Beacon Wind LLC

Beacon Wind 1
Article VII Application

Appendix B2
Underwater Acoustics Report

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JASCO APPLIED SCIENCES

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Memo

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TO: Jennifer Banks (AECOM)

Subject: Distance to regulatory thresholds for vibratory pile driving of sheet piles

1. Introduction

As part of the export cable landing, two cofferdams (Figure 1) may be constructed using vibratory driving to install steel sheet piles. Vibratory pile driving produces non-impulsive sounds that may result in harassment of marine mammals. The distances to thresholds associated with potential auditory injury and behavioral disruption of marine mammals are computed here by propagating measured source levels in the construction area and then comparing the resulting sound fields to regulatory thresholds.

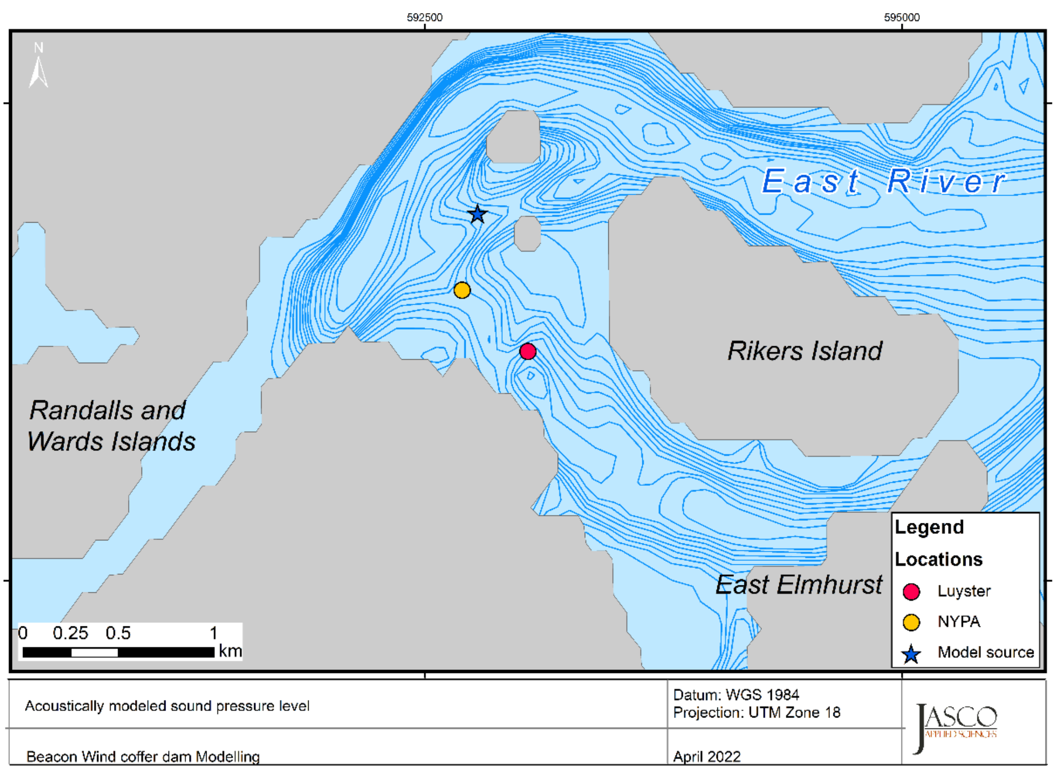

Figure 1. Proposed cofferdam locations (Luyster, NYPA) and acoustic modeling site (model source).

2. Methods

2.1. Evaluation Criteria

Injury to the hearing apparatus of a marine mammal may result from a fatiguing stimulus measured in terms of the sound exposure level (SEL), which considers the sound level and duration of the exposure signal. A permanent threshold shift (PTS) in hearing may be considered injurious but there are no published data on the sound levels that cause PTS in marine mammals. There are, however, data that indicate the received sound levels at which temporary threshold shifts (TTS) occurs, and PTS onset may be extrapolated from TTS onset level and an assumed growth function (Southall et al. 2007). In 2018, the National Oceanographic and Atmospheric Administration's (NOAA) National Marine Fisheries Service (NMFS) issued a Technical Guidance document (NMFS 2018) that incorporated the best available science to estimate PTS onset thresholds in marine mammals from sound energy, SEL, accumulated within 24 hrs. NMFS (2018) also provided guidance on the use of weighting functions to adjust the received sound levels according to the hearing sensitivity of marine mammals. Acoustic criteria and weighting function application are divided into functional hearing groups (low-, mid-, and high-frequency cetaceans and phocid and otariid pinnipeds) that species are assigned to based on their respective hearing frequency ranges. Hearing group frequency ranges that are used to define the auditory weighting function are shown in Table 1 and the hearing group thresholds are shown in Table 2. Otariid pinnipeds do not occur in the Project Area and are therefore not analyzed in this document.

Numerous studies on marine mammal behavioral responses to sound exposure have not resulted in consensus in the scientific community regarding the appropriate metric for assessing behavioral reactions. NMFS currently uses behavioral response thresholds of 120 dB re 1 μPa for non-impulsive/continuous sounds for all marine mammal species (NMFS 2018), based on observations of mysticetes (Malme et al. 1983, 1984, Richardson et al. 1986, 1990b).

Table 1 Marine mammal hearing groups and frequency ranges (Sills et al. 2014, NMFS 2018).

Faunal group	Generalized hearing range[a]
Low-frequency (LF) cetaceans (mysticetes or baleen whales)	7 Hz to 35 kHz
Mid-frequency (MF) cetaceans (odontocetes: delphinids, beaked whales)	150 Hz to 160 kHz
High-frequency (HF) cetaceans (other odontocetes)	275 Hz to 160 kHz
Phocid pinnipeds in water (PPW)	50 Hz to 86 kHz

[a] The generalized hearing range is for all species within a group. Individual hearing will vary.

Table 2 Summary of permanent threshold shift onset acoustic thresholds for marine mammals (NMFS 2018).

Faunal group	Non-impulsive signals Frequency-weighted $L_{E,24h}$ (dB re 1 µPa²·s)
Low-frequency (LF) cetaceans	199
Mid-frequency (MF) cetaceans	198
High-frequency (HF) cetaceans	173
Phocid pinnipeds in water (PPW)	201

2.2. Source and Propagation modeling

Illingworth and Rodkin (2017) measured vibratory driving of four 12-in wide connected sheet piles (48 inch/122 cm total width) using an APE Model 300 vibratory hammer (1842.0 kN centrifugal force). The sound exposure level (SEL) at 10 m from the pile was included in the frequency band 5–25,000 Hz. The Illingworth and Rodkin (2017) source spectrum of vibratory pile driving (Figure 2) was used here to define the source characteristics for acoustic propagation modeling.

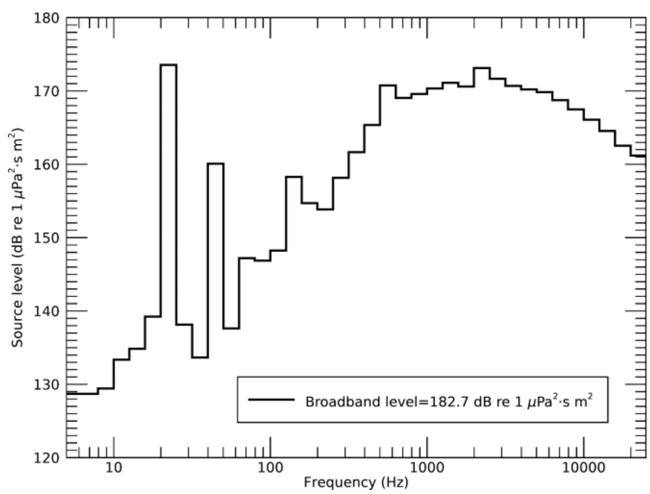

Figure 2. Decidecade-band spectral levels, at 10 m, for vibratory driving of sheet pile (Illingworth & Rodkin 2017).

JASCO's Marine Operations Noise Model (MONM) was used to predict SEL and SPL sound fields at a representative location near the proposed cofferdam sites considering the influence of bathymetry, seabed, water sound speed, and water attenuation. MONM uses a wide-angle parabolic equation solution to the acoustic wave equation (Collins 1993) based on a version of the U.S. Naval Research Laboratory's Range-dependent Acoustic Model (RAM), which has been modified to account for a solid seabed (Zhang and Tindle 1995). The sheet pile was represented as a point source at 2 m depth, and total sound energy transmission loss was computed at the center frequencies of decidecade bands as a function of range and depth from the source. The acoustic field in three dimensions was generated by modeling 2-D vertical planes radially spaced at 2.5° in a 360° swath around the source (N x 2-D). Composite broadband received SEL was computed by summing the received decidecade band levels across frequency and taking the maximum-over-depth. Major modeling assumptions are listed in Table 3.

Table 3 Major assumptions used in underwater acoustic modeling of vibratory driving of steel sheet piles.

Parameter	Value	Reference (if applicable)
Hammer	APE Model 300 (vibratory)	Illingworth and Rodkin (2017)
Pile type	Sheet pile	Illingworth and Rodkin (2017)
Bathymetry	3 arc-second U.S. Coastal Relief Model (CRM)	National Center for Environmental Information (NCEI) (https://www.ngdc.noaa.gov/)
Sound speed	Uniform sound speed* profile in depth	National Buoy Data Center (NDBC(noaa.gov))
Geoacoustics	Medium to coarse silt without rock basement	U.S. Geological Survey, Atlantic Seafloor Sediment (CONMAP) (Poppe et al. 2014) Ainslie (2010)

**Sound speed was derived from mean summer surface temperature measured at stations KPTN6 (2019) and BATN6H (2021).*

3. Results

Assuming eight hours of vibratory pile driving will occur in a 24-hour period, the frequency-weighted distances to potential injury for the marine mammal hearing groups are shown in Table 4. The acoustic range to the SPL 120 dB re 1 µPa threshold (NMFS 2018), without frequency weighting, was found to extend to 2.2 km from the modeled source, or 1.7 km when excluding 5% of the farthest points. Bathymetry was the dominant factor in determining the range to threshold. The farthest range occurred east of the NYPA source where sound propagated within the East River channel (Figure 3). Propagation extent and shoreline is determined by water depth at the time of measurement that may vary tidally and seasonally.

Table 4. Distances to PTS onset for marine mammal hearing groups (NMFS 2018) exposed to non-impulsive sounds generated by vibratory driving of sheet piles

Hearing group	Frequency-weighted $L_{E,24h}$ (dB re 1 µPa^2·s)	R_{max} (m)	$R_{95\%}$ (m)
Low-frequency (LF) cetaceans	199	50	45
Mid-frequency (MF) cetaceans	198	15	15
High-frequency (HF) cetaceans	173	270	245
Phocid pinnipeds in water (PPW)	201	25	25

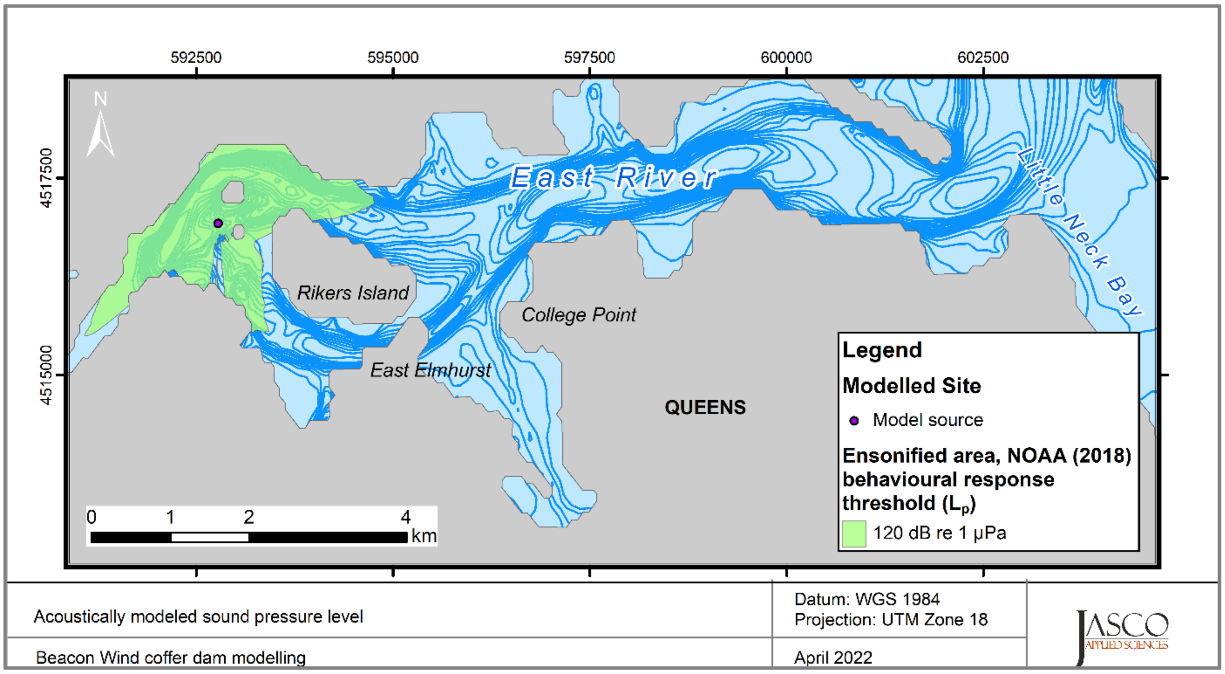

Figure 3. Modelled sound pressure level (SPL) at 120 dB re 1 µPa for a representative coffer dam sheet pile source. The behavioral threshold for vibratory pile driving is SPL 120 dB re 1 µPa.

4. Summary

Marine mammal PTS injury is unlikely to occur from the proposed cofferdam construction because the ranges to respective PTS thresholds are <50 m for all hearing groups, except for high-frequency cetaceans which have a predicted range to PTS threshold of ~250 m (Table 4). These distances, however, are considered very conservative because they assume that animals will remain stationary within the area ensonfied to the PTS threshold for the full 8-hour duration of cofferdam installation. In reality, marine mammals are mobile and if they occur in the area when cofferdam construction is occurring, they are likely to avoid the construction noise before it exceeds the level that would result in PTS, minimizing the likelihood of injury. The only high frequency cetacean species in the Project Area is the harbor porpoise, which would not be expected to occur in the planned cofferdam installation locations. While the longest modeled distance to the behavioral threshold of SPL 120 dB re 1 µPa is ~2 km, the area ensonified to the 120 dB re 1 µPa threshold does not extend to the full ~2 km in all directions from the modeled source as it is obscured by bathymetry and land features in severaldirections, resulting in shorter distances to the behavioral threshold (Figure 3). It is also noted that, for technical reasons, the source was modeled in slightly deeper water than the actual cofferdam locations, making the modeled ranges to thresholds conservative compared to the actual planned cofferdam installations.

5. Literature cited

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