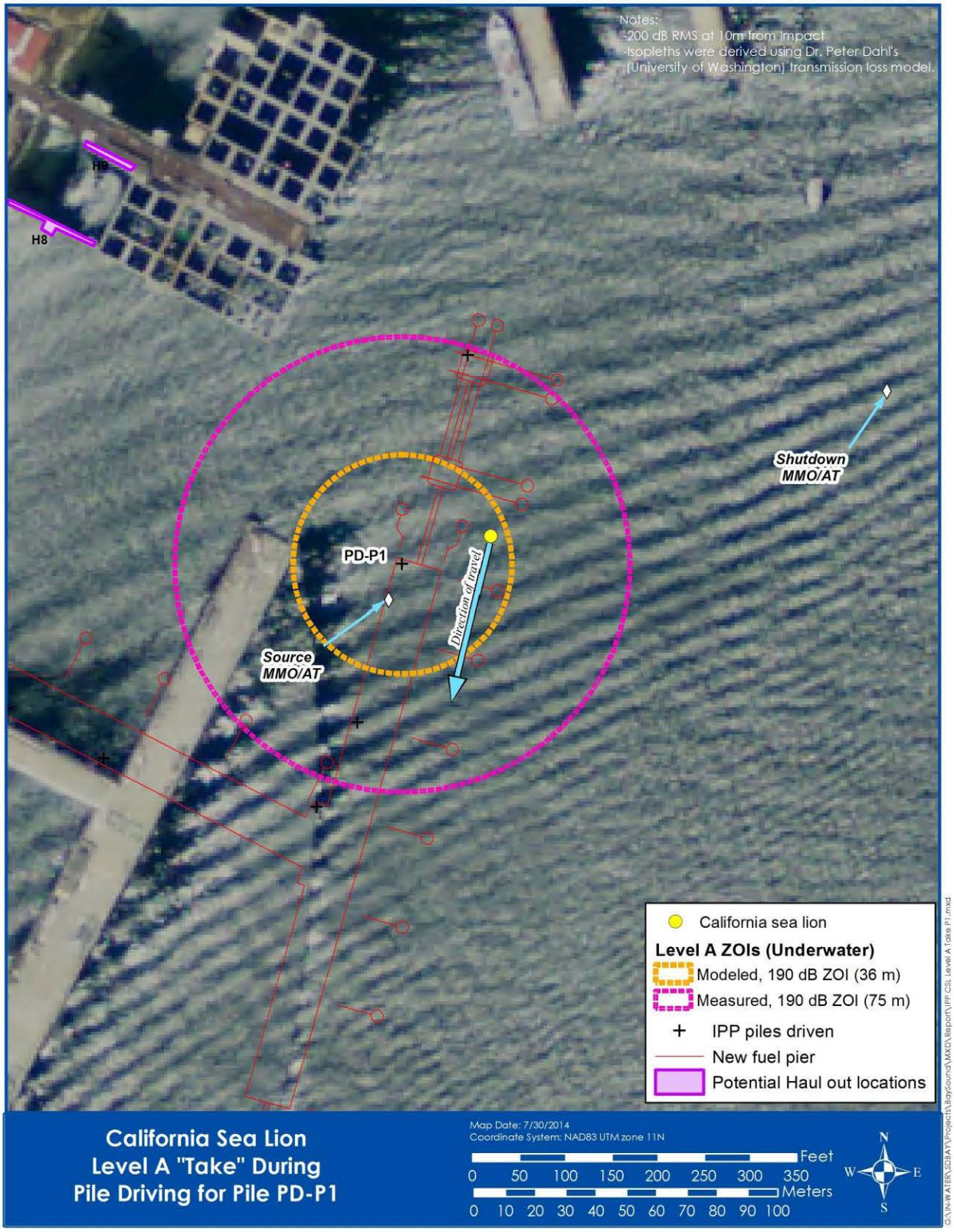


Figure 3-32. Level A "take" for a Single California Sea Lion During Pile Driving.

4.0 Discussion

Sound pressure levels documented during pile removal and pile driving of 12-inch and 16-inch concrete piles at NMAWC fell somewhat outside of expected levels. The implementation of acoustic and marine species monitoring during NMAWC provided valuable lessons in terms of logistics, communications, data collection, and wav file processing. Maximum and average hydroacoustic dB rms SPLs, derived from wav file post-processing, for a 16-inch concrete piles, were approximately 6 to 10 dB rms greater than levels reported for similar piles and methods elsewhere (CalTrans 2009). The NMAWC project site was relatively shallow 2 to 4 m (6.5 to 13 ft) depth and acoustic boundary conditions created by construction barges, existing marina structures, and the narrow width of the channel likely contributed to variability in acoustic sound level recording results. SPLs analyzed from raw wav files in conjunction with LZF_{max} dB values archived in the LD 831 reporting metrics provided sufficient SPL values needed to assess NMAWC site specific transmission loss and identify applicable marine species ZOIs. Transmission loss for NMAWC piles was calculated by plotting all source and far-field dB rms SPLs for the varying distances and examining the slope of the line. The transmission loss coefficient was approximately 20logR placing the 160 dB rms behavioral disturbance ZOI for marine mammals at between 100 and 125 m (328 and 410 ft) for source levels of 180 to 182 dB rms, respectively.

During NMAWC, SPLs were documented for each type and size of pile as well as each separate in-water construction activity. Pile removal activities generated non impulse sound that did not exceed 155 dB rms. The greatest SPLs documented during pile removal occurred during crane dead pulling in conjunction with water jetting and during barge movements utilizing a push barge. SPLs and turbidity associated with pile removal activities for 12-in and 16-inch concrete piles did not exceed regulatory thresholds, with impacts confined to areas mostly within 30 m (98.4 ft) of the piles. Airborne sound levels were highly variable at the NMAWC site and were noticeably affected by boundary conditions created by the narrow channel, building structures, and landside topography. Overall, acoustic monitoring results provided effective delineation of both the underwater and airborne isopleths needed to establish associated marine species ZOIs as well as to determine impacts for each of the individual species.

During the Fuel Pier IPP SPLs documented from pile driving of 30-inch and 36-inch steel pipe piles fell outside of expected levels. Modeling performed during the planning process analyzed SPLs predicted for impact and vibratory driving of 48 inch steel pipe piles and were reported to be 195 dB rms and 190 dB rms at source (10 m [32.8 ft]), respectively (CalTrans 2009). Hydroacoustic sound level recordings collected and analyzed during the IPP for vibratory and impact pile driving recorded lower than expected dB rms SPLs for vibratory pile driving (≈ 170 dB rms) for both 30-inch and 36-inch steel pipe piles and greater than expected (≈ 202 dB rms) dB rms SPLs for impact pile driving.

Analysis of raw wav files collected from the LD 831 SLM and Loggerhead® units showed that the two units provided reliable values and could be used interchangeably or to perform quality control comparisons. Post-processing of raw wav files from the LD 831 SLM and Loggerhead® units proved to be time intensive and not all files could effectively be analyzed prior the next day's field data collection efforts. An in situ evaluation of SPLs during the IPP was most

effectively conducted using the UW APLs Hydro DB real time dB rms SLM which displayed dB peak, dB rms, and dB SEL in a graphical format in near real time as the unit was deployed at various distances from source (see Figure 3-14). During the first two days of the IPP SPL measurements collected using the Hydro DB SLM provided confirmation of source levels and transmission loss sufficient to maintain and amend MMO locations and ZOI boundaries.

For both vibratory and impact pile driving methods, results showed that transmission loss for piles driven shoreward (inside) of the existing fuel pier was greater than piles driven bayward (outside). Differences in-depth, sediment type, and existing in-water pier/wharf structures likely accounted for differences in rms SPLs recorded by the shutdown and far-field ATs located at similar distances. SPLs documented at shutdown and far field locations during pile driving of both inside and outside steel pipe piles of the same size recorded observably different SPLs. Differences in the two IPP locations required implementation of amended acoustic monitoring strategies for both underwater and airborne acoustic data collection efforts.

Acoustic monitoring results during the IPP for vibratory and impact pile driving activities displayed consistent SPLs for each separate size, location, and hammer energy setting. Differences in received SPLs at source (10 m [32.8 ft]), shutdown (125 to 300 m [492 to 984 ft]), and at far-field locations (1,500 to 4,000 m [4,921 to 13,123 ft]) were within 5 dB with few exceptions. Examination of wave forms derived from raw wav files displayed regularity in voltages and resulting SPLs for each impact hammer energy level. For impact pile driving differences in received SPLs between soft start (Level 1) and the maximum hammer energy setting (Level 4) was approximately 10 to 15 dB rms, at source (10 m [32.8 ft]). The soft start technique was applied consistently during all pile driving activities and appeared effective as an initial warning to marine species within the immediate area.

Vibratory pile driving results documented that source levels consistently reached 170 dB rms and fluctuated both temporally and spatially. Variations in SPLs during vibratory driving events of individual piles were noted by ATs on station and were evident in resulting wave forms. Based on notes collected by the source AT changes in SPLs most frequently occurred over short durations of 3 to 10 seconds and appeared related to stratified sediment layers at different depths. Soft start was performed prior to each vibratory pile driving event and followed the identical procedure as the impact soft start method. The vibratory hammer was utilized at only one energy setting during all soft start and driving events and no difference in SPL's recorded at source were observed. Since source SPLs were below expected levels documented and observed SPLs at the shutdown and far field locations were of less concern. At far field locations ATs had difficulty differentiating SPLs less than 140 dB rms, from the continuous sound source produced by vibratory driving, from snapping shrimp and boat noise. Due to the relatively low SPLs (<170 dB rms) and limited number of sample data events for vibratory pile driving acousticians were unable to define where SPLs generated from vibratory pile driving became discernible from background sound levels. Reporting metrics for vibratory pile driving were not developed and will be more completely evaluated during acoustic monitoring during the 2014/2015 production year.

For the IPP measured SPLs for each similar pile size and location were analyzed by UW APL acousticians to determine the 190, 180, and 160 dB rms isopleths. Considering the limited number

of piles driven in both the inside and outside locations some best fit modeling was integrated into the results. The distance to isopleths from source was greater than previously modeled for the 190 dB isopleth, and was accounted for by increased source level (modeled using a 200 dB rms source level). The location of the 180 dB rms isopleth remained consistent throughout the IPP, for pile driving activities, staying at approximately 450 m (1,476 ft). In contrast the 160 dB rms isopleths was located closer to the source than previously modeled. Acoustical analysis of multiple recordings collected by both stationary SLMs and the Hydro DB SLM conservatively placed the 160 dB rms isopleth at a distance of 2,500 m (8,202.1 ft) from the source. A single conservative 160 dB ZOI distance was applied to all piles sizes and locations facilitate future IHA take estimates and account for variability in documented far-field SPLs in separate locations. The change to the 160 dB rms isopleths distance did not appreciably change the area or responsibility for the far-field MMOs. The most important amendment to measured ZOIs was to the 190 dB rms isopleth which was at 75 m (246 ft), rather than the modeled 36 m (118.1 ft). See hydroacoustic SPLs for a full synopsis of the distances to the regulatory thresholds.

During the IPP each individual pile was subjected to restrikes to assess maximum vertical and horizontal load engineering requirements. SPLs recorded during restrikes were at or below initial impact pile driving levels and available files were post processed for all reporting metrics (Appendix L). Unfortunately SLM calibration file recordings needed for raw wav file post processing during restrikes necessitated the exclusion of recorded wave files at source. Calibration file recordings were conducted using a pistonphone that experienced an internal failure and was shipped back to the manufacturer. Fortunately, the use of a second pistonphone utilized by shutdown and far-field acoustic recording stations and the SLMs archiving of the LZF_{max} values preserved sufficient data for evaluation and comparison of initial impact pile driving SPLs.

Airborne sound attenuation at the IPP site was much greater than that documented for NMWAC and was near typical spherical spreading loss levels used to model potential impacts in the IHA (NMFS 2013). Acoustic monitoring results provided effective delineation of both underwater and airborne isopleths need to establish associated marine species ZOIs and determine impacts for each of the individual species.

Marine mammal species at NMAWC and during the IPP generally did not show any visible reactions to sound within the measured ZOIs for the Level A and Level B harassment criteria. There were five cases of reactions that might be considered a result of a stimulus (see Table 3-20 and the coastal bottlenose dolphin section of the IPP Results). These sightings equated to a relatively small proportion (0.2%) of the total number of sightings for all species. Direct impacts occurred with relative infrequency and the lack of overt reactions to pile driving indicates that, overall, marine mammals in the area have either habituated to these noise levels, or have developed mechanisms to cope with the noise environment in San Diego Bay.

The total number of marine mammal sightings at NMAWC made up a small proportion (1.3%) of the total number of sightings throughout the whole project timeframe (January, 2014 to May, 2014). California sea lions were the most sighted species at NMAWC, followed by Pacific harbor seals. Sightings of Pacific harbor seals were unexpected because they had not been sighted in the area during previous Navy-sponsored Baywide marine mammal surveys (Merkel

and Assoc, 2008; TDI 2014), as well as by NMMF personnel (Victoria Bowman, NMMF, pers. comm.) who are well acquainted with the area. This may represent a short-term attraction to the area due to the construction activity, but this cannot be verified without further surveys in the area after all construction has been completed. The single coastal bottlenose dolphin sighting was likely an animal that was transiting further into San Diego Bay.

The California sea lion was the most sighted marine mammal during the IPP, with congregations of animals around the haul out locations identified in Figure 2-1. Prior to the IPP, the Everingham Brother's Bait Barge was a known haul out location with up to 332 individual California sea lions congregating at that location at one time (Merkel and Assoc, 2008; TDI 2014). As a result of its proximity to the project (approximately 500 m [1.640 ft]), it was moved in mid-April before pile driving began in order to reduce the potential for large aggregations of California sea lions in the project area. It was thought that California sea lions were using the bait barge as a location for easy feeding opportunities, and that they would follow the bait barge to its new location further in San Diego Bay. The EA (Navy 2013a) and IHA application (Navy 2013b) provide a full accounting of the new location for the bait barge. What became apparent as the project progressed into the pile driving phase was that many of the California sea lions that congregated at the bait barge were not leaving the area and following the bait barge, but were using the piers and docks closer to the south (approximately 150 m [492 ft]) and north (from 100 to 350 m [328 to 1,148 ft]) of the Fuel Pier as substitute haul out locations. As a result, MMOs were designated to specifically monitor the animals that congregated at these locations (see Figure 2-1). Behaviorally, individuals at these locations did not show overt reactions to pile driving and their behaviors were consistent between pile driving and non-pile driving sightings.

Similar to California sea lions, other marine species (Pacific harbor seals, coastal bottlenose dolphins, and California least terns) sighted during the IPP did not appear to be impacted by noise generated during pile driving. A concern was that prey species might leave the area as a result of pile driving. Based on data evaluated in the Fish Study as part of the IPP (Appendix C), the fish species studied showed little behavioral reaction to pile driving, and no change in site fidelity. Specifically, California least terns were identified as a species that might potentially be affected by a reduction in prey species density in the area. Across all sightings during pile driving at the MMO observation points closest to the Fuel Pier, birds that were noted as foraging had a 100% (n=28) success rate. The sighting rate during pile driving (13.90 individuals per hour) was almost three and a half times the sightings rate as during non-pile driving (4.07 individuals per hour). This high foraging success rate, and the increase in individuals per hour, during pile driving may be a result of California least tern prey species reacting to pile driving and becoming more visible by hovering birds; however, without baseline data for California least terns in these areas, conclusions should not be drawn as to whether foraging success was the same or different during the IPP timeframe, but rather that foraging still occurred during pile driving.

California sea lions sightings made up a majority of the marine species sightings at both NMAWC and during the IPP, with 94% of all marine mammal sightings. Similar to San Diego Bay, other construction projects have occurred along the western coast of the United States involving the installation of steel piles using vibratory and impact pile driving. In many of these areas, California sea lions are also common visitors or residents of the area and are known to

haul out on man-made structures such as piers, docks, navigation buoys, and Naval vessels (Navy 2011; HDR 2012; HartCrowser 2013; USCG 2013). California sea lions are thought to haul out to rest, socialize, breed or molt. In each of the above projects, marine mammal monitoring was used to minimize impacts to the surrounding environment and document the occurrence of marine species and potential behavioral responses. Overall, similar responses (or a lack thereof) were observed at each of these areas. In most cases, disturbance was minimal and included small behavioral responses such as an increased alertness, barking, and/or looking in the general direction of the sound source (USCG 2013; Navy 2011). California sea lions were typically seen conducting the same or similar behaviors during pile driving as they were during non-pile driving. Animals occasionally left the immediate area but it was also reported that many individuals did not exhibit any change in behavior and either remained in the area or continued on the original path of travel (HDR 2012; HartCrowser 2013). In no report were behavioral changes such as increased swimming speeds, increased surfacing time, or decreased foraging observed (Navy 2011; HDR 2012; HartCrowser 2013; USCG 2013). While there were four instances during the IPP of California sea lions changing their behavior as a response to a stimulus, the small number of behavioral changes relative to the overall number of California sea lion sightings should not be viewed as indicative of a trend with regards to pile driving during the IPP. Furthermore, the haul out locations near the pier are potentially going to be removed, further reducing the potential for California sea lions to be in the area.

Weather conditions in the vicinity of the IPP were more variable than at NMAWC. This is most likely because the area is much more exposed than the enclosed embayment at NMAWC; however, while more variable, weather conditions during the IPP timeframe were still favorable for sighting marine species. California sea lion group size increased with the increased BSS (see Table 3-21). Relative to other pile driving projects in areas with highly variable weather conditions (HDR 2012; HartCrowser 2013) conditions, in general, in San Diego Bay were favorable for monitoring. During the IPP, the increase in group size of the California sea lions during BSS of three to five may be indicative of individuals forming larger groups when weather conditions deteriorate.

Per the monitoring protocol, a shutdown would be called for in the event that an animal was seen within or approaching the Level A ZOI. The California sea lion that was within the Level A ZOI during the IPP was initially sighted relatively close to the barge, but was assumed to be outside of the ZOI at its initial sighting. If there had been any question about the location of the sea lion relative to the ZOI, the observer would have communicated with an additional observer either on the barge or at source to verify its location relative to the pile. A shutdown was not called because the animal was not confirmed by any other observer(s) to have entered the ZOI and was already moving south, away from the pile at the initial sighting. Furthermore, the individual was not observed in the area prior to this sighting and it transited out of the area without any apparent reaction. No video or photographic evidence was gathered because the animal was assumed to be outside of the Level A injury ZOI.

Data is not available for the rate at which pups may be born in San Diego Bay, but, based on the fact that recently birthed pups were identified as being in the area, there is at least some potential birthing activity. The three sea lions pups that were found dead in the vicinity of the Fuel Pier were all found after a weekend, which would seem to indicate that whatever may have caused

their death happened outside of pile driving activities. Furthermore, a U.S. Army veterinarian who examined the pups determined that they died of malnutrition. Level B "take" did not exceed the allowed "take" as specified in the IHA (NMFS 2013; Table 4-1); however, based on data provided from the on-going San Diego Bay marine mammal surveys (Merkel and Assoc, 2008; TDI 2014), and presented in the IHA Application (Navy 2013b), there has been an increase in the California sea lion abundance in San Diego Bay. The data presented in the Results section of this document shows that there were 229.9 individuals sighted per day, with an average of 11.09 "takes" per day during the IPP. The overall number of animals seen per day is higher than the 175 individuals anticipated to be in the project area as presented in the IHA Application (Navy 2013b). While every effort was made to minimize counting the same animal more than once, the fact that California sea lions look very similar to one another at various stages of their lives, as well as the fact that they are very social animals that tend to congregate in large groups, made it impractical to maintain visual contact with each individual animal. This higher number of animals per day could be a result of observer over-estimation, or because many California sea lions were sighted in distinct areas and may have been counted more than once between different sightings. Because the monitoring for this project is not based on a comprehensive survey protocol to assess abundance, the 229.9 animals per day should not be viewed as representative of the overall population in northern San Diego Bay.

The modeled Level B (behavioral) harassment zone was modeled to extend to 6,470 m (21,227 ft); however, the SPL values provided by ATs showed that the Level B ZOI was closer to 3,000 m (9,842 ft). As a result, the whole ensonified area associated with project was able to be monitored. Monitoring coverage of the Level A shutdown zone was consistently excellent; however, it was not always possible to have 100% coverage of the Level B (behavioral) harassment zone during in-water pile operations because a MMO could only look in one direction at any given time. Additionally, the efficacy of visual detection of marine mammals depended on several factors, including the observer's ability to detect the animal, environmental conditions (e.g., visibility and sea state), and the position of the monitoring platforms. The proportion of animals that may have been missed during monitoring effort was likely small given that all MMOs were experienced professionals with a skillset that enabled them to identify as many animals as possible in the project area.

Table 4-1. Summary of Total "Take" During All Construction Activities.

Species	Allowed "Take" (Level B only)	Total "Take"		Takes Per Day	
		Level A	Level B	Level A	Level B
California sea lion	994	1	388 (39%)	0.03	11.09
Coastal bottlenose dolphin	307	0	13 (4%)	0	4.66
Common dolphin	0	0	0	0	0
Pacific harbor seal	90	0	7 (7%)	0	0.2
Total		1	408		

5.0 Conclusion

The implementation of the IPP was critical in assessing location specific pile driving methods and determining resulting SPLs for each size of pile and installation method, prior to scheduled production pile driving and removal in September 2014. The acoustic and marine species monitoring conducted to evaluate in-water construction activities, specifically pile driving and removal activities, presented significant challenges in terms of logistics, field data collection, and data processing. In order to comply with IHA acoustic and marine species data collection and reporting requirements proposed monitoring methods and reporting metrics required amendments as well as additional personnel and redundant acoustic recording equipment. Acoustic data collection procedures and required reporting metrics stipulated by NOAA in the IHA were difficult to comply with for all impulse and continuous sound source recordings. Specific reporting metrics stipulated in the IHA were not sufficiently defined in terms of applying needed analysis parameters therefore Dr. Peter Dahl of UW APL defined the parameters for the reported IPP reporting metrics analysis (see Acoustic Methods). These proposed modifications to the acoustic methodologies and analysis are will be further discussed during the IHA application process. Site specific bathymetry, in conjunction with extensive commercial and recreational structures and use in San Diego Bay and other urbanized locations, introduces variables to transmission loss that were difficult to isolate or assess. Future acoustic monitoring efforts of the NBPL FLC Fuel Pier Replacement Project will strive to improve the consistency of data collection efforts and comprehensively document ZOIs associated with both vibratory and impact pile driving of piles installed bayward of the existing fuel pier. Additionally, the project will continue to work collaboratively with Dr. Peter Dahl and NOAA to develop applicable and concise reporting metrics.

Marine species monitoring of pile driving activities producing SPLs greater than 190 dB rms requires a broad application of conservative ZOIs to assure avoidance of Level A injury takes of pinnipeds and cetacean species. Differences in pile location over a large project site containing variable bathymetry, visual obstructions, and acoustic boundary conditions requires frequent amendments to monitoring locations and strategies. While these conditions created logistical complications, all monitoring was completed as efficiently as possible. In most cases, species sighted did not show any overt reactions to pile driving, even while inside the designated monitoring ZOIs. For those species that did show a potential reaction to pile driving activities, the sightings were outside of the Level A ZOIs. The only animal that was within the modeled, and measured, Level A ZOI did not show any obvious reaction to the pile being driven during the sighting. While individual animals may react differently to stimuli, overall, it does not appear that pile driving directly impacted animals in the area. It appears that animals have become habituated to the sounds associated with the Fuel Pier, and likely the noisy environment in San Diego Bay.

6.0 Recommendations

For future pile driving and removal activities for the NBPL Fuel Pier Replacement project, the following recommendations are requested for consideration:

1. We recommend use of a Loggerhead DSG-ocean acoustic data logger system as the primary acoustic sound level recorder at source and shutdown. Use of this hydrophone system would alleviate issues with recording calibration tones and in developing voltage to RVS relationships needed for raw wav files post-processing;
2. Based on the best available acoustic equipment in the current marketplace, acousticians at the UW APL recommend that NOAA consider waving the requirement to observe SPLs in real time during production pile driving. Several of the best systems for in-water hydroacoustic data collection are not designed to provide real-time values, but rather are designed to be calibrated infrequently and deployed in the water column to collect data continuously;
3. Adjustment of the calibration frequency (time) criteria to be consistent with professionally accepted practices, or with SLM, acoustic data logger, and hydrophone manufacturer recommendations. We suggest an intermittent insertion of a calibration tone into the recording system, for a through-the-system calibration;
4. Based on acoustic data collected during the IPP, we recommend reducing the number and frequency of acoustic data collection. Acoustical analysis of 10% of the piles proposed for Year 2 of the project would provide sufficient data to further validate the acoustic data that was collected during the IPP;
5. Based on the presence of common dolphins during the IPP, this species should be included in any future permits for the Fuel Pier construction; and
6. No green sea turtles were observed during the duration of construction activities at NMAWC or during the IPP. With the decommissioning of the South Bay Power Plant in southern San Diego Bay, further detailed analysis of green sea turtle density should be completed to provide updates to current available data.

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