APPENDIX F
<u>Noise Study</u>

Draft Noise Technical Report

Long Beach Cruise Terminal Improvement Project

Prepared for ATKINS Global

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11183495| 10 | Report No 2 | April 30, 2019

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Acronym List

A-	noise level estimated at “C” meters
APE-	American Pile Driving Equipment, INC
B-	wildlife threshold
C-	distance (meters) of a known or measured sound level
CADNA	Computer Aided Noise Abatement
Caltrans-	California Department of Transportation
CDFW-	California Department of Fish and Wildlife
CEDA-	Central Dredging Association
CESA-	California Endangered Species Act
CFR-	Code of Federal Regulations
cy-	cubic yards
D-	wildlife isopleth threshold
dB-	decibel
dBA-	A-weighted decibel
dB_{peak}-	Peak Sound Pressure Level
dB_{rms}-	units for the root mean squared sound pressure level
DEIR-	Draft Environmental Impact Report
DMMT-	Dredged Material Management Team
DOI-	Department of the Interior’s
ESA-	Endangered Species Act
FEIR-	Final Environmental Impact Report
FGC-	California Fish and Game Code
FHWA-	Federal Highway Administration
ft-	feet
ft-lbs-	foot pound-force
GARFO-	Greater Atlantic Regional Fisheries Office
HF-	high-frequency
Hz-	Hertz
IHA-	Incidental Harassment Authorization
kHz-	kilo-Hertz

km-	kilometers
kNm-	kilonewton meters
LA-	Los Angeles
LBCT	Long Beach Cruise Terminal
$L_{E, p}$-	Cumulative Sound Pressure Level
L_{eq}-	Equivalent Sound Level
LF-	low-frequency
LOA-	Letters of Authorization
$L_{p, 0\text{-}pk}$ -	Peak Sound Pressure Level
LT1	Long term monitoring location at marina in LA Harbor
LT2	Long term monitoring location on deck of Queen Mary
m-	meters
m^2-	square meter
MBTA-	Migratory Bird Treaty Act
MF-	mid-frequency
MLLW-	Mean Lower Low Water
MMPA-	Marine Mammal Protection Act
msec-	millseconds
NMFS-	National Marine Fisheries Service
NOAA-	National Oceanic and Atmospheric Administration
NOS-	National Ocean Service
ODMDS-	Ocean Dredged Material Disposal Site
OW-	otariid pinnipeds
PK-	Peak Sound Pressure Level
PLC-	Public Limited Company
POLB-	Port of Long Beach
POR 1-	Queen Mary Aft Deck (LT2)
POR 2-	Queen Mary Mid Deck (ST3)
POR 3-	Queen Mary Aft Deck (ST4)
POR 4-	Harbor Center (LT1)
POR 5-	Harbor East End (ST1)
POR 6-	Harbor West End (ST2)

PSLM-	practical spreading loss model
PTS-	permanent threshold shifts
PW-	phocid pinnipeds
R_1-	distance of a known or measured sound level
R_2-	estimated distance required for the sound to attenuate
RCNM-	Road Construction Noise Model
re-	reference
RMS-	Root Mean Squared
s^{-1}-	cycle per second
SAF-	Simplified Attenuation Formula
SEL-	Sound Exposure Level
SEL_{cum}	Cumulative Sound Pressure Level
SPL-	Sound Pressure Level
SPL_{peak}	Peak Sound Pressure Level
sq ft-	square feet
ST1	South End of Harbor
ST2	North End of Harbor
ST3	Queen Mary Mid Deck
ST4-	Queen Mary Fore Deck
T-	underwater noise attenuation rate
TL-	Transmission Loss
TTS-	temporary threshold shifts
U.S.-	United States
USC-	U.S. Code
USFWS-	U.S. Fish and Wildlife Service
WSDOT-	Washington Department of Transportation
µPa-	microPascals

1. Introduction

Carnival Corporation ("Carnival") desires to make improvements to its facilities at the Long Beach Cruise Terminal (LBCT) near the Queen Mary located at Pier H in the Port of Long Beach (POLB), Long Beach, California (Appendix A, Figures 1-2). These improvements are to ensure that (i) the new class of cruise ships with approximately 4,000 passengers can be safely moored at the POLB and be serviced and ii) improve existing safety at the berth related to swells. The improvements will entail all actions and activities necessary to safely accommodate the larger vessel and the associated increase in passenger numbers (hereafter the Proposed Project). Implementation of the Proposed Project would require the dredging of approximately 33,250 cubic yards (cy) of dredge material from the existing berth and immediate surrounding area, disposal of the dredged material, as well as berth improvements such as the installation of new high-capacity mooring dolphins, fenders, and a new passenger bridge system. Additional onshore improvements include extensions to the existing parking structure, reconfiguration of leasehold traffic lanes, and final removal of an abandoned tunnel system.

The City of Long Beach (City) is the lead agency. Due to the location and scope of the Project, there is potential for the Project to impact sensitive noise receptors (humans and wildlife). This Noise Technical Report has been prepared in order to evaluate the potential for construction activities associated with the Proposed Project to generate an increase in in-air and underwater noise. Future operational noise levels were also examined. Additionally, this report provides recommendations to minimize or mitigate construction-generated noise.

2. The Fundamentals of Noise

Noise is generated when an object moves in space and creates waves (either in air or water). Ears perceive these waves as sound (WSDOT 2012). Sound is more formally defined as "an alteration in pressure propagated by the action of elastic stresses in an elastic medium and that involves local compression and expansion of the medium" (ANSI 2013). The following sections explain general noise terms used in this technical report more clearly.

The amplitude (loudness) of a sound is its pressure, whereas its intensity is proportional to power and is pressure squared. The standard international unit of measurement for pressure is the Pascal, which is a force of one Newton exerted over an area of one square meter (m^2); sound pressures are measured in microPascals (μPa).

Considering the range of pressures and intensities collected during measurements of sound, a logarithmic scale is used, based on the decibel (dB), for sound pressure level (SPL), the amplitude ratio in dB is 20 times the $\log_{10}$ ratio of measurement to reference. Hence each increase of 20 dB in SPL reflects a 10-fold increase in signal amplitude. That means that 20 dB is 10 times less the amplitude than 40 dB Decibels (dB) is a relative measure and must be accompanied by an amplitude reference. In describing underwater sound pressure, the reference amplitude is usually 1 μPa, and is expressed as "dB re 1 μPa." For in-air sound pressure, the reference (re) amplitude is usually 20 μPa and is expressed as "dB re 20 μPa."

2.1 A-weighted Sound Level, dBA

Loudness is a subjective rating that enables a listener to order the magnitude of different sounds on a scale from soft to loud. Perceived loudness of a sound is based on its sound pressure, frequency and duration.

Sound pressure level is typically expressed as a ratio of the absolute sound pressure to a standard reference value, such as the lowest intensity sound that can be heard by the average person. Sound pressure level is always expressed in decibels, a logarithmic scale.

Frequency is the number of oscillations per second in a sound wave, expressed in units known as Hertz (Hz). Sounds heard in the environment usually consist of a range of frequencies. The distribution of sound energy as a function of frequency is termed the "frequency spectrum."

The human ear does not respond equally to different frequencies even at identical decibel levels, hence the subjectivity of loudness. The normal frequency range of hearing for most people extends from a low of about 20 Hz to a high of 10,000 Hz on average, but can be up to 20,000 Hz. Human ears are most sensitive to sounds in the voice range, between about 500 Hz to 2,000 Hz (Yost 2007). Therefore, in order to effectively measure and convey the combined effect of sound pressure and frequency as perceived by people, the sound energy spectrum is adjusted or "weighted."

The weighting system most commonly used to correlate with people's response to noise is "A-weighting" (or the "A-filter") and the resultant noise level is called the "A-weighted noise level", expressed in decibel-A units (dBA) (Yost 2007). A-weighting significantly de-emphasizes parts of the frequency spectrum that occur at frequencies both below and above human hearing (below 500 Hz and above 10,000 Hz). The system instead accentuates frequencies in the middle to high frequency range with the peak around 3,000 Hz. This results in a graph profile that looks like a truncated bell curve. A-weighting has been found to correlate better with the human perception of "noisiness" than other weighting systems, such as C-weighting. The C-weighting system is weighted more evenly through the middle range while tapering towards the outer ends of human hearing. This gives its graph profile a more "flat" or table-like appearance. One of the primary advantages of the A-weighting system is that it emphasizes the frequency range where human speech occurs, and therefore the range in which noise would most interfere with speech communication.

2.2 Equivalent Sound Level, L_{eq}

The Equivalent Sound Level, abbreviated L_{eq}, is a measure of the total exposure resulting from the accumulation of A-weighted sound levels over a particular period of interest -- for example: an hour, an 8-hour school day, nighttime, or a full 24-hour day (Yost 2007). However, because the length of the period can be different depending on the time frame of interest, the applicable period should always be identified or clearly understood when discussing the metric. Such durations are often identified through a subscript, for example Leq_{1h}, or $Leq_{(24)}$.

L_{eq} may be thought of as a constant sound level over the period of interest that contains as much sound energy as (is "equivalent" to) the actual time-varying sound level with its normal peaks and valleys. It is important to recognize, however, that the two signals (the constant one and the time-varying one) would sound very different from each other. Also, the "average" sound level suggested by L_{eq} is not a linear function, but logarithmic, or "energy-averaged" sound level. Thus, the loudest events may dominate the noise environment described by the metric, depending on the relative loudness of the events.

2.3 Statistical Sound Level Descriptors

Statistical descriptors of the time-varying sound level are often used instead of, or in addition to L_{eq} to provide more information about how the sound level varied during the time period of interest. The descriptor includes a subscript that indicates the percentage of time the sound level is exceeded during the period. The L_{50} is an example, which represents the sound level exceeded 50 percent of the time, and equals the median sound level (Yost 2007). Another commonly used descriptor is the L_{10}, which represents the sound level exceeded 10 percent of the measurement period and describes the sound level during the louder portions of the period. The L_{90} is often used to describe the quieter background sound levels that occurred, since it represents the level exceeded 90 percent of the period.

2.4 Sound in Air versus Water

Due to the fact that water is denser than air, sound waves travel further and faster underwater than in air when unimpeded. In air, noise levels diminish by 6 dB as the distance doubles. In comparison, noise levels only reduce by ~4.5 dB per doubling distance underwater (depends on properties of water body). Airborne and underwater noise also have different reference values. The reference value for sound in air is dB re 20 μPa and dB re 1 μPa in water (IAGC 2014, National Oceanic and Atmospheric Administration (NOAA 2015)).

Temperature affects the speed of sound underwater, with sound traveling faster in warm versus cold water (NOAA 2015). Transmission loss in water, or the "decrease in acoustic intensity as an acoustic pressure waves propagates out from a source" may be also affected by numerous factors other than temperature including water chemistry, topography, and sea conditions (Scientific Fisheries Systems, Inc. 2009). A full list of in-air and underwater sound-related terms used in this technical report is provided below.

Table 2.1 Definition of Terms

Term	Abbreviation(s)	Reference Value	Unit	Definition
Decibel	dB	1 µPa (in water at 1 meter) 20 µPa (in air at 1 meter)	dB	One-tenth of a bel. Unit of level when the base of the logarithm is the tenth root of ten, and the quantities concerned are proportional to power[c]. Used to measure the amplitude of sound[b].
A-weighted decibel	dBA	20 µPa (in air at 1 meter)		A-weighted decibel. In-air noise measured on the A-weighted scale is designed to approximate human hearing. Scale starts at 0 dBA (faintest sound detectable by humans) to ~180 dBA (rocket launch)[g]. Increase in 10 dBA indicates 2x as loud.
Frequency	N/A	N/A	s^{-1}	The number of oscillations occurring over a unit of time (unless otherwise stated, cycles per second or hertz)[d].
Hertz	Hz	N/A	s^{-1}	Hertz (Hz): Unit of frequency corresponding to the number of cycles per second. One hertz corresponds to one cycle per second[a].
Sound Exposure Level	SEL	1 µPa sec (in water at 1 meter) 20 µPa sec (in air at 1 meter)	dB	The constant sound level in one second, which has the same amount of acoustic energy as the original time-varying sound (i.e., the total energy of an event). SEL is calculated by summing the cumulative pressure squared over the time of the event[f].
Sound Pressure Level	SPL	1 µPa (in water at 1 meter) 20 µPa (in air at 1 meter)	dB	A measure of sound level that represents only the pressure component of sound. Ten times the logarithm to the base 10 of the ratio of time-mean-square pressure of a sound in a stated frequency band to the square of the reference pressure[c].
Root Mean Squared Sound Pressure Level	RMS	1 µPa (in water at 1 meter) 20 µPa (in air at 1 meter)	dB_{rms}	Decibel measure of the square root of mean square (RMS) pressure. For impulses, the average of the squared pressures over the time that comprise that portion of the waveform containing 90 percent of the sound energy of the impulse[f].
Peak Sound Pressure Level	$L_{p,\ 0\text{-pk}}$ SPL_{peak} dB_{peak} PK	1 µPa (in water at 1 meter) 20 µPa (in air at 1 meter)	dB	Maximum instantaneous sound pressure from a short impulse sound/short sound duration[a].

Table 2.1 Definition of Terms

Term	Abbreviation(s)	Reference Value	Unit	Definition
Cumulative Sound Pressure Level	$L_{E,p}$ SEL$_{cum}$	1 μPa^{2}s	dB	Received level and duration of sound exposure over a given period of time or event. Metric is weighted in calculations for marine mammals based on National Marine Fisheries Service (NMFS) marine mammal auditory weighting functions[a].

[a]NMFS 2018a
[b]NOAA 2015
[c]ANSI 2013
[d]Yost 2007
[e]ISO 2017
[f]Buehler et al. 2015
[g]WSDOT 2012

3. Project Description

3.1 Background

The Proposed Project site is currently leased to Carnival by POLB and Urban Commons LLC, the master tenant from the City. These leases were originally acquired for Carnival's relocation in 2003 from Los Angeles' San Pedro Port to the POLB, when it moved the vessels from the Port of Los Angeles to POLB. The Carnival Cruise Lines Relocation Project Final Environmental Impact Report (FEIR) (November 2000) assessed the implications of the original relocation to POLB Four vessels currently call on the POLB Cruise Terminal. The *Carnival Splendor,* with an approximate capacity of 3,012 passengers, typically sails one day a week for cruises from seven to 14 days in duration. The *Carnival Imagination* (2,056 passengers) and *Carnival Inspiration* (2,054 passengers) vessels call on the terminal four days a week (combined) for three to four-day cruises. The *Carnival Miracle* occasionally docks at the POLB (scheduled for seven calls in 2019) and has a capacity of 2,124 guests. The company also arranged to lease the entirety of an onsite dome and, in early 2018, it opened the newly-renovated dome as a passenger terminal and 'home-ported' a 3,012-passenger vessel to Long Beach. Carnival transports approximately 600,000 passengers a year into the POLB for embarkation and debarkation. As stated previously, Carnival has run the Long Beach Cruise Terminal since 2003, the United States' only privately-operated cruise terminal. It is one of the busiest terminals in North America, with ships docking at the facility five days per week resulting in a more than 70% utilization rate. The increased size of the vessel is expected, under current economic conditions, to generate an additional 50,000 passengers per year.

3.2 Project Objectives

The purpose of the Proposed Project is to make improvements at the existing berth and its environs to enable new Vista-class ships to safely moor and be serviced. Also, the Proposed Project would resolve safety issues in the existing parking structure and vessel mooring. The improvements will enable the home-porting of the 4,008-passenger *Carnival Panorama* at POLB, which is planned for arrival in Long Beach in 2019. This will be the first new Carnival ship based in Southern California in 20 years, providing additional economic growth for the City of Long Beach and the Southern California region. The *Carnival Panorama* will be replacing the 3,012 *Carnival Splendor*, which is currently home-ported at Long Beach until December 2019, as the largest craft operating out of Carnival's POLB wharf.

3.3 Project Location

The POLB is located in San Pedro Bay within the southwest portion of the City of Long Beach in southern Los Angeles (LA) County, California. Figure 1 (Appendix A) serves as a map of the Long Beach region, indicating the Project vicinity. State Route 47 (via Interstate 110 Freeway) and the Interstate 710 Freeway provide access to the site from the surrounding area.

The POLB is administered by the City of Long Beach Harbor Department and encompasses 3,200 acres, with 31 miles of waterfront, 10 piers, and 80 berths. The POLB is the second-busiest container seaport in the United States, handling trade valued at more than $180 billion annually, with the aim of creating the world's most modern, efficient, and sustainable seaport. In 2004, The Board of Harbor Commissioners (BHC) directed the POLB to establish a Green Port Policy. The POLB complied and the BHC adopted the policy in January 2005. This policy serves as a guide for decision making and established a framework for environmentally friendly POLB operations.

The Project Area is located adjacent to Royal Mail Ship Queen Mary (Pier J), at Pier H within the Queen Mary Seaport at 231 Windsor Way (Appendix A, Figure 2). The Queen Mary Seaport is located at the south end of the Interstate 710 Freeway, directly across Queensway Bay from downtown Long Beach.

Current bathymetric data for the area indicates water depth of the existing berth ranges from approximately 28 feet (ft) to 47 ft Mean Lower Low Water (MLLW) within the berth perimeter. Water depths in this area generally slope from slightly lower bathymetry in the west (near the pier) to deeper depths to the east.

A proposed disposal site for dredge material is located at the LA-2 ocean dredged material disposal site (ODMDS), an existing disposal site just south of the POLB. The site is located in the Pacific Ocean at 33°37' 6" N, 118°17'24" W (Appendix A, Figure 1).

3.4 Construction

The Proposed Project would introduce maritime improvements at Carnival's Long Beach Cruise Terminal and onshore at Pier H within the adjacent parking garage. The enhancements are therefore discussed as maritime and onshore improvements (Appendix A, Figure 2).

3.4.1 Maritime Improvements

The maritime improvements are focused on accommodating safe and secure moorage along the sole wharf of the facility and to accommodate the *Vista* class vessel design. These improvements and associated activities include:

- Deepening the existing berth from the current design depth of 30 feet (ft) Mean Lower Low Water (MLLW) plus 1 foot of over-dredge to a new design depth of 36 ft MLLW plus 1 foot of over-dredge for a total depth of 37 ft MLLW. Over-dredge is a standard construction design method for dredging that occurs outside the required authorized dimensions to compensate for physical conditions and inaccuracies in the dredging process and allow for efficient dredging practices. Environmental documentation must reflect the total quantities likely to be dredged including authorized dimensions and allowable over-depth (Tavolaro et al. 2007). The new dredging depth will increase navigable and mooring margins; to cope with the pitch and roll movement of the vessels due to long period wave swells and to manage mooring loads on the dock structure. The estimated dredging volume is approximately 33,250 cubic yards (cy), which consists of the following:
    - Total dredging volume to 37 ft MLLW within the existing berth: 28,250 cy
    - Total dredging volume to 37 ft MLLW within the proposed berth extension area: 5,000 cy
    - Dredging the material is expected to take approximately 1 month
    - Disposal of approximately 33,250 cy of dredged material at the LA-2 ODMDS. This location has been selected based on the findings of the physical, chemical, and biological tests conducted on the material and in consultation with the Southern California Dredged Material Management Team. The disposal option selected would be the most cost-effective management option that best addresses the needs of environmental protection and economic development.
- The addition of two high-capacity, pile-founded mooring dolphins are needed to allow for adequate mooring capacity during reasonably anticipated dockside conditions, often including high winds and long-period wave swell actions, which have been anecdotally observed more frequently than in the past. The new dolphins will structurally follow the design detail applied to a similar installation performed in 2008 for the existing dolphins, which are located off the north and south ends of the dock. All dolphins will connect back to the wharf deck of the marine structure via installed catwalk bridge elements. The current dolphins have had capacity issues based upon current ship calls; thus the new dolphins will alleviate these problems.
- An extension to the existing passenger bridge system for an added ramp section to include an additional tower element on the existing wharf deck. A new tower and platform deck using new or current piles just south of the existing wharf deck. These new structures will connect to the existing gangway and will be approximately 63 feet above the water's surface. This will be designed to follow the specifications and design criteria of the existing gangway, to be adjustable for tidal conditions while remaining compliant with the American Disabilities Act.
- Replacement of the existing foam-filled fenders with oversized high-density foam-filled fenders and backing plates to improve the dampening characteristics that manage vessel movement and provide safe vessel stand-off distances from structures.

- Expansion of the existing water lease between POLB and Carnival from 7.81 acres to 11.8 acres to encompass the additional dredged area required. The existing and proposed lease does not encompass the full dredge limits; however, the lease language does allow dredging in the vicinity required for operation of the wharf. The total overwater work area is 17.06 acres, which includes the proposed water lease as well as the dredge extents.

3.4.2 Onshore Improvements

The onshore improvements are focused on an expansion of the existing parking garage to resolve current congestion and to support the increased passenger throughput expected from the larger vessel. Approximately an additional 500 vehicles will park at the facility on Saturdays for the *Carnival Panorama*. The onshore improvements include:

- Expanding the existing 5-level parking garage from 1,430 parking spaces to approximately 2,055 parking spaces by extending the parking garage laterally towards the southwest and northeast. This will expand existing levels at the same height of the existing structure. Both extensions are over the existing roadways on the leasehold, with vertical clearance heights maintained for all through traffic lanes to accommodate commercial vehicles, including emergency response vehicles (from an adjacent fire department).
- Removal of a dilapidated and abandoned concrete tunnel, ramp and support structures (the Island Express Passengerway). The tunnel is approximately 450ft and runs adjacent to the southwestern façade of the parking garage, under Windsor Way to behind the IEX Helicopters building.
- Reconfiguration of the leasehold traffic lanes on the southwestern side of the existing parking garage. The existing traffic around the southern corner of the parking garage is open in both directions to the public with traffic moving counter-clockwise on the outside lanes and clockwise on the inside lanes. This project proposes to modify that configuration with traffic open to the public only in the counter-clockwise direction on the inside lanes and a fire lane in the outside lane operating in the clockwise direction.
- Due to the need to maintain existing parking for current vessel operations, construction of the garage improvements is estimated to take 13 months and will include (i) installation of 236 foundation piles and (ii) backfilling of the tunnel system over a two-week period.

3.4.3 Dates, Duration, and Location of Construction Activities

Construction of the proposed project would occur in two major phases, from August 2019 to November 2020. Maritime improvements would occur under Phase I, an approximate 4-month duration from August 2019 to December 2019. The onshore improvements would occur under Phase II over an approximate 13-month duration from October 2019 to November 2020. Approximate details are set out as follows:

- Dredging berth area: one month (maximum). The equipment to be used for the dredging operations includes a barge with electric clamshell dredge with at least two tug boats, and two hopper barges. Active dredging is anticipated to take approximately 21 days, due to ship schedules. The dredging work may occur during times when pile driving is also taking place.

- Construction of mooring dolphins/catwalks: 2 months (may occur same time as dredging). Forty-nine piles need to be installed. Pile driving will be performed using a derrick barge with pile driver. Active pile-driving is anticipated to be completed within 3 to 4 weeks and may be concurrent with the dredging work days.
- Passenger boarding bridge foundation construction and tower installation: 2 months (to occur concurrently with dolphin construction)
- Parking garage: 13 months (to occur concurrently with maritime improvements and continue after completion of water-side work)
- Construction work will be undertaken by an estimated seven construction workers

The construction schedule is given in two tables. The first describes the offshore activities, including dredging, pile driving, and marine construction. The second describes the onshore activities at the garage area, including demolition, earthwork, structure, finishing, and hardscape and landscape.

In water work will be limited from August 27, 2019 to December 18, 2019. In total, pile driving is expected to take thirteen construction working days while dredging is expected to take three working days.

Table 3.1 Marine Construction Schedule

Phase	Work Activity	Start Date	End Date	Total Work Days
Pile Driving	Mobilization - Derrick Barge 1	8/27/2019	9/15/2019	15 days
	Pile Driving - Passenger Bridge Cap	9/16/2019	9/18/2019	3 days
	Pile Driving - South Dolphin	9/19/2019	9/25/2019	5 days
	Pile Driving - North Dolphin	9/26/2019	10/2/2019	5 days
Construction	Mobilize Derrick Barge 2	9/13/2019	9/18/2019	5 days
	Passenger Bridge Cap - Construction	9/19/2019	10/9/2019	15 days
	Passenger Bridge - Install Transition Tower	8/23/2019	9/18/2019	20 days
	Install Expansion Tower & Bridge	10/10/2019	11/6/2019	20 days
	South Dolphin - Construction	11/7/2019	12/11/2019	25 days
	North Dolphin - Construction	10/3/2019	11/6/2019	25 days
	Other Work	11/7/2019	12/11/2019	25 days
	Demobilize Derrick Barge 2	12/12/2019	12/18/2019	5 days

Table 3.1 Marine Construction Schedule

Phase	Work Activity	Start Date	End Date	Total Work Days
	Demobilize Derrick Barge 1	12/12/2019	12/18/2019	5 days
Dredging	Dredge - Mobilization	10/3/2019	10/9/2019	5 days
	Dredge Template	10/10/2019	10/31/2019	21 days
	Offshore Placement	10/10/2019	10/31/2019	10 days
	Dredging - Demobilization	10/31/2019	11/05/2019	5 days

Table 3.2 Onshore Construction Schedule (Garage)

Phase	Work Activity	Start Date	End Date	Total Work Days
Mobilization	Mobilization/ Safe Off	10/1/2019	10/19/2019	13
South Parking Garage	Demolition	10/19/2019	11/30/2019	30
	Earthwork and Utilities	1/30/2019	2/2/2020	46
	Structure	2/2/2020	8/26/2020	147
	Exterior Finishes	8/6/2020	9/24/2020	35
	Interior Finishes	7/7/2020	10/31/2020	83
North Parking Garage	Demolition	11/23/2019	1/15/2020	38
	Earthwork and Utilities	1/15/2020	3/19/2020	46
	Structure	3/19/2020	9/6/2020	122
	Exterior Finishes	8/17/2020	10/5/2020	35
	Interior Finishes	7/18/2020	10/31/2020	75
Hardscape and Landscape	Hardscape and Landscape	8/27/2020	10/18/2020	37

An examination of the schedule indicates that phases for both ends of the garage approximately overlap, so they were modeled as occurring together. As there is actually both blockage from the existing garage and greater distance to the receptors for sound from the south end, only the north end will be heard by residents when construction at both is occurring.

4. Legal Protections for Humans and Wildlife Against Injurious or Disruptive Noise

4.1 Humans

The City of Long Beach has both construction and non-construction in-air noise limits which are applied to various locations. The Long Beach Shoreline marina would be in Planned Development District (PD)-21 of the Long Beach zoning map. The actual noise limits do not apply to harbor operations; however, the local permitting authority uses them to determine if a project is appropriate. The construction levels are set at 70 dBA, day and night, while the non-construction levels would be 50 dBA at night in quiet residential areas, such as the marina across the harbor (District PD-6). Where the background noise would already approach or exceed this level, 5 dBA over current levels are allowed for these locations.

4.2 Wildlife

A number of federal and state laws protect wildlife from anthropogenic activities that may be injurious or disruptive to individuals or populations, including those generating noise. Depending on a number of factors such as animal sensitivity and proximity, construction-related noise has the possibility to permanently or temporarily damage animal hearing or cause life-threating embolisms, prevent animals from communicating normally (e.g., echolocation), or cause changes in normal animal behavior (such as abandoning nests or pups). These laws are described in further detail below.

4.2.1 Marine Mammal Protection Act (MMPA)

The MMPA (16 United States (U.S.) Code (USC) 1362) of 1972 prohibits the “taking” of marine mammals and restricts the import, export, or sale of marine mammals. Take is defined as “the act of hunting, killing, capture, and/or harassment of any marine mammal; or, the attempt at such.” Harassment includes disruption of behavioral patterns. The MMPA specifies injury to marine mammals as “Level A Harassment” and disturbance as “Level B Harassment” (16 USC 1361 et seq). Specifically, the MMPA defines Level A Harassment as “any act of pursuit, torment, or annoyance which has the potential to injure a marine mammal or marine mammal stock in the wild” and Level B Harassment as “acts that have the potential to disturb (but not injure) a marine mammal or marine mammal stock in the wild by disrupting behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering” (50 Code of Federal Regulations (CFR) 216.3). Implementation of the MMPA is divided between U.S. Fish and Wildlife Service (USFWS) (sea otters, walruses, polar bears, manatees, and dugongs) and National Oceanic and Atmospheric Administration (NOAA) Fisheries (pinnipeds including seals and sea lions and cetaceans including dolphins and whales). Incidental Harassment Authorizations (IHA) or Letters of Authorization (LOA) may be issued for certain activities which can result in small amounts of take associated with another activity.

4.2.2 Migratory Bird Treaty Act (MBTA)

Seabirds within the Port Complex (Port of Los Angeles and Port of Long Beach) are protected under the federal Migratory Bird Treaty Act (MBTA). The MBTA of 1918, as amended (16 USC 703-711), established federal responsibilities for the protection of nearly all species of birds, their eggs, and nests. A migratory bird is defined as any species or family of birds that live, reproduce, or migrate within or across international borders at some point during their annual life cycle. The MBTA prohibits the take, possession, buying, selling, purchasing, or bartering of any migratory bird listed in 50 CFR Part 10, including feathers or other parts, nests, eggs, or products, except as allowed by implementing regulations (50 CFR 21). Only exotic species such as Rock Pigeons (*Columba livia*), House Sparrows (*Passer domesticus*), and European Starlings (*Sturnus vulgaris*) are exempt from protection.

In 2001, President Clinton defined "take" in Executive Order 13186 to include both "intentional" and "unintentional." However, in 2017, the Department of the Interior's (DOI) Office of Solicitor argued via Opinion M-37050 that incidental take was not prohibited under the Migratory Bird Treaty Act. Opinion M-37050 is currently the subject of a lawsuit between eight U.S. states and the U.S. DOI.

4.2.3 Endangered Species Act (ESA)

Listed bird species in the Port Complex receive protection under the ESA. The ESA of 1973 (16 USC 1531 et seq.) establishes a national policy that all federal departments and agencies provide for the conservation of threatened and endangered species and their ecosystems. The Secretary of the Interior and the Secretary of Commerce are designated in the ESA as responsible for: (1) maintaining a list of species likely to become endangered within the foreseeable future throughout all or a significant portion of its range (threatened) and that are currently in danger of extinction throughout all or a significant portion of its range (endangered); (2) carrying out programs for the conservation of these species; and (3) rendering opinions regarding the impact of proposed federal actions on listed species. The ESA also outlines what constitutes unlawful taking, importation, sale, and possession of listed species and specifies civil and criminal penalties for unlawful activities.

Pursuant to the requirements of the ESA, an agency reviewing a proposed project within its jurisdiction must determine whether any federally listed or proposed species may be present in the project region, and whether the proposed project would result in a "take" of such species. The ESA prohibits "take" of a single threatened and endangered species, except under certain circumstances and only with authorization from the USFWS or the NOAA through a permit under Section 7 (for federal entities or federal actions) or 10(a) (for non-federal entities) of the Act. "Take" under the ESA includes activities such as "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." USFWS regulations define harass to include "an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering."

In addition, the agency is required to determine whether the project is likely to jeopardize the continued existence of any species proposed to be listed under the ESA, or result in the destruction or adverse modification of critical habitat for such species (16 USC 1536[3][4]). If it is determined that a project may result in the "take" of a federally-listed species, a permit would be required under Section 7 or Section 10 of the ESA.

Critical Habitat is defined by the ESA as a specific geographic area containing features essential for the conservation of an endangered or threatened species. Under Section 7 of the ESA, critical habitat should be evaluated if designated for federally listed species that may be present.

4.2.4 California Endangered Species Act (CESA)

Listed seabirds are also protected under CESA. CESA includes provisions for the protection and management of species listed by the State of California as endangered, threatened, or designated as candidates for such listing (California Fish and Game Code (FGC) Sections 2050 through 2085). The CESA generally parallels the main provisions of the ESA and is administered by the California Department of Fish and Wildlife (CDFW), who maintains a list of state threatened and endangered species as well as candidate and species of special concern. The CESA prohibits the “take” of any species listed as threatened or endangered unless authorized by the CDFW in the form of an Incidental Take Permit. Under FGC, “take” is defined as to “hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill.”

Species of special concern are broadly defined as species that are of concern to the CDFW, because of population declines, restricted distributions, and/or they are associated with habitats that are declining in California. Impacts to special status plants and animals may be considered significant under CEQA.

4.2.5 California Fish and Game Code (FGC)

Seabirds within the Port Complex are also protected under the California Fish and Game Code (FGC). Section 3503 of the FGC prohibits the take, possession, or needless destruction of the nest or eggs of any bird. Subsection 3503.5 specifically prohibits the take, possession, or destruction of any birds in the orders Falconiformes (hawks and eagles) or Strigiformes (owls) and their eggs or nests. These provisions, along with the federal MBTA, essentially serve to protect nesting native birds. Non-native species, including the European Starling, Rock Dove, and House Sparrow, are not afforded protection under the MBTA or FGC. The FGC also provides protection for “fully protected birds” (Section 3511), “fully protected mammals” (Section 4700), “fully protected reptiles and amphibians” (Section 5050), and “fully protected fish” (Section 5515). As fully protected species, the CDFW cannot authorize any project or action that would result in “take” of these species even with an incidental take permit.

5. Expected Construction-related Noise

5.1.1 General Construction Equipment In-Air Noise Modeling

It is expected that the Project will be built in a phased approach. An evaluation of the construction noise was completed for the various site activities involved in different construction phases. A list of probable construction equipment to be used for the various activities estimated based on typical construction projects is shown below. Most sound data were obtained from the Road Construction

Noise Model, the Federal Highway Administration's (FHWA) approved construction noise model, which contains data from equipment used on the Boston Central Artery project, and used in the Cadna/A (Computer Aided Noise Abatement) noise model for modeling purposes. GHD modeled the closest residential receptors, which included locations on the Queen Mary and the marina directly across the harbor. During modeling, it was assumed that all equipment operates simultaneously as the worst case scenario. For modeling purposes, each piece of equipment was placed in representative positions for site operations in the closest area to each relevant receptor. This gives typical worst case sound conditions.

Table 5.1 In-air Construction Equipment Reference Values (FHWA 2006)

Construction Equipment	Worst-Case (L_{max}) Equipment Daytime Sound Level (dBA)*
Backhoe	80
Bulldozer	85
Dredging Tugboat	87
Clam Shovel Dredge	87
Impact Pile Driver	111
Vibratory Pile Driver	101
Dump Truck	84
Service Truck	84
Excavator	85
Front-end Loader	80
Street Sweeper	80
Fork Lift	81
Generator	82
Jackhammer	85
Roller	85
Hoe Ram	90
Concrete Batch Plant	83
Concrete Mixer Truck	85
Concrete Saw	90
Grader	85
Paver	85
Scraper	85

The equipment for each construction phase modeled is shown below. Note that there is actually more mobile equipment on site that isn't modeled; it is assumed that only one dump truck at a time will be used during construction activities. Standard sound reduction procedures and devices (mufflers) will be used on all equipment. Low noise equipment such as hand tools and small gas engines are not included in the analysis; as it would not be audible at the Queen Mary and nearby locations.

Table 5.2 Garage Demolition

Construction Equipment	Number of Pieces
Jackhammer	1
Hoe Ram	1
Cat 330 Loader	1
Dump Truck	1
Water Truck	1
Service Truck	1
Fork Lift	1

Table 5.3 Earthwork

Construction Equipment	Number of Pieces
Excavator	1
Dump Truck	1
Backhoe	1

Table 5.4 Structure

Construction Equipment	Number of Pieces
Backhoe	1
Concrete Saw	1
Forklift	3
Dump Truck	1
Crane	1
Concrete Pump	1
Concrete Trucks	1

Table 5.5 Finishes

Construction Equipment	Number of Pieces
Flat Bed Truck	1
Service Truck	1
Street Sweeper	1

Table 5.6 Hardscape and Landscape

Construction Equipment	Number of Pieces
Back Hoe	1

Table 5.6 Hardscape and Landscape

Construction Equipment	Number of Pieces
Water Truck	1
Forklift	1
Crane	1
Flat Bed Trucks	1
Concrete Trucks	2
Paving Machine	2
Roller Machine	1
Blade Machine	1
Tractor	1

5.1.2 In-Air and Underwater Noise Modeling for Wildlife

We provide below a compilation of noise data collected from pile driving and dredging in environments similar to that of the POLB. These reference values were used to estimate airborne and underwater noise impacts to wildlife in Sections 7.3 and 7.4.

5.2 Pile Driving

Project impacts will include instances of noise and vibration related to the use of a vibratory hammer and an impact pile driver during discrete periods of time (up to 30 minutes per pile) associated with piling installation. Vibratory hammers are “oscillatory hammers that vibrate the pile, causing the sediment surrounding the pile to liquefy and allow pile penetration” (Buehler et al. 2015). Vibratory hammers are frequently employed as a mitigation measure to reduce environmental impacts on aquatic wildlife since they generally produce noise levels 10 to 20 dB lower than impact pile drivers. However, while peak sound levels may be lower for vibratory hammers than impact hammers, the total energy generated in-water can be similar since vibratory hammers operate continuously and take a longer period of time to install a pile than impact hammers. Impact pile drivers are known to produce extremely high levels of noise, both in-air and underwater (Buehler et al. 2015). A vibratory hammer that may be used on this Project is the APE (American Pile Driving Equipment, INC) model 200-6 vibro and the impact pile driver will be a DELMAG D100 or D80. According to DELMAG’s specs for the D100-13, the energy per blow ranges from 214 to 360 kilonewton meters (kNm). This is equivalent to 157,838 to 265,552 ft-lbs (foot pound-force) (DELMAG 2018).

5.2.1 Pile Driving Airborne Noise Impacts

Impact pile drivers and vibratory hammers generate significantly high levels of airborne noise. The FHWA (2006) has published typical noise levels for these hammers to aid in analyzing airborne noise impacts. These reference values are re-printed below in Table 5.7.

Table 5.7 Reference Values for Estimating In-air Pile Driving Noise (FHWA 2006)

Construction Equipment	Measured In-air Sound Levels	
	Distance (meters)	Typical Noise Level (dBA)
Impact Pile Driver	15	111
Vibratory Hammer	15	101

5.2.1 Pile-driving Underwater Noise Impacts

In order to calculate underwater noise impacts to wildlife, it was necessary to estimate the metric "number of strikes per pile." This value is not as commonly measured as other metrics in pile driving. However, the Washington Department of Transportation (WSDOT) has published this value for similar projects (in terms of substrate, pile diameter, and pile type) (WSDOT 2018). These values are re-printed below.

Table 5.8 Reference Values for Estimating the Number of Strikes Per Pile

Project	Vibed First	Hammer Strength (ft-lbs)	# of Strikes Per Pile	# of Piles/ Day	# of Strikes/ Day	Pile Type	Pile Diameter (inches)	Substrate
Anacortes Ferry Terminal[a]	Yes	165,000	341-675	4	2,494	steel pipe	36	sand and silt
Mukilteo Test Pile Project #1[a]	Yes	164,000	73-227	4	682	steel pipe	36	sand and silt
Mukilteo Test Pile Project #2[a]	Yes	164,000	204-225	2	459	steel pipe	36	sand and silt
Unknown Caltrans* Project[b]	unknown	unknown	Unknown	2-4	1,600-2,400	steel pipe	30	unknown

* California Department of Transportation (Caltrans)
[a]WSDOT 2018
[b]Buehler et al. 2015

In addition, metrics for source level RMS SPL and SPL_{peak} were needed in order to calculate underwater noise impacts to wildlife. These values have been published for similar projects (in terms of pile diameter, pile type, and water depth) and are re-printed below.

Table 5.9 Reference Values for Estimating Underwater RMS SPL and SPL_{peak}

Project	Pipe Diameter (inches)	Hammer Type	Water Depth (meters)	Measured Underwater Sound Levels			
				Distance (meters)	SPL_{peak}	RMS	SEL
Humboldt Bay Bridges (Caltrans)[a]	36	Delmag D36-32	10	10	210*	193*	183*
Humboldt Bay Bridges (Caltrans)[a]	36	Delmag D36-32	10	50	198*	182*	N/A
Stockton Wastewater Treatment Plant Utility Crossing[a]	36	Vibe to set (ICE-66), Impact to drive (Del-Mag D46-42)	3-4	10	197-199**	185-186**	175**
Port MacKenzie Dock Modifications[b]	36	Vibe to set (APE 400B), Impact to drive (Del-Mag D62-22)	10-17	62	204-206*	189-190*	178-180*
Siuslaw River Bridge[a]	30	Delmag D-52	~3m	10	210**	190**	177**

[a]Buehler et al. 2015
[b]Blackwell 2005
*No attenuation, bare pile
**used bubble curtain

5.3 Dredging

5.3.1 Dredging Airborne Noise Impacts

It is expected that dredging operations will occur in an area parallel to the existing dock and dolphin structures used by the Carnival Cruise ships. Operations would involve the use of tugboats and clamshell dredgers. Typically, this would involve two tugboats and one clamshell dredger, running continuously. Reference values were obtained for this equipment from the FHWA Road Construction Noise Model (RCNM) and are reprinted below (FHWA 2006). Note that these sound power levels for the tugboat are conservative; they would only occasionally run at full power under most scenarios.

Table 5.10 Tugboat and Dredge In-air Sound Power Summary Information (FHWA 2006)

Construction Equipment	Estimated Duration	Estimated Source dBA
Clam Shell Dredger	60 minutes/hour	87
Tugboat	60 minutes/hour	87

5.3.2 Dredging Underwater Noise Impacts

Dredging at the Carnival Cruise dock will elevate underwater noise levels in the Project vicinity. Operations would involve the use of tugboats and clamshell dredgers. Typically, this would involve two tugboats and one clamshell dredger, running continuously. Reference values were obtained for this equipment from a Central Dredging Association (CEDA) summary paper on underwater sound, a study on underwater dredging sound in New York, and a study on underwater ship noise (Reine et al. 2012, Jones et al. 2015, Veirs et al. 2016). Based on existing reference values, the dredge/tug engine would produce the highest levels of noise associated with the dredging construction phase.

Table 5.11 Clam Shell/Backhoe Dredge Underwater Sound Reference Values

Activity	Sound	Distance at Which Sound Measured (meters)
Tugboat Engine Noise[a]	134 dB_{rms} 167 dB_{rms}	135 1
Bottom contact of clam shell bucket[b]	124 dB	150
Digging of sediment[b]	113 dB	150
Bucket closing[b]	99 dB	150
Winch in/out of bucket[b]	116 dB	150
Material Dropped onto barge[b]	108 dB	150
Tugboat Engine Noise[c]	Source Level: 170 ± 5 dB_{rms} SPL_{peak}: 134-141 dB	1

[a]Reine et al. 2012
[b]Dickerson et al. 2001 cited in Jones et al. 2015
[c]Veirs et al. 2016

5.4 Dredge Material Disposal

One of the proposed dredge material disposal areas is located offshore at a pre-existing disposal site, LA-2 ODMDS. Marine mammals, fish, and seabirds are likely to be present offshore between the dredge area and the dredge material disposal site and could experience increased airborne and underwater noise as a result of dredge material disposal activities. However, any impacts associated with this activity have been previously addressed in existing permits specific to LA-2 ODMDS.

5.5 Future Operational Levels

The new dredging operations will mean that slightly larger ships will use the Carnival terminal. The proposed *Carnival Panorama* ship will increase the size of the ships in the POLB harbor from the existing level of 113,300 tons for the *Carnival Splendor* to about 133,500 tons. Since engine noise scales approximately as 10*LOG((tons old)/(tons new)), the proposed new ship would actually increase noise levels by less than a decibel over the existing ship, and might even be quieter due to improvements in ship design technology. This would mean that noise levels from the new ship would be essentially unchanged from those of the old one, especially as the ship equipment will be powered from shore while berthed.

Noise measurements were made at two locations, the Long Beach shoreline marina and on the Queen Mary. Evaluating first the marina, the Carnival terminal and the Carnival ship stack noise are far enough away to not dominate the marina's sound environment; sound at this location is primarily from closer sources (cars, pedestrians, planes, etc.). At the Queen Mary, the sound levels on the ship's deck were dominated almost entirely by both equipment on board the ship itself and by on-board social activities; sound from the Carnival port activities, including traffic, is relatively low compared to these two sources. As traffic noise from passenger car equivalents (PQEs) also scales as 10*LOG((new PQE /old PQE)), changing traffic volumes from 3,012 passengers/ship to 4,008 would add approximately one decibel to the traffic noise level, which would be completely drowned out by on-board noise on the ship (it would also not be heard at the marina at all) (Wu 2005). This means that no detailed traffic noise study is required for this report. Therefore, the change in operational noise from larger ships would not significantly affect the sound environment at either location.

6. Existing Conditions

6.1 Human Environment

The POLB is a typical harbor area, dominated by sound from activities that would occur in a harbor with significant boat activity. Two areas were examined during the background monitoring study, the marina area and the deck of the Queen Mary. Sound sources were considerably different at each location. In the marina, sound was dominated by a number of sources. These included wind in trees, boats with cables clanking, car passbys, boats in the harbor, pedestrian noise, and plane overflights. On the deck of the Queen Mary, sound was primarily produced by continuously operating deck equipment, which gave a nearly constant background level during the evening and nighttime hours. During the daytime, these levels were increased by the addition of human activity on the decks, plane and helicopter overflights, and boats in the harbor. Note that activities from the POLB contributed relatively little to the overall sound levels in the Study Area.

6.2 Biological Resources

The Project Area is within a major port complex which has been extensively modified over a period of more than a century. As a result, most of the area is not in a natural condition, and there is considerable anthropogenic activity which generates noise. Open water portions of the POLB are generally maintained for shipping (28-47 feet depth MLLW in the project dredge footprint). Shorelines are generally rock armored, with very limited mostly non-native vegetation growing on the few vegetated shoreline areas. Terrestrial areas are generally paved as roads, parking lots, or service areas. Small areas of landscaping are present generally as linear strips along roadsides or in medians or adjacent to structures. Overall, there is very little habitat structure within either marine or terrestrial habitats. Areas surrounding the POLB on the land side are generally dense urban or industrial, with a few small maintained recreational parks and beaches. In part, because of the modified habitat structure and intensive human activity, there may be fewer sensitive wildlife receptors present than in a more natural area of coastline.

The Port Complex provides habitat for numerous common species of gulls, waterfowl, aerial fish-foragers, and wading birds. In addition, several species of marine mammals including California Sea Lions (*Zalophus californianus*), Harbor Seals (*Phoca vitulina richardii*), and Common Bottlenose Dolphins (*Tursiops truncatus*) are commonly observed in the Port Complex and have a high potential to occur in the Study Area during project implementation. Green Sea Turtles have a moderate chance of occurring in the Study Area based on nearby records (Sahagun 2008, Roy 2013). Only common fish species were documented during a thorough survey of the Port Complex in 2013-2014, and no special status fish species are likely to occur in the Project Area (MBC Applied Environmental Sciences 2016). Two important marine habitat types (eelgrass and kelp forests) do have small areas of known presence within the POLB (MBC Applied Environmental Sciences 2016).For a more detailed description of the biological resources likely to occur at the site, see the associated Biological Resources Report (GHD 2019b).

The proposed disposal site for dredge material is located at LA-2 ODMDS, an existing, permitted disposal site just south of the POLB. The site is located in the Pacific Ocean at 33°37'6" N, 118°17'24" W.

7. Methods

7.1 Definition of Wildlife Study Area

The wildlife Study Area includes the Project Area and a modified circular buffer around the Project Area (Appendix A, Figure 3). The buffered area is designed to address the area within which any physical impacts to sensitive biological resources could occur as well as possible auditory and visual disturbance to aquatic and terrestrial wildlife. Therefore, the radius of the buffer varies in relation to underwater versus above ground Project impacts. The land side of the buffer was truncated within urban Long Beach after a site visit verified that Project-related impacts would not occur there. The remaining Study Area is intentionally conservative, and intended to encompass even the lowest probability impact areas for the purposes of this review. In order to develop the Study Area, we considered NMFS (National Marine Fisheries Service), USFWS, and California Department of Transportation (Caltrans) guidance on underwater auditory impacts to marine mammals and fish (physical injury as well as disturbance thresholds), underwater auditory impacts to seabirds (physical injury as well as disturbance thresholds), in-air impacts to marine mammals and seabirds (disturbance thresholds), as well as visual disturbance to wildlife (USFWS 2006, Fisheries Hydroacoustic Working Group 2008, USFWS 2012, Buehler et al. 2015, NMFS 2018a, WSDOT 2018). In addition, we considered the noise impacts of dredging on wildlife in the harbor and just offshore.

7.2 Ambient Noise

Ambient noise or the background sound level is defined as "all-encompassing sound normally associated with a given environment being usually a composite of sound from many sources near and far" (ANSI 1999). Tetra Tech (2011) reported that the underwater ambient noise levels in active shipping areas of the POLB were roughly 140 dB re μPa and noise levels in non-shipping areas (Terminal Island) were between 120 dB and 132 dB re μPa. These underwater ambient noise levels are typical of a large marine bay with heavy commercial boat traffic (Buehler et al. 2015). Ambient airborne noise was measured in the Study Area and methods are provided below in Section 7.3.

7.3 In-air Noise Modeling

Noise modeling is only as current and accurate as of the last calculation model in February 2019. Updated modeling will be included in final draft and will be available in necessary permit documents, such as GHD's Biological Assessment and Incidental Harassment Authorization (GHD 2019a, GHD 2019c)

7.3.1 Humans

48-Hour Baseline Noise Monitoring

A total of two sites were chosen for long-term (48 hour) sound measurements in the POLB. These sites had daily monitors for two-one day intervals during the monitoring program. The monitoring locations were approved by the City of Long Beach. Figure 4, Appendix A shows the harbor and monitoring locations. These sites were selected to represent the closest residents at the nearby marina and on board the Queen Mary. Short-term monitoring results are described in Section 8.1.1.

The two long-term monitoring locations were as follows:

- LT1 – Located near the Long Beach Shoreline Marina at LA Harbor. The latitude and longitude coordinates are 33° 45.424' N 118° 11.289' W
- LT2 – Located on the Queen Mary. The latitude and longitude coordinates are 33° 45.124'N, 118° 11.301'W

At each location, long-term data was collected in one hour intervals with the meter on "slow" setting. The L_{10}, L_{50}, and L_{90} metrics were collected. The hourly L_{eq} (average) level was also collected. In-air noise monitoring data is provided in Appendix F.

Noise measurements were conducted with Larson Davis 831 octave band sound level meters (m)/noise analyzers for intervals of one hour, in order to comply with the Long Beach monitoring requirements. Field calibrations with acoustic calibrators were conducted for all of the measurements. All instrumentation components, including microphones, preamplifiers and field calibrators have current laboratory certified calibrations traceable to the National Institute of Standards and Technology. Microphones were fitted with windscreens.

The November measurement program was conducted by Howard Quin from November 7, 2018 to November 11, 2018. Weather varied moderately during the measurement period. High temperatures ranged from about 71 degrees to 81 degrees Fahrenheit (F), while lows ranged from about 45 degrees to about 55 degrees °F. Winds were out of the northwest, typically at 1-5 mph. There was relatively little surface chop on the harbor water during the measurement period. Photos of short-term and long-term sound monitoring stations are provided in Appendix B.

Operational Noise Modeling

To model the actual expected noise levels from the new ship stack, we obtained sound power data from the Carnival Spirit, a ship of 88,000 tons. We then scaled the data for the new *Carnival Panorama* using the same formula as above, and performed Cadna modeling for the new ship. The sound from the new ship was modeled as point source with a sound power level of 114.3 dBA at about 50 meters elevation, with the stack at the same location as the *Carnival Splendor*.

7.3.2 Wildlife

Marine mammals are known to occur year-round in the Project vicinity and an increase in airborne noise (associated with pile driving and dredging) could impact marine mammals in the Study Area. In addition, special-status seabirds are known to nest, forage, and winter in the Study Area and an increase in airborne noise (associated with pile driving and dredging) could also impact seabird behavior. To investigate in-air noise impacts to wildlife in the Study Area, we used the practical spreading loss model recommended by NMFS (2012a) for spherical-spreading noise. The practical spreading loss model is presented in NMFS (2012a) as:

$$\text{Transmission Loss (TL)} = 15 \log (R_2/R_1)$$

Where R_1 is the distance of a known or measured sound level and R_2 is the estimated distance required for the sound to attenuate to a predetermined acoustic threshold. The number 15 serves as the transmission loss constant in water while this is substituted for a value of 20 on land (NMFS 2012a, WSDOT 2012).

The equation may be rearranged to solve for R_2 (the isopleth or area of potential noise effects for the purposes of our analysis) as:

$$R_2 = R_1 * 10\text{^} ((\text{dB at }_{R1} – \text{dB}_{\text{acoustic threshold}})/15)$$

Tables 7.1 summarize the values we used to calculated airborne noise impacts to wildlife (values reprinted from examples given in section 4). These values represent the “worst case scenario” in terms of airborne noise impacts on wildlife and provide conservative estimates to inform project minimization and mitigation methods.

Table 7.1 Metrics Used for the Port of Long Beach Airborne Noise Impacts Calculations

Construction Equipment	dBA	Distance at Which Sound Received (meters)
Pile driving[a]	111	15
Clam shell dredge[a]	87	15

[a]FHWA 2006

Marine Mammals

Applicable Noise Thresholds

NOAA Fisheries (2018) has provided the following guidance on in-air noise behavioral disruption thresholds for Harbor Seals and non-Harbor Seal pinnipeds. Behavioral disruption guidance has not been published by NOAA for other marine mammal species/groups at this time. Therefore, we used the published behavioral disruption threshold for Harbor Seals (more sensitive group/more conservative threshold) when analyzing airborne noise impacts to marine mammals. These thresholds are reprinted below in Table 7.2 for reference.

Table 7.2 Marine Mammal Behavioral Disruption Thresholds for In-Air Noise (Level B Harassment) (NOAA Fisheries 2018)

Marine Mammal Group[a]	Behavioral Disruption Threshold[a]
Harbor Seals	90 dB_{rms}
Non-harbor seal pinnipeds	100 dB_{rms}

[a]NOAA Fisheries 2018

Model Input and Assumptions - Impact Pile Driving

To calculate the impacts of airborne pile driving noise on marine mammals, we input the following values into the practical spreading loss model:

- Estimated airborne noise from impact pile driving is 111 dBA (measured at a distance of 15 meters). Airborne noise impact numbers were not available for pile driving in dB_{rms} and not applicable based on the type of activity (airborne discrete versus continuous noise). Peak dBA values serve as a conservative approach/worst case scenario to evaluate impacts (FHWA 2006).
- Behavioral disturbance threshold for Harbor Seals of 90 dB_{rms} (NOAA Fisheries 2018). We used the marine mammal with the lower reported behavioral disruption threshold (versus non-harbor seal pinnipeds) to ensure a conservative model estimate.
- Transmission loss constant of 20 for airborne noise over hard ground (assumes a 6.0 dB reduction per doubling distance) (WSDOT 2012).

The resultant model is:

$$R_2 = 15 * 10\text{^} ((111 \text{ dBA}– 90 \text{ dB}_{rms})/20)$$

Model Input and Assumptions – Dredging

To calculate the impacts of airborne dredging noise on marine mammals, we input the following values into the practical spreading loss model:

- Estimated airborne noise from a clam shell dredge is 87 dBA (measured at a distance of 15 meters). Airborne noise impact numbers were not available for dredging in dB_{rms}. Peak dBA values serve as a conservative approach/worst case scenario to evaluate impacts (FHWA 2006).

- Behavioral disturbance threshold for Harbor Seals of 90 dB_{rms} (NOAA Fisheries 2018). We used the marine mammal with the lower reported behavioral disruption threshold (versus non-harbor seal pinnipeds) to ensure for a conservation model estimate.
- Transmission loss constant of 20 for airborne noise over hard ground (assumes a 6.0 dB reduction per doubling distance) (WSDOT 2012).

The resultant model is:

$$R_2 = 15 * 10\text{^} ((87 \text{ dBA} – 90 \text{ dB}_{rms})/20)$$

Seabirds

To our knowledge, no studies exist on the hearing or airborne auditory thresholds of special-status seabird species likely to occur in the Study Area (e.g., California Least Tern), or on closely phylogenetically-related species. Reference values from a sample of studies on general avian hearing are provided below. Birds are unusual in comparison to mammals in that their hearing loss following noise-related damage is not permanent (sensory hair cells in the basilar papilla repair themselves) (Caltrans 2016).

Applicable Noise Thresholds

Table 7.3 Avian Injury and Behavioral Disruption Thresholds for In-Air Noise (USFWS 2012)

Species	Behavioral Disruption Threshold[a]	Threshold shift/Injury
Marbled Murrelet[a]	92 dBA	N/A
Budgerigar[b]	N/A	125 dBA (multiple impulse) 140 dBA (single impulse)
Parakeet[c]	N/A	106 dB* 76 dB**
Japanese Quail[d]	N/A	116 dB*

[a]USFWS 2012
[b]Hashino et al. 1988 in Caltrans 2016
[c]Dooling and Saunders 1974
[d]Niemiec et al. 1994
*papilla repaired over multiple days
**papilla repaired in a few hours

To model airborne noise impacts to seabirds, we used USFWS guidance developed for Marbled Murrelets (2012). In 2011, the USFWS in collaboration with the U.S. Navy and a panel of experts, adopted criteria to identify sound exposure levels injurious or disruptive to Marbled Murrelets. They determined that an airborne sound of 92 dBA or greater would likely cause potential behavioral effects/result in disturbance to Marbled Murrelets (USFWS 2012). To our knowledge, this is the only existing regulatory guidance available that specifies airborne noise behavioral disturbance thresholds for a seabird. We broadly applied this guidance to the extent to which airborne noise may impact seabirds in the Study Area.

Model Input and Assumptions - Impact Pile Driving

To calculate the impacts of airborne pile driving noise on seabirds, we input the following values into the practical spreading loss model:

- Airborne noise from impact pile driving is 111 dBA (measured at a distance of 15 meters) (FHWA 2006)
- Behavioral disturbance threshold for Marbled Murrelets of 92 dBA (USFWS 2012). For the purposes of this analysis we believe auditory data on Marbled Murrelets best approximates expected auditory impacts to other seabirds likely to occur in the Study Area.
- Transmission loss constant of 20 for airborne noise over hard ground (assumes a 6.0 dB reduction per doubling distance) (WSDOT 2012).

The resultant model is:

$$R_2 = 15 * 10\text{^} ((111 \text{ dBA} - 92 \text{ dBA})/20)$$

Model Input and Assumptions - Dredging

To calculate the impacts of airborne dredging noise on seabirds, we input the following values into the practical spreading loss model:

- Estimated airborne noise from a clam shell dredge is 87 dBA (FHWA 2006).
- Behavioral disturbance threshold for Marbled Murrelets of 92 dBA (USFWS 2012). For the purposes of this analysis we believe auditory data on Marbled Murrelets best approximates expected auditory impacts to other seabirds likely to occur in the Study Area.
- Transmission loss constant of 20 for airborne noise over hard ground (assumes a 6.0 dB reduction per doubling distance) (WSDOT 2012).

The resultant model is:

$$R_2 = 15 * 10^{\wedge} ((87 \text{ dBA} - 92 \text{ dBA})/20)$$

7.4 Underwater Noise Modeling

7.4.1 Estimating Underwater Noise Impacts to Wildlife

Unmitigated Impact Modeling

Marine mammals are known to occur year-round in the Project vicinity and an increase in underwater noise (associated with pile driving and dredging) in the Study Area could cause permanent injury to marine mammal hearing, temporary injury to hearing, and masking (through auditory interference) of important communication calls (NOAA 2016). In addition, special-status seabirds are known to nest, forage, and winter in the Study Area and an increase in underwater noise (associated with pile driving and dredging) could also impact seabird behavior. Underwater noise impacts to special status fish or sea turtles are less likely to occur (based on rarity in the Study Area), but still possible. To investigate underwater noise impacts to wildlife in the Study Area, we used a variety of species-specific excel calculators provided by NMFS (described in greater detail below for each species). In addition, we used the Simplified Attenuation Formula (SAF), developed by NMFS Greater Atlantic Regional Fisheries Office (GARFO) (2018), to calculate the impacts of underwater noise on wildlife. NMFS GARFO recommends the SAF over the practical spreading loss model (PSLM) for calculating underwater noise impacts in shallow, nearshore, and port environments. According to the NMFS GARFO (2018), this provides more accurate estimates of project-related underwater noise impacts in nearshore environments, while the practical spreading loss model is more appropriate to use for calculating underwater impacts in the open ocean (e.g. construction noise associated with building offshore wind turbines). However, due to the fact that the PSLM is still widely used, we provide those values as well for comparison.

The Simplified Attenuation Formula is presented in NMFS GARFO (2018) and modified here for ease of interpretation as:

$$D = C + ((A - B) / T) * 10)$$

Where “D” is the wildlife isopleth threshold (i.e. underwater impact area), “C” is the distance (meters) of a known or measured sound level, “A” is the noise level estimated at “C” meters from pile, “B” is the wildlife threshold, and “T” is the underwater noise attenuation rate (5 for nearshore waters based on NMFS GARFO 2018).

We estimated the impacts of impulsive as well as non-impulsive underwater sound sources on wildlife in the Study Area. Finneran (2016) defines impulsive noise as “noise with high peak sound pressure, short duration, fast rise-time, and broad frequency content” and non-impulsive noise as “steady-state noise.” For the purposes of this analysis and in accordance with NMFS guidance (2018a), we consider pile driving to be impulsive noise and dredging (with associated activities) to be non-impulsive noise. Tables 7.4 and 7.5 summarize the values we used to calculate underwater noise impacts to wildlife (values reprinted from examples given in Section 5). These values represent the “worst case scenario” in terms of underwater noise impacts on wildlife and provide conservative estimates to inform project minimization and mitigation methods.

Table 7.4 Impact Pile-driving Metrics Used for the Port of Long Beach Underwater Noise Impact Calculations*

Pile Driving Method	Estimated Number of Strikes Per Pile	Estimated Strike Duration	Estimated Number of Piles Per Day	Estimated Source RMS SPL	SPL_{peak}	SEL	Pile Diameter (inches)	Pile Type
Impact Pile Driving (pre-vibed)	675[d]	100 msec[c]	5[b]	193 (at 10 meters)[a]	210 (at 10 meters)[a]	183 (at 10 meters)[a]	36[b]	Steel pipe[b]

*Based on Data Collected on Similar Projects Referenced in Section 4
[a]Buehler et al. 2015
[b]Atkins, personal communication
[c]NMFS 2018b
[d]WSDOT 2018

Table 7.5 Clam Shell Dredging and Tugboat Metrics Used for the Port of Long Beach Underwater Noise Impact Calculations*

Activity	Received Sound	Distance at Which Sound Measured (meters)
Tugboat Engine Noise[a]	Source Level: 170 ± 5 dB_{rms} SPL_{peak}: 141 dB	1
Bottom contact of clam shell bucket[b]	124 dB	150

*Based on Data Collected on Similar Projects Referenced in Section 4
[a]Veirs et al. 2016
[b]Jones et al. 2015

Marine Mammals

Underwater noise impacts to marine mammals were modeled based on the NMFS 2018 Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (NMFS 2018a). NMFS, NOS (National Ocean Service), and the Office of National Marine Sanctuaries first developed this guidance in 2016 to facilitate the assessment of underwater anthropogenic noise on the hearing of marine mammals. The guidance describes the thresholds at which marine mammals may experience permanent or temporary injurious impacts to their hearing. Threshold shifts are defined by NMFS as “the received levels… at which individual marine mammals are predicted to experience changes in their hearing sensitivity (either temporary or permanent) for acute, incidental exposure to underwater anthropogenic sound sources” (NMFS 2018a). Permanent (PTS) and Temporary (TTS) Threshold Shifts were determined for all NMFS-defined marine mammal hearing groups: low- (LF), mid- (MF), and high- (HF) frequency cetaceans as well as otariid (OW) and phocid (PW) pinnipeds (Table 7.7) (NMFS 2018a). The Marine Mammal Protection Act (1972), as amended specifies injury to marine mammals as “Level A Harassment” (16 USC 1361 et seq). Specifically, the MMPA defines Level A Harassment as “any act of pursuit, torment, or annoyance which has the potential to injure a marine mammal or marine mammal stock in the wild” and Level B Harassment as “acts that have the potential to disturb (but not injure) a marine mammal or marine mammal stock in the wild by disrupting behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering” (50 CFR 216.3). NMFS defines PTS as Level A Harassment and behavioral disturbance and Level B Harassment.

We used the NMFS Optional User Spreadsheet Tool (Version 2.0) to estimate underwater marine mammal thresholds for the onset of injurious permanent threshold shifts (PTS) as a result of impulsive and non-impulsive noise (NMFS 2018b). Since marine mammals (depending on species) may heavily rely on their hearing for intraspecific communication, the identification of food resources, navigation, etc., permanent and temporary impacts to their hearing would significantly impact individual animals (NMFS 2018a). To estimate the effects of impulsive noise (e.g., pile driving), we used the NMFS Optional User Spreadsheet Tool tab E.1 (Impact Pile Driving). To estimate the effects on non-impulsive noise (e.g. dredging), we used tab A for stationary source, non-impulsive, continuous noise (NMFS 2018b).

We also investigated marine mammal behavioral disturbance as a result of impulsive and non-impulsive noise. The NMFS 2018 Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing does not include published guidance on Level B Harassment thresholds (NMFS 2018a). However, NOAA Fisheries has published general underwater behavioral disturbance guidelines for all marine mammals as 160 dB_{rms} for impulsive noise and 120 dB_{rms} for continuous noise (NOAA Fisheries 2018). Since NMFS has only developed new, more sensitive criteria for modeling Level A impacts, Level B guidance for underwater marine mammal hearing thresholds (an average number that encompasses the sensitives of all marine mammals) may result in estimates that are too low to evaluate disturbance to species/groups with more sensitive hearing, such as cetaceans.

Applicable Noise Thresholds

PTS, TTS, and behavioral disturbance thresholds for underwater noise impacts on marine mammals were obtained from NMFS (2018a) and NOAA Fisheries (2018) guidance. Reference values are reprinted below in Table 7.6.

Table 7.6 Marine Mammal PTS, TTS, and Behavioral Disruption Thresholds for Underwater Noise *

Hearing Group[a]	Generalized Hearing Range[a]	PTS Onset Threshold[a]		TTS Onset Threshold[a]	Behavioral Disturbance Threshold[b]	
		Impulsive	Non-impulsive		Impulsive	Non-impulsive
Low-frequency (LF) cetaceans (baleen whales)	7 Hz to 35 kHz	SEL_{cum}: 183 PK: 219	SEL_{cum} :199 dB	SEL_{cum}: 179 dB	160 dB_{rms}	120* dB_{rms}
Mid-frequency (MF) cetaceans (dolphins, toothed whales, beaked whales,	150 Hz to 160 kHz	SEL_{cum}: 185 PK: 230	SEL_{cum} :198 dB	SEL_{cum}: 178 dB		
High-frequency (HF) cetaceans (true porpoises, *Kogia*, river dolphins, *cephalorhynchid*, *Lagenorhynchus cruciger* & *L. australis*)	275 Hz to 160 kHz	SEL_{cum}: 155 PK: 202	SEL_{cum} :173 dB	SEL_{cum}: 153 dB		
Phocid pinnipeds (PW) (underwater) (true seals)	50 Hz to 86 kHz	SEL_{cum}: 185 PK: 218	SEL_{cum} :201 dB	SEL_{cum}: 181 dB		
Otariid pinnipeds (OW) (underwater) (sea lions and fur seals)	60 Hz to 39 kHz	SEL_{cum}: 203 PK: 232	SEL_{cum} :219 dB	SEL_{cum}: 199 dB		

[a]NMFS 2018a; generalized hearing range representative of the group based on an incomplete sampling of species

[b]NOAA Fisheries 2018

Notes:

*The 120 dB threshold may be slightly adjusted if background noise levels are at or above this level

Model Input and Assumptions - Impact Pile Driving - Level A Harassment (PTS Threshold Shift) - Unmitigated

To calculate the impacts of underwater pile driving noise on marine mammals (Level A Harassment), we input the following values into the NMFS Optional User Spreadsheet Tool tab E.1 (Version 2.0) (2018c) (full spreadsheet provided in Appendix C):

- Source level RMS SPL for underwater impact pile driving estimated as 193 dB_{rms} at 10 meters (Buehler et al. 2015).
- 5 Steel pipe piles installed per day (estimate agreed to be reasonable by Atkins; personal communication 2018)
- Strike duration of 100 millseconds (msec) (NMFS 2018b)
- 675 Strikes Per Pile (high-end estimate) (WSDOT 2018)
- Value of 15 for underwater sound propagation constant (NMFS 2018b)
- SPL_{peak} of 210 dB SPL at 10 meters (Buehler et al. 2015)
- Weighting Factor Adjustment of 2 kHz (kilo-Hertz) (specific weighting factor for pile driving)

Model Input and Assumptions - Impact Pile Driving – Level B Harassment (Behavioral Disruption) - Unmitigated

To calculate the impacts of underwater pile driving noise on marine mammals (Level B Harassment), we input the following values into the Simplified Attenuation Formula:

- Source level RMS SPL for underwater impact pile driving estimated as 193 dB_{rms} at 10 meters (Buehler et al. 2015).
- Behavioral disruption for impulsive noise for marine mammals at 160 dB_{rms} (NOAA Fisheries 2018).
- Transmission loss constant of 5 for nearshore underwater noise (NMFS GARFO 2018).

The resultant model is:

$$\text{Level B Harassment Threshold} = 10 + ((193\ dB_{rms} - 160\ dB_{rms})/5)*10$$

Model Input and Assumptions – Dredging - Level A Harassment (PTS Threshold Shift)

To calculate the impacts of underwater dredging noise on marine mammals (Level A Harassment), we input the following values into the NMFS Optional User Spreadsheet Tool (Version 2.0) tab A for stationary source, non-impulsive, continuous noise (2018c) (full spreadsheet provided in Appendix C):

- Loudest aspect of underwater dredging is anticipated to be associated with the tugboat engine, estimated as 170 dB_{rms} (at 1 meter) (Veirs et al. 2016).
- Weighting Factor Adjustment of 2.5 kHz (specific weighting factor for vibratory hammer; most similar metric provided in NMFS 2018c to continuous engine noise)

- Duration of sound production (hours) within 24 – hour period estimated as 10 hours (based on anticipated 10 hour work day)
- Transmission loss constant of 15 for underwater noise (NMFS 2012a).

Model Input and Assumptions - Dredging – Level B Harassment (Behavioral Disruption)

To calculate the impacts of underwater dredging noise on marine mammals (Level B harassment), we input the following values into the Simplified Attenuation Formula:

- Loudest aspect of underwater dredging is anticipated to be associated with the tugboat engine, estimated as 170 dBrms (at 1 meter) (Veirs et al. 2016).
- Behavioral disruption for non-impulsive noise for marine mammals at 120 dB_{rms} (NOAA Fisheries 2018).
- Transmission loss constant of 5 for nearshore underwater noise (NMFS GARFO 2018).

The resultant model is:

$$\text{Level B Harassment Threshold} = 1 + ((170\ dB_{rms} - 120\ dB_{rms})/5)*10$$

Fish

According to Buehler et al. 2015, "Little is known regarding the thresholds of behavioral effects of pile driving sound on fish of the types of behavioral modification that may be considered harm or harassment. It is clear that fish can react to a sudden loud sound with a startle or avoidance response, but they may also quickly habituate to the sound." There is currently no scientifically supported threshold for the onset of changes in fish behavior resulting from underwater sound (Hastings and Popper 2005). However, NMFS and USFWS set interim criteria for injury to fish from pile driving activities in June 2008. The criteria identifies sound pressure levels of 206 dB_{peak} (Peak Sound Pressure Level) and 187 dB SEL_{cum} (cumulative sound exposure level) for all fish except for those that are less than 2 grams as potentially causing physical injury. For fish less than 2 grams, the injury threshold for SEL_{cum} is 183 dB. Additionally, SELs greater than 150 dB may cause behavioral effects (Fisheries Hydroacoustic Working Group 2008).

Applicable Noise Thresholds

Table 7.7 Fish Injury and Behavioral Disruption Thresholds for Underwater Noise (Fisheries Hydroacoustic Working Group 2008)

Fish Mass (grams)	Onset of Physical Injury		Behavior Threshold (db_{rms})
	Peak dB	Cumulative SEL dB	
≥ 2 grams	206 dB	187 SEL dB	150 dB_{rms}
< 2 grams		183 SEL dB	

Model Input and Assumptions - Impact Pile Driving - Unmitigated

To calculate the impacts of underwater pile driving noise on fish, we used the SAF, developed by NMFS GARFO (2018), to calculate the impacts of underwater noise on wildlife. As mentioned above, this model provides more accurate estimates of project-related underwater noise impacts in nearshore environments than the practical spreading loss model (modeling method used in the older NMFS pile driving calculator from 2012). The PSLM is more appropriate to use for calculating impacts for open ocean projects (e.g. offshore wind turbines). We input the following values into the SAF models:

- RMS SPL for underwater impact pile driving estimated as 193 dB_{rms} at 10 meters with a SPL_{peak} of 210 and a dB SEL of 183 (Buehler et al. 2015).
- Onset of physical injury for fish ≥ 2 grams at 206 SPL_{peak} and 183 dB SEL (Fisheries Hydroacoustic Working Group 2008).
- Onset of physical injury for fish < 2 grams at 206 SPL_{peak} and 187 dB SEL (Fisheries Hydroacoustic Working Group 2008).
- Behavioral disruption for impulsive noise for fish at 150 dB_{rms} (Fisheries Hydroacoustic Working Group 2008).
- Transmission loss constant of 5 for nearshore underwater noise (NMFS GARFO 2018).

The resultant models are:

- Fish ≥ 2 grams Physical Injury Threshold Model (peak dB): = 10 + ((210 dB_{peak} – 206 dB_{peak})/5)*10
- Fish < 2 grams Physical Injury Threshold Model (peak dB): 10 + ((210 dB_{peak} – 206 dB_{peak})/5)*10
- Fish ≥ 2 grams Physical Injury Threshold Model (Cumulative SEL dB): 10 + ((183 dB SEL – 183 dB SEL)/5)*10
- Fish < 2 grams Physical Injury Threshold Model (Cumulative SEL dB): 10 + ((183 dB SEL – 187 dB SEL)/5)*10
- Fish Behavioral Disturbance Threshold Model (RMS): 10 + ((193 dB_{rms} – 150 dB_{rms})/5)*10

Model Input and Assumptions - Dredging

To calculate the impacts of underwater dredging noise on fish, we used the Simplified Attenuation Formula and input the following values:

- Loudest aspect of underwater dredging is anticipated to be associated with the tugboat engine, estimated as 170 dB_{rms} (at 1 meter) or 141 SPL_{peak} (Veirs et al. 2016).
- Onset of physical injury for fish ≥ 2 grams at 206 SPL_{peak} and 187 dB SEL (Fisheries Hydroacoustic Working Group 2008).
- Onset of physical injury for fish < 2 grams at 206 SPL_{peak} and 183 dB SEL (Fisheries Hydroacoustic Working Group 2008).
- Behavioral disruption for impulsive noise for fish at 150 dB_{rms} (Fisheries Hydroacoustic Working Group 2008).

- Transmission loss constant of 5 for nearshore underwater noise (NMFS GARFO 2018).

The resultant models are:

- Fish ≥ 2 grams Physical Injury Threshold Model (peak dB): = 1 + ((141 SPL_{peak} – 206 dB_{peak})/5)*10
- Fish < 2 grams Physical Injury Threshold Model (peak dB): 1 + ((141 SPL_{peak} – 206 dB_{peak})/5)*10
- Fish ≥ 2 grams Physical Injury Threshold Model (Cumulative SEL dB): 1 + ((141 SPL_{peak} – 183 dB SEL)/5)*10
- Fish < 2 grams Physical Injury Threshold Model (Cumulative SEL dB): 1 + ((141 SPL_{peak} – 187 dB SEL)/5)*10
- Fish Behavioral Disturbance Threshold Model (RMS): 1 + ((170 dB_{rms} – 150 dB_{rms})/5)*10

Seabirds

In 2011, the USFWS in collaboration with the U.S. Navy and a panel of experts, adopted criteria to identify underwater sound exposure levels injurious to Marbled Murrelets. They determined that a SEL of 202 dB would result in the onset of injury (loss of hearing via inner ear hair cell loss) and that a SEL of 208 dB would cause more severe injuries such as barotraumas (Science Applications 2011). In 2012, the USFWS further refined these thresholds by issuing additional guidelines for disturbance levels. Specifically, the USFWS defined underwater sound resulting from pile driving equal to or greater than 150 dB_{rms} as likely to cause potential behavioral effects (USFWS 2012).

To model underwater noise impacts to seabirds, we used the USFWS guidance developed for Marbled Murrelets (2012). To our knowledge, this is the only existing regulatory guidance available that specifies underwater noise injury and behavioral change thresholds for a seabird. We broadly applied this guidance to the extent to which underwater noise many impact seabirds in the Study Area.

Applicable Noise Thresholds

Table 7.8 Seabird Injury and Behavioral Disruption Thresholds for Underwater Noise (NMFS Guidance)

Bird Species	Physical Injury (dB SEL)	Auditory Injury (dB SEL)	TTS (dB SEL)	Behavioral Threshold (db_{rms})
Marbled Murrelet	208	202	183	150

Model Input and Assumptions - Impact Pile-driving - Unmitigated

To calculate the impacts of underwater pile driving noise on seabirds, we used the SAF and input the following values:

- Estimated underwater noise from impact pile driving is 183 dB SEL at a distance of 10 meters or 193 dB_{rms} (based on similar projects referenced in Section 4.2.1) (Buehler et al. 2015)
- Physical injury at 208 dB SEL, auditory injury at 202 dB SEL, a non-injurious hearing threshold shift at 183 dB SEL, and a disturbance threshold of 150 dB_{rms} for Marbled Murrelets (USFWS 2012). For the purposes of this analysis we believe auditory data on Marbled Murrelets best approximates expected auditory impacts to other seabirds likely to occur in the Study Area.
- Transmission loss constant of 5 for nearshore underwater noise (NMFS 2012a).

The resultant models are:

- Seabird Physical Injury Threshold Model: 10 + ((183 dB SEL – 187 dB SEL)/5)*10
- Seabird Auditory Injury Threshold Model: 10 + ((183 dB SEL – 208 dB SEL)/5)*10
- Seabird Non-injurious TTS Model: 10 + ((183 dB SEL – 183 dB SEL)/5)*10
- Seabird Behavioral Effects Threshold Model: 10 + ((193 dB_{rms} – 150 dB_{rms})/5)*10

Model Input and Assumptions - Dredging

To calculate the impacts of underwater dredging noise on seabirds, we used the SAF and input the following values:

- Loudest aspect of underwater dredging is anticipated to be associated with the tugboat engine, estimated as 170 dB_{rms} (at 1 meter) or 141 SPL_{peak} (Veirs et al. 2016).
- Physical injury at 208 dB SEL, auditory injury at 202 dB SEL, a non-injurious hearing threshold shift at 183 dB SEL, and a disturbance threshold of 150 dB_{rms} for Marbled Murrelets (USFWS 2012). For the purposes of this analysis we believe auditory data on Marbled Murrelets best approximates expected auditory impacts to other seabirds likely to occur in the Study Area.
- Transmission loss constant of 5 for nearshore underwater noise (NMFS 2012a).

The resultant models are:

- Seabird Physical Injury Threshold Model: 1 + ((141 SPL_{peak} – 187 dB SEL)/5)*10
- Seabird Auditory Injury Threshold Model: 1 + ((141 SPL_{peak} – 208 dB SEL)/5)*10
- Seabird Non-injurious TTS Model: 1 + ((141 SPL_{peak} – 183 dB SEL)/5)*10
- Seabird Behavioral Effects Threshold Model: = 1 + ((170 dB_{rms} – 150 dB_{rms})/5)*10

Sea Turtles

Underwater hearing in sea turtles has not been thoroughly studied. It is thought that sea turtles do not use sound for communication between individuals underwater but rather that they use sound for navigation, finding prey, and avoiding predators (NOAA 2016). Several species of sea turtles, such as Green Sea Turtles, have been shown to respond to low-frequency vibratory and acoustic stimuli underwater (Ridgway et al. 1969, Piniak et al. 2016, NOAA 2016). However, little is known of the physiological effects of underwater noise on sea turtles.

The NMFS Greater Atlantic Regional Fisheries Office (GARFO) has recently published guidance on underwater noise thresholds for sea turtles (NMFS GARFO 2016). Based on the NMFS guidance, underwater noise greater than or equal to 166 dB re 1µPa RMS could result in changes in normal sea turtle behavior. In addition, underwater noise greater than or equal to 180 dB re 1µPa RMS could result in physical injury to sea turtle hearing.

Applicable Noise Thresholds

Table 7.9 Sea Turtle Underwater Noise Thresholds (NMFS GARFO 2016)

Hearing Group	Injury Threshold	Behavioral Disturbance Threshold
Sea Turtle[a]	180 dB re 1µPa RMS	166 dB re 1µPa RMS

[a]NMFS GARFO 2016

Model Input and Assumptions - Impact Pile Driving - Unmitigated

We used the SAF to calculate the impacts of underwater pile driving on sea turtles in shallow, confined, or nearshore waters (NMFS GARFO 2016).

- Estimated underwater noise from impact pile driving is 183 dB SEL at a distance of 10 meters or 193 dB_{rms} (based on similar projects referenced in Section 4.2.1) (Buehler et al. 2015)
- Physical injury at 180 dB re 1µPa RMS and a disturbance threshold of 166 dB re 1µPa RMS (NMFS GARFO 2016).
- Transmission loss constant of 5 for nearshore underwater noise (NMFS GARFO 2018).

The resultant models are:

- Sea Turtle Injury Threshold Model: 10 + ((193 dB_{rms} – 180 dB_{rms})/5)*10
- Sea Turtle Behavioral Disruption Threshold Model: 10 + ((193 dB_{rms} – 166 dB_{rms})/5)*10

Model Input and Assumptions - Dredging

To calculate the impacts of underwater dredging noise on sea turtles, we used the SAF and input the following values:

- Loudest aspect of underwater dredging is anticipated to be associated with the tugboat engine, estimated as 170 dB_{rms} (at 1 meter) or 141 SPL_{peak} (Veirs et al. 2016).
- Physical injury at 180 dB re 1µPa RMS and a disturbance threshold of 166 dB re 1µPa RMS (NMFS GARFO 2016).
- Transmission loss constant of 5 for nearshore underwater noise (NMFS GARFO 2018).

The resultant models are:

- Sea Turtle Physical Injury Threshold Model: 1 + ((170 dB_{rms} – 180 dB_{rms})/5)*10
- Sea Turtle Behavioral Effects Threshold Model: 1 + ((170 dB_{rms} – 166 dB_{rms})/5)*10

8. Results

Noise modeling is only as current and accurate as of the last calculation model in February 2019. Updated modeling will be included in final draft and will be available in necessary permit documents, such as GHD's Biological Assessment and Incidental Harassment Authorization (GHD 2019a, GHD 2019c)

8.1 In-air Noise Impacts

8.1.1 Humans

Modeling Results

Short-term monitoring, consisting of 20 minute spot measurements, was conducted at the marina and on the Queen Mary to supplement the long-term data at two locations each (shown in Appendix A, Figure 4). Average (L_{eq}) recorded sound levels ranged from about 45 to 68 dBA at the marina. On the Queen Mary, average L_{eq} levels ranged from 62 to 68 dBA. The levels show some expected diurnal variation. On the Queen Mary, evening and nighttime sound was dominated by on board equipment operating continuously. The daytime levels included passenger activities on the aft deck as well as the equipment. In the harbor, the levels varied considerably during the day and night. Noise sources varied depending on location. In the harbor locations (locations LT1, ST1, and ST2), sound came from a variety of sources. These included cars, birds, wind in trees, boats creaking, the Carnival PA system, helicopters, and airplanes. On the Queen Mary, most of the sound came from on board equipment operating continuously. Additional sound came from boats passing by, helicopters, planes, birds, and strollers on deck.

Table 8.1 Short-term In-air Noise Monitoring Results

Location	Description	Date	Time	L_{eq} (dBA)	L_{90} (dBA)	L_{50} (dBA)	L_{10} (dBA)
ST1	South End of Harbor	11/8/2018	8:45 A.M.	58.3	51.5	54.4	62.7
ST2	North End of Harbor	11/8/2018	9:12 A.M.	52.6	48.4	51.5	54.7
ST3	Queen Mary Mid Deck	11/8/2018	11:02 A.M.	60.0	58.9	59.5	61.0
ST4	Queen Mary Fore Deck	11/8/2018	11:25 A.M.	62.4	61.8	62.1	62.8
ST1	South End of Harbor	11/8/2018	1:05 P.M.	56.5	52.9	54.4	57.6
ST2	North End of Harbor	11/8/2018	1:29 P.M.	62.9	53.3	56.5	61.7
ST3	Queen Mary Mid Deck	11/8/2018	9:45 P.M.	62.7	62.3	62.6	63.2
ST2	North End of Harbor	11/8/2018	10:28 P.M.	48.3	45.8	46.7	48.4
ST1	South End of Harbor	11/8/2018	10:55 P.M.	55.0	52.5	54.5	56.9
ST1	South End of Harbor	11/9/2018	1:20 P.M.	54.8	51.0	53.0	56.9
ST2	North End of Harbor	11/9/2018	1:46 P.M.	51.7	47.5	49.7	51.7
ST3	Queen Mary Mid Deck	11/9/2018	2:32 P.M.	57.8	55.6	56.8	59.9
ST4	Queen Mary Fore Deck	11/9/2018	2:56 P.M.	66.8	66.5	66.8	66.9
ST1	South End of Harbor	11/8/2018	8:45 A.M.	58.3	51.5	54.4	62.7

Figure 8-1 Monitoring Location LT1

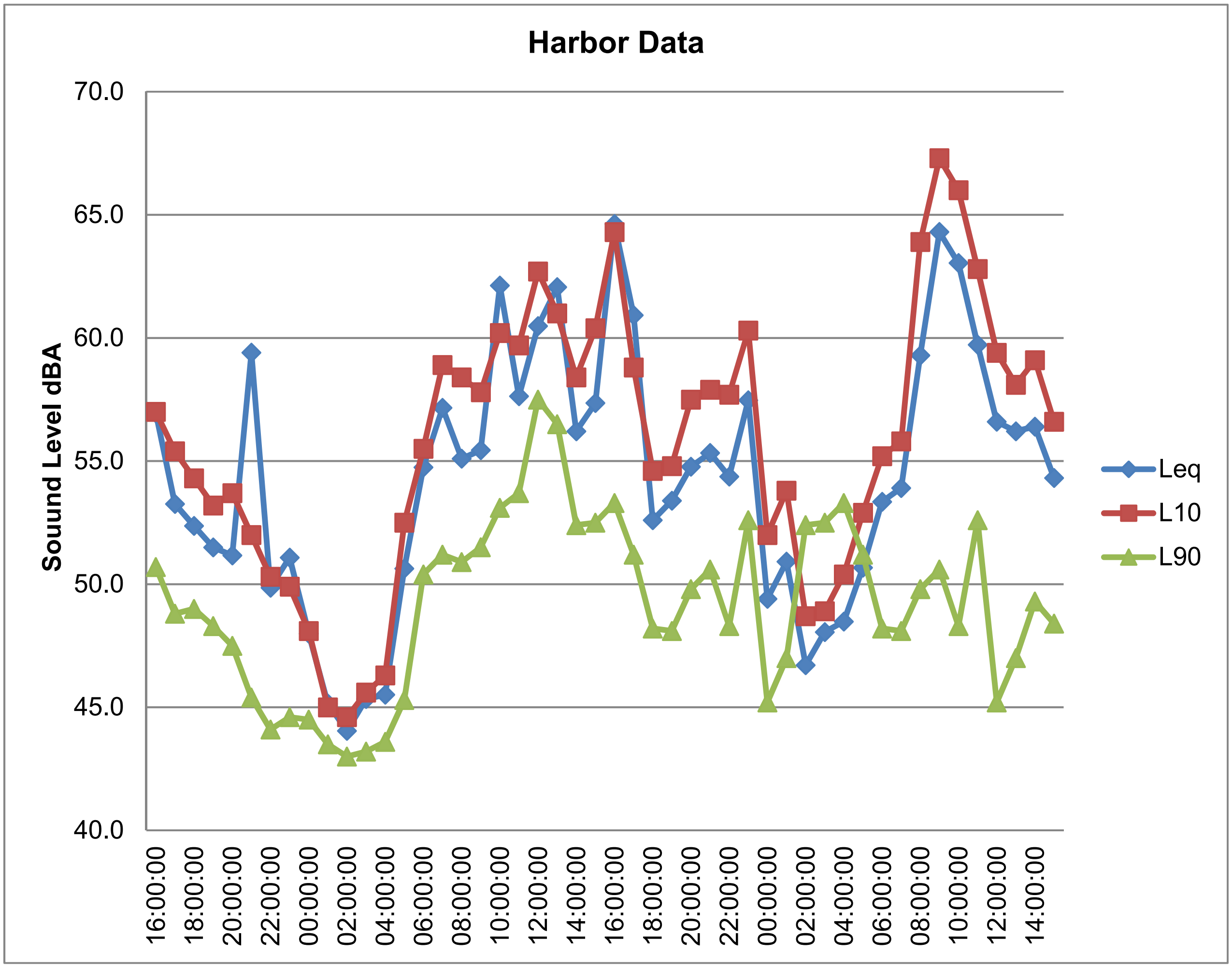
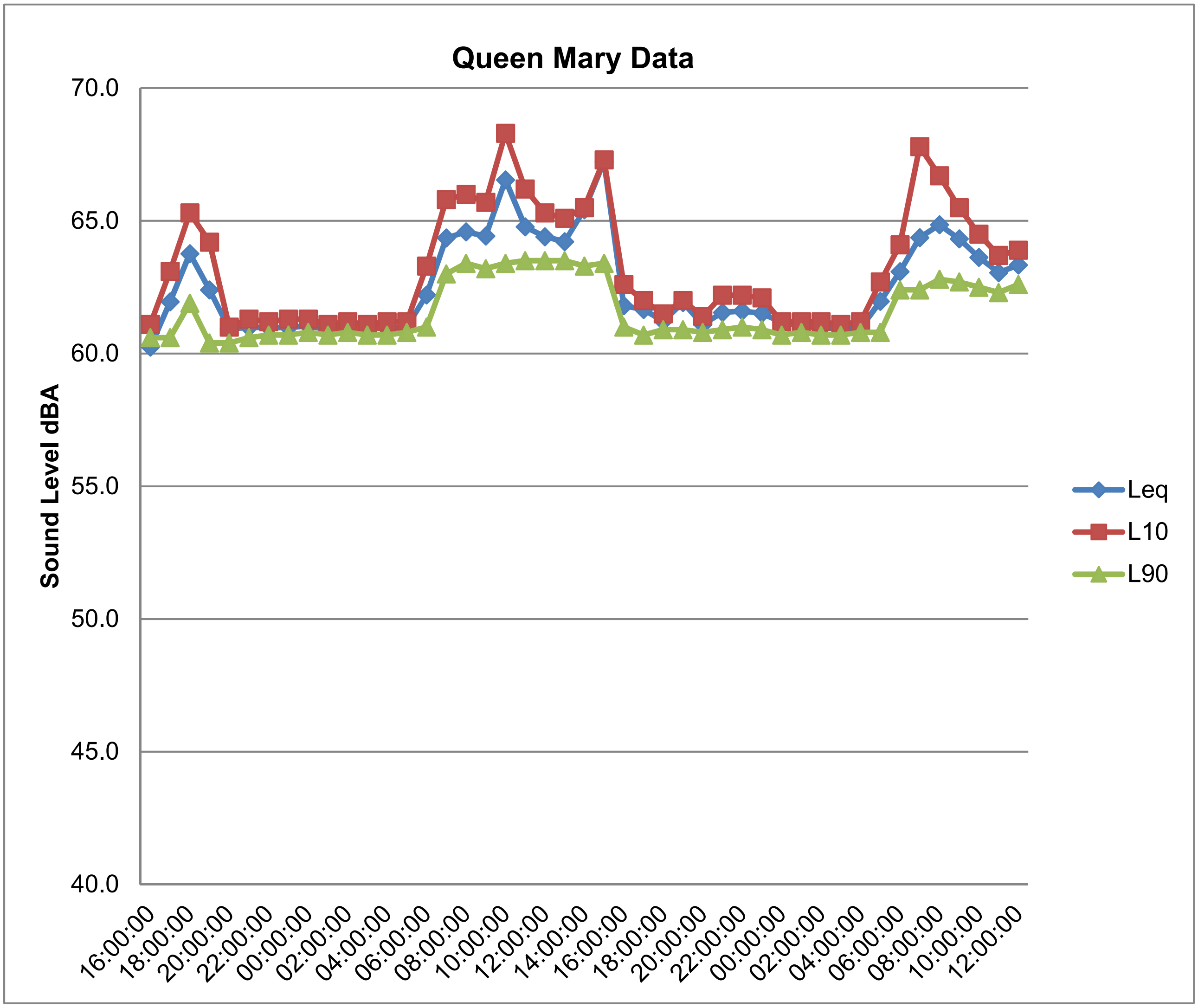


Figure 8-2 Monitoring Location LT2



Modeling Results

Cadna noise modeling was done for all relevant construction noise sources. These included: pile driving, dredge operations, marine construction, garage demolition, garage earthwork, garage structure construction, garage finishing, and garage landscaping. For the marine sources, sound levels were computed for receptors at both the marina across the harbor and at the Queen Mary. For the garage sources, sound levels are only computed on the Queen Mary, as the marina receptors are too far away to experience any significant sound levels from the garage construction. The equipment for each construction phase modeled is shown below. Note that there is actually more mobile equipment on site that isn't modeled; it is assumed that only one dump truck at a time will be used during construction activities. To see maps illustrating all in-air noise modeling results (human impacts), see Appendix D, Cadna Figures 1- 9).

The construction noise levels would clearly exceed the City of Long Beach construction noise limit of 70 dBA for pile driving activities. The residents in the marina would likely hear impact pile driving clearly and might occasionally find it annoying. The other marine construction activities would be audible at the marina, but not typically at a level which would be annoying. It is expected that all reasonable noise mitigation methods (discussed in Section 9) will be used for this activity. For garage construction activities, it seems likely that exceedances of the noise standard would only occur when all significant equipment is running simultaneously; it would not likely occur under most operational scenarios, except for demolition activity, where it might occur for short periods of time during pavement breaking. It is expected that the contractor will make reasonable efforts at mitigation, as discussed later.

Table 8.2 Impact Pile Driving

Receptor	Receptor Description	Modeled Level (dBA)
POR 1	Queen Mary Aft Deck (LT2)	84
POR 2	Queen Mary Mid Deck (ST3)	79
POR 3	Queen Mary Aft Deck (ST4)	76
POR 4	Harbor Center (LT1)	73
POR 5	Harbor East End (ST1)	69
POR 6	Harbor West End (ST2)	68

Table 8.3 Vibratory Hammer Pile Driving

Receptor	Receptor Description	Modeled Level (dBA)
POR 1	Queen Mary Aft Deck (LT2)	74
POR 2	Queen Mary Mid Deck (ST3)	69
POR 3	Queen Mary Aft Deck (ST4)	69
POR 4	Harbor Center (LT1)	63
POR 5	Harbor East End (ST1)	59
POR 6	Harbor West End (ST2)	58

Table 8.4 Dredging

Receptor	Receptor Description	Modeled Level (dBA)
POR 1	Queen Mary Aft Deck (LT2)	71
POR 2	Queen Mary Mid Deck (ST3)	67
POR 3	Queen Mary Aft Deck (ST4)	64
POR 4	Harbor Center (LT1)	64
POR 5	Harbor East End (ST1)	59
POR 6	Harbor West End (ST2)	61

Table 8.5 Marine Construction

Receptor	Receptor Description	Modeled Level (dBA)
POR 1	Queen Mary Aft Deck (LT2)	69
POR 2	Queen Mary Mid Deck (ST3)	67
POR 3	Queen Mary Aft Deck (ST4)	63
POR 4	Harbor Center (LT1)	63
POR 5	Harbor East End (ST1)	58
POR 6	Harbor West End (ST2)	60

Table 8.6 Garage Demolition

Receptor	Receptor Description	Modeled Level (dBA)
POR 1	Queen Mary Aft Deck (LT2)	68
POR 2	Queen Mary Mid Deck (ST3)	73
POR 3	Queen Mary Aft Deck (ST4)	73

Table 8.7 Garage Earthwork

Receptor	Receptor Description	Modeled Level (dBA)
POR 1	Queen Mary Aft Deck (LT2)	64
POR 2	Queen Mary Mid Deck (ST3)	68
POR 3	Queen Mary Aft Deck (ST4)	69

Table 8.8 Garage Structure

Receptor	Receptor Description	Modeled Level (dBA)
POR 1	Queen Mary Aft Deck (LT2)	66
POR 2	Queen Mary Mid Deck (ST3)	71
POR 3	Queen Mary Aft Deck (ST4)	70

Table 8.9 Garage Finishing

Receptor	Receptor Description	Modeled Level (dBA)
POR 1	Queen Mary Aft Deck (LT2)	65
POR 2	Queen Mary Mid Deck (ST3)	67
POR 3	Queen Mary Aft Deck (ST4)	67

Table 8.10 Garage Hardscape and Landscape

Receptor	Receptor Description	Modeled Level (dBA)
POR 1	Queen Mary Aft Deck (LT2)	69
POR 2	Queen Mary Mid Deck (ST3)	73
POR 3	Queen Mary Aft Deck (ST4)	73

Operational Modeling Results

Table 8.11 Modeled Panorama Ship Stack Levels

Receptor	Receptor Description	Modeled Level (dBA)
POR 1	Queen Mary Aft Deck (LT2)	59
POR 2	Queen Mary Mid Deck (ST3)	56
POR 3	Queen Mary Aft Deck (ST4)	52
POR 4	Harbor Center (LT1)	48
POR 5	Harbor East End (ST1)	45
POR 6	Harbor West End (ST1)	44

These results show that sound levels in the harbor would be about 44-48 dBA at the marina when the ship is at anchor and the engine is revving; similar levels would occur when the ship is moving. Levels on board the Queen Mary would be about 52-59 dBA from the Carnival ship. At the marina, these levels would be comparable to those heard typically during the day from waves, wind in trees, and local boat noise. On board the Queen Mary, these levels would be about 5-10 dBA less than the typical noise heard on board the boat due to equipment operating on the Queen Mary

Loading and unloading noise, including traffic noise, should scale with the number of passengers embarking and disembarking. This means that the amount of sound should increase by about 10*LOG((Panorama #)/(Splendor #)), where Panorama # and Splendor # are the total number of passengers embarking or disembarking at one time. Since there are currently about 3,000 passengers embarking or disembarking on the Splendor, and about 4,000 are estimated to embark or disembark on the Panorama, this means that overall sound levels from human activity should increase by about slightly more than one dBA due to human activity. This would not be a noticeable increase, especially as such activity is currently virtually inaudible across the harbor at the marina, and below the background levels on board the Queen Mary.

8.1.2 Marine Mammals

Table 8.12 Anticipated Marine Mammal Behavioral (Harbor Seal) Disruption As A Result of Construction-related Airborne Noise (Level B Harassment)

Activity	Behavioral Disturbance Isopleth (disturbance within x meters)	Behavioral Disturbance Isopleth (disturbance within x feet)
Pile driving	168.3	552.2
Dredging	11	36.1

Pacific Harbor Seals (*Phoca vitulina richardii*) on land (e.g., haul-outs) within 168.3 meters (552.2 feet) of impact pile driving may be disturbed. In addition, Harbor Seals on land (e.g., haul-outs) within 11-11.8 meters (36.1 feet) of dredging may be disturbed (Appendix A, Figure 5-Not Updated). At the POLB, this species is known to occur in the Project Area year-round and is said to occasionally follow cruise ships to forage on organisms churned up from the harbor bottom and on food thrown off the deck by passengers (MBC Applied Environmental Sciences 2016, GHD 2019b, iNaturalist 2018). This species has a high potential of occurring in the Study Area during construction activities. Harbor Seals are protected under the federal Marine Mammal Protection Act and disruption of normal feeding activities could constitute harassment (particularly during the breeding season, since this could result in decreased pup provisioning rates). However, disturbances associated with pile driving would be temporary and of short duration. In addition, the Carnival Cruise berth only occupies a small portion of the POLB and nearshore Pacific coastline, and Harbor Seals are found throughout the Port Complex (as well as the nearshore Pacific Ocean). No breeding activity (only foraging) is expected to occur within ~168 meters of pile driving activities. This being the case, it is anticipated that above water noise disturbance from impact pile driving and dredging would not result in substantial disturbance to Harbor Seals on haul-outs and therefore have no measurable effect on adult or pup provisioning rates and survival. A further analysis of impacts by species is including in the Project's concurrent Incidental Harassment Authorization (IHA).

8.1.3 Seabirds

Table 8.13 Anticipated Seabird Behavioral Disruption As A Result of Construction-related Airborne Noise

Activity	Behavioral Disturbance Isopleth (disturbance within x meters)	Behavioral Disturbance Isopleth (disturbance within x feet)
Pile driving	133.7	438.7
Dredging	8	26.2

Seabirds on land (e.g., nest sites, roosts, etc) within 133.7 meters (438.7 feet) of impact pile driving or 8-9.3 meters (26.2 feet) from dredging activities may be disturbed (Appendix A, Figure 6-Not Updated). The Study Area provides habitat for numerous common species of gulls, waterfowl, aerial wading birds, and aerial fish foragers such as the federally and state Endangered California Least

Tern (*Sternula antillarum browni*). This species is known to forage in the immediate Project Area. In addition, there is a known nesting population on Pier 400 just to the west of the Project Area in the Port of Los Angeles (MBC Applied Environmental Sciences 2016, eBird 2018). Disruption of normal feeding activities could constitute harassment during the breeding season since this could result in decreased chick provisioning rates. However, all disturbances would be temporary and of short duration. In addition, the Carnival Cruise berth only occupies a small portion of the POLB and seabirds are found throughout the Port Complex POLB (as well as the nearshore Pacific Ocean). The major seabird nest colony within the Port Complex are well outside the largest area of airborne auditory impact (438.7 feet). This being the case, it is anticipated that above water disturbance from impact pile driving and dredging would not result in substantial disturbance to seabirds at nesting or perching sites and therefore have no measurable effect on chick provisioning rates and survival.

8.2 Underwater Noise Impacts

8.2.1 Marine Mammals

Table 8.14 Marine Mammals Resultant Isopleths – Underwater Pile Driving Noise (Level A Harassment) (NMFS 2018c)

Hearing Group[a]	SEL_{cum} Threshold[a]	PTS Isopleth to threshold (meters)	PTS Isopleth to threshold (feet)	PK Threshold[a]	PTS PK Isopleth to threshold (meters)	PTS PK Isopleth to threshold (feet)
Low-Frequency Cetaceans	183	2,246.9	7,371.7	219	2.2	7.2
Mid-Frequency Cetaceans	185	79.9	262.1	230	N/A	N/A
High-Frequency Cetaceans	155	2,676.4	8,780.8	202	29.3	96.1
Phocid Pinnipeds	185	1,202.4	3,944.88	218	2.5	8.2
Otariid Pinnipeds	203	87.5	287.1	232	N/A	N/A

[a]NMFS 2018a

Based on the NMFS (2018a) Optional Worksheet, pile driving on this Project may result in underwater noise levels that could cause auditory injury (PTS threshold shift) to marine mammals. Calculations using the SEL_{cum} metric versus the SPL_{peak} metric produced the largest isopleths (most conservative model results) and the PTS Isopleth to Threshold values are considered below to discuss possible "worst case scenario"/unmitigated project impacts. High frequency cetaceans (e.g., porpoises and dolphins; most sensitive to this type of noise) could experience PTS within 2,676.4 meters (8,780.8 feet) of unmitigated pile driving activities (Appendix A, Figure 7-Not Updated). Other marine mammals would be somewhat less sensitive as shown in Table 8.14. However, this isopleth would likely be slightly smaller in areas where the underwater noise waves bounce off structure such as the harbor jetties. Common Bottlenose Dolphins (*Tursiops truncatus*) as well as other dolphin species are commonly observed in the Port Complex and have a moderate to high potential to occur in the Study Area during project implementation (MBC Applied Environmental Sciences 2016, GHD 2019b). Dolphins are protected under the federal MMPA. A “soft start” when initiating pile driving (see Section 9. Mitigation Measures and Recommendations) and presence of biological monitors should allow marine mammals a chance to vacate the immediate area before full-force pile driving is initiated.

Table 8.15 Marine Mammals Resultant Isopleths – Underwater Dredging Noise (Level A Harassment) (NMFS 2018c)

Hearing Group[a]	SEL_{cum} Threshold[a]	PTS Isopleth to threshold (meters)	PTS Isopleth to threshold (feet)
Low-Frequency Cetaceans	199	12.6	43.3
Mid-Frequency Cetaceans	198	1.1	3.6
High-Frequency Cetaceans	173	18.7	61.4
Phocid Pinnipeds	201	7.7	25.3
Otariid Pinnipeds	219	0.5	1.6

[a]NMFS 2018a

Based on the NMFS (2018a) Optional Worksheet, dredging may result in underwater noise levels that could cause auditory injury (PTS threshold shift) to marine mammals only directly adjacent to dredging activities. High frequency cetaceans (e.g., porpoises and dolphins) would be the most sensitive to dredging activities, and may experience PTS within 18.7 meters (61.4 feet) of construction (Appendix A, Figure 8-Not Updated). However, marine mammals are highly mobile and any individuals in the immediate project vicinity are expected to move out of the area once loud construction activities commence.

Table 8.16 Anticipated Marine Mammal Behavioral Disruption As A Result of Construction-related Underwater Noise (Level B Harassment)

Activity	Behavioral Disturbance Isopleth (disturbance within x meters), SAF Model	Behavioral Disturbance Isopleth (disturbance within x feet)), SAF Model	Behavioral Disturbance Isopleth (disturbance within x meters), PSLM Model	Behavioral Disturbance Isopleth (disturbance within x feet), PSLM Model
Pile driving	76.0	249.3	1,584.9	5,199.8
Dredging	101.0	331.4	2,154.4	7,068.2

Based on the SAF model, marine mammals foraging underwater may also exhibit behavioral changes (Level B Harassment) within 76 meters (249.3 feet) of pile driving activities (Appendix A, Figure 9-Not Updated). Calculated Level B Harassment Zones were smaller that Level A Zones due to the use of new SAF modeling techniques for nearshore environments versus the older PSLM that calculated Level A zones are partially based on (Appendix A, Figure 10-Not Updated) (NMFS GARFO 2018). In addition, NMFS has only developed new, more sensitive criteria for modeling Level A impacts while Level B guidance for underwater marine mammal hearing thresholds is an average number that encompasses the sensitives of all marine mammals. This may result in Level B estimates that are too low to evaluate disturbance to species/groups with more sensitive hearing, such as cetaceans.

Dredging is unlikely disturb any underwater marine mammals unless they are within 101 meters (331.4 feet) of construction activities. However, this isopleth would likely be slightly smaller in areas where the underwater noise waves bounce off structure such as the harbor jetties. It is important to note that while the marine mammal underwater threshold for non-impulsive noise (e.g., dredging) is 120 dB_{rms}, ambient noise in the POLB is likely significantly higher than 120 dB_{rms} in certain areas. Tetra Tech (2011) reported that that the underwater ambient noise levels in active shipping areas of the POLB were roughly 140 dB re μPa and noise levels in non-shipping areas (Terminal Island) were between 120 dB and 132 dB re μPa. These underwater ambient noise levels are typical of a large marine bay with heavy commercial boat traffic (Buehler et al. 2015). Therefore, the models for marine mammal disturbance thresholds (Level B Harassment) for dredging may be too conservative in terms of estimating marine mammal sensitivity to boat traffic, particularly in a heavily used POLB.

8.2.2 Fish

Table 8.17 Fish Resultant Isopleths – Underwater Pile Driving Noise (NMFS 2012b)*

Fish Class[a]	Peak Threshold (dB)[a]	SEL_{cum} Threshold[a]	Behavioral Threshold (dB_{rms})	Peak Threshold Isopleth (meters)	Peak Threshold Isopleth (feet)	Cumulative Threshold Isopleth (meters)	Cumulative Threshold Isopleth (feet)	Behavioral Threshold Isopleth (meters)	Behavioral Threshold Isopleth (feet)
≥ 2 grams	206	183	150	18 (18)	59.1 (59.1)	2 (5)	6.7 (32.8)	96 (7,356)	315 (24,133.9)
< 2 grams	206	187				10 (10)	32.8 (32.8)		

[a]Fisheries Hydroacoustic Working Group 2008

*SAF Model Results are presented with PSLM results in parentheses

Based on the SAF model, pile driving associated with the Long Beach Cruise Terminal Improvement Project may result in underwater noise levels (dB_{peak}) that could cause physical injury to all fish within 18 meters (59.1 feet) of pile driving activities. In addition, cumulative noise levels (SEL_{cum}) may cause physical injury to fish within 2 to 10 meters (6.7 to 32.8 feet) of pile driving. Pile driving will likely also disrupt the normal behaviors of fish foraging within 96 meters (315 feet) of construction activities (Appendix A, Figure 11-Not Updated). However, this isopleth would likely be slightly smaller in areas where the underwater noise waves bounce off structure such as the harbor jetties. Although unlikely, federally endangered Southern California Steelhead DPS (*Oncorhynchus mykiss irideus*) have a small chance of occurring in the Project vicinity. SC Steelhead DPS are winter-run populations only (any potentially occurring Steelhead runs would only be present from January-April when winter rains swell rivers and creeks, allowing passage into breeding habitat) (Caltrout 2017). A “soft start” when initiating pile driving (see Section 9. Mitigation Measures and Recommendations) should allow fish a chance to vacate the immediate area before full-force pile driving is initiated.

Table 8.18 Fish Resultant Isopleths – Underwater Dredging Noise*

Fish Class[a]	Peak Threshold (dB)[a]	SEL_{cum} Threshold[a]	Behavioral Threshold (dB_{rms})	Peak Threshold Isopleth (meters)	Peak Threshold Isopleth (feet)	Cumulative Threshold Isopleth (meters)	Cumulative Threshold Isopleth (feet)	Behavioral Threshold Isopleth (meters)	Behavioral Threshold Isopleth (feet)
≥ 2 grams	206	183	150	0 (0)	0 (0)	0 (0)	0 (0)	41 (21.5)	134.5 (70.5)
< 2 grams		187				0 (0)	0 (0)		

[a]Fisheries Hydroacoustic Working Group 2008

*SAF Model Results are presented with PSLM results in parentheses

Fish of any size class are unlikely to be injured by noise associated with dredging activities. However, fish may exhibit behavioral changes and be disturbed from normal foraging activities within 41 meters (134.5 feet) of dredging (Appendix A, Figure 12-Not Updated).

8.2.3 Seabirds

Table 8.19 Seabird Resultant Isopleths – Underwater Pile Driving Noise - Unmitigated

	Physical (non-auditory) Injury	Auditory Injury	TTS	Behavioral Disturbance
Threshold[a]	208 dB SEL	202 dB SEL	183 dB SEL	150 dB_{rms}
SAF Isopleth	0 m (0 ft)	0 m (0 ft)	10.0 m (32.8 ft)	96 m (314 ft)
PSLM Isopleth	0.2 m (0.7 ft)	0.5 m (1.6 ft)	15.0 m (49.2 ft)	7356.4 (24,133.9 ft)

[a] Marbled Murrelet Guidance from USFWS 2012

Based on the SAF model, pile driving at the Carnival Cruise Terminal in the POLB is unlikely to result in underwater noise levels that could cause physical injury to underwater foraging seabirds. Modeling indicated that seabirds would only experience a temporary non-injurious TTS within 10 meters (32.8 feet) of pile driving activities. It is unlikely that seabirds would be foraging this close to impact pile driving and we anticipate they will move out of the immediate area once construction starts. In terms of behavior, modeling results indicate that seabirds may exhibit changes in normal underwater foraging within 96 meters (314 feet) of impact pile driving (Appendix A, Figure 13-Not Updated). A “soft start” when initiating pile driving (see Section 9. Mitigation Measures and Recommendations) should allow seabirds a chance to vacate the immediate area before full-force pile driving is initiated.

Table 8.20 Seabird Resultant Isopleths – Underwater Dredging Noise

	Physical (non-auditory) Injury	Auditory Injury	TTS	Behavioral Disturbance
Threshold[a]	208 dB SEL	202 dB SEL	183 dB SEL	150 dB_{rms}
SAF Isopleth	0 m (0 ft)	0 m (0 ft)	0 m (0 ft)	41 m (134.5 ft)
PSLM Isopleth	0 m (0 ft)	0 m (0 ft)	0.1 m (0.3 ft)	13.6 (ft)

[a] Marbled Murrelet Guidance from USFWS 2012

Dredging at the Carnival Cruise terminal in the POLB is unlikely to result in underwater noise levels that could cause physical injury to underwater foraging seabirds. In terms of behavior, modeling results indicate that seabirds may exhibit changes in normal underwater foraging activities within 41 meters (134.5 feet) dredging (Appendix A, Figure 14-Not Updated). It is unlikely that seabirds would be foraging this close to dredging activities and we anticipate they will move out of the immediate area once construction starts.

8.2.4 Sea Turtles

Table 8.21 Sea Turtle Resultant Isopleths – Underwater Pile Driving and Dredging Noise

	Physical Injury	Behavioral Disturbance
Sea Turtle Acoustic Threshold[a]	180 dB re 1μPa RMS	166 dB re 1μPa RMS
SAF Pile Driving Isopleth	36.0 m (118.0 ft)	64.0 m (210.0 ft)
PSLM Pile Driving Isopleth	76.6 m (251.3 ft)	631.0 m (2,070.2 ft)
SAF Dredging Isopleth	0 m (0 ft)	9 m (30.0 ft)
PSLM Dredging Isopleth	0.2 (0.7 ft)	1.8 m (5.9 ft)

[a]NMFS GARFO 2016

Based on the SAF model, pile driving at the Carnival Cruise Terminal in the POLB is unlikely to result in underwater noise levels that could cause physical injury to underwater foraging sea turtles (unless they are within 36.0 meters (118.0 feet) of pile driving activities. It is unlikely that sea turtles would be foraging this close to impact pile driving and we anticipate they would move out of the immediate area once construction starts. In terms of behavior, modeling results indicate that sea turtles may exhibit changes in normal underwater foraging within 64 meters (210.0 feet) of impact pile driving (Appendix A, Figure 15-Not Updated). Underwater dredging noise is not anticipated to result in physical injury to sea turtles. However, sea turtles within 9 meters (30.0 feet) of dredging may exhibit changes in normal behavior. There are no records of sea turtles from within the Port Complex and they are unlikely to occur in the Project vicinity. However, a “soft start” when initiating pile driving (see Section 9. Mitigation Measures and Recommendations) should allow sea turtles a chance to vacate the immediate area before full-force pile driving is initiated.

9. Mitigation Measures and Recommendations

Noise mitigation measures, such as bubble curtains shall be implemented on an “as needed” basis in order to ensure that Project underwater noise impacts do not exceed federally published noise thresholds for special-status and/or protected marine mammal species.

Table 9.1 Pile Driving Physical Mitigation Methods (Reprinted from NMFS GARFO 2018)

Attenuation Measure	Associated Reduction in Underwater Noise	Source
Bubble Curtain	10 dB reduction in underwater noise	Buehler et al. 2015 (pg. 4-10)
Vibratory Hammer (instead of impact hammer)	10 to 20 dB reduction from unattenuated impact hammer underwater sound levels	Buehler et al. 2015 (pg. 4-16)

The following mitigation measures serve as options that shall be implemented in the field, depending on site specific measured underwater noise levels (during test pile installation).

1. A vibratory hammer (versus a pile driver) shall be used during construction to partially install steel pipe piles, while an impact pile driver will be used to proof the piles and set them to their final depth. Vibratory hammers are frequently employed as a mitigation measure to reduce environmental impacts on aquatic wildlife since they generally produce noise levels 10 to 20 dB lower than impact pile drivers (Buehler et al. 2015).
2. A qualified marine mammal biological monitor shall be present during dredging and pile driving portions of construction.
3. Pile driving shall only occur 45 minutes after sunrise to 45 minutes before sunset which allows biological monitors time to complete their pre- and post-construction surveys.
4. A "soft start" shall be conducted prior to the initiation of full-power pile driving at the beginning of each day, or following a 30 minute or longer break in pile driving, to warn any marine mammals to move away from the construction area. This shall involve an initial set of strikes at reduced energy followed by a 1 minute waiting period (to allow wildlife to move out of the area).
5. Bubble curtains shall be implemented in association with pile driving. Use of an air bubble curtain can generally reduce sound pressure levels by 5-10 dB, with higher effectiveness at higher sound levels (Buehler et al. 2015).
6. Number of piles installed per day shall be limited to five.
7. Heavy equipment, such as dredges, operating from barges or nearshore shall be idled for 15 minutes prior to full-force power.
8. Low noise equipment shall be utilized for garage construction where feasible. The contractor shall work to make sure that construction motorized equipment is well tuned, in a state of good repair, and appropriate effective mufflers shall be utilized on all gasoline or diesel powered construction equipment.

Table 9.2 Proposed Biological Monitoring Zones (Appendix A, Figure 16)

Source	Level B Monitoring Zone*	Level A Exclusion Zone
Impact Pile Driving	1585 m (1.6 km)	2,676.40 m (2.7 km)
Dredging	2154 m (2.2 km)	18.7 m (0.02 km)

*Calculated Level B Harassment Zones were smaller that Level A Zones due to the use of new Simplified Attenuation Formula (SAF) modeling techniques for nearshore environments versus the older Practical Spreading Loss Model (PSLM) that calculated Level A zones are partially based on. Therefore, we extend Level B Zones out to unmitigated construction values calculated using the PSLM to ensure a more conservative Level B monitoring area.

10. Conclusion

The Project Area is within one of the busiest ports on the west coast of the U.S., within highly modified habitat. In spite of the generally degraded habitat conditions, a few special-status or sensitive wildlife species are present or potentially present as described above and in the 2018 Biological Resources Report (GHD 2019b). These include a number of birds, marine mammals, sea turtles, and one special status fish species. Due to the nature of the Project, airborne noise could impact humans and airborne and underwater construction-related noise could impact marine mammals, fish, sea turtles, and seabirds foraging and residing within the Port Complex.

Certain construction activities at the garage area and offshore may be noticeable to residents on board the Queen Mary. An attempt will be made to use quiet, well-maintained equipment for operations near the residents. Also, vibratory hammers will be used when possible to avoid noise impacts to nearby residents, and other impact equipment usage will be used to the minimum extent practical. To the extent practical, other impacts will be avoided, minimized, or mitigated.

Implementation of mitigated pile driving (versus bare pile) would allow for a considerable reduction in the underwater noise Project disturbance area for marine mammals and other wildlife species. In addition, as described in Section 9, marine mammal biological monitors will be present during pile driving activities with the power to exercise Stop Work Authority if marine mammals or special status wildlife species move within the Level A isopleths and exhibit behavioral disturbance to construction noise. With implementation of the proposed mitigation measures, airborne and underwater noise impacts to wildlife will be minimized and mitigated.

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12. Personal Communications

Atkins

Laura McCue, NOAA Fisheries Long Beach, November 19, 2018

Lisa Mangione, USACE Los Angeles District, December 4, 2018.

Appendices

A. Figures

B. Monitoring Station Photographs

C. Wildlife Noise Impact Calculators

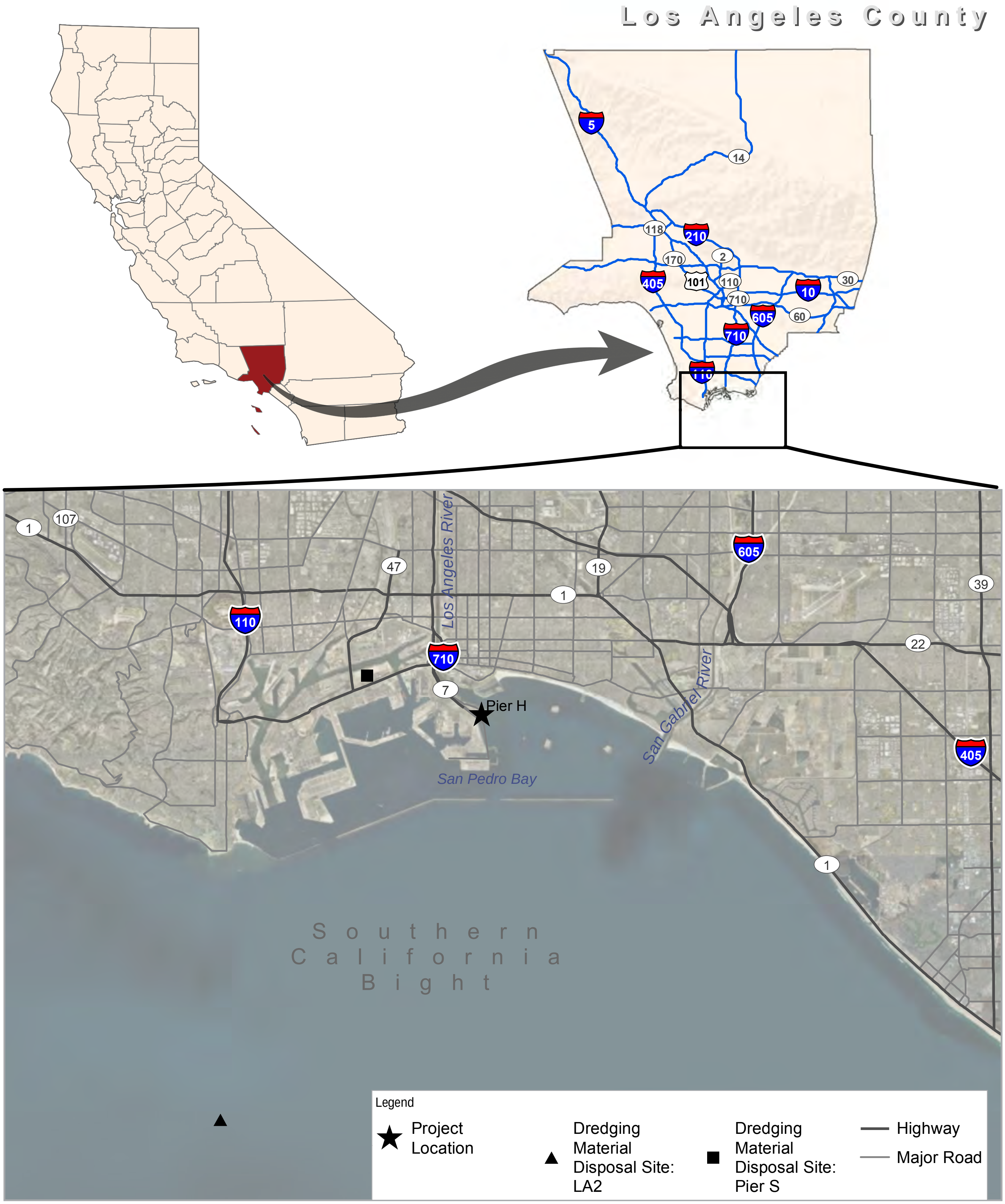
D. CADNA Figures

E. CEQA Executive Summary and Checklist

F. In-air Noise Data

Appendix A Figures

Appendix A: Figures



Paper Size ANSI A

0 1 2 3

Miles

1 " = 3 mi

Map Projection: Lambert Conformal Conic

Horizontal Datum: North American 1983

Grid: NAD 1983 StatePlane California V FIPS 0405 Feet

N

GHD

City of Long Beach
Port of Long Beach Carnival Cruise
Lines Terminal Improvement Project

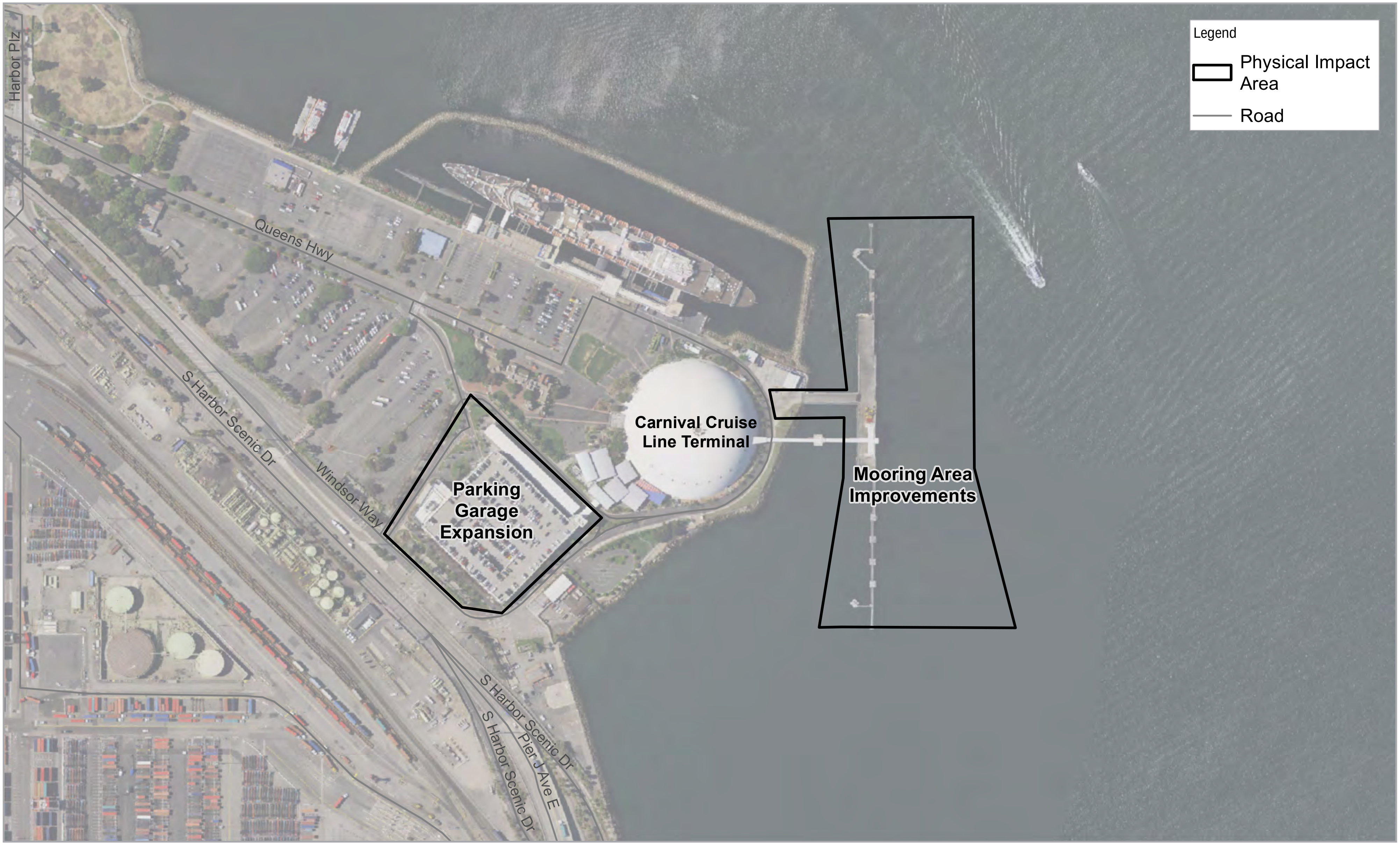
Project No. 11183495
Revision No. -
Date 02/19/2019

Vicinity Map

FIGURE 01

\\ghdnet\ghd\US\Sacramento\Projects\111\11183495 Atkins Long Beach Cruz Terminal Imp\08-GIS\Maps\Deliverables\NTR\11183495_NTR_001_Vicinity.mxd
Print date: 19 Feb 2019 - 16:10

Data source: Sources: Esri, USGS, NOAA
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community. Created by: jclark2



Paper Size ANSI A

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Feet
1 " = 400 '
Map Projection: Lambert Conformal Conic
Horizontal Datum: North American 1983
Grid: NAD 1983 StatePlane California V FIPS 0405 Feet

N

GHD

City of Long Beach
Port of Long Beach Carnival Cruise
Lines Terminal Improvement Project

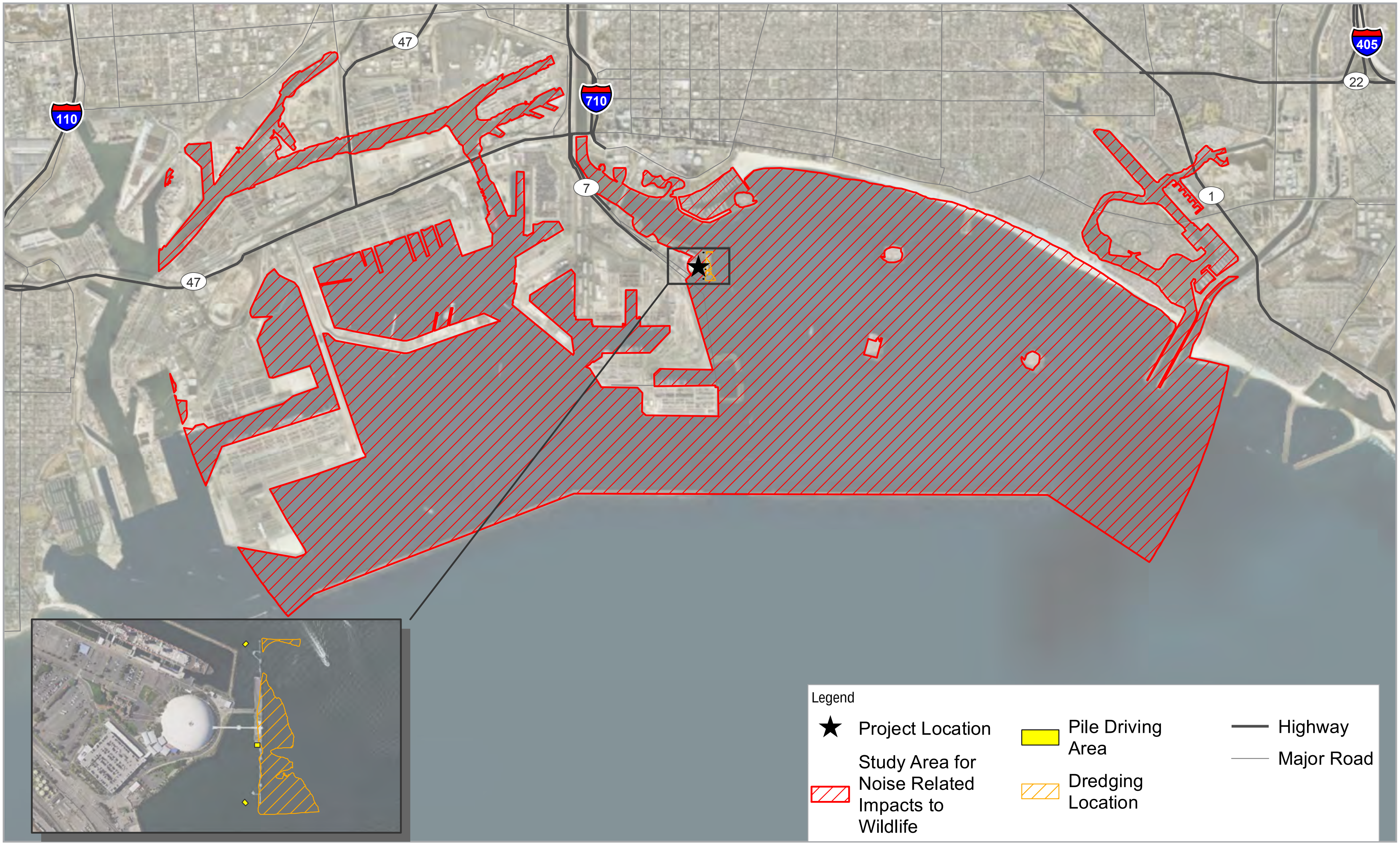
Project Area

Project No. 11183495
Revision No. -
Date 02/01/2019

FIGURE 02

\\ghdnet\ghd\US\Sacramento\Projects\111\11183495 Atkins Long Beach Cruz Terminal Imp\08-GIS\Maps\Deliverables\NTR\11183495_NTR_002_ProjectArea.mxd
Print date: 01 Feb 2019 - 13:49

Data source: Project Area Boundary, GHD; The National Map imagery, 2016; . Created by: jclark2



Paper Size ANSI A

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Miles

1 " = 6,000 '

Map Projection: Lambert Conformal Conic
Horizontal Datum: North American 1983
Grid: NAD 1983 StatePlane California V FIPS 0405 Feet

N

GHD

City of Long Beach
Port of Long Beach Carnival Cruise Lines Terminal Improvement Project

Study Area Boundary

Project No. 11183495
Revision No. -
Date 02/01/2019

FIGURE 03

\\ghdnet\ghd\US\Sacramento\Projects\111\11183495 Atkins Long Beach Cruz Terminal Imp\08-GIS\Maps\Deliverables\NTR\11183495_NTR_003_StudyArea.mxd
Print date: 01 Feb 2019 - 13:51

Data source: Study Area Boundary, Pile driving and dredging locations, Atkins; GHD 11/20/2018; The National Map imagery, 2016; Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community. Created by: jclark2

Paper Size ANSI A

0 210 420 630 840

Feet
1 " = 750 '
Map Projection: Lambert Conformal Conic
Horizontal Datum: North American 1983
Grid: NAD 1983 StatePlane California V FIPS 0405 Feet

N

City of Long Beach
Port of Long Beach Carnival Cruise
Lines Terminal Improvement Project

Project No. 11183495
Revision No. -
Date 02/01/2019

In-Air Noise Monitoring Locations

FIGURE 04

\\ghdnet\ghd\US\Sacramento\Projects\111\11183495 Atkins Long Beach Cruz Terminal Imp\08-GIS\Maps\Deliverables\NTR\11183495_NTR_004_InAirNoiseMonitoringLocations.mxd
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Data source: Study Area Boundary, Pile driving and dredging locations, Atkins; GHD 11/20/2018; The National Map imagery, 2016; Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community. Created by: jclark2

Paper Size ANSI A

0 110 220 330 440

Feet
1 " = 408.33 '
Map Projection: Lambert Conformal Conic
Horizontal Datum: North American 1983
Grid: NAD 1983 StatePlane California V FIPS 0405 Feet

N

City of Long Beach
Port of Long Beach Carnival Cruise
Lines Terminal Improvement Project
Marine Mammal Level B Harassment
from Airborne Noise

Project No. 11183495
Revision No. -
Date 02/01/2019

FIGURE 05

\\ghdnet\ghd\US\Sacramento\Projects\111\11183495 Atkins Long Beach Cruz Terminal Imp\08-GIS\Maps\Deliverables\NTR\11183495_NTR_Isopleth_MB.mxd
Print date: 01 Feb 2019 - 15:03

Data source: Study Area Boundary, Pile driving and dredging locations, Atkins; GHD 11/20/2018; The National Map imagery, 2016; Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community. Created by: jclark2

Paper Size ANSI A

0 100 200 300 400

Feet
1 " = 375 '
Map Projection: Lambert Conformal Conic
Horizontal Datum: North American 1983
Grid: NAD 1983 StatePlane California V FIPS 0405 Feet

N

City of Long Beach
Port of Long Beach Carnival Cruise
Lines Terminal Improvement Project
Seabird Level B Harassment from
Airborne Noise

Project No. 11183495
Revision No. -
Date 02/01/2019

FIGURE 06

\\ghdnet\ghd\US\Sacramento\Projects\111\11183495 Atkins Long Beach Cruz Terminal Imp\08-GIS\Maps\Deliverables\NTR\11183495_NTR_Isopleth_MB.mxd
Print date: 01 Feb 2019 - 15:03

Data source: Study Area Boundary, Pile driving and dredging locations, Atkins; GHD 11/20/2018; The National Map imagery, 2016; Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community. Created by: jclark2

Paper Size ANSI A

0 925 1,850 2,775 3,700

Feet

1 " = 3,308.33 '

Map Projection: Lambert Conformal Conic

Horizontal Datum: North American 1983

Grid: NAD 1983 StatePlane California V FIPS 0405 Feet

N

City of Long Beach

Port of Long Beach Carnival Cruise Lines Terminal Improvement Project

Marine Mammal Level A Harassment from Underwater Impulsive Impact Pile Driving Noise

Project No. 11183495

Revision No. -

Date 02/20/2019

FIGURE 07

\\ghdnet\ghd\US\Sacramento\Projects\111\11183495 Atkins Long Beach Cruz Terminal Imp\08-GIS\Maps\Deliverables\NTR\11183495_NTR_Isopleth_MB.mxd

Print date: 20 Feb 2019 - 12:58

Data source: Study Area Boundary, Pile driving and dredging locations, Atkins; GHD 11/20/2018; The National Map imagery, 2016; Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community. Created by: jclark2

Paper Size ANSI A

0 70 140 210 280

Feet

1 " = 250 '

Map Projection: Lambert Conformal Conic

Horizontal Datum: North American 1983

Grid: NAD 1983 StatePlane California V FIPS 0405 Feet

N

City of Long Beach
Port of Long Beach Carnival Cruise
Lines Terminal Improvement Project

Marine Mammal Level A Harassment from Underwater Non-Impulsive Dredging Noise

Project No. 11183495
Revision No. -
Date 02/01/2019

FIGURE 08

\\ghdnet\ghd\US\Sacramento\Projects\111\11183495 Atkins Long Beach Cruz Terminal Imp\08-GIS\Maps\Deliverables\NTR\11183495_NTR_Isopleth_MB.mxd
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Paper Size ANSI A

0 100 200 300 400

Feet

1 " = 358.33 '

Map Projection: Lambert Conformal Conic

Horizontal Datum: North American 1983

Grid: NAD 1983 StatePlane California V FIPS 0405 Feet

N

City of Long Beach
Port of Long Beach Carnival Cruise
Lines Terminal Improvement Project

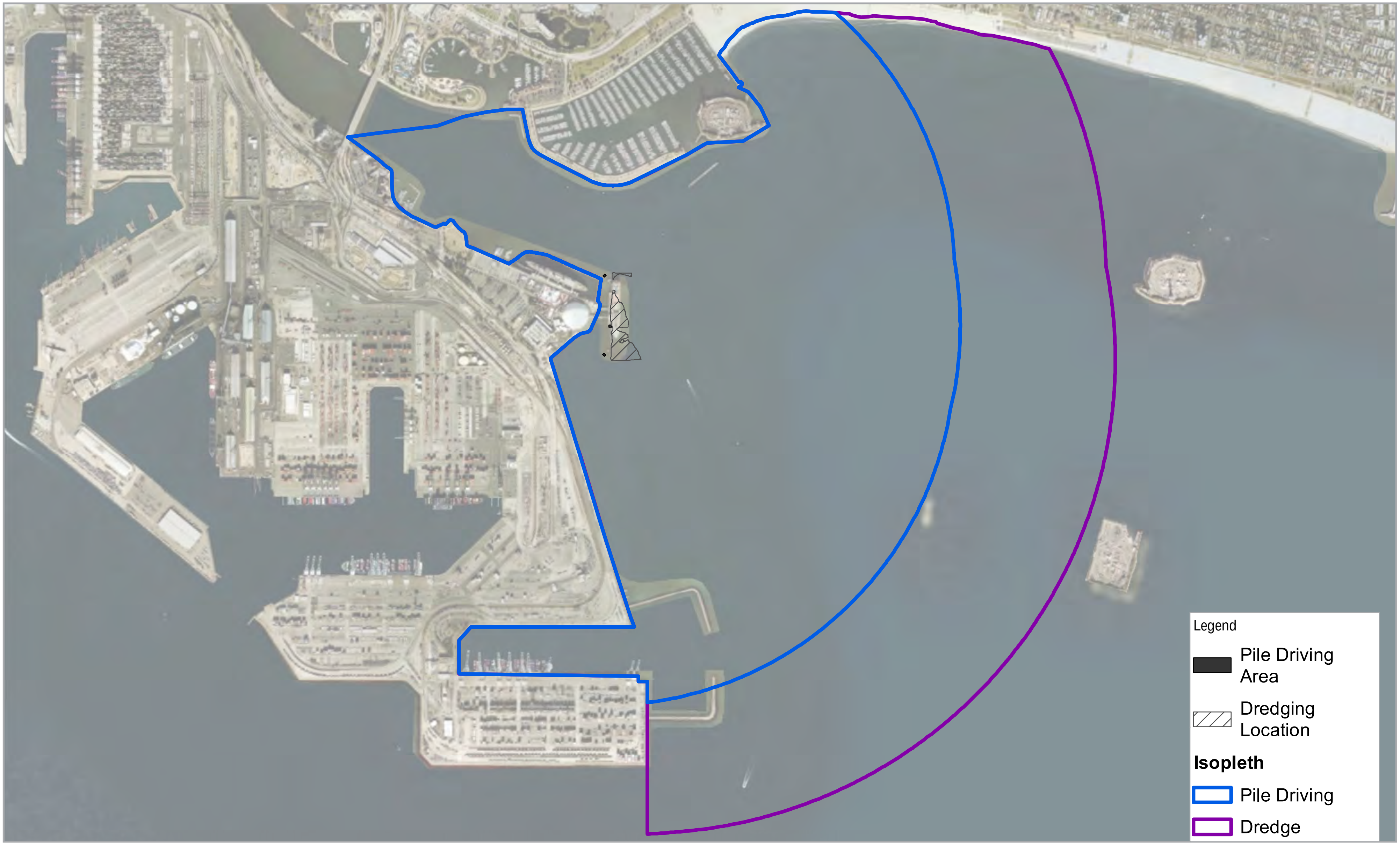
Marine Mammal Level B Harassment from Underwater Impulsive & Non-Impulsive Noise, SAF Model

Project No. 11183495
Revision No. -
Date 02/18/2019

FIGURE 09

\\ghdnet\ghd\US\Sacramento\Projects\111\11183495 Atkins Long Beach Cruz Terminal Imp\08-GIS\Maps\Deliverables\NTR\11183495_NTR_Isopleth_MB.mxd
Print date: 18 Feb 2019 - 16:18

Data source: Study Area Boundary, Pile driving and dredging locations, Atkins; GHD 11/20/2018; The National Map imagery, 2016; Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community. Created by: jclark2



Paper Size ANSI A

0 560 1,120 1,680 2,240

Feet

1 " = 2,000 '

Map Projection: Lambert Conformal Conic

Horizontal Datum: North American 1983

Grid: NAD 1983 StatePlane California V FIPS 0405 Feet

N

City of Long Beach
Port of Long Beach Carnival Cruise
Lines Terminal Improvement Project

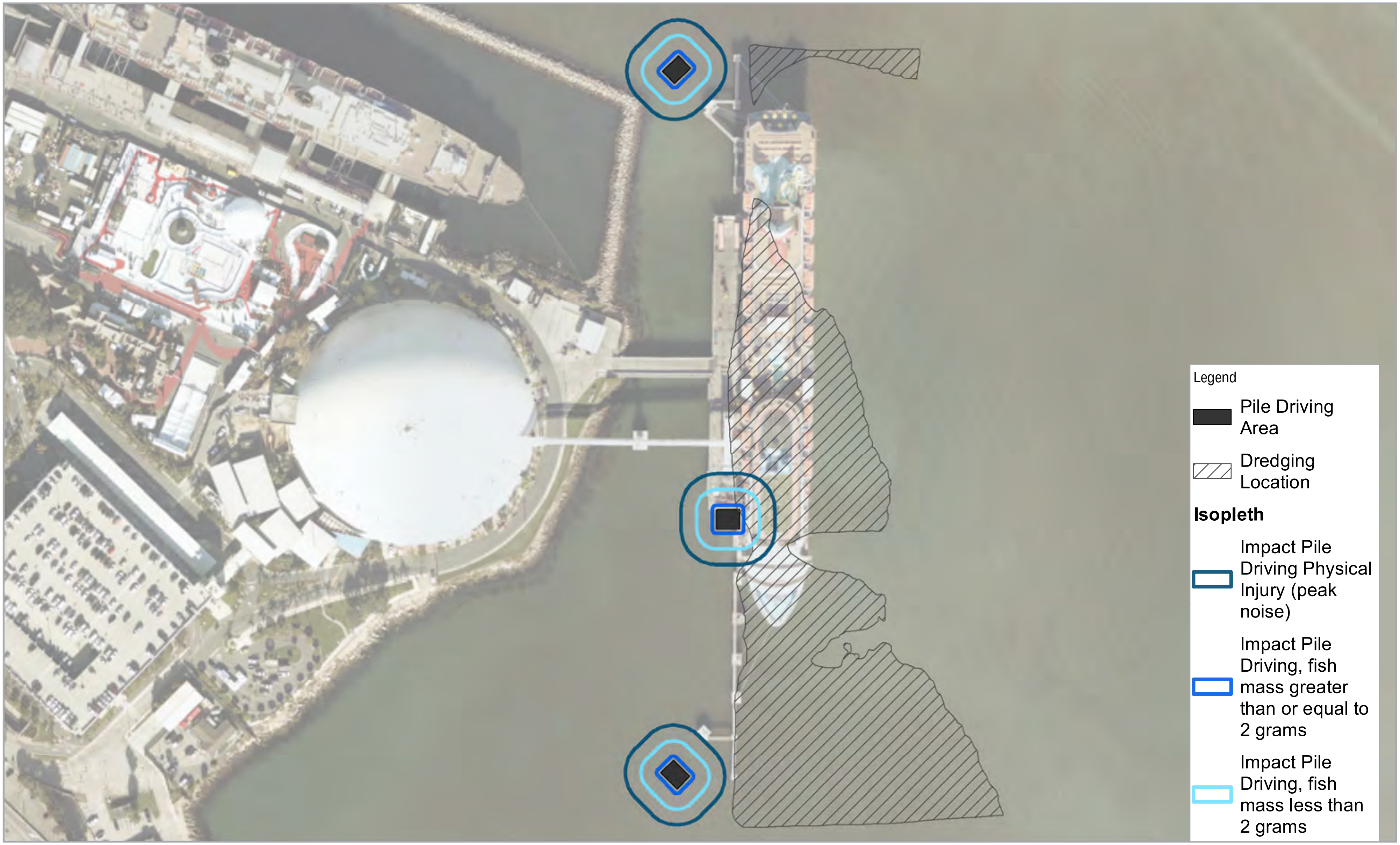
Marine Mammal Level B Harassment from Underwater Impulsive & Non-Impulsive Noise, PSLM Model

Project No. 11183495
Revision No. -
Date 02/01/2019

FIGURE 10

\\ghdnet\ghd\US\Sacramento\Projects\111\11183495 Atkins Long Beach Cruz Terminal Imp\08-GIS\Maps\Deliverables\NTR\11183495_NTR_010_Mammal_PSLM.mxd
Print date: 01 Feb 2019 - 15:28

Data source: Study Area Boundary, Pile driving and dredging locations, Atkins; GHD 11/20/2018; The National Map imagery, 2016; Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community. Created by: jclark2



Paper Size ANSI A

0 60 120 180 240

Feet

1 " = 225 '

Map Projection: Lambert Conformal Conic

Horizontal Datum: North American 1983

Grid: NAD 1983 StatePlane California V FIPS 0405 Feet

N

City of Long Beach

Port of Long Beach Carnival Cruise Lines Terminal Improvement Project

Fish Injury Isopleth for Underwater Impulsive Impact Pile Driving Noise, SAF Model

Project No. 11183495

Revision No. -

Date 03/13/2019

FIGURE 11

\\ghdnet\ghd\US\Sacramento\Projects\111\11183495 Atkins Long Beach Cruz Terminal Imp\08-GIS\Maps\Deliverables\NTR\11183495_NTR_Isopleth_MB.mxd

Print date: 13 Mar 2019 - 11:52

Data source: Study Area Boundary, Pile driving and dredging locations, Atkins; GHD 11/20/2018; The National Map imagery, 2016; Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community. Created by: jclark2

Paper Size ANSI A

0 75 150 225 300

Feet

1 " = 275 '

Map Projection: Lambert Conformal Conic

Horizontal Datum: North American 1983

Grid: NAD 1983 StatePlane California V FIPS 0405 Feet

N

City of Long Beach

Port of Long Beach Carnival Cruise Lines Terminal Improvement Project

Fish Behavioral Disturbance Isopleth for Underwater Non-Impulsive Dredging Noise

Project No. 11183495

Revision No. -

Date 02/18/2019

FIGURE 12

\\ghdnet\ghd\US\Sacramento\Projects\111\11183495 Atkins Long Beach Cruz Terminal Imp\08-GIS\Maps\Deliverables\NTR\11183495_NTR_Isopleth_MB.mxd

Print date: 18 Feb 2019 - 16:18

Data source: Study Area Boundary, Pile driving and dredging locations, Atkins; GHD 11/20/2018; The National Map imagery, 2016; Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community. Created by: jclark2

Paper Size ANSI A

0 90 180 270 360

Feet

1 " = 325 '

Map Projection: Lambert Conformal Conic

Horizontal Datum: North American 1983

Grid: NAD 1983 StatePlane California V FIPS 0405 Feet

N

City of Long Beach

Port of Long Beach Carnival Cruise Lines Terminal Improvement Project

Seabird Injury and Disturbance Isopleths for Underwater Impulsive Impact Pile Driving Noise

Project No. 11183495

Revision No. -

Date 02/18/2019

FIGURE 13

\\ghdnet\ghd\US\Sacramento\Projects\111\11183495 Atkins Long Beach Cruz Terminal Imp\08-GIS\Maps\Deliverables\NTR\11183495_NTR_Isopleth_MB.mxd

Print date: 18 Feb 2019 - 16:18

Data source: Study Area Boundary, Pile driving and dredging locations, Atkins; GHD 11/20/2018; The National Map imagery, 2016; Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community. Created by: jclark2

Paper Size ANSI A

0 75 150 225 300

Feet

1 " = 275 '

Map Projection: Lambert Conformal Conic

Horizontal Datum: North American 1983

Grid: NAD 1983 StatePlane California V FIPS 0405 Feet

N

City of Long Beach

Port of Long Beach Carnival Cruise Lines Terminal Improvement Project

Seabird Behavioral Disturbance Isopleth for Underwater Non-Impulsive Dredging Noise

Project No. 11183495

Revision No. -

Date 02/18/2019

FIGURE 14

\\ghdnet\ghd\US\Sacramento\Projects\111\11183495 Atkins Long Beach Cruz Terminal Imp\08-GIS\Maps\Deliverables\NTR\11183495_NTR_Isopleth_MB.mxd

Print date: 18 Feb 2019 - 16:18

Data source: Study Area Boundary, Pile driving and dredging locations, Atkins; GHD 11/20/2018; The National Map imagery, 2016; Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community. Created by: jclark2

Paper Size ANSI A

0 80 160 240 320

Feet

1 " = 291.67 '

Map Projection: Lambert Conformal Conic

Horizontal Datum: North American 1983

Grid: NAD 1983 StatePlane California V FIPS 0405 Feet

N

City of Long Beach

Port of Long Beach Carnival Cruise Lines Terminal Improvement Project

Turtle Physical Injury & Behavioral Disturbance Isopleths for Impulsive & Non-Impulsive Underwater Noise

Project No. 11183495

Revision No. -

Date 02/18/2019

FIGURE 15

\\ghdnet\ghd\US\Sacramento\Projects\111\11183495 Atkins Long Beach Cruz Terminal Imp\08-GIS\Maps\Deliverables\NTR\11183495_NTR_Isopleth_MB.mxd

Print date: 18 Feb 2019 - 16:19

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Paper Size ANSI A

0 0.15 0.3 0.45 0.6

Miles

1 " = 3,500 '

Map Projection: Lambert Conformal Conic

Horizontal Datum: North American 1983

Grid: NAD 1983 StatePlane California V FIPS 0405 Feet

N

City of Long Beach
Port of Long Beach Carnival Cruise
Lines Terminal Improvement Project

Project No. 11183495
Revision No. -
Date 02/19/2019

Proposed Biological Monitoring Zones

FIGURE 16

\\ghdnet\ghd\US\Sacramento\Projects\111\11183495 Atkins Long Beach Cruz Terminal Imp\08-GIS\Maps\Deliverables\NTR\11183495_NTR_016_BioMonitoringZones.mxd
Print date: 19 Feb 2019 - 14:41

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Appendix B: Monitoring Station Photographs

Photo 1: Airborne Sound Monitoring Location (LT1; long-term station) for Long Beach Cruise Terminal.

Photo 2: Airborne Sound Monitoring Location (LT2; long-term station) for Long Beach Cruise Terminal.

Photo 3: Airborne Sound Monitoring Location (ST1; short-term station) for Long Beach Cruise Terminal.

Photo 4: Airborne Sound Monitoring Location (ST2; short-term station) for Long Beach Cruise Terminal.

Appendix B: Monitoring Station Photographs

Photo 5: Airborne Sound Monitoring Location (ST3; short-term station) for Long Beach Cruise Terminal.

Photo 6: Airborne Sound Monitoring Location (ST4; short-term station) for Long Beach Cruise Terminal.

Appendix B: Monitoring Station Photographs

Appendix C: Wildlife Noise Modeling Calculators

A: STATIONARY SOURCE: Non-Impulsive, Continuous

VERSION 2.0: 2018

KEY

(green)	**User Provided Information**
(pink)	**NMFS Provided Information (Technical Guidance)**
(blue)	**Resultant Isopleth**

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	Long Beach Cruise Terminal Improvement Project
PROJECT/SOURCE INFORMATION	dredge engine, estimated as 170 dBrms (at 1 meters) (Viers et al. 2012).
Please include any assumptions	
PROJECT CONTACT	Ken Mierzwa, ken.mierzwa@ghd.com

STEP 2: WEIGHTING FACTOR ADJUSTMENT

		Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value.
Weighting Factor Adjustment (kHz)[¥]	2.5	source-specific WFA (2.5 kHz for vibratory hammer; most similar to continous vehicle motor)

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

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 47), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

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

STEP 3: SOURCE-SPECIFIC INFORMATION

Source Level (RMS SPL)	170
Duration of Sound Production (hours) within 24-h period	10
Duration of Sound Production (seconds)	36000
10 Log (duration of sound production)	45.56
Propagation (xLogR)	15

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

RESULTANT ISOPLETHS

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	199	198	173	201	219
PTS Isopleth to threshold (meters)	**12.6**	**1.1**	**18.7**	**7.7**	**0.5**

WEIGHTING FUNCTION CALCULATIONS

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

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

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

VERSION 2.0: 2018

KEY

(green)	**User Provided Information**
(pink)	**NMFS Provided Information (Technical Guidance)**
(blue)	**Resultant Isopleth**

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	Long Beach Cruise Terminal Improvement Project
PROJECT/SOURCE INFORMATION	CalTrans 2015 technical guidance; P. 128, 504; WDOT technical BA guidance

Please include any assumptions

PROJECT CONTACT	Ken Mierzwa, GHD; 707-443-8326

STEP 2: WEIGHTING FACTOR ADJUSTMENT

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

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

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

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

STEP 3: SOURCE-SPECIFIC INFORMATION

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

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

SEL_{cum}

Source Level (RMS SPL)	193
Number of piles per day	5
Strike Duration[Δ] (seconds)	0.1
Number of strikes per pile	675
Duration of Sound Production (seconds)	337.5
10 Log (duration of sound production)	25.28
Propagation (xLogR)	15
Distance of source level measurement (meters)*	10

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

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

PK

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

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

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

RESULTANT ISOPLETHS*

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

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	**2,246.9**	**79.9**	**2,676.4**	**1,202.4**	**87.5**
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	**2.5**	**NA**	**34.1**	**2.9**	**NA**

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

Unweighted $SEL_{cum\ (at\ measured\ distance)}$ = SEL_{ss} + 10 Log (# strikes)	**#NUM!**

SEL_{cum}

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

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

PK

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

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

RESULTANT ISOPLETHS*

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

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

WEIGHTING FUNCTION CALCULATIONS

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

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

												SAF		PSLM		SAF			PSLM				SAF		PSLM		
Approximate Pile Size	**Pile Type**	**Hammer Type**	**Water Depth (m)**	**Distance (m)**	**Peak (dB)**	**RMS (dB)**	**SEL**	**# of strikes (impact) or # of seconds (vibratory)**	**cSEL[1]**	**Attentuation Rate dB/10 m**	**Transmission loss constant (for PSLM)**	**Sea Turtle Distance to Physiological (m)**	**Sea Turtle Distance to Behavioral(m)**	**Sea Turtle Distance to Physiological (m)**	**Sea Turtle Distance to Behavioral (m)**	**Sturgeon/Salmon Distance to 206 Peak dB (m)**	**Sturgeon/Salmon Distance to Physiological SEL (m) [2]**	**Sturgeon/Salmon Distance to Behavioral RMS (m)**	**Sturgeon/Salmon Distance to 206 Peak dB (m)**	**Sturgeon/Salmon Distance to >2g Physiological cSEL (m)**	**Sturgeon/Salmon Distance to <2g Physiological cSEL (m)**	**Sturgeon/Salmon Distance to Behavioral RMS (m)**	**Cetacean Distance to Behavioral (impulsive) RMS (m)**	**Cetacean Distance to Behavioral (non-pulse) RMS (m)**	**Cetacean Distance to Behavioral (impulsive) RMS (m)**	**Cetacean Distance to Behavioral (non-pulse) RMS (m)**	**Notes**
36"	Steel Pipe	Impact	10	10	210	193	183	NA	NA	5	15	36.0	64.0	73.6	631.0	18.0	76	96	18.47849797	NA	NA	7356.422545	76	156	1584.893192	735642.2545	Sound pressure levels taken from Table I.2-1 of Caltrans (2012). No project specific info provided - SPLs are likely an average of multiple measurements taken for 36" piles.

<u>**Action Agencies**</u>: For your effects analysis, **always include Tables 1 & 2**, below. Use of Tables 3-5 will depend on whether or not those species are affected by the pile driving.
You can delete/add rows from the tables, as necessary, just be sure that the formulas carry over.

TABLE 1:
Proxy Projects for Estimating Underwater Noise

Project Location	Water Depth (m)	Pile Size (inches)	Pile Type	Hammer Type	Attenuation rate (dB/10m)
#REF!	10	36"	Steel Pipe	Impact	5
#REF!	0	0	0	0	0
#REF!	0	0	0	0	0
#REF!	0	0	0	0	0
#REF!	0	0	0	0	0
#REF!	0	0	0	0	0

TABLE 2:
Proxy-Based Estimates for Underwater Noise

Type of Pile	Hammer Type	Estimated Peak Noise Level (dB_{Peak})	Estimated Pressure Level (dB_{RMS})	Estimated Single Strike Sound Exposure Level (dB_{sSEL})
36" Steel Pipe	Impact	210	193	183
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0

TABLE 3:
Estimated Distances to Sturgeon/Salmon Injury and Behavioral Thresholds

Type of Pile	Hammer Type	Distance (m) to $206dB_{Peak}$	Distance (m) to sSEL of 150 dB	Distance (m) to Behavioral
36" Steel Pipe	Impact	18.0	76.0	96.0
	0	0.0	0.0	0.0
	0	0.0	0.0	0.0
	0	0.0	0.0	0.0
	0	0.0	0.0	0.0
	0	0.0	0.0	0.0

TABLE 4
Estimated Distances to Sea Turtle Injury and Behavioral Thresholds

Type Pile	Hammer Type	Distance (m) to 180 dB RMS	Distance (m) to 166 dBRMS
36" Steel Pipe	Impact	36.0	64.0
	0	0.0	0.0
	0	0.0	0.0
	0	0.0	0.0
	0	0.0	0.0
	0	0.0	0.0

TABLE 5:
Estimated Distances to Cetacean Behavioral Thresholds

Type Pile	Hammer Type	Distance (m) to 160 dB RMS (behavior for impulsive noise)	Distance (m) to 120 dB RMS (behavior for non-pulse noise)
36" Steel Pipe	Impact	76.0	NA
	0	0.0	0.0
	0	0.0	0.0
	0	0.0	0.0
	0	0.0	0.0
	0	0.0	0.0

Appendix D CADNA Figures

Appendix D: CADNA Figures

N

60
65
70
75
80
85

ACOUSTIC ASSESMENT
LONG BEACH HARBOR PILE DRIVING

FIGURE 1
NOISE CONTOUR PLOT

N

60
65
70
75
80
85

ACOUSTIC ASSESMENT
LONG BEACH HARBOR DREDGING

FIGURE 2
NOISE CONTOUR PLOT

60	
65	
70	
75	
80	
85	

ACOUSTIC ASSESMENT
LONG BEACH HARBOR MARINE CONSTRUCTION

FIGURE 3
NOISE CONTOUR PLOT

N

	60
	65
	70
	75
	80
	85

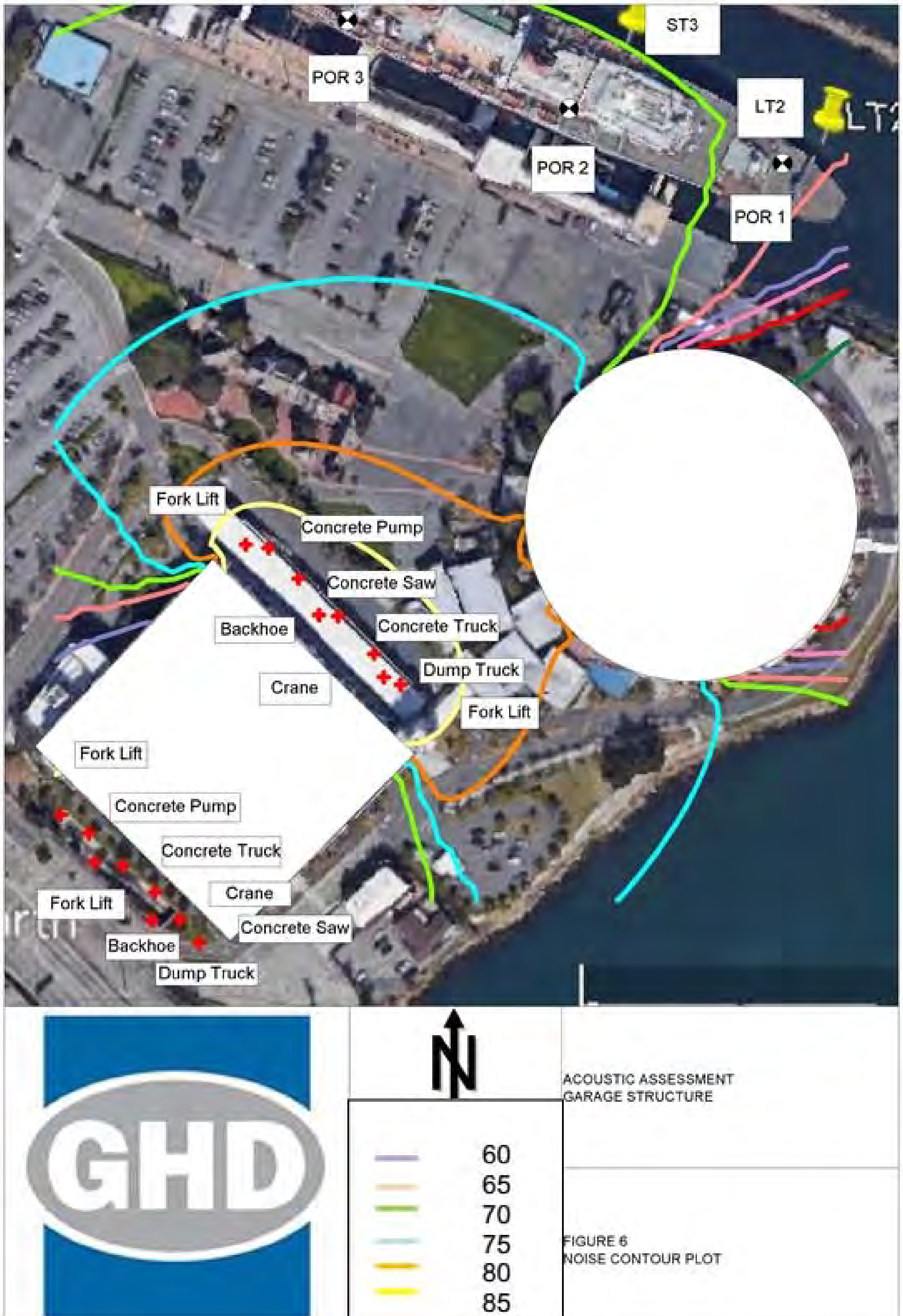
ACOUSTIC ASSESMENT
GARAGE DEMOLITION

FIGURE 4
NOISE CONTOUR PLOT

60	
65	
70	
75	
80	
85	

ACOUSTIC ASSESMENT
GARAGE EARTHWORK

FIGURE 5
NOISE CONTOUR PLOT



ACOUSTIC ASSESSMENT
GARAGE STRUCTURE

FIGURE 6
NOISE CONTOUR PLOT

N

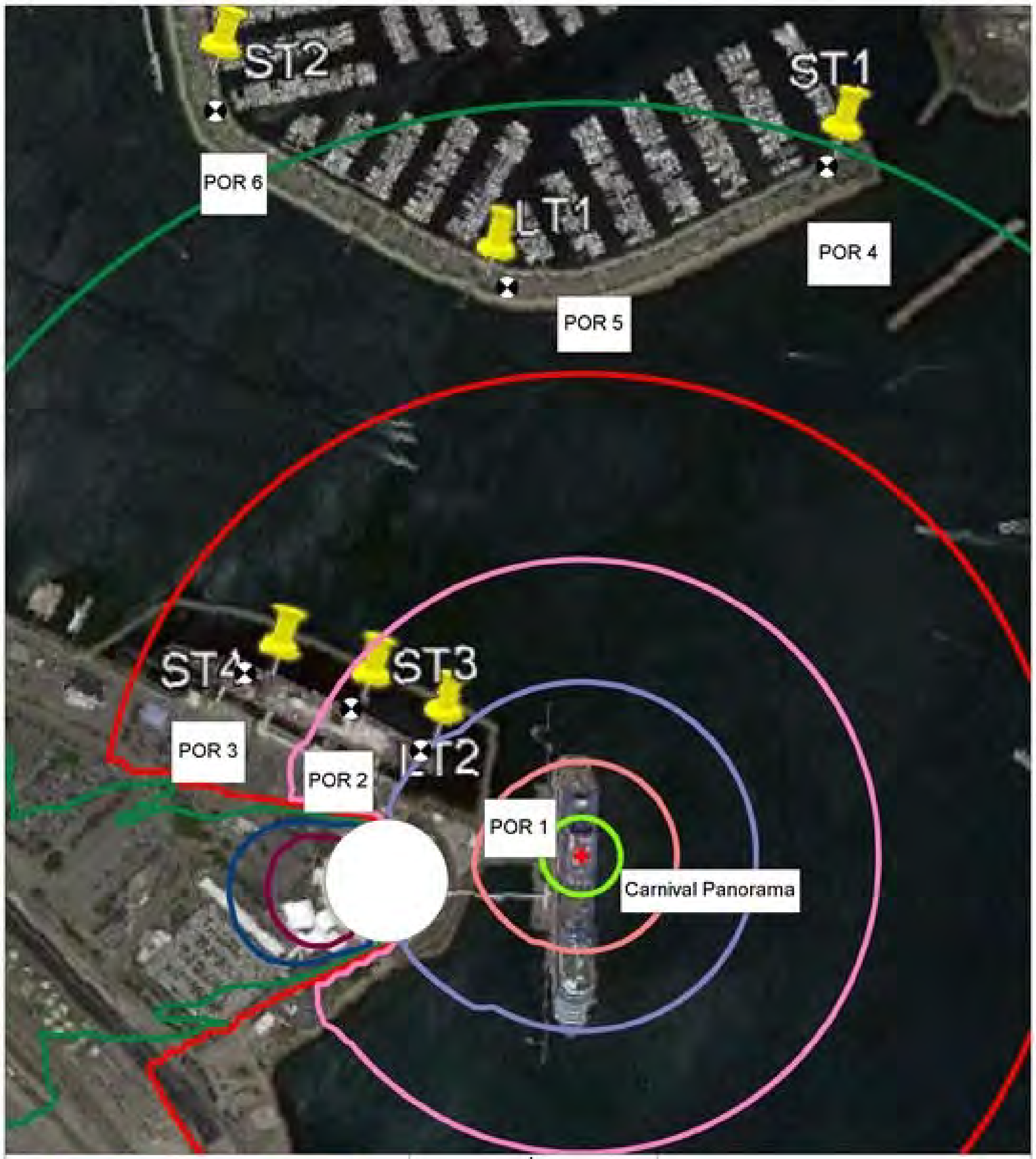
60
65
70
75
80
85

ACOUSTIC ASSESMENT
GARAGE FINISHES

FIGURE 7
NOISE CONTOUR PLOT

ACOUSTIC ASSESMENT
HARDSCAPE AND LANDSCAPE

FIGURE 8
NOISE CONTOUR PLOT



60	
65	
70	
75	
80	
85	

ACOUSTIC ASSESMENT
PANORAMA STACK

FIGURE 9
NOISE CONTOUR PLOT

Appendix E CEQA Summary

CEQA Impacts Executive Summary

A noise analysis was made of the area surrounding the proposed dredging, marine construction, and garage expansion project for the Carnival cruise line terminal in Long Beach harbor. Both in-air and underwater noise were examined. For the in-air noise, background noise measurements were made of the area at the marina across the harbor and on board the Queen Mary. Cadna noise modeling was then done for the proposed marine and on-shore construction sources and for changes in operational noise due to the activity of slightly larger cruise ships.

For marine construction, it was shown that pile driving noise levels would likely exceed the construction noise levels specified in the City of Long Beach Municipal Code Chapter 8.80 at both the marina and the Queen Mary, while dredging and marine construction could be near or slightly above the 70 dBA limit. For garage construction, it was shown that there might be slight exceedances on the Queen Mary for demolition, structure, and hardscape phase sound levels may be near or slightly above the 70 dBA limit. However, existing noise levels on the Queen Mary are sufficiently high that non-impact equipment construction noise would typically not be considered intrusive. Appropriate typical mitigation measures would be recommended for these operations.

For ship operations, changes in ship size and passenger number would have only a minor (less than 2 dBA) effect on the surrounding environment. Such sound levels would be at or below the existing ambient levels in the marina an on-board the Queen Mary.

The Project area is within one of the busiest ports on the west coast of the U.S., within highly modified habitat. In spite of the generally degraded habitat conditions, a few special-status or sensitive wildlife species are present or potentially present as described above and in the 2018 Biological Resources Report (GHD 2018). These include a number of birds, marine mammals, and one special status fish species. Due to the nature of the Project, airborne and underwater construction-related noise could impact marine mammals, fish, and seabirds foraging and residing within the Port Complex.

Based on in-air noise modeling, construction related noise is unlikely to significantly impact any wildlife on land unless the individual is directly adjacent to pile driving or dredging activity. The potential for impacts will be reduced with the implementation of mitigation measures.

In addition, underwater noise modeling indicates that construction noise will likely result in Level A and Level B take of marine mammals. Disturbance to fish and seabirds is also likely. Disturbance to sea turtles is possible but unlikely due to the fact that there are no records of sea turtles from the port. Underwater noise impacts will be minimized and mitigation with the implementation of proposed mitigation measures.

Appendix F In-air Noise Data

Appendix E: In-air Noise Data

Noise Monitoring Data

Short Term Data

GHD LONG BEACH NOISE MONITORING FIELD NOTES

Client Site #:

Performed By:

MEASUREMENT	
Location #:	ST-8
Location:	Eucl and harbor (ST8)
Date:	11/7/18
Start Time/End Time:	1:05 PM
Run #:	

MEASUREMENT LOCATION (SKI

WEATHER CONDITIONS: (per http://www.erh.noaa.gov/)

	Start	End
Temperature:	75°	
Wind Speed:	5-10	
Wind Direction:	NW	
Humidity:	54%	
Sky:	Clear	

SOUND SOURCES (order by most prominent)

			LNs
1)	Wind in trees / palms	Laeq	56.5
2)	cars	L10	57.6
3)	boats creaking	L15	
4)	harbor motor	L25	
5)	helicopter	L50	54.4
5)		L90	52.9

MONITORING NOTES (describe & note time of intrusions, changes in condition, etc.)

GHD LONG BEACH NOISE MONITORING FIELD NOTES

______________________ Client Site #: ______________

Performed By: ______________

MEASUREMENT		MEASUREMENT LOCATION (SKETCH)
Location #:	572 (north end of	
Location:	harbor)	
Date:	1/7/18	
Start Time/End Time:	1:20 p.m.	
Run #:		

WEATHER CONDITIONS: (per http://www.erh.noaa.gov/)

	Start	End
Temperature:	70	
Wind Speed:	9 mph W	
Wind Direction:	W	
Humidity:	/	
Sky:	Clear	

SOUND SOURCES (order by most prominent)

1)	Birds	Laeq	62.9
2)	equipt.	L10	61.7
3)	Drones	L15	
4)	bangs	L25	
5)	wind in trees	L50	56.5
5)	helicopter	L90	53.3

MONITORING NOTES (describe & note time of intrusions, changes in condition, etc.)

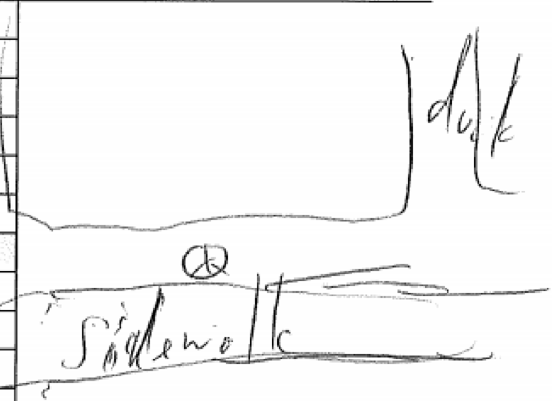
GHD LONG BEACH NOISE MONITORING FIELD NOTES

_______________ **Client Site #:** _______________

Performed By: _______________

MEASUREMENT	
Location #:	ST1
Location:	Entity Harbor
Date:	11/8/18
Start Time/End Time:	8:45 Am
Run #:	

MEASUREMENT LOCATION (SKI



WEATHER CONDITIONS: (per http://www.erh.noaa.gov/)	Start	End
Temperature:	65°	
Wind Speed:	0-2	
Wind Direction:		
Humidity:	Sunny	
Sky:	Cloudy	

SOUND SOURCES (order by most prominent)			LNs
1)	Equipt	Laeq	58.3
2)	Birds	L10	62.7
3)	Car starting	L15	
4)	boats creaking	L25	
5)	Carnival (imagination)	L50	54.4
5)		L90	51.5

MONITORING NOTES (describe & note time of intrusions, changes in condition, etc.)

dock

at 2nd from end

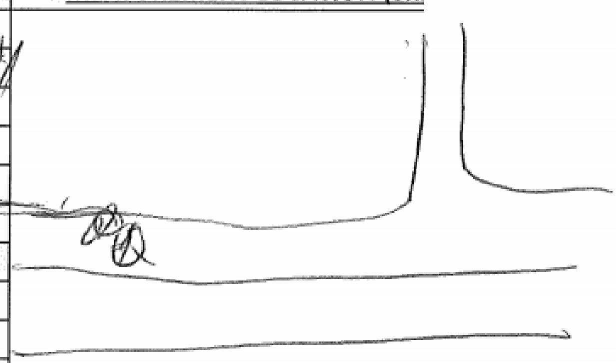
GHD LONG BEACH NOISE MONITORING FIELD NOTES

_____________________ **Client Site #:** _____________________

Performed By: _____________________

MEASUREMENT	
Location #:	5
Location:	[illegible] dock [illegible] west end
Date:	11/8/18
Start Time/End Time:	9:12
Run #:	

MEASUREMENT LOCATION (SKI



WEATHER CONDITIONS: (per http://www.erh.noaa.gov/)		
	Start	End
Temperature:	65°	
Wind Speed:	5-7	
Wind Direction:	NW	
Humidity:	50%	
Sky:	Clear	

SOUND SOURCES (order by most prominent)		LNs	
1)	Cars	Laeq	52.6
2)	birds	L10	54.7
3)	Carnival ship	L15	
4)	pedestrians	L25	
5)		L50	51.5
5)		L90	48.4

MONITORING NOTES (describe & note time of intrusions, changes in condition, etc.)

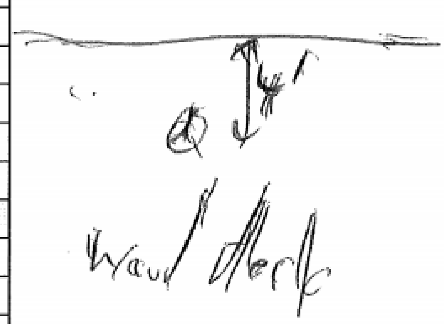
GHD LONG BEACH NOISE MONITORING FIELD NOTES

Client Site #:

Performed By:

MEASUREMENT	
Location #:	ST-B
Location:	Ward Deck
Date:	11/8/18
Start Time/End Time:	11:02/11:08 AM
Run #:	

MEASUREMENT LOCATION (SKI



WEATHER CONDITIONS: (per http://www.erh.noaa.gov/)

	Start	End
Temperature:	70°	
Wind Speed:	0-2	
Wind Direction:	NW	
Humidity:	58%	
Sky:	Clear	

SOUND SOURCES (order by most prominent) — LNs

1)	~~helicopter~~	Laeq	60.0
2)	~~[illegible]~~ bkgd	L10	61.0
3)	planes	L15	
4)	people on deck	L25	
5)	birds	L50	59.8
5)	helicopter	L90	58.9

MONITORING NOTES (describe & note time of intrusions, changes in condition, etc.)

GHD LONG BEACH NOISE MONITORING FIELD NOTES

______________________ **Client Site #:** ______________

Performed By: ______________________

MEASUREMENT	
Location #:	ST-4
Location:	Sidewalk deck
Date:	11/8/18
Start Time/End Time:	11:28 A.M.
Run #:	

MEASUREMENT LOCATION (SK

WEATHER CONDITIONS: (per http://www.erh.noaa.gov/)		
	Start	**End**
Temperature:	70°	
Wind Speed:	0-2	
Wind Direction:	NW	
Humidity:	60	
Sky:	Clear	

SOUND SOURCES (order by most prominent)		LNs	
1)	Equipt.	Laeq	67.4
2)	Birds	L10	62.8
3)	Planes	L15	
4)		L25	
5)		L50	62.1
5)		L90	61.8

MONITORING NOTES (describe & note time of intrusions, changes in condition, etc.)

GHD LONG BEACH NOISE MONITORING FIELD NOTES

______________________ Client Site #: ______________

Performed By: ______________

MEASUREMENT		MEASUREMENT LOCATION (SKETCH)
Location #:	ST 9 - Queen Mary	
Location:		
Date:	11/8/18	
Start Time/End Time:	9:45 PM	
Run #:		

WEATHER CONDITIONS: (per http://www.erh.noaa.gov/)

	Start	End
Temperature:	65°	
Wind Speed:	5-10	
Wind Direction:	SW	
Humidity:		
Sky:		

SOUND SOURCES (order by most prominent)

1)	Shipping terms	Laeq	62.7
2)	wind	L10	63.2
3)		L15	
4)		L25	
5)		L50	62.1
5)		L90	62.3

MONITORING NOTES (describe & note time of intrusions, changes in condition, etc.)

GHD LONG BEACH NOISE MONITORING FIELD NOTES

Client Site #: ____________

Performed By: ____________

MEASUREMENT		MEASUREMENT LOCATION (SKETCH)
Location #:	577 Ninth St &	
Location:	Busby	
Date:	11/8/18	
Start Time/End Time:	10:28 PM	
Run #:		

WEATHER CONDITIONS: (per http://www.erh.noaa.gov/)	Start	End
Temperature:	60°	
Wind Speed:	0-5	
Wind Direction:	NW	
Humidity:		
Sky:	Clear	

SOUND SOURCES (order by most prominent)			
1)	wind	Laeq	48.3
2)	rattling equipt.	L10	48.4
3)		L15	
4)		L25	
5)		L50	46.7
5)		L90	45.8

MONITORING NOTES (describe & note time of intrusions, changes in condition, etc.)

GHD LONG BEACH NOISE MONITORING FIELD NOTES

______________________ Client Site #: ______________

Performed By: ______________

MEASUREMENT	
Location #:	5th Gardner
Location:	
Date:	11/8/18
Start Time/End Time:	10:53
Run #:	

MEASUREMENT LOCATION (SKETCH)

WEATHER CONDITIONS: (per http://www.erh.noaa.gov/)

	Start	End
Temperature:	60°	
Wind Speed:	5	
Wind Direction:	NW	
Humidity:		
Sky:	Clear	

SOUND SOURCES (order by most prominent)

1)	window fans	Laeq	55.0
2)	helicopters	L10	56.9
3)		L15	
4)		L25	
5)		L50	54.5
5)		L90	52.5

MONITORING NOTES (describe & note time of intrusions, changes in condition, etc.)

GHD LONG BEACH NOISE MONITORING FIELD NOTES

Client Site #: ______

Performed By: ______

MEASUREMENT		MEASUREMENT LOCATION (SKETCH)
Location #:	ST1 Smith and Ash Lobby	
Location:		
Date:	11/9/18	
Start Time/End Time:	11:25	
Run #:		

WEATHER CONDITIONS: (per http://www.erh.noaa.gov/)

	Start	End
Temperature:	78°	
Wind Speed:	0–5 W	
Wind Direction:	NW	
Humidity:		
Sky:	Clear	

SOUND SOURCES (order by most prominent)

1)	Long Beach Fwy	Laeq	54.3
2)	Birds	L10	56.4
3)	Stroller	L15	
4)		L25	
5)		L50	52.5
5)		L90	50.5

MONITORING NOTES (describe & note time of intrusions, changes in condition, etc.)

GHD LONG BEACH NOISE MONITORING FIELD NOTES

______________________ Client Site #: ____________

Performed By: ____________

MEASUREMENT		MEASUREMENT LOCATION (SKETCH)
Location #:	ST2 (north end of harbor)	
Location:		
Date:	11/9/18	
Start Time/End Time:	1:41 P.M.	
Run #:		

WEATHER CONDITIONS: (per http://www.erh.noaa.gov/)		
	Start	End
Temperature:	75°	
Wind Speed:	0–5	
Wind Direction:	NW	
Humidity:		
Sky:	Clear	

SOUND SOURCES (order by most prominent)

1)	Wind in trees	Laeq	51.2
2)	plane	L10	53.1
3)		L15	
4)		L25	
5)		L50	49.2
5)		L90	47.0

MONITORING NOTES (describe & note time of intrusions, changes in condition, etc.)

GHD LONG BEACH NOISE MONITORING FIELD NOTES

______________________ Client Site #: ______________

Performed By: ______________

MEASUREMENT		MEASUREMENT LOCATION (SKETCH)
Location #:	ST3 (Queen Mary)	
Location:		
Date:	12/9/18	
Start Time/End Time:	2:32 PM	
Run #:		

WEATHER CONDITIONS: (per http://www.erh.noaa.gov/)		
	Start	End
Temperature:	65°	
Wind Speed:	0-5	
Wind Direction:	NW	
Humidity:		
Sky:	Clear	

SOUND SOURCES (order by most prominent)

1)	ocean	Laeq	57.3
2)	People walking	L10	59.4
3)	Tour Boats (max	L15	
4)	P.A. System	L25	
5)		L50	56.3
5)		L90	55.1

MONITORING NOTES (describe & note time of intrusions, changes in condition, etc.)

GHD LONG BEACH NOISE MONITORING FIELD NOTES

______________________ Client Site #: ______________

Performed By: ______________

MEASUREMENT		
Location #:	Queen Mary Free Deck	
Location:	57-2134	
Date:	11/9/18	
Start Time/End Time:	2:56	
Run #:		

MEASUREMENT LOCATION (SKETCH)

WEATHER CONDITIONS: (per http://www.erh.noaa.gov/)		
	Start	End
Temperature:	75°	
Wind Speed:	0-3	
Wind Direction:	NW	
Humidity:		
Sky:	Clear	

SOUND SOURCES (order by most prominent)			
1)	Background Equip.	Laeq	66.3
2)	Tour Boats	L10	66.9
3)		L15	
4)		L25	
5)		L50	66.3
5)		L90	66.1

MONITORING NOTES (describe & note time of intrusions, changes in condition, etc.)

LONG TERM DATA

Marina Long Term Data – Location LT1

Date	Hour		Leq		L10		L90
11/7/2018	16:00:00		56.9		57.0		50.7
11/7/2018	17:00:00		53.3		55.4		48.8
11/7/2018	18:00:00		52.4		54.3		49.0
11/7/2018	19:00:00		51.5		53.2		48.3
11/7/2018	20:00:00		51.2		53.7		47.5
11/7/2018	21:00:00		59.4		52.0		45.4
11/7/2018	22:00:00		49.9		50.3		44.1
11/7/2018	23:00:00		51.1		49.9		44.6
11/8/2018	00:00:00		48.0		48.1		44.5
11/8/2018	01:00:00		45.1		45.0		43.5
11/8/2018	02:00:00		44.0		44.6		43.0
11/8/2018	03:00:00		45.3		45.6		43.2
11/8/2018	04:00:00		45.5		46.3		43.6
11/8/2018	05:00:00		50.6		52.5		45.3
11/8/2018	06:00:00		54.7		55.5		50.4
11/8/2018	07:00:00		57.2		58.9		51.2
11/8/2018	08:00:00		55.1		58.4		50.9
11/8/2018	09:00:00		55.4		57.8		51.5
11/8/2018	10:00:00		62.1		60.2		53.1
11/8/2018	11:00:00		57.6		59.7		53.7
11/8/2018	12:00:00		60.5		62.7		57.5
11/8/2018	13:00:00		62.1		61.0		56.5
11/8/2018	14:00:00		56.2		58.4		52.4
11/8/2018	15:00:00		57.4		60.4		52.5
11/8/2018	16:00:00		64.6		64.3		53.3
11/8/2018	17:00:00		60.9		58.8		51.2
11/8/2018	18:00:00		52.6		54.6		48.2
11/8/2018	19:00:00		53.4		54.8		48.1
11/8/2018	20:00:00		54.8		57.5		49.8
11/8/2018	21:00:00		55.3		57.9		50.6
11/8/2018	22:00:00		54.4		57.7		48.3
11/8/2018	23:00:00		57.5		60.3		52.6
11/9/2018	00:00:00		49.4		52.0		45.2

11/9/2018	01:00:00		50.9		53.8		47.0
11/9/2018	02:00:00		46.7		48.7		52.4
11/9/2018	03:00:00		48.1		48.9		52.5
11/9/2018	04:00:00		48.5		50.4		53.3
11/9/2018	05:00:00		50.7		52.9		51.2
11/9/2018	06:00:00		53.3		55.2		48.2
11/9/2018	07:00:00		53.9		55.8		48.1
11/9/2018	08:00:00		59.3		63.9		49.8
11/9/2018	09:00:00		64.3		67.3		50.6
11/9/2018	10:00:00		63.0		66.0		48.3
11/9/2018	11:00:00		59.7		62.8		52.6
11/9/2018	12:00:00		56.6		59.4		45.2
11/9/2018	13:00:00		56.2		58.1		47.0
11/9/2018	14:00:00		56.4		59.1		49.3
11/9/2018	15:00:00		54.3		56.6		48.4

Queen Mary Long Term Data – Location LT2

Date	Hour		Leq		L10		L90
11/9/2018	16:00:00		60.2		61.1		60.6
11/9/2018	17:00:00		61.9		63.1		60.6
11/9/2018	18:00:00		63.8		65.3		61.9
11/9/2018	19:00:00		62.4		64.2		60.4
11/9/2018	20:00:00		60.9		61.0		60.4
11/9/2018	21:00:00		61.0		61.3		60.6
11/9/2018	22:00:00		61.0		61.2		60.7
11/9/2018	23:00:00		61.0		61.3		60.7
11/10/2018	00:00:00		61.0		61.3		60.8
11/10/2018	01:00:00		60.9		61.1		60.7
11/10/2018	02:00:00		61.0		61.2		60.8
11/10/2018	03:00:00		60.9		61.1		60.7
11/10/2018	04:00:00		60.9		61.2		60.7
11/10/2018	05:00:00		61.0		61.2		60.8
11/10/2018	06:00:00		62.2		63.3		61.0
11/10/2018	07:00:00		64.4		65.8		63.0
11/10/2018	08:00:00		64.6		66.0		63.4
11/10/2018	09:00:00		64.4		65.7		63.2
11/10/2018	10:00:00		66.5		68.3		63.4
11/10/2018	11:00:00		64.8		66.2		63.5
11/10/2018	12:00:00		64.4		65.3		63.5
11/10/2018	13:00:00		64.2		65.1		63.5
11/10/2018	14:00:00		65.4		65.5		63.3
11/10/2018	15:00:00		67.2		67.3		63.4

11/10/2018	16:00:00		61.8		62.6		61.0
11/10/2018	17:00:00		61.7		62.0		60.7
11/10/2018	18:00:00		61.2		61.5		60.9
11/10/2018	19:00:00		61.9		62.0		60.9
11/10/2018	20:00:00		61.1		61.4		60.8
11/10/2018	21:00:00		61.5		62.2		60.9
11/10/2018	22:00:00		61.6		62.2		61.0
11/10/2018	23:00:00		61.5		62.1		60.9
11/11/2018	00:00:00		61.2		61.2		60.7
11/11/2018	01:00:00		61.0		61.2		60.8
11/11/2018	02:00:00		61.0		61.2		60.7
11/11/2018	03:00:00		60.9		61.1		60.7
11/11/2018	04:00:00		61.0		61.2		60.8
11/11/2018	05:00:00		62.0		62.7		60.8
11/11/2018	06:00:00		63.1		64.1		62.4
11/11/2018	07:00:00		64.4		67.8		62.4
11/11/2018	08:00:00		64.9		66.7		62.8
11/11/2018	09:00:00		64.3		65.5		62.7
11/11/2018	10:00:00		63.6		64.5		62.5
11/11/2018	11:00:00		63.0		63.7		62.3
11/11/2018	12:00:00		63.3		63.9		62.6